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REGIONE LIGURIA

#ItaliaSicura
Presidenza del Consiglio dei Ministri

COMUNE DI GENOVA

PIANO STRALCIO PER LE AREE METROPOLITANE E LE AREE URBANE CON ALTO LIVELLO DI POPOLAZIONE ESPOSTA AL RISCHIO DI ALLUVIONI

Presidenza del Consiglio dei Ministri

PRESIDENZA DEL CONSIGLIO DEI MINISTRI
COMMISSARIO STRAORDINARIO
delegato per l'attuazione degli interventi inseriti nell'A.d.P. del 16.09.2010 e ss.ii.
(ex art. 10 del D.L. n. 91 del 24.06.2014)

Commissario straordinario
Dott. Giovanni TOTI

PROGETTISTI

CAPOGRUPPO MANDATARIA:

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA
nel campo della GEOINGEGNERIA

MANDANTI:

art ambiente risorse territorio

HYDRODATA INGEGNERIA DELLE RISORSE IDRICHE

Ing. Mario CANGIANO

Ing. Paolo GALLO

Ing. Francesco DE SANCTIS

Dott.ssa Francesca GIOMI

RESPONSABILE STRUTTURA COMMISSARIALE
Ing. Luca BERRUTI

RESPONSABILE UNICO PROCEDIMENTO
Ing. Stefano PINASCO

Progettista responsabile integrazioni prestazioni specialistiche e Direttore Tecnico della mandataria.
Rocksoil S.p.A.
Ing. Giovanna Cassani
Ord. Ingg. Milano N° 20997



Progettista/Progettisti responsabili elaborato
Rocksoil S.p.A.
Ing. Giovanna Cassani
Ord. Ingg. Milano N° 20997



Intervento/Opera

SECONDO LOTTO DEI LAVORI RELATIVI ALLA REALIZZAZIONE DELLA GALLERIA SCOLMATRICE DEL TORRENTE BISAGNO IN COMUNE DI GENOVA

PROGETTO ESECUTIVO

N° Progr. ----

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Oggetto della tavola

PIANO DI MONITORAGGIO DI SUPERFICIE

Studio delle interferenze scavi-edifici (relazione tecnica e di calcolo)

Scala
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Data
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I DISEGNI E LE INFORMAZIONI IN ESSI CONTENUTE SONO PROPRIETA' ESCLUSIVA DELLA STRUTTURA COMMISSARIALE E NON POSSONO ESSERE MODIFICATI, RIPRODOTTI, RESI PUBBLICI O UTILIZZATI PER USI DIFFERENTI DA QUELLI PER CUI SONO STATI REDATTI, SALVO AUTORIZZAZIONE SCRITTA.

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1 INTRODUZIONE

La presente Relazione Tecnica e di Calcolo fa parte dei documenti previsti nell'ambito del Progetto Esecutivo del 2° Lotto dei lavori per la realizzazione della galleria scolmatrice del torrente Bisagno, in comune di Genova.

L'intervento oggetto dell'affidamento di progettazione esecutiva comprende nello specifico il complesso delle opere di presa e sistemazione dell'alveo Bisagno, la galleria scolmatrice con sviluppo complessivo di 6500 m circa da scavarsi con sistema meccanizzato e gli interventi connessi allo sbocco a mare presso la spiaggia di San Giuliano, con il completamento del manufatto di convergenza della galleria Bisagno sulla galleria scolmatrice del torrente Fereggiano, i cui lavori sono in corso di completamento.

L'oggetto della relazione è lo studio delle interferenze tra scavo della galleria e fabbricati/opere esistenti, in particolare nelle zone di bassa copertura. Nei seguenti capitoli si riporta la procedura operativa seguita per la valutazione del bacino di subsidenza e la determinazione delle classi di danno dei fabbricati classificati come interferenti; in particolare verrà definito il campo di applicazione, ovvero in dominio di terreno (offset in superficie per la copertura critica) entro cui si stima che lo scavo si propaghi con effetti ingegneristicamente apprezzabili; verranno definite le modalità di analisi in più fasi e con più metodologie (fase 1 empirica, fase 2 di approfondimento con metodi numerici per le situazioni più significative), definite le classi di danno sui fabbricati e infine presentate le analisi. I risultati delle analisi empiriche, riportati per primi, forniranno un quadro generale su tutti gli edifici, mettendo in evidenza i casi che saranno studiati mediante analisi a elementi finiti. Il capitolo 6 infine tratterà di ulteriori approfondimenti mediante analisi FEM, riportate allo scopo di supportare ulteriormente la scelta di utilizzare metodi empirici, i quali si dimostrano cautelativi ed adatti per analizzare in maniera diffusa tutti gli edifici ed entrare nel dettaglio solo di quelli più significativi. Successivamente verranno presentate le analisi di fase 2 relative al Forte di San Giuliano, rimandando per i dettagli, ad una relazione specificatamente redatta e i risultati delle analisi sull'interferenza con le gallerie della linea ferroviaria esistente.

2 SOFTWARE DI CALCOLO

Ai fini della valutazione dell'interferenza scavo/edifici si è fatto uso dei seguenti software/strumenti di calcolo:

- PHASE 2 - Versione 8.0 –Rocscience
- Fogli di calcolo Excel specificatamente implementati per il calcolo dei bacini di subsidenza e delle classi di danno

3 INQUADRAMENTO METODOLOGICO E CENNI TEORICI

In questo capitolo viene ripercorsa la metodologia di studio dell'interferenza tra lo scavo delle gallerie e le preesistenze in superficie.

Lo studio ha inizio con la definizione della fascia di interazione a piano campagna e di una copertura critica. La prima grandezza fa riferimento ad una previsione dell'estensione in superficie del disturbo generato dallo scavo della galleria; in terreni incoerenti a grana grossa (sabbie e ghiaie), tale disturbo risulta in genere meno esteso (ovvero meno "disperso", in termini statistici), quindi più concentrato in asse alla galleria; in terreni coesivi (argille e rocce) la curva di subsidenza è più "piatta", quindi il bacino di interferenza è più esteso ma caratterizzato da valori di cedimento massimo minori. La seconda grandezza, ovvero la copertura critica, è il valore di copertura al di sopra del quale i cedimenti indotti dallo scavo (in condizioni di avanzamento in fronte e cavo stabili) non sono apprezzabili in superficie, quindi non si ha nessuna interazione con le preesistenze.

Per quanto riguarda la larghezza della fascia di interazione, ovvero la zona di studio dell'interferenza scavo/edifici, viene fissata a 100 m in asse galleria (50 m a destra dell'asse e 50 m a sinistra). La copertura critica viene invece fissata a 5 diametri, circa 50 m.

Entrambe queste grandezze sono state assunte in base all'esperienza di progettazione e realizzazione di gallerie negli stessi contesti geologici/geomeccanici e in base a curve empiriche di subsidenza tracciate con ipotesi che verranno presentate nel seguito.

Sulla base di queste assunzioni, sono stati individuati nr. 88 edifici da esaminare, rappresentati sinteticamente negli elaborati grafici BIS2E-R-RIL02-PL01, BIS2E-R-RIL02-PL02, BIS2E-R-RIL02-PL03, cui si rimanda. Come si intuisce dalle tavole e come si vedrà dettagliatamente nel capitolo di presentazione dei risultati, la zona più critica coincide con gli ultimi 1000 m di tracciato in corrispondenza dello sbocco a mare. Per ognuno degli 88 edifici è stato effettuato un censimento sul campo e sono stati raccolti dati geometrici dei fabbricati (dimensioni planimetriche del fabbricato, altezza fuori piano, tipologia costruttiva, epoca di realizzazione etc…), raccolti nella monografia BIS2E-R-RIL02-RE01 (schede fabbricati) facente parte del Progetto Esecutivo. Per alcuni dati, ad esempio la presenza di piani interrati, la quota di imposta delle fondazioni e la tipologia delle stesse, sono state effettuate ipotesi ragionevoli in quanto non sempre è stato possibile reperire tali informazioni di dettaglio dai proprietari degli immobili.

Si precisa che lo scopo del lavoro non è quello di stabilire lo stato di conservazione dei fabbricati ante operam, per la quale verranno redatti, a cura dell'Appaltatore dei lavori, specifici testimoniali di stato.

A valle della raccolta dei dati sui fabbricati, è stato possibile valutare l'effetto indotto dallo scavo della galleria sugli edifici preesistenti. Le analisi sono state condotte per tutti gli edifici mediante formulazioni empiriche di comprovata validità ed affidabilità, impiegate innumerevoli volte con riscontri positivi sia in analoghi contesti geomeccanici sia in contesti di materiale più scadente (vedi cenni teorici riportati nei seguenti sottoparagrafi). Sulla base dei risultati ottenuti in termini di bacini di subsidenza, zone di flesso, posizione degli edifici rispetto alla galleria ed entità dei cedimenti, sono state determinate le classi di danno sugli edifci secondo le formulazioni di Boscandin e Cording. Si precisa sin da ora che le curve di subsidenza, e di conseguenza la classe di danno degli edifici, sono fortemente ed intrinsecamente dipendenti da 2 parametri dati in input all'analisi, vale a dire la percentuale di volume perso durante lo scavo e il parametro k dipendente dalla natura dei terreni, che regola l'ampiezza del bacino di subsidenza. Per questi parametri è stato assunto un range stimato cautelativamente, basato su analisi a elementi finiti bidimensionali e esperienza progettazione e di scavo nei medesimi contesti e con le medesime tecnologie. Nonostante la taratura di tali parametri sia basata su assunzioni cautelative, occorrerà necessariamente verificarli in fase di scavo mediante analisi a ritroso basate sull'osservazione del comportamento dell'ammasso, dell'andamento delle pressioni di avanzamento della macchina, della velocità di scavo e materiale smarinato, effettuando back-analyses sulla base dei dati di monitoraggio rilevati.

3.1 Studio dei cedimenti

Allo scopo di esaminare il comportamento deformativo lungo l'asse delle gallerie, ossia valutare l'entità dei cedimenti in avanzamento indotti dagli scavi, sono stati condotti, come accennato, calcoli specifici secondo metodologie di carattere empirico. Nel seguente paragrafo verrà descritto più nel dettaglio l'approccio teorico/empirico sul quale si è basato lo studio dei cedimenti di fase 1.

3.1.1 Cenni teorici

I metodi empirici si basano sull'osservazione sperimentale dei bacini di subsidenza di opere già eseguite ed aventi una notevolissima bibliografia in merito (Peck 1969, Attewell e Fermer 1974; Attwell 1977; Attwell&Woodman 1982; O'Reilly e New 1982; Rankin 1987; Shirlaw e Doran, 1988).

Le correlazioni che sono state dedotte consentono di valutare la distribuzione spaziale, l'ampiezza e l'evoluzione delle subsidenze sulla base di parametri di semplice determinazione.

Definiti quindi i parametri geometrici delle gallerie e le caratteristiche del terreno attraversato è possibile individuare i profili di subsidenza trasversale.

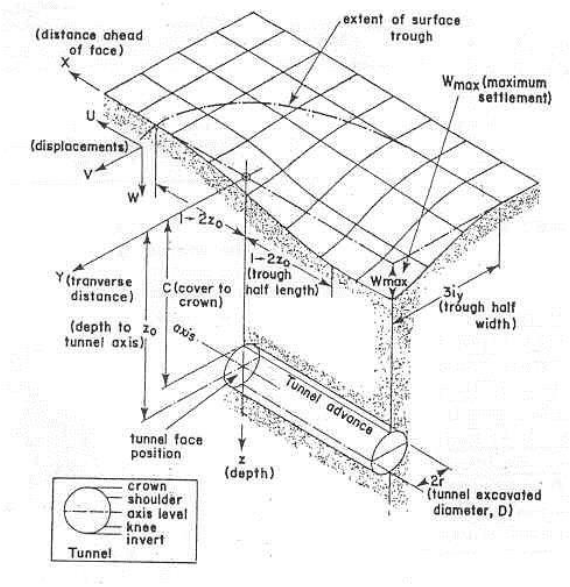


Figura 1 – Curva di subsidenza

L'inviluppo della zona interessata dalle deformazioni è quindi funzione della distanza dall'asse verticale delle gallerie e dipende dalle dimensioni delle gallerie stesse, dalla sua quota, dal volume perso, dai parametri di resistenza-deformabilità del terreno attraversato.

3.1.2 Bacino trasversale di subsidenza

Gli andamenti della curva di subsidenza in direzione trasversale rispetto all'asse di una galleria sono ben rappresentabili da una funzione normale di probabilità di tipo gaussiano, caratterizzata da due parametri: il cedimento massimo S_{max} (in corrispondenza dell'asse della galleria) e la distanza *i* tra l'asse della galleria ed il punto di flesso della curva, da cui dipende la larghezza della conca.

La funzione di subsidenza può quindi essere espressa dalla relazione:

$$S(x) = S_{max} \cdot e^{\left(-\frac{y^2}{2i^2}\right)} \quad (1)$$

dove S(x) è il generico spostamento verticale a distanza y dall'asse della galleria, S_{max} è lo spostamento massimo (ad y=0) ed *i* rappresenta la deviazione standard della curva.

Il volume totale della conca di subsidenza per unità di lunghezza della galleria V_s può essere ottenuto dall'integrazione della (1) e risulta essere pari a

$$V_s = \sqrt{2\pi} \cdot i \cdot S_{max} \cong 2.5 \cdot i \cdot S_{max} \quad (2)$$

La grandezza S_{max} può essere quindi ricavata stabilendo a priori il valore di V_s atteso

$$S_{max} = \frac{V_s}{2.5 \cdot i} \quad (3)$$

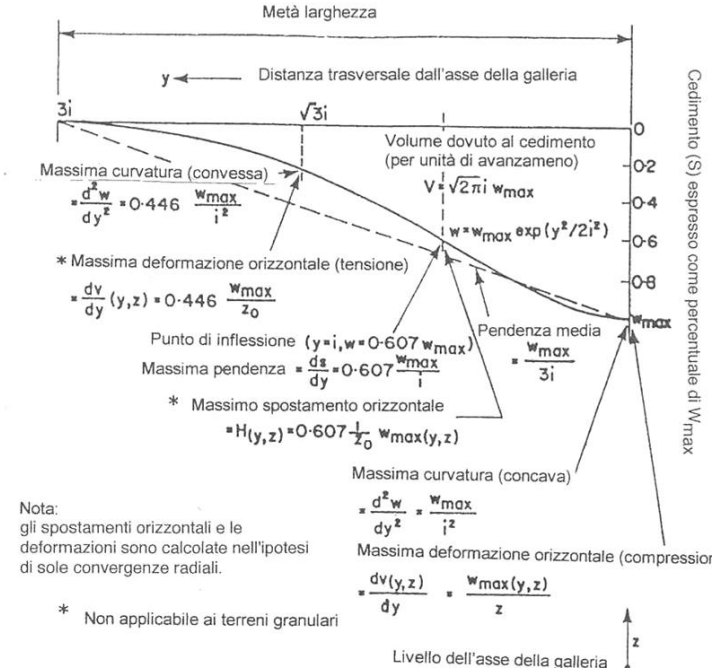


Figura 2 – Profilo trasversale di subsidenza

Il valore del volume della conca V_s viene assunto pari al volume perduto allo scavo, ovvero come una percentuale del volume scavato V_{exc}.

Per la valutazione del parametro *i*, questo dipende dalla tipologia del terreno e dalla profondità della galleria; in accordo con quanto proposto da O'Reilly e New (1991), per valori della copertura maggiori del

diametro della galleria, si ha una relazione lineare tra larghezza della conca e profondità della galleria, con coefficiente diverso a seconda del tipo di terreno:

$$i = k \cdot Z \tag{4}$$

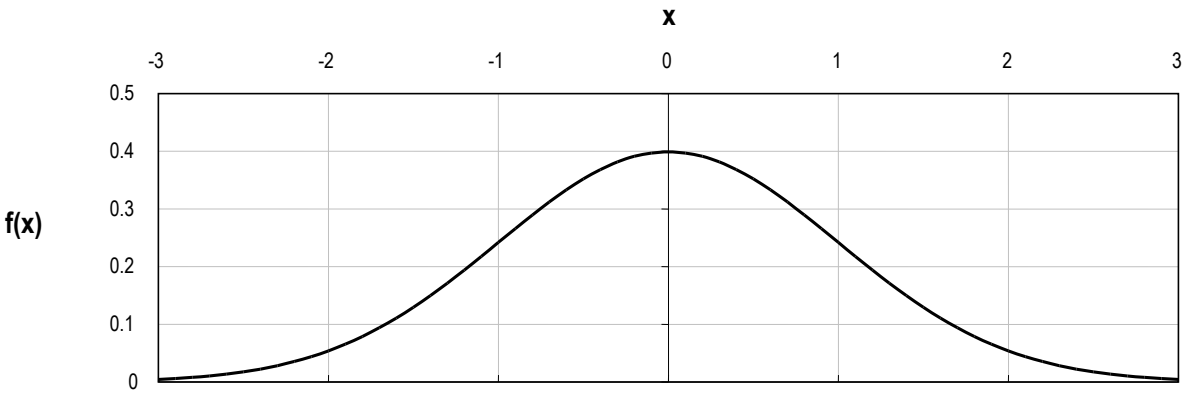
Per i terreni attraversati, costituiti da sabbie e ghiaie, si adottano generalmente valori di k nel range 0.30-0.40. Le analisi sono state svolte con un valore medio pari a k=0.35. Per quanto riguarda il volume perso è stato assunto, come valore di previsione, un valore pari allo 0.5%, sulla base di esperienze raccolte a Milano o in contesti simili a quelli di Milano, in termini di caratteristiche di terreni attraversati. È stato inoltre considerato, nell'ambito di uno scenario di rischio, un volume perso pari allo 0.7%.

3.1.3 *Cedimenti longitudinali*

Per rappresentare la sezione della conca di subsidenza in direzione longitudinale, parallela all'asse della galleria, Attewell e Woodman (1982) hanno proposto di utilizzare la funzione integrale della funzione gaussiana, o curva di probabilità cumulata, F(x):

$$F(x) = \int_{-\infty}^{x} \frac{1}{\sqrt{2\pi}} \exp\left(\frac{-t^2}{2}\right) dt \tag{5}$$

a)



b)

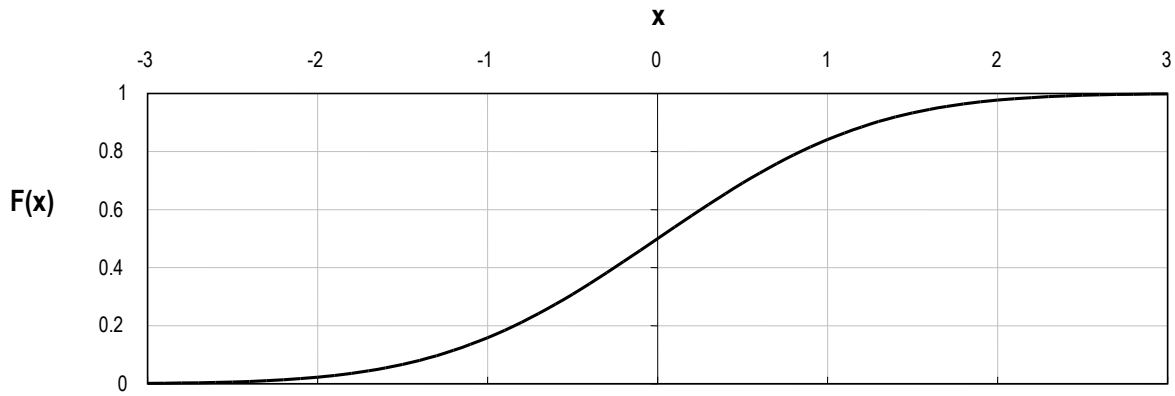


Figura 3 – Curva gaussiana (a) e funzione di probabilità cumulata (b)

In un riferimento cartesiano (0, x, y, z) caratterizzato da:

- Origine 0 posizionata al piano campagna;
- Asse y orizzontale e perpendicolare all'asse della galleria;
- Asse x orizzontale, parallelo all'asse della galleria e diretto nel verso di avanzamento dello scavo;
- Asse z: verticale e diretto verso il basso;

indicando con u, v e w le componenti dello spostamento lungo gli assi x, y e z, rispettivamente, e con x_0, y_0 e z_0 le coordinate del centro della galleria, le espressioni generali delle componenti del campo di spostamenti indotto dallo scavo della galleria sono riportate di seguito (adattate da Attewell e Woodman, 1982):

$$w(x,y,z)=\frac{V_S}{\sqrt{2\pi}i}\exp\left[\frac{-y^2}{2i^2}\right]\left\{F\left(\frac{x-x_i}{i}\right)-F\left(\frac{x-x_f}{i}\right)\right\} \quad (6)$$

$$v(x,y,z)=\frac{-n}{z_0-z}\,y\cdot w(x,y,z) \quad (7)$$

$$u(x,y,z)=\frac{nV_S}{2\pi(z_0-z)}\exp\left[\frac{-y^2}{2i^2}\right]\left\{\exp\left[\frac{-(x-x_i)^2}{2i^2}\right]-\exp\left[\frac{-(x-x_f)^2}{2i^2}\right]\right\} \quad (8)$$

Con n viene indicato l'esponente della legge di variazione con la profondità i(z) della distanza del punto di flesso dall'asse della galleria. Il pedice "*i*" sta per "iniziale" e indica dove parte lo scavo, il pedice "*f*" indica invece il fronte dello scavo.

In definitiva, ad ogni profondità z, nelle sezioni trasversali all'asse della galleria, il profilo degli spostamenti verticali è sempre rappresentato da curve di tipo gaussiano amplificate attraverso la funzione $F\left(\frac{x-x_f}{i}\right)$ che permette di tenere conto della distanza del fronte di scavo dalla sezione trasversale.

Nel paragrafo successivo viene descritto il metodo empirico per l'analisi di interazione terreno-struttura in cui sono analizzati gli effetti dei cedimenti indotti dallo scavo delle future gallerie sulle preesistenze interferenti con riferimento ai valori di copertura tra piano di imposta fondazione e chiave calotta, sulla base dei dati sulle strutture in nostro possesso.

3.2 Categorie di danno

Sulla base dello studio dei cedimenti indotti dallo scavo è possibile stimare l'entità dell'estensione del bacino di subsidenza, quindi, unitamente alle caratteristiche geometriche, strutturali e di conservazione degli edifici, si può conseguentemente effettuare una valutazione del probabile rischio di danno in merito ai risentimenti provocati sugli edifici dallo scavo delle gallerie.

Nel seguito si riassumono i criteri di classificazione del danno rispettivamente basati sulla determinazione della distorsione limite e sulla stima delle deformazioni di trazione generate nelle strutture secondo le formulazioni di Mayer, Burland e Taylor.

Alla luce di un'attenta analisi delle interferenze presenti lungo la tratta in esame, l'analisi dei cedimenti è stata finalizzata agli edifici ritenuti più significativi per lo studio proposto.

Una volta determinato il regime di cedimenti indotto dallo scavo delle future gallerie e delle stazioni e valutate le deformazioni associabili agli stessi si è proceduto ad individuare l'effetto indotto sui fabbricati mediante il calcolo delle categorie di danno secondo quanto riportato in letteratura (Mayer, Taylor e Burland,1996). Secondo tali approcci la categoria di danno è correlata con la deformazione unitaria massima di allungamento ε_{max}. Per i singoli edifici analizzati, sulla base della deformazione massima di trazione ε_{max}e del relativo bacino di subsidenza, è stato possibile associare ad un valore di volume perso V_p (definito sulla base di contesti analoghi) un determinato valore del parametro "categoria di danno" secondo quanto esposto nelle tabelle di sintesi riportate in letteratura (Boscardin e Cording, 1989), ottenendo così una prima valutazione delle situazioni a rischio.

3.2.1 Spostamenti e distorsioni limite

Al fine di stabilire le ripercussioni degli scavi sulle preesistenze in superficie, appare importante individuare i valori limite di spostamento e distorsione.

Oltre al cedimento massimo, un parametro molto significativo per la valutazione dei danni a fabbricati e manufatti è la "distorsione angolare" fra due punti dell'edificio/manufatto, essendo principalmente il cedimento differenziale la causa dell'insorgere di lesioni e rotture.

Al riguardo, facendo riferimento alla bibliografia esistente sull'argomento, Skempton e MacDonald (1956), basandosi sull'osservazione di 98 edifici e con riferimento anche allo studio di Ricceri e Sorazo (1985) su 25 strutture realizzate in Italia, evidenziano che non si ha comparsa di fessure sulle strutture di tamponamento fino a valori di β< 1/300 e per vedere danni sulle strutture portanti in calcestruzzo è necessario arrivare a valori di β pari a 1/150.

In Polschin e Tokar (1957) si considera un approccio più conservativo, indicando valori ammissibili pari a 1/500 per strutture a telaio in calcestruzzo armato con tamponature, e pari a 1/200 per telai aperti.

Stessi valori vengono indicati anche nell'ambito dell'Eurocodice 7, appendice H, dove si indica come ammissibile una distorsione pari a 1/500, evidenziando una condizione di stato limite ultimo pari a 1/150.

Il valore del cedimento assoluto, come pure il valore differenziale, dovrà essere valutato in dettaglio in funzione delle condizioni dell'edificio e delle reali geometrie delle fondazioni.
In prima battuta, in assenza informazioni puntuali sulle caratteristiche dei fabbricati, le analisi di danno sono state condotte considerando il valore degli spostamenti assoluti e tenendo conto delle deformazioni di trazione generate nelle strutture secondo le formulazioni di Mayer, Burland e Taylor, come illustrato nel seguito.

3.2.2 Stima delle deformazioni e definizione delle categorie di danno

Nel caso in esame si è proceduto ad individuare la categoria di danno secondo quanto suggerito dalla letteratura (Mayer, Taylor e Burland – *Predictionofgroundmovements and assessmentofriskof building damage due toboredtunneling*). Come indicato in Mayer, Taylor e Burland, la categoria di danno è correlata con la deformazione unitaria massima di allungamento ε_{max}.

La determinazione di tale deformazione può essere individuata assimilando l'edificio ad un corpo elastico di altezza H, lunghezza L, momento d'inerzia I e rapporto tra moduli elastici E/G pari a 12.5 per il cemento

armato e a 2.6 per la muratura. Nell'analisi svolta cautelativamente gli edifici misti muratura-c.a. sono stati considerati con un valore di E/G pari a 2.6, assimilati quindi a edifici in muratura.

Il bacino di subsidenza può essere suddiviso in due zone distinte in base alle modalità di deformazione del piano campagna, come rappresentato in Figura 4.

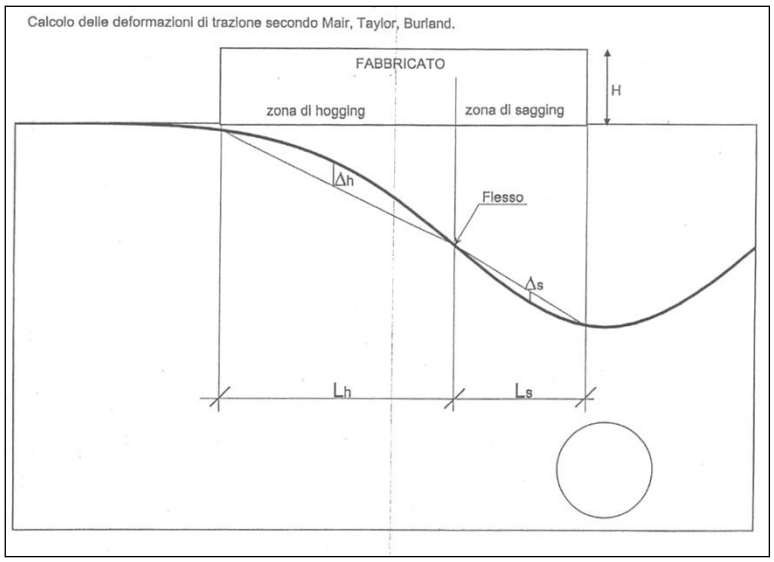


Figura 4 – Zona di hogging e sagging

Zona di hogging(concavità della deformata orientata verso il basso):

momento d'inerzia edificio⇒ $I=H^3/3$

distanza asse neutro dal lembo teso = H

Zona di sagging(concavità della deformata rivolta verso l'alto):

momento d'inerzia edificio⇒ I=H3/12

distanza asse neutro dal lembo teso = H/2

Il punto di inflessione dello spostamento, (i), divide quindi l'edificio nelle due zone sopra indicate.

Nella zona di hogging (-i > y > i) dove l'asse neutro è pari ad H, tutti gli sforzi dovuti alla flessione sono di trazione, mentre nella zona di sagging, dove l'asse neutro si assume pari ad H/2, la flessione induce sforzi sia di compressione che di trazione.

Definita l'inflessione massima Δ/L, così come indicato dagli Autori, è possibile risalire alle deformazioni unitarie massime per trazione.

Per quanto dovuto a sollecitazioni di flessione, le deformazioni si sviluppano parallelamente all'asse dell'edificio e valgono:

$$\varepsilon_b = \left(\frac{\Delta}{L}\right) \times \frac{1}{\left[\left(\frac{L}{12t}\right) + \left(\frac{3EI}{2tLHG}\right)\right]}$$

dove t = (H;H/2) secondo se ci si trova in zona Hogging o Sagging.

Invece per le deformazioni dovute taglio si ha:

$$\varepsilon_d = \left(\frac{\Delta}{L}\right) \times \frac{1}{\left[1 + \left(\frac{HL^2G}{18EI}\right)\right]}$$

Si considera inoltre il contributo dovuto alle deformazioni orizzontali (ε_h) che verrà combinato con la deformazione di flessione e taglio.

$\varepsilon_{bt} = \varepsilon_h + \varepsilon_b$

$$\varepsilon_{dt} = 0.35\varepsilon_h + \sqrt{\left((0.65\varepsilon_h)^2 + \varepsilon_d{}^2\right)}$$

Si ottiene quindi la massima deformazione di trazione ε_{max}pari al valore massimo tra ε_{bt} e ε_{dt}

Si riportano nel seguito le tabelle di sintesi di Boscarding e Cording (1989).

Categoria del danno	Intensità del danno	Deformazione limite di trazione ε_{lim} (%)
0	Trascurabile	0÷0.05
1	Molto lieve	0.05÷0.075
2	Lieve	0.075÷0.15
3	Moderata	0.15÷0.3
4	Severa	0.3÷0.45
5	Molto severa	>0.45

Tabella 1 – Boscardin e Cording, 1989

Categoria del danno	Intensità del danno	Descrizione
0	Trascurabile	Fessure capillari con aperture ≤ 0.1mm.
1	Molto lieve	Fessure sottili cui si rimedia facilmente con lavori di pitturazione. Il danno è limitato agli intonaci delle pareti interne. Fessure alle parti esterne rilevabili con attento esame. Tipica apertura delle lesioni ≤ 1mm.
2 bassa 2 alta	Lieve Meno Lieve	Fessure facilmente stuccabili, ripitturazione necessaria. Le fessure ricorrenti possono essere mascherate con opportuni rivestimenti. Fessure anche visibili all'esterno; può essere necessaria qualche ripresa della spillatura per garantire l'impermeabilità. Possibili difficoltà nell'apertura di porte e finestre. Tipica apertura delle lesioni ≤ 5m.
3	Moderata	Le fessure richiedono cuci e scuci della muratura. Anche all'esterno necessari interventi sulla muratura. Possibile blocco di porte e finestre. Rottura di tubazioni. Spesso l'impermeabilità non è garantità. Tipica apertura delle lesioni 5 ÷ 15 mm, oppure molte lesioni ≤ 3.
4	Severa	Necessarie importanti riparazioni, compresa demolizione e ricostruzione di parti di muri, specie al di sopra di porte e finestre. I telai di porte e finestre si distorcono; percepibile pendenza di pavimenti. Muri inclinati o spanciati; qualche perdita d'appoggio di travi. Tubazioni distrutte. Tipica apertura delle lesioni 15 ÷ 25 mm, dipendente anche dal numero di lesioni.
5	Molto severa	Richiesti importanti lavori con parziale e totale demolizione e ricostruzione. Le travi perdono l'appoggio, i muri si inclinano fortemente e richiedono puntellatura. Pericolo di instabilità. Tipica apertura delle lesioni superiori a 25 mm, dipendente anche dal numero di lesioni.

Tabella 2 – Boscardin e Cording, 1989

La categoria di *danno ammissibile* per un fabbricato dipende dalle caratteristiche dell'edificio stesso, ovvero dalla metodologia costruttiva (strutture in c.a./acciaio o muratura), dallo stato di conservazione (stato buono o precario) e dalla destinazione d'uso.

3.3 Osservazioni

La metodologia impiegata per le analisi di interferenza, descritta nei capitoli precedenti, si basa sulle seguenti ipotesi:

- gli spostamenti e le deformazioni indotte sugli edifici sono assunte pari a quelle corrispondenti alla condizione "*green-field*";
- la rigidezza degli edifici analizzati è considerata nulla; in realtà le opere di fondazione interagiscono con il terreno riducendo il rapporto di inflessione e le deformazioni orizzontali ottenute nella condizione "*green-field*";

- nessuna distinzione tra fondazioni su plinti, su trave e su platea che presentano chiaramente comportamenti differenti soprattutto nei confronti degli spostamenti orizzontali;

L'approccio risulta sicuramente conservativo, determinando quindi classi di danno che possono essere assunte come condizioni superiori, affinabili verso classi inferiori in virtù di modelli più approfonditi.

3.4 Procedura operativa di analisi

Una volta individuate le opere interferenti con la galleria scolmatrice mediante lo studio delle planimetrie e dei profili altimetrici del tracciato, sulla base della caratterizzazione geotecnica dei terreni è stata condotta un'analisi su più livelli di dettaglio. Il procedimento seguito è schematizzabile nelle tre fasi seguenti:

- FASE 1: Valutazione del comportamento deformativo dei terreni, ossia dell'entità dei cedimenti e delle distorsioni indotte dagli scavi applicando le formulazioni tipiche di letteratura che riconducono il bacino di subsidenza a funzioni gaussiane di entità dipendente dal volume perso in fase di scavo e dalle caratteristiche del terreno mediante il coefficiente k (Peck, 1969; O'Reilly e New 1982). A seguito della definizione del probabile bacino di subsidenza e determinato, quindi, il regime di cedimenti a piano campagna che si verificano a seguito dallo scavo della galleria, sono state valutate le deformazioni ad essi associabili e si è individuato l'effetto indotto sui fabbricati mediante il calcolo delle categorie di danno secondo quanto riportato in letteratura (Mair e Taylor e Burland,1996).

- FASE 2: Studio approfondito degli edifici aventi categoria di danno maggiore di un certo valore definito a priori (Classe di danno 2) o di situazioni più significative, tramite l'utilizzo del software ad elementi finiti Phase2 v8. Tali analisi si prefiggono lo scopo di valutare il bacino di subsidenza in modo più accurato ed in funzione delle fasi di scavo, così da poter determinare con più affidabilità le ripercussioni sui manufatti interferiti svincolandosi dai parametri empirici delle formulazioni di Peck, O'Reilly e New.

4 RILIEVO FABBRICATI E REDAZIONE SCHEDE DI CENSIMENTO

Le caratteristiche geometriche e strutturali dei fabbricati, nonché le informazioni riguardanti il periodo di costruzione, gli eventuali interventi successivi, la presenza di elementi artistici di pregio, …, sono stati raccolti in sopralluoghi. Gli esiti delle indagini visive condotte per ogni edificio situato all'interno del bacino di subsidenza, sono riportate in apposite schede di censimento e raccolte nella monografia BIS2E-R-RIL02-RE01, cui si rimanda per maggiori dettagli.

Di seguito si riporta, a titolo di esempio, la scheda fabbricato dell'edificio nr. 6 (Forte San Giuliano).

ED 6 - Via Piero Gobetti 5



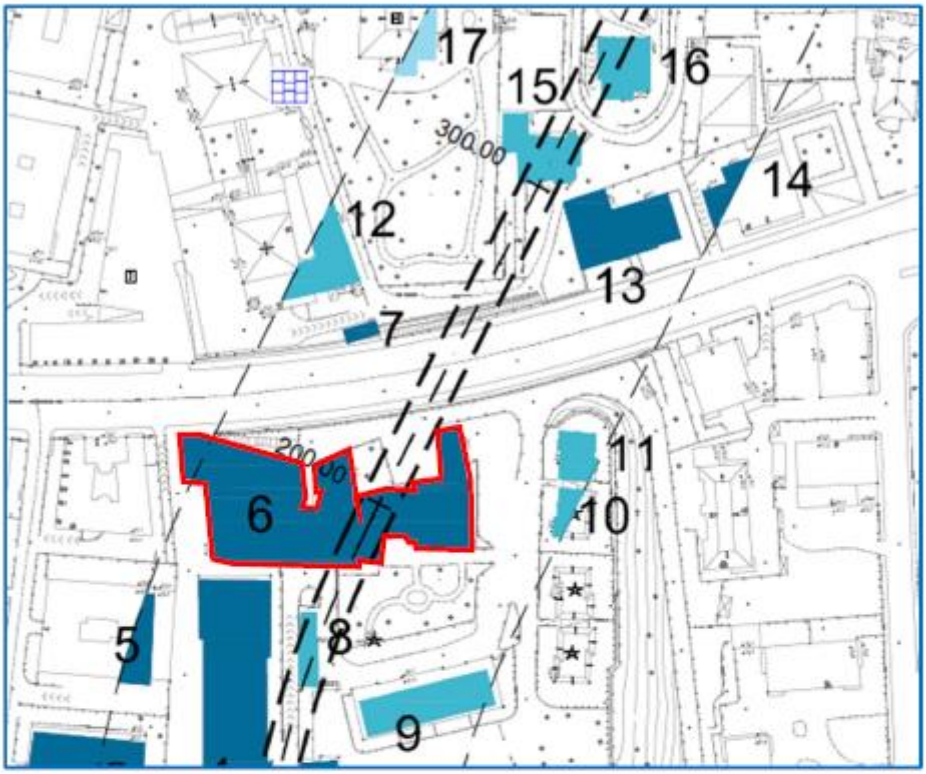
DATI GENERALI			
Ingresso:	Via Piero Gobetti 5	Destinazione:	Struttura Militare
Dati catastali		Tipo di proprietà:	Militare
Beni culturali e del paesaggio:	Bellezza puntuale e Area Bellezze d'Insieme	Proprietario o altro referente:	

ED 6 - Via Piero Gobetti 5- CARATTERISTICHE DEL FABBRICATO



Caratteristiche morfologiche		Caratteristiche Strutturali	
Anno di costruzione:		Tipo di struttura:	Muratura
Numero di piani interrati:		Tipo di orizzontamento:	*Volte in muratura*
Numero dei piani fuori terra:	3+1	Tipo di fondazione:	*In corso di verifica*
Altezza fuori terra:	13m	Quadro lesionativo:	No
FONTI:			
(1) Progetto - Rilievi - Indagini documentali			
(2) Informazioni - Indagini visive		*Data sopralluogo: 28/11/2017*	
(3) Valutazione critica			

ED 6 - Via Piero Gobetti 5 - POSIZIONE FABBRICATO IN RELAZIONE AL TRACCIATO



Caratteristiche del tracciato		Caratteristiche del fabbricato	
Profondità tracciato (copertura):	13.00 m	Tipologia di fondazioni	*In corso di verifica*
Rapporto di posizione tra edificio e tracciato:	Il sedime del fabbricato è esterno al tracciato, disposto ad una distanza minima di circa 25 metri dall'impronta dello scavo	Quota d'imposta fondazioni:	
FONTI:			
(1) Progetto			
(2) Informazioni - Indagini visive			
(3) Valutazione critica			

5 RISULTATI ANALISI EMPIRICHE

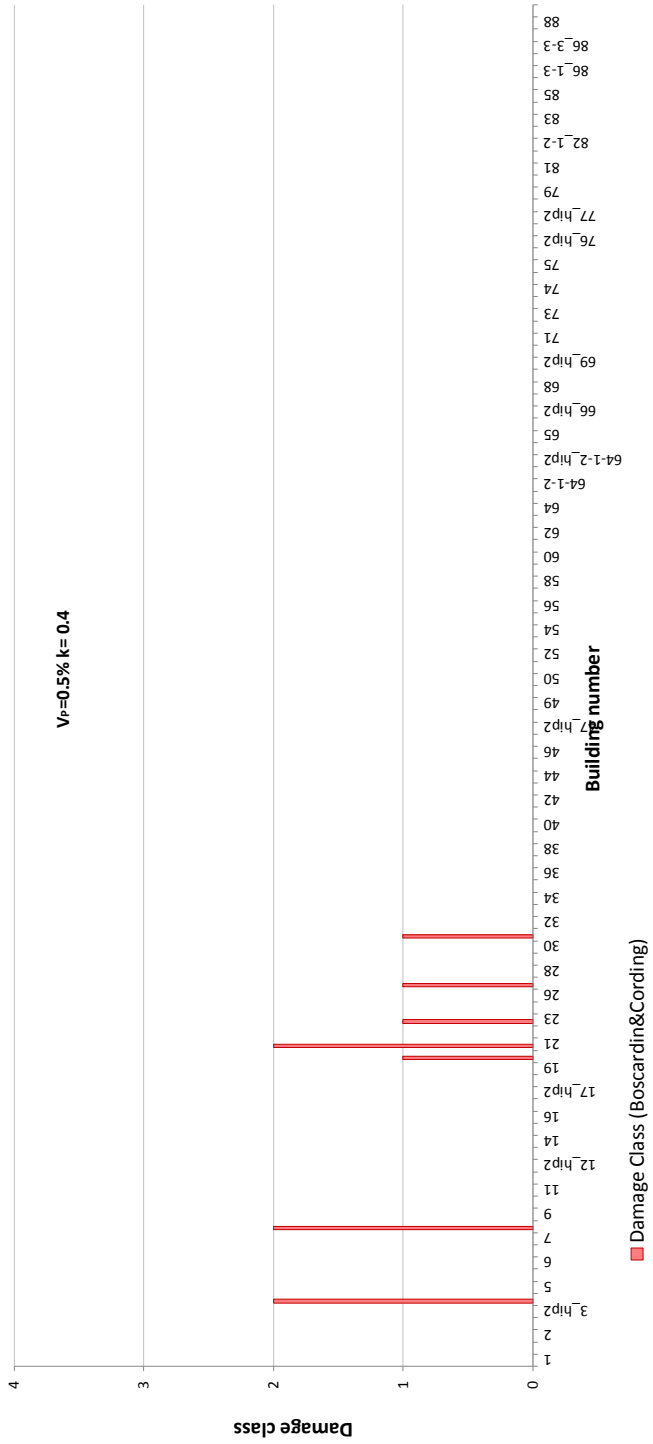
Le analisi empiriche sono state condotte con riferimento alla quota di fondazione utilizzando un Volume perso variabile **Vp = 0.3÷0.5%** e un valore del parametro **k = 0.4÷0.6.** Tali valori derivano dal confronto con analisi a elementi finiti (ad esempio gli approfondimenti condotti per il forte San Giuliano) ed esperienza di progettazione e scavo nei medesimi contesti. In particolare, vengono riportate le tabelle di sintesi dei risultati in cui si evidenziano i valori ottenuti attraverso le analisi empiriche, in termini di cedimento massimo dell'edificio, deformazioni massime nelle zone di hogging (zona tesa) e sagging (zona compressa) e relativa classe di danno. Considerate le geometrie in pianta degli edifici, per alcuni di essi sono state considerate più sezioni di analisi al fine di individuare la più critica per il fabbricato in esame. Ad esempio per gli edifici nr. 1, 3, 5, 6, 12 etc… vengono riportate più casistiche ovvero viene ipotizzata una diversa quota delle fondazioni o l'edificio viene spezzato in più corpi in quanto edificato su di un terreno terrazzato. Il conteggio globale dei casi considerati per ogni combinazione di Vp e k, risulta 109 a fronte di 88 edifici presenti nella monografia.

Le classi di danno sugli edifici vengono calcolate con il metodo di Boscardin e Cording. **Gli edifici che risultassero da analisi empiriche in classe di danno > 2 saranno studiati mediante approfondite analisi a elementi finiti.** Tali analisi, sebbene molto più onerose di quelle empiriche, permettono di cogliere le fasi di scavo della galleria e di modellare in maniera accurata il terreno/roccia, prescindendo dall'imposizione dei parametri Vp e k.

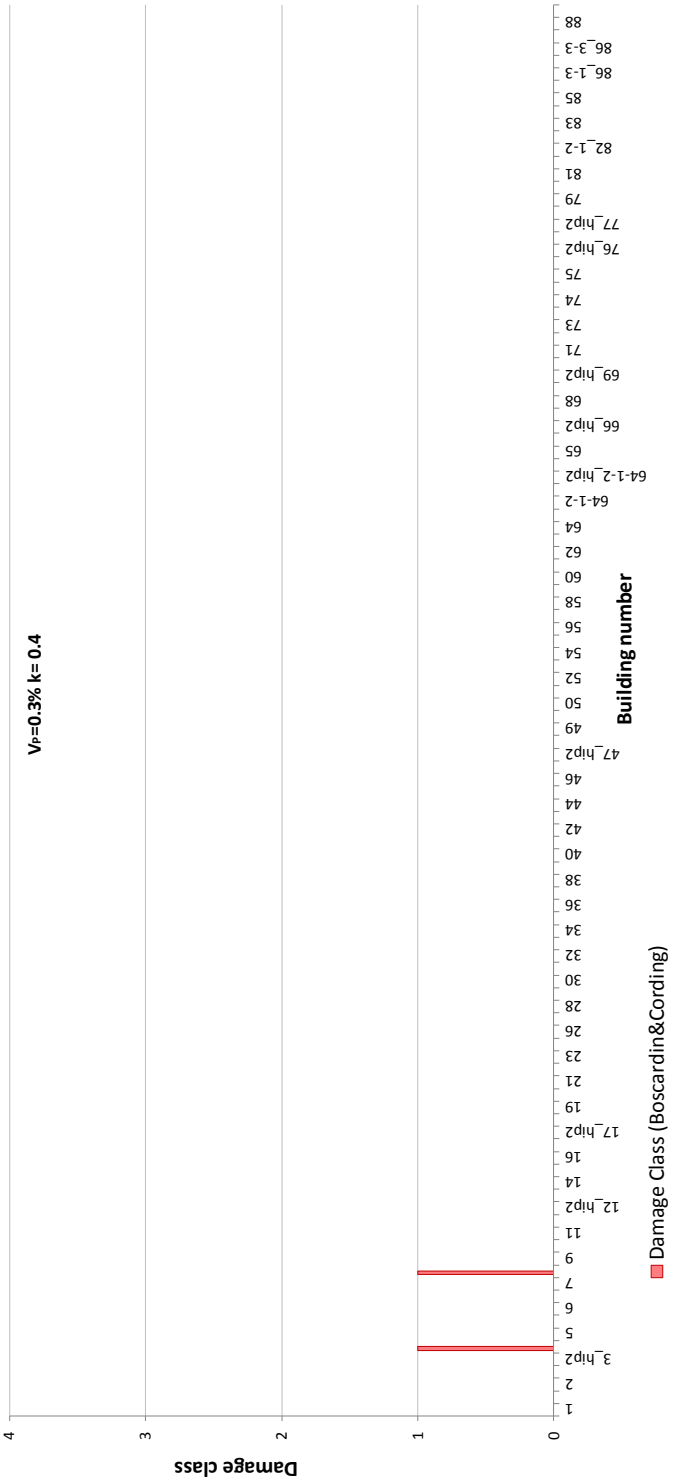
Come si vedrà, lo studio delle subsidenze mediante analisi di tipo numerico, porterà in tutti i casi ad una sensibile diminuzione della classe di danno dei fabbricati evidenziando come l'approccio mediante analisi empiriche risulti cautelativo.

Si riportano nel seguito tabelle in cui sono sintetizzati i dati di input e output di tutte le analisi empiriche e i grafici che mostrano l'andamento della classe di danno.

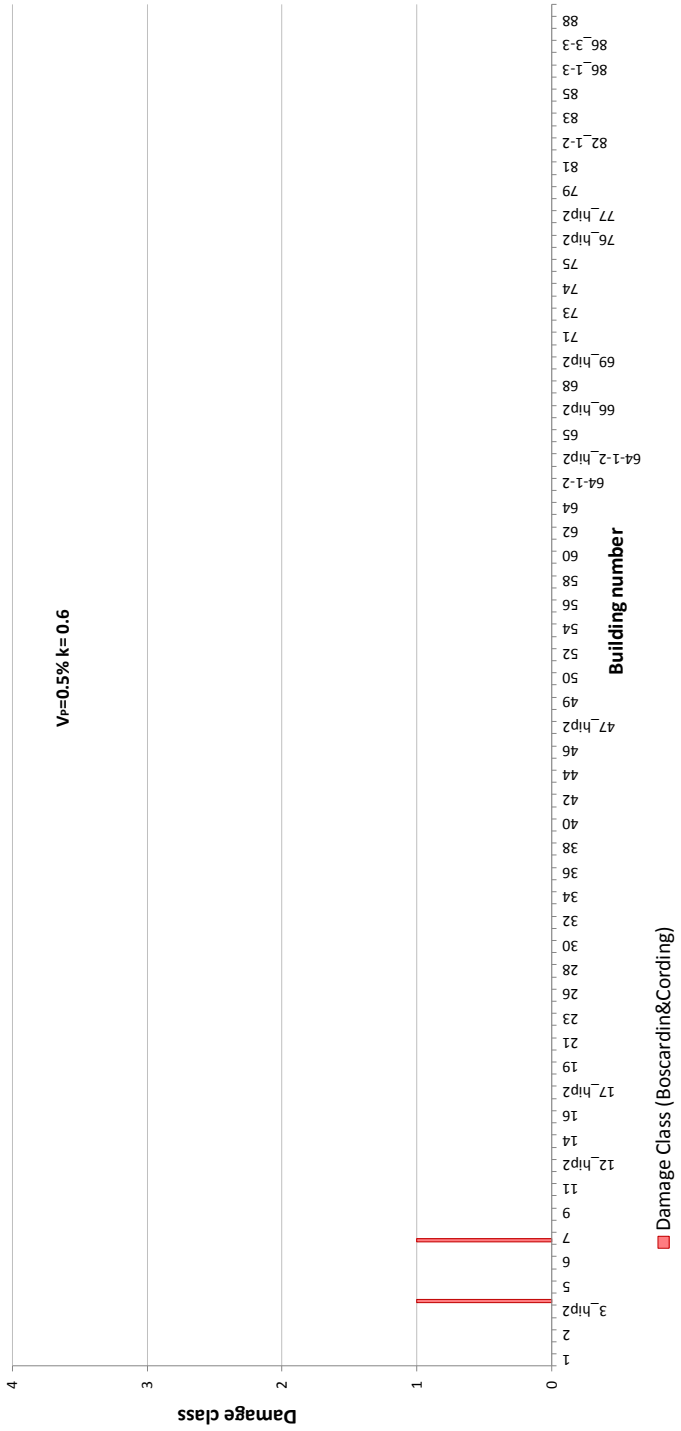
DATI INPUT_SUBSIDENZE												DATI OUTPUT_SUBSIDENZE						
Buildings	VP	Diam	Copertura da p.c.	K	dist canne	A	B	altezza	fondazioni	BRICKWORK / C.A. /MIXED	destinazione	Buildings	Ced_A	Ced_B	Ced_max bacino	Ced_max edificio	ε SAGG	ε HOGG	Damage Class (Boscardin&Cording)
-	%	m	m	-	m	m	m	m	m	-	-	-	mm	mm	mm	mm	%	%	-
1	0.5%	10.6	13	0.4	0	30	68	23	1.5	C.A.	civile	1	0.00	0.00	52.39	0.00		0.000%	0
1_hip2	0.5%	10.6	13	0.4	0	30	68	17	7.5	C.A.	civile	1_hip2	0.00	0.00	81.49	0.00		0.000%	0
2	0.5%	10.6	13	0.4	0	-22	14	9	1.5	BRICKWORK	militare	2	VEDI APPROFONDIMENTO ANALISI FEM						
3	0.5%	10.6	12	0.4	0	34	69	19	1.5	C.A.	civile	3	0.00	0.00	55.70	0.00		0.000%	0
3_hip2	0.5%	10.6	12	0.4	0	34	69	16	4.5	C.A.	civile	3_hip2	0.00	0.00	68.76	0.00		0.000%	0
4	0.5%	10.6	12	0.4	0	-2	38	13	1.5	C.A.	militare	4	52.98	0.00	55.71	55.71	0.110%	0.123%	2
5	0.5%	10.6	16	0.4	0	40	50	17	1.5	C.A.	civile	5	0.00	0.00	44.45	0.00		0.000%	0
5_hip2	0.5%	10.6	16	0.4	0	40	50	14	4.5	C.A.	civile	5_hip2	0.00	0.00	52.39	0.00		0.000%	0
6	0.5%	10.6	13	0.4	0	-27	52	13	1.5	BRICKWORK	militare	6	VEDI APPROFONDIMENTO ANALISI FEM						
6_hip2	0.5%	10.6	13	0.4	0	-27	52	10	4.5	BRICKWORK	militare	6_hip2	VEDI APPROFONDIMENTO ANALISI FEM						
7	0.5%	10.6	16	0.4	0	20	30	3	1.5	C.A.	civile	7	1.83	0.03	44.45	1.83		0.021%	0
8	0.5%	10.6	20	0.4	0	-6	7	3	1.5	BRICKWORK	militare	8	30.32	28.22	36.98	36.98	0.083%	0.000%	2
9	0.5%	10.6	20	0.4	0	-52	-16	9	1.5	C.A.	militare	9	0.00	9.01	36.98	9.01		0.041%	0
10	0.5%	10.6	16	0.4	0	-50	-43	7	1.5	C.A.	militare	10	0.00	0.00	44.45	0.00		0.000%	0
11	0.5%	10.6	16	0.4	0	-50	-36	7	1.5	C.A.	militare	11	0.00	0.00	44.45	0.00		0.000%	0
12	0.5%	10.6	16	0.4	0	34	50	15	1.5	C.A.	civile	12	0.00	0.00	44.45	0.00		0.000%	0
12_hip2	0.5%	10.6	16	0.4	0	34	50	12	4.5	C.A.	civile	12_hip2	0.00	0.00	52.38	0.00		0.000%	0
13	0.5%	10.6	25	0.4	0	-42	-8	7	1.5	C.A.	civile	13	0.04	24.01	30.56	24.01	0.002%	0.036%	0
14	0.5%	10.6	24	0.4	0	-50	-42	13	1.5	C.A.	civile	14	0.00	0.03	31.66	0.03		0.000%	0
15	0.5%	10.6	25	0.4	0	-8	16	10	1.5	C.A.	civile	15	24.01	11.65	30.56	30.56	0.040%	0.021%	0
16	0.5%	10.6	24	0.4	0	-16	6	13	1.5	C.A.	civile	16	11.24	27.37	31.66	31.66	0.041%	0.025%	0
17	0.5%	10.6	25	0.4	0	42	50	15	1.5	C.A.	civile	17	0.04	0.00	30.56	0.04		0.001%	0
17_hip2	0.5%	10.6	25	0.4	0	42	50	12	4.5	C.A.	civile	17_hip2	0.01	0.00	34.11	0.01		0.000%	0
18	0.5%	10.6	24	0.4	0	34	45	13	1.5	C.A.	civile	18	0.30	0.01	31.66	0.30		0.003%	0
19	0.5%	10.6	24	0.4	0	4	24	13	1.5	C.A.	civile	19	29.68	3.08	31.66	29.68	0.010%	0.043%	0
20	0.5%	10.6	22	0.4	0	-33	-10	4	1.5	C.A.	civile	20	0.21	21.33	34.11	21.33	0.000%	0.052%	1
21	0.5%	10.6	20	0.4	0	-5	9	3	1.5	BRICKWORK	civile	21	32.22	23.65	36.98	36.98	0.081%	0.000%	2
22	0.5%	10.6	20	0.4	0	-50	-44	16	1.5	C.A.	civile	22	0.00	0.00	36.98	0.00		0.000%	0
23	0.5%	10.6	20	0.4	0	-24	-4	13	1.5	C.A.	civile	23	1.54	33.86	36.98	33.86	0.011%	0.062%	1
25	0.5%	10.6	20	0.4	0	-50	-31	10	1.5	C.A.	civile	25	0.00	0.18	36.98	0.18		0.003%	0
26	0.5%	10.6	20	0.4	0	-44	-24	3	1.5	C.A.	civile	26	0.00	1.54	36.98	1.54		0.015%	0
27	0.5%	10.6	19	0.4	0	-10	5	16	1.5	C.A.	civile	27	21.16	33.22	38.60	38.60	0.064%	0.009%	1
28	0.5%	10.6	19	0.4	0	17	48	13	1.5	C.A.	civile	28	6.79	0.00	38.60	6.79		0.038%	0
29	0.5%	10.6	20	0.4	0	35	44	13	1.5	C.A.	civile	29	0.04	0.00	36.98	0.04		0.001%	0
30	0.5%	10.6	20	0.4	0	42	50	13	1.5	C.A.	civile	30	0.00	0.00	36.98	0.00		0.000%	0
31	0.5%	10.6	21	0.4	0	-14	14	13	1.5	C.A.	civile	31	13.11	13.11	35.49	35.49	0.064%	0.030%	1
32	0.5%	10.6	21	0.4	0	6	16	2	1.5	C.A.	civile	32	29.56	9.66	35.49	29.56	0.004%	0.041%	0
33	0.5%	10.6	21	0.4	0	25	50	10	1.5	C.A.	civile	33	1.48	0.00	35.49	1.48		0.013%	0
34	0.5%	10.6	21	0.4	0	36	50	13	1.5	C.A.	civile	34	0.05	0.00	35.49	0.05		0.001%	0
35	0.5%	10.6	25	0.4	0	-5	50	3	1.5	C.A.	civile	35	27.81	0.00	30.56	30.56	0.026%	0.040%	0
36	0.5%	10.6	28	0.4	0	-50	-38	7	1.5	C.A.	civile	36	0.01	0.32	27.68	0.32		0.003%	0
37	0.5%	10.6	30	0.4	0	-48	-7	10	1.5	BRICKWORK	civile	37	0.05	22.77	26.04	22.77	0.004%	0.044%	0
38	0.5%	10.6	33	0.4	0	-48	-19	19	1.5	C.A.	civile	38	0.12	10.40	23.92	10.40		0.023%	0
39	0.5%	10.6	33	0.4	0	4	16	6	1.5	C.A.	civile	39	23.05	13.25	23.92	23.05	0.007%	0.003%	0
40	0.5%	10.6	27	0.4	0	-5	30	16	1.5	C.A.	civile	40	26.32	1.47	28.58	28.58	0.031%	0.037%	0
41	0.5%	10.6	29	0.4	0	-32	10	19	1.5	C.A.	civile	41	1.37	20.07	26.83	26.83	0.034%	0.032%	0
42	0.5%	10.6	30	0.4	0	-50	-30	22	1.5	C.A.	civile	42	0.03	2.22	26.04	2.22		0.011%	0
43	0.5%	10.6	28	0.4	0	-5	32	20	1.5	C.A.	civile	43	25.62	1.17	27.68	27.68	0.029%	0.035%	0
44	0.5%	10.6	34	0.4	0	26	58	16	1.5	C.A.	civile	44	5.31	0.01	23.28	5.31		0.016%	0
45	0.5%	10.6	27	0.4	0	30	50	22	1.5	C.A.	civile	45	1.47	0.01	28.58	1.47		0.010%	0
46	0.5%	10.6	34	0.4	0	-50	-28	12	4.5	C.A.	civile	46	0.04	3.34	25.29	3.34		0.014%	0
47	0.5%	10.6	38	0.4	0	-46	-6	14	1.5	C.A.	civile	47	0.48	19.74	21.06	19.74	0.004%	0.020%	0
47_hip2	0.5%	10.6	38	0.4	0	-46	-6	11	4.5	C.A.	civile	47_hip2	0.28	21.05	22.68	21.05	0.005%	0.022%	0
48	0.5%	10.6	41	0.4	0	-26	11	16	4.5	C.A.	civile	48	6.28	16.96	21.06	21.06	0.019%	0.013%	0
49	0.5%	10.6	38	0.4	0	7	30	17	1.5	C.A.	civile	49	19.29	4.21	21.06	19.29	0.004%	0.017%	0
49_hip2	0.5%	10.6	38	0.4	0	7	30	14	4.5	C.A.	civile	49_hip2	20.49	3.50	22.68	20.49	0.004%	0.021%	0
50	0.5%	10.6	44	0.4	0	-50	-32	13	1.5	C.A.	civile	50	0.60	4.54	18.41	4.54		0.014%	0
51	0.5%	10.6	44	0.4	0	-12	8	17	1.5	C.A.	civile	51	15.12	16.87	18.41	18.41	0.011%	0.000%	0
52	0.5%	10.6	42	0.4	0	4	54	19	1.5	C.A.	civile	52	18.76	0.25	19.22	18.76	0.005%	0.016%	0
53	0.5%	10.6	41	0.4	0	34	50	13	1.5	C.A.	civile	53	3.25	0.40	19.65	3.25		0.013%	0
54	0.5%	10.6	47	0.4	0	-14	-5	7	1.5	C.A.	civile	54	13.67	16.81	17.33	16.81	0.003%	0.000%	0
55	0.5%	10.6	47	0.4	0	-6	10	10	1.5	C.A.	civile	55	16.59	15.35	17.33	17.33	0.007%	0.000%	0
56	0.5%	10.6	47	0.4	0	14	37	17	1.5	C.A.	civile	56	13.67	3.30	17.33	13.67	0.001%	0.011%	0
57	0.5%	10.6	47	0.4	0	36	50	19	1.5	C.A.	civile	57	3.61	0.84	17.33	3.61		0.013%	0
58	0.5%	10.6	49	0.4	0	-40	-7	8	1.5	BRICKWORK	civile	58	2.77	15.78	16.67	15.78	0.004%	0.014%	0
59	0.5%	10.6	50	0.4	0	-50	-44	16	1.5	C.A.	civile	59	1.10	2.02	16.36	2.02		0.011%	0
60	0.5%	10.6	50	0.4	0	24	46	16	1.5	C.A.	civile	60	8.78	1.67	16.36	8.78		0.012%	0
61	0.5%	10.6	52	0.4	0	-5	26	13	1.5	C.A.	civile	61	15.38	8.00	15.77	15.77	0.007%	0.003%	0
62	0.5%	10.6	52	0.4	0	40	50	16	1.5	C.A.	civile	62	3.17	1.28	15.77	3.17		0.011%	0
63	0.5%	10.6	50	0.4	0	18	58	16	1.5	C.A.	civile	63	11.53	0.43	16.36	11.53	0.000%	0.012%	0
64	0.5%	10.6	50	0.4	0	-32	8	12	1.5	C.A.	civile	64	5.42	15.27	16.36	16.36	0.008%	0.007%	0
64_hip2	0.5%	10.6	50	0.4	0	-32	8	9	4.5	C.A.	civile	64_hip2	5.01	16.03	17.33	17.33	0.009%	0.009%	0
64-1-2	0.5%	10.6	50	0.4	0	-32	-10	12	1.5	C.A.	civile	64-1/2	5.42	14.69	16.36	14.69	0.002%	0.007%	0
64-2-2	0.5%	10.6	50	0.4	0	-10	8	9	1.5	C.A.	civile	64-2/2	14.69	15.27	16.36	16.36	0.007%	0.000%	0
64-1-2_hip2	0.5%	10.6	50	0.4	0	-32	-10	9	4.5	C.A.		64-1/2_hip2	5.01	15.35	17.33	15.35	0.002%	0.009%	0
64-2-2_hip2	0.5%	10.6	50	0.4	0	-10	8	6	4.5	C.A.		64-2/2_hip2	15.35	16.03	17.33	17.33	0.008%	0.000%	0
65	0.5%	10.6	47	0.4	0	-66	-30	20	1.5	C.A.	civile	65	0.09	5.83	17.33	5.83		0.011%	0
66	0.5%	10.6	47	0.4	0	-20	8	25	1.5	C.A.	civile	66	10.67	16.03	17.33	17.33	0.011%	0.000%	0
66_hip2	0.5%	10.6	47	0.4	0	-20	8	19	7.5	C.A.	civile	66_hip2	10.54	17.78	19.65	19.65	0.015%	0.003%	0
67	0.5%	10.6	47	0.4	0	15	32	16	4.5	C.A.	civile	67	13.54	4.54	18.41	13.54	0.000%	0.011%	0
68	0.5%	10.6	47	0.4	0	38	78	17	4.5	C.A.	civile	68	2.56	0.00	18.41	2.56		0.008%	0
69	0.5%	10.6	47	0.4	0	8	26	17	1.5	C.A.	civile	69	16.03	7.64	17.33	16.03	0.003%	0.005%	0
69_hip2	0.5%	10.6	47	0.4	0	8	26	14	4.5	C.A.	civile	69_hip2	16.87	7.30	18.41	16.87	0.003%	0.007%	0
70	0.5%	10.6	47	0.4	0	-54	-12	17	1.5	C.A.	civile	70	0.51	14.55	17.33	14.55	0.001%	0.013%	0
71	0.5%	10.6	47	0.4	0	7	42	20	1.5	C.A.	civile	71	16.33	2.05	17.33	16.33	0.003%	0.013%	0
72	0.5%	10.6	47	0.4	0	-26	-5	19	1.5	C.A.	civile	72	7.64	16.81	17.33	16.81	0.004%	0.005%	0
73	0.5%	10.6	46	0.4	0	-48	-16	22	1.5	C.A.	civile	73	0.97	12.80	17.67	12.80	0.000%	0.014%	0
73_hip2	0.5%	10.6	46	0.4	0	-48	-16	16	7.5	C.A.	civile	73_hip2	0.47	13.24	20.09	13.24	0.000%	0.018%	0
74	0.5%	10.6	46	0.4	0	20	10	15	1.5	C.A.	civile	74	10.68	15.58	17.67	15.58	0.002%	0.000%	0
74_hip2	0.5%	10.6	46	0.4	0	20	10	12	4.5	C.A.	civile	74_hip2	10.63	16.31	18.81	16.31	0.002%	0.002%	0
75	0.5%	10.6	48	0.4	0	-18	68	10	1.5	C.A.	civile	75	11.65	0.08	16.99	16.99	0.010%	0.013%	0
76	0.5%	10.6	66	0.4	0	-92	90	44	1.5	C.A.	civile	76	0.06	0.07	12.61	12.61	0.008%	0.007%	0
76_hip2	0.5%	10.6	66	0.4	0	-92	90	38	7.5	C.A.	civile	76_hip2	0.02	0.03	13.80	13.80	0.010%	0.008%	0
77	0.5%	10.6	40	0.4	0	38	62	14	1.5	C.A.	civile	77	1.91	0.04	20.09	1.91		0.007%	0
77_hip2	0.5%	10.6	40	0.4	0	38	62	8.5	7	C.A.	civile	77_hip2	1.06	0.01	22.98	1.06		0.006%	0
78	0.5%	10.6	50	0.4	0	9	64	28	1.5	C.A.	civile	78	14.99	0.20	16.36	14.99	0.002%	0.012%	0
79	0.5%	10.6	50	0.4	0	-24	4	13	1.5	C.A.	civile	79	8.78	16.08	16.36	16.36	0.007%	0.002%	0
80	0.5%	10.6	50	0.4	0	-44	-10	10	1.5	C.A.	civile	80	2.02	14.69	16.36	14.69	0.002%	0.011%	0
81	0.5%	10.6	40	0.4	0	-68	-42	22	1.5	C.A.	civile	81	0.01	1.14	20.09	1.14		0.005%	0
82	0.5%	10.6	41	0.4	0	-14	24	13	1.5	C.A.	civile	82	14.48	8.01	19.65	19.65	0.016%	0.008%	0
82_1-2	0.5%	10.6	41	0.4	0	-14	5	3	1.5	C.A.	civile	82_1/2	14.48	18.90	19.65	19.65	0.009%	0.000%	0
82_2-2	0.5%	10.6	41	0.4	0	5	24	13	1.5	C.A.	civile	82_2/2	18.90	8.01	19.65	18.90	0.005%	0.008%	0
83	0.5%	10.6	48	0.4	0	24	63	13	1.5	C.A.	civile	83	8.69	0.17	16.99	8.69		0.012%	0
84	0.5%	10.6	48	0.4	0	-18	21	14	1.5	C.A.	civile	84	11.65	10.17	16.99	16.99	0.012%	0.000%	0
85	0.5%	10.6	54	0.4	0	-55	-44	14	1.5	C.A.	civile	85	0.90	2.49	15.23	2.49		0.010%	0
86	0.5%	10.6	54	0.4	0	-34	14	17	1.5	C.A.	civile	86	5.16	12.68	15.23	15.23	0.009%	0.006%	0
86_1-3	0.5%	10.6	54	0.4	0	-34	-24	3	1.5	C.A.	civile	86_1/3	5.16	8.88	15.23	8.88		0.007%	0
86_2-3	0.5%	10.6	54	0.4	0	-24	-5	17	1.5	C.A.	civile	86_2/3	8.88	14.88	15.23	14.88	0.003%	0.001%	0
86_3-3	0.5%	10.6	54	0.4	0	-5	14	9	1.5	C.A.	civile	86_3/3	14.88	12.68	15.23	15.23	0.005%	0.000%	0
87	0.5%	10.6	23.4	0.4	0	15	56	17	4.5	C.A.	civile	87	10.95	0.00	36.37	10.95		0.044%	0
88	0.5%	10.6	6.7	0.4	0	-54	-28	15	1.5	C.A.	civile	88	0.00	0.00	83.80	0.00		0.000%	0
88_hip2	0.5%	10.6	6.7	0.4	0	-54	-28	12	4.5	C.A.	civile	88_hip2	0.00	0.00	117.29	0.00		0.000%	0


Vp=0.5% k= 0.4
Building number
Damage Class (Boscardin&Cording)
Damage class
0
1
2
3
4
1
2
3_hp2
5
6
7
9
11
12_hp2
14
16
17_hp2
19
21
23
26
28
30
32
34
36
38
40
42
44
46
47_hp2
49
50
52
54
56
58
60
62
64
64-1-2
64-1-2_hp2
65
66_hp2
68
69_hp2
71
73
74
75
76_hp2
77_hp2
79
81
82_1-2
83
85
86_1-3
86_3-3
88

DATI INPUT_SUBSIDENZE												DATI OUTPUT_SUBSIDENZE						
Buildings	VP	Diam	Copertura da p.c.	K	dist canne	A	B	altezza	fondazioni	BRICKWORK / C.A. /MIXED	destinazione	Buildings	Ced_A	Ced_B	Ced_max bacino	Ced_max edificio	ε SAGG	ε HOGG	Damage Class (Boscardin&Cording)
-	%	m	m	-	m	m	m	m	m	-	-	-	mm	mm	mm	mm	%	%	-
1	0.3%	10.6	13	0.4	0	30	68	23	1.5	C.A.	civile	1	0.00	0.00	31.43	0.00		0.000%	0
1_hip2	0.3%	10.6	13	0.4	0	30	68	17	7.5	C.A.	civile	1_hip2	0.00	0.00	48.90	0.00		0.000%	0
2	0.3%	10.6	13	0.4	0	-22	14	9	1.5	BRICKWORK	militare	2	VEDI APPROFONDIMENTO ANALISI FEM						
3	0.3%	10.6	12	0.4	0	34	69	19	1.5	C.A.	civile	3	0.00	0.00	33.42	0.00		0.000%	0
3_hip2	0.3%	10.6	12	0.4	0	34	69	16	4.5	C.A.	civile	3_hip2	0.00	0.00	41.26	0.00		0.000%	0
4	0.3%	10.6	12	0.4	0	-2	38	13	1.5	C.A.	militare	4	31.79	0.00	33.42	33.42	0.066%	0.074%	1
5	0.3%	10.6	16	0.4	0	40	50	17	1.5	C.A.	civile	5	0.00	0.00	26.67	0.00		0.000%	0
5_hip2	0.3%	10.6	16	0.4	0	40	50	14	4.5	C.A.	civile	5_hip2	0.00	0.00	31.43	0.00		0.000%	0
6	0.3%	10.6	13	0.4	0	-27	52	13	1.5	BRICKWORK	militare	6	VEDI APPROFONDIMENTO ANALISI FEM						
6_hip2	0.3%	10.6	13	0.4	0	-27	52	10	4.5	BRICKWORK	militare	6_hip2	VEDI APPROFONDIMENTO ANALISI FEM						
7	0.3%	10.6	16	0.4	0	20	30	3	1.5	C.A.	civile	7	1.10	0.02	26.67	1.10		0.012%	0
8	0.3%	10.6	20	0.4	0	-6	7	3	1.5	BRICKWORK	militare	8	18.19	16.93	22.19	22.19	0.050%	0.000%	1
9	0.3%	10.6	20	0.4	0	-52	-16	9	1.5	C.A.	militare	9	0.00	5.40	22.19	5.40		0.025%	0
10	0.3%	10.6	16	0.4	0	-50	-43	7	1.5	C.A.	militare	10	0.00	0.00	26.67	0.00		0.000%	0
11	0.3%	10.6	16	0.4	0	-50	-36	7	1.5	C.A.	militare	11	0.00	0.00	26.67	0.00		0.000%	0
12	0.3%	10.6	16	0.4	0	34	50	15	1.5	C.A.	civile	12	0.00	0.00	26.67	0.00		0.000%	0
12_hip2	0.3%	10.6	16	0.4	0	34	50	12	4.5	C.A.	civile	12_hip2	0.00	0.00	31.43	0.00		0.000%	0
13	0.3%	10.6	25	0.4	0	-42	-8	7	1.5	C.A.	civile	13	0.02	14.41	18.34	14.41	0.001%	0.022%	0
14	0.3%	10.6	24	0.4	0	-50	-42	13	1.5	C.A.	civile	14	0.00	0.02	19.00	0.02		0.000%	0
15	0.3%	10.6	25	0.4	0	-8	16	10	1.5	C.A.	civile	15	14.41	6.99	18.34	18.34	0.024%	0.013%	0
16	0.3%	10.6	24	0.4	0	-16	6	13	1.5	C.A.	civile	16	6.75	16.42	18.99	19.00	0.025%	0.015%	0
17	0.3%	10.6	25	0.4	0	42	50	15	1.5	C.A.	civile	17	0.02	0.00	18.34	0.02		0.000%	0
17_hip2	0.3%	10.6	25	0.4	0	42	50	12	4.5	C.A.	civile	17_hip2	0.01	0.00	20.47	0.01		0.000%	0
18	0.3%	10.6	24	0.4	0	34	45	13	1.5	C.A.	civile	18	0.18	0.01	19.00	0.18		0.002%	0
19	0.3%	10.6	24	0.4	0	4	24	13	1.5	C.A.	civile	19	17.81	1.85	19.00	17.81	0.006%	0.026%	0
20	0.3%	10.6	22	0.4	0	-33	-10	4	1.5	C.A.	civile	20	0.12	12.80	20.47	12.80	0.000%	0.031%	0
21	0.3%	10.6	20	0.4	0	-5	9	3	1.5	BRICKWORK	civile	21	19.33	14.19	22.19	22.19	0.049%	0.000%	0
22	0.3%	10.6	20	0.4	0	-50	-44	16	1.5	C.A.	civile	22	0.00	0.00	22.19	0.00		0.000%	0
23	0.3%	10.6	20	0.4	0	-24	-4	13	1.5	C.A.	civile	23	0.92	20.31	22.19	20.31	0.007%	0.037%	0
25	0.3%	10.6	20	0.4	0	-50	-31	10	1.5	C.A.	civile	25	0.00	0.11	22.19	0.11		0.002%	0
26	0.3%	10.6	20	0.4	0	-44	-24	3	1.5	C.A.	civile	26	0.00	0.92	22.19	0.92		0.009%	0
27	0.3%	10.6	19	0.4	0	-10	5	16	1.5	C.A.	civile	27	12.70	19.93	23.16	23.16	0.038%	0.005%	0
28	0.3%	10.6	19	0.4	0	17	48	13	1.5	C.A.	civile	28	4.08	0.00	23.16	4.08		0.023%	0
29	0.3%	10.6	20	0.4	0	35	44	13	1.5	C.A.	civile	29	0.03	0.00	22.19	0.03		0.000%	0
30	0.3%	10.6	20	0.4	0	42	50	13	1.5	C.A.	civile	30	0.00	0.00	22.19	0.00		0.000%	0
31	0.3%	10.6	21	0.4	0	-14	14	13	1.5	C.A.	civile	31	7.87	7.87	21.29	21.29	0.038%	0.018%	0
32	0.3%	10.6	21	0.4	0	6	16	2	1.5	C.A.	civile	32	17.73	5.80	21.29	17.73	0.003%	0.024%	0
33	0.3%	10.6	21	0.4	0	25	50	10	1.5	C.A.	civile	33	0.89	0.00	21.29	0.89		0.008%	0
34	0.3%	10.6	21	0.4	0	36	50	13	1.5	C.A.	civile	34	0.03	0.00	21.29	0.03		0.001%	0
35	0.3%	10.6	25	0.4	0	-5	50	3	1.5	C.A.	civile	35	16.69	0.00	18.34	18.34	0.015%	0.024%	0
36	0.3%	10.6	28	0.4	0	-50	-38	7	1.5	C.A.	civile	36	0.01	0.19	16.61	0.19		0.002%	0
37	0.3%	10.6	30	0.4	0	-48	-7	10	1.5	BRICKWORK	civile	37	0.03	13.66	15.62	13.66	0.002%	0.027%	0
38	0.3%	10.6	33	0.4	0	-48	-19	19	1.5	C.A.	civile	38	0.07	6.24	14.35	6.24		0.014%	0
39	0.3%	10.6	33	0.4	0	4	16	6	1.5	C.A.	civile	39	13.83	7.95	14.35	13.83	0.004%	0.002%	0
40	0.3%	10.6	27	0.4	0	-5	30	16	1.5	C.A.	civile	40	15.79	0.88	17.15	17.15	0.018%	0.022%	0
41	0.3%	10.6	29	0.4	0	-32	10	19	1.5	C.A.	civile	41	0.82	12.04	16.10	16.10	0.021%	0.019%	0
42	0.3%	10.6	30	0.4	0	-50	-30	22	1.5	C.A.	civile	42	0.02	1.33	15.62	1.33		0.007%	0
43	0.3%	10.6	28	0.4	0	-5	32	20	1.5	C.A.	civile	43	15.37	0.70	16.61	16.61	0.017%	0.021%	0
44	0.3%	10.6	34	0.4	0	26	58	16	1.5	C.A.	civile	44	3.19	0.01	13.97	3.19		0.010%	0
45	0.3%	10.6	27	0.4	0	30	50	22	1.5	C.A.	civile	45	0.88	0.00	17.15	0.88		0.006%	0
46	0.3%	10.6	34	0.4	0	-50	-28	12	4.5	C.A.	civile	46	0.02	2.01	15.17	2.01		0.008%	0
47	0.3%	10.6	38	0.4	0	-46	-6	14	1.5	C.A.	civile	47	0.29	11.85	12.63	11.85	0.003%	0.012%	0
47_hip2	0.3%	10.6	38	0.4	0	-46	-6	11	4.5	C.A.	civile	47_hip2	0.17	12.63	13.61	12.63	0.003%	0.013%	0
48	0.3%	10.6	41	0.4	0	-26	11	16	4.5	C.A.	civile	48	3.77	10.18	12.63	12.63	0.012%	0.008%	0
49	0.3%	10.6	38	0.4	0	7	30	17	1.5	C.A.	civile	49	11.57	2.53	12.63	11.57	0.002%	0.010%	0
49_hip2	0.3%	10.6	38	0.4	0	7	30	14	4.5	C.A.	civile	49_hip2	12.29	2.10	13.61	12.29	0.002%	0.012%	0
50	0.3%	10.6	44	0.4	0	-50	-32	13	1.5	C.A.	civile	50	0.36	2.72	11.05	2.72		0.009%	0
51	0.3%	10.6	44	0.4	0	-12	8	17	1.5	C.A.	civile	51	9.07	10.12	11.05	11.05	0.007%	0.000%	0
52	0.3%	10.6	42	0.4	0	4	54	19	1.5	C.A.	civile	52	11.26	0.15	11.53	11.26	0.003%	0.010%	0
53	0.3%	10.6	41	0.4	0	34	50	13	1.5	C.A.	civile	53	1.95	0.24	11.79	1.95		0.008%	0
54	0.3%	10.6	47	0.4	0	-14	-5	7	1.5	C.A.	civile	54	8.20	10.09	10.40	10.09	0.002%	0.000%	0
55	0.3%	10.6	47	0.4	0	-6	10	10	1.5	C.A.	civile	55	9.95	9.21	10.40	10.40	0.004%	0.000%	0
56	0.3%	10.6	47	0.4	0	14	37	17	1.5	C.A.	civile	56	8.20	1.98	10.40	8.20	0.000%	0.007%	0
57	0.3%	10.6	47	0.4	0	36	50	19	1.5	C.A.	civile	57	2.16	0.50	10.40	2.16		0.008%	0
58	0.3%	10.6	49	0.4	0	-40	-7	8	1.5	BRICKWORK	civile	58	1.66	9.47	10.00	9.47	0.003%	0.008%	0
59	0.3%	10.6	50	0.4	0	-50	-44	16	1.5	C.A.	civile	59	0.66	1.21	9.82	1.21		0.006%	0
60	0.3%	10.6	50	0.4	0	24	46	16	1.5	C.A.	civile	60	5.27	1.00	9.82	5.27		0.007%	0
61	0.3%	10.6	52	0.4	0	-5	26	13	1.5	C.A.	civile	61	9.23	4.80	9.46	9.46	0.004%	0.002%	0
62	0.3%	10.6	52	0.4	0	40	50	16	1.5	C.A.	civile	62	1.90	0.77	9.46	1.90		0.007%	0
63	0.3%	10.6	50	0.4	0	18	58	16	1.5	C.A.	civile	63	6.92	0.26	9.82	6.92	0.000%	0.007%	0
64	0.3%	10.6	50	0.4	0	-32	8	12	1.5	C.A.	civile	64	3.25	9.16	9.82	9.82	0.005%	0.004%	0
64_hip2	0.3%	10.6	50	0.4	0	-32	8	9	4.5	C.A.	civile	64_hip2	3.01	9.62	10.40	10.40	0.006%	0.006%	0
64-1-2	0.3%	10.6	50	0.4	0	-32	-10	12	1.5	C.A.	civile	64-1/2	3.25	8.81	9.82	8.81	0.001%	0.004%	0
64-2-2	0.3%	10.6	50	0.4	0	-10	8	9	1.5	C.A.	civile	64-2/2	8.81	9.16	9.82	9.82	0.004%	0.000%	0
64-1-2_hip2	0.3%	10.6	50	0.4	0	-32	-10	9	4.5	C.A.		64-1/2_hip2	3.01	9.21	10.40	9.21	0.001%	0.005%	0
64-2-2_hip2	0.3%	10.6	50	0.4	0	-10	8	6	4.5	C.A.		64-2/2_hip2	9.21	9.62	10.40	10.40	0.005%	0.000%	0
65	0.3%	10.6	47	0.4	0	-66	-30	20	1.5	C.A.	civile	65	0.05	3.50	10.40	3.50		0.007%	0
66	0.3%	10.6	47	0.4	0	-20	8	25	1.5	C.A.	civile	66	6.40	9.62	10.40	10.40	0.007%	0.000%	0
66_hip2	0.3%	10.6	47	0.4	0	-20	8	19	7.5	C.A.	civile	66_hip2	6.32	10.67	11.79	11.79	0.009%	0.002%	0
67	0.3%	10.6	47	0.4	0	15	32	16	4.5	C.A.	civile	67	8.12	2.72	11.05	8.12	0.000%	0.007%	0
68	0.3%	10.6	47	0.4	0	38	78	17	4.5	C.A.	civile	68	1.53	0.00	11.05	1.53		0.005%	0
69	0.3%	10.6	47	0.4	0	8	26	17	1.5	C.A.	civile	69	9.62	4.58	10.40	9.62	0.002%	0.003%	0
69_hip2	0.3%	10.6	47	0.4	0	8	26	14	4.5	C.A.	civile	69_hip2	10.12	4.38	11.05	10.12	0.002%	0.004%	0
70	0.3%	10.6	47	0.4	0	-54	-12	17	1.5	C.A.	civile	70	0.30	8.73	10.40	8.73	0.001%	0.008%	0
71	0.3%	10.6	47	0.4	0	7	42	20	1.5	C.A.	civile	71	9.80	1.23	10.40	9.80	0.002%	0.008%	0
72	0.3%	10.6	47	0.4	0	-26	-5	19	1.5	C.A.	civile	72	4.58	10.09	10.40	10.09	0.002%	0.003%	0
73	0.3%	10.6	46	0.4	0	-48	-16	22	1.5	C.A.	civile	73	0.58	7.68	10.60	7.68	0.000%	0.008%	0
73_hip2	0.3%	10.6	46	0.4	0	-48	-16	16	7.5	C.A.	civile	73_hip2	0.28	7.95	12.06	7.95	0.000%	0.011%	0
74	0.3%	10.6	46	0.4	0	20	10	15	1.5	C.A.	civile	74	6.41	9.35	10.60	9.35	0.001%	0.000%	0
74_hip2	0.3%	10.6	46	0.4	0	20	10	12	4.5	C.A.	civile	74_hip2	6.38	9.78	11.28	9.78	0.001%	0.001%	0
75	0.3%	10.6	48	0.4	0	-18	68	10	1.5	C.A.	civile	75	6.99	0.05	10.19	10.19	0.006%	0.008%	0
76	0.3%	10.6	66	0.4	0	-92	90	44	1.5	C.A.	civile	76	0.03	0.04	7.57	7.57	0.005%	0.004%	0
76_hip2	0.3%	10.6	66	0.4	0	-92	90	38	7.5	C.A.	civile	76_hip2	0.01	0.02	8.28	8.28	0.006%	0.005%	0
77	0.3%	10.6	40	0.4	0	38	62	14	1.5	C.A.	civile	77	1.15	0.02	12.06	1.15		0.004%	0
77_hip2	0.3%	10.6	40	0.4	0	38	62	8.5	7	C.A.	civile	77_hip2	0.64	0.00	13.79	0.64		0.004%	0
78	0.3%	10.6	50	0.4	0	9	64	28	1.5	C.A.	civile	78	8.99	0.12	9.82	8.99	0.001%	0.007%	0
79	0.3%	10.6	50	0.4	0	-24	4	13	1.5	C.A.	civile	79	5.27	9.65	9.82	9.82	0.004%	0.001%	0
80	0.3%	10.6	50	0.4	0	-44	-10	10	1.5	C.A.	civile	80	1.21	8.81	9.82	8.81	0.001%	0.007%	0
81	0.3%	10.6	40	0.4	0	-68	-42	22	1.5	C.A.	civile	81	0.01	0.68	12.06	0.68		0.003%	0
82	0.3%	10.6	41	0.4	0	-14	24	13	1.5	C.A.	civile	82	8.69	4.81	11.79	11.79	0.009%	0.005%	0
82_1-2	0.3%	10.6	41	0.4	0	-14	5	3	1.5	C.A.	civile	82_1/2	8.69	11.34	11.79	11.79	0.005%	0.000%	0
82_2-2	0.3%	10.6	41	0.4	0	5	24	13	1.5	C.A.	civile	82_2/2	11.34	4.81	11.79	11.34	0.003%	0.005%	0
83	0.3%	10.6	48	0.4	0	24	63	13	1.5	C.A.	civile	83	5.21	0.10	10.19	5.21		0.007%	0
84	0.3%	10.6	48	0.4	0	-18	21	14	1.5	C.A.	civile	84	6.99	6.10	10.19	10.19	0.007%	0.000%	0
85	0.3%	10.6	54	0.4	0	-55	-44	14	1.5	C.A.	civile	85	0.54	1.49	9.14	1.49		0.006%	0
86	0.3%	10.6	54	0.4	0	-34	14	17	1.5	C.A.	civile	86	3.10	7.61	9.14	9.14	0.005%	0.004%	0
86_1-3	0.3%	10.6	54	0.4	0	-34	-24	3	1.5	C.A.	civile	86_1/3	3.10	5.33	9.14	5.33		0.004%	0
86_2-3	0.3%	10.6	54	0.4	0	-24	-5	17	1.5	C.A.	civile	86_2/3	5.33	8.93	9.14	8.93	0.002%	0.000%	0
86_3-3	0.3%	10.6	54	0.4	0	-5	14	9	1.5	C.A.	civile	86_3/3	8.93	7.61	9.14	9.14	0.003%	0.000%	0
87	0.3%	10.6	23.4	0.4	0	15	56	17	4.5	C.A.	civile	87	6.57	0.00	21.82	6.57		0.027%	0
88	0.3%	10.6	6.7	0.4	0	-54	-28	15	1.5	C.A.	civile	88	0.00	0.00	50.28	0.00		0.000%	0
88_hip2	0.3%	10.6	6.7	0.4	0	-54	-28	12	4.5	C.A.	civile	88_hip2	0.00	0.00	70.38	0.00		0.000%	0


Vp=0.3% k= 0.4
Building number
Damage Class (Boscardin&Cording)
Damage class
0
1
2
3
4
1
2
3_hip2
5
6
7
9
11
12_hip2
14
16
17_hip2
19
21
23
26
28
30
32
34
36
38
40
42
44
46
47_hip2
49
50
52
54
56
58
60
62
64
64-1-2
64-1-2_hip2
65
66_hip2
68
69_hip2
71
73
74
75
76_hip2
77_hip2
79
81
82_1-2
83
85
86_1-3
86_3-3
88

DATI INPUT_SUBSIDENZE												DATI OUTPUT_SUBSIDENZE						
Buildings	VP	Diam	Copertura da p.c.	K	dist canne	A	B	altezza	fondazioni	BRICKWORK / C.A. /MIXED	destinazione	Buildings	Ced_A	Ced_B	Ced_max bacino	Ced_max edificio	ε SAGG	ε HOGG	Damage Class (Boscardin&Cording)
-	%	m	m	-	m	m	m	m	m	-	-	-	mm	mm	mm	mm	%	%	-
1	0.5%	10.6	13	0.6	0	30	68	23	1.5	C.A.	civile	1	0.42	0.00	34.93	0.42		0.007%	0
1_hip2	0.5%	10.6	13	0.6	0	30	68	17	7.5	C.A.	civile	1_hip2	0.00	0.00	54.33	0.00		0.000%	0
2	0.5%	10.6	13	0.6	0	-22	14	9	1.5	BRICKWORK	militare	2	VEDI APPROFONDIMENTO ANALISI FEM						
3	0.5%	10.6	12	0.6	0	34	69	19	1.5	C.A.	civile	3	0.06	0.00	37.14	0.06		0.001%	0
3_hip2	0.5%	10.6	12	0.6	0	34	69	16	4.5	C.A.	civile	3_hip2	0.00	0.00	45.84	0.00		0.000%	0
4	0.5%	10.6	12	0.6	0	-2	38	13	1.5	C.A.	militare	4	36.32	0.01	37.14	37.14	0.042%	0.067%	1
5	0.5%	10.6	16	0.6	0	40	50	17	1.5	C.A.	civile	5	0.10	0.00	29.63	0.10		0.002%	0
5_hip2	0.5%	10.6	16	0.6	0	40	50	14	4.5	C.A.	civile	5_hip2	0.01	0.00	34.93	0.01		0.000%	0
6	0.5%	10.6	13	0.6	0	-27	52	13	1.5	BRICKWORK	militare	6	VEDI APPROFONDIMENTO ANALISI FEM						
6_hip2	0.5%	10.6	13	0.6	0	-27	52	10	4.5	BRICKWORK	militare	6_hip2	VEDI APPROFONDIMENTO ANALISI FEM						
7	0.5%	10.6	16	0.6	0	20	30	3	1.5	C.A.	civile	7	7.18	1.22	29.63	7.18		0.057%	1
8	0.5%	10.6	20	0.6	0	-6	7	3	1.5	BRICKWORK	militare	8	22.57	21.86	24.65	24.65	0.026%	0.000%	0
9	0.5%	10.6	20	0.6	0	-52	-16	9	1.5	C.A.	militare	9	0.03	13.16	24.65	13.16		0.032%	0
10	0.5%	10.6	16	0.6	0	-50	-43	7	1.5	C.A.	militare	10	0.00	0.04	29.63	0.04		0.001%	0
11	0.5%	10.6	16	0.6	0	-50	-36	7	1.5	C.A.	militare	11	0.00	0.30	29.63	0.30		0.005%	0
12	0.5%	10.6	16	0.6	0	34	50	15	1.5	C.A.	civile	12	0.49	0.00	29.63	0.49		0.007%	0
12_hip2	0.5%	10.6	16	0.6	0	34	50	12	4.5	C.A.	civile	12_hip2	0.12	0.00	34.92	0.12		0.003%	0
13	0.5%	10.6	25	0.6	0	-42	-8	7	1.5	C.A.	civile	13	1.06	18.30	20.37	18.30	0.003%	0.027%	0
14	0.5%	10.6	24	0.6	0	-50	-42	13	1.5	C.A.	civile	14	0.24	0.89	21.11	0.89		0.012%	0
15	0.5%	10.6	25	0.6	0	-8	16	10	1.5	C.A.	civile	15	18.30	13.27	20.37	20.37	0.014%	0.000%	0
16	0.5%	10.6	24	0.6	0	-16	6	13	1.5	C.A.	civile	16	13.32	19.78	21.11	21.11	0.015%	0.000%	0
17	0.5%	10.6	25	0.6	0	42	50	15	1.5	C.A.	civile	17	1.06	0.31	20.37	1.06		0.013%	0
17_hip2	0.5%	10.6	25	0.6	0	42	50	12	4.5	C.A.	civile	17_hip2	0.57	0.12	22.74	0.57		0.009%	0
18	0.5%	10.6	24	0.6	0	34	45	13	1.5	C.A.	civile	18	2.64	0.55	21.11	2.64		0.022%	0
19	0.5%	10.6	24	0.6	0	4	24	13	1.5	C.A.	civile	19	20.51	7.50	21.11	20.51	0.006%	0.017%	0
20	0.5%	10.6	22	0.6	0	-33	-10	4	1.5	C.A.	civile	20	2.34	18.46	22.74	18.46	0.001%	0.034%	0
21	0.5%	10.6	20	0.6	0	-5	9	3	1.5	BRICKWORK	civile	21	23.19	20.21	24.65	24.65	0.027%	0.000%	0
22	0.5%	10.6	20	0.6	0	-50	-44	16	1.5	C.A.	civile	22	0.05	0.21	24.65	0.21		0.005%	0
23	0.5%	10.6	20	0.6	0	-24	-4	13	1.5	C.A.	civile	23	6.01	23.71	24.65	23.71	0.007%	0.031%	0
25	0.5%	10.6	20	0.6	0	-50	-31	10	1.5	C.A.	civile	25	0.05	2.34	24.65	2.34		0.016%	0
26	0.5%	10.6	20	0.6	0	-44	-24	3	1.5	C.A.	civile	26	0.21	6.01	24.65	6.01		0.033%	0
27	0.5%	10.6	19	0.6	0	-10	5	16	1.5	C.A.	civile	27	19.70	24.07	25.73	25.74	0.022%	0.000%	0
28	0.5%	10.6	19	0.6	0	17	48	13	1.5	C.A.	civile	28	11.89	0.05	25.73	11.89		0.033%	0
29	0.5%	10.6	20	0.6	0	35	44	13	1.5	C.A.	civile	29	1.22	0.21	24.65	1.22		0.016%	0
30	0.5%	10.6	20	0.6	0	42	50	13	1.5	C.A.	civile	30	0.33	0.05	24.65	0.33		0.006%	0
31	0.5%	10.6	21	0.6	0	-14	14	13	1.5	C.A.	civile	31	15.20	15.20	23.66	23.66	0.025%	0.000%	0
32	0.5%	10.6	21	0.6	0	6	16	2	1.5	C.A.	civile	32	21.81	13.27	23.66	21.81	0.004%	0.004%	0
33	0.5%	10.6	21	0.6	0	25	50	10	1.5	C.A.	civile	33	5.77	0.08	23.66	5.77		0.025%	0
34	0.5%	10.6	21	0.6	0	36	50	13	1.5	C.A.	civile	34	1.27	0.08	23.66	1.27		0.012%	0
35	0.5%	10.6	25	0.6	0	-5	50	3	1.5	C.A.	civile	35	19.54	0.31	20.37	20.37	0.010%	0.028%	0
36	0.5%	10.6	28	0.6	0	-50	-38	7	1.5	C.A.	civile	36	0.60	2.54	18.45	2.54		0.018%	0
37	0.5%	10.6	30	0.6	0	-48	-7	10	1.5	BRICKWORK	civile	37	1.05	16.36	17.36	16.36	0.004%	0.025%	0
38	0.5%	10.6	33	0.6	0	-48	-19	19	1.5	C.A.	civile	38	1.50	11.01	15.94	11.01	0.000%	0.016%	0
39	0.5%	10.6	33	0.6	0	4	16	6	1.5	C.A.	civile	39	15.69	12.26	15.94	15.69	0.003%	0.000%	0
40	0.5%	10.6	27	0.6	0	-5	30	16	1.5	C.A.	civile	40	18.37	5.10	19.05	19.05	0.011%	0.017%	0
41	0.5%	10.6	29	0.6	0	-32	10	19	1.5	C.A.	civile	41	4.77	15.72	17.89	17.89	0.012%	0.015%	0
42	0.5%	10.6	30	0.6	0	-50	-30	22	1.5	C.A.	civile	42	0.83	5.81	17.36	5.81		0.020%	0
43	0.5%	10.6	28	0.6	0	-5	32	20	1.5	C.A.	civile	43	17.83	4.52	18.45	18.45	0.011%	0.017%	0
44	0.5%	10.6	34	0.6	0	26	58	16	1.5	C.A.	civile	44	8.05	0.59	15.52	8.05		0.016%	0
45	0.5%	10.6	27	0.6	0	30	50	22	1.5	C.A.	civile	45	5.10	0.49	19.05	5.10		0.022%	0
46	0.5%	10.6	34	0.6	0	-50	-28	12	4.5	C.A.	civile	46	0.96	6.86	16.86	6.86		0.020%	0
47	0.5%	10.6	38	0.6	0	-46	-6	14	1.5	C.A.	civile	47	2.61	13.64	14.04	13.64	0.003%	0.011%	0
47_hip2	0.5%	10.6	38	0.6	0	-46	-6	11	4.5	C.A.	civile	47_hip2	2.15	14.63	15.12	14.63	0.003%	0.014%	0
48	0.5%	10.6	41	0.6	0	-26	11	16	4.5	C.A.	civile	48	8.20	12.75	14.04	14.04	0.007%	0.001%	0
49	0.5%	10.6	38	0.6	0	7	30	17	1.5	C.A.	civile	49	13.50	6.86	14.04	13.50	0.002%	0.004%	0
49_hip2	0.5%	10.6	38	0.6	0	7	30	14	4.5	C.A.	civile	49_hip2	14.45	6.59	15.12	14.45	0.003%	0.006%	0
50	0.5%	10.6	44	0.6	0	-50	-32	13	1.5	C.A.	civile	50	2.69	6.59	12.28	6.59		0.009%	0
51	0.5%	10.6	44	0.6	0	-12	8	17	1.5	C.A.	civile	51	11.25	11.81	12.28	12.28	0.003%	0.000%	0
52	0.5%	10.6	42	0.6	0	4	54	19	1.5	C.A.	civile	52	12.68	1.86	12.81	12.68	0.003%	0.010%	0
53	0.5%	10.6	41	0.6	0	34	50	13	1.5	C.A.	civile	53	5.89	2.32	13.10	5.89		0.012%	0
54	0.5%	10.6	47	0.6	0	-14	-5	7	1.5	C.A.	civile	54	10.39	11.40	11.55	11.40	0.001%	0.000%	0
55	0.5%	10.6	47	0.6	0	-6	10	10	1.5	C.A.	civile	55	11.33	10.95	11.55	11.55	0.002%	0.000%	0
56	0.5%	10.6	47	0.6	0	14	37	17	1.5	C.A.	civile	56	10.39	5.53	11.55	10.39	0.001%	0.003%	0
57	0.5%	10.6	47	0.6	0	36	50	19	1.5	C.A.	civile	57	5.75	3.01	11.55	5.75		0.008%	0
58	0.5%	10.6	49	0.6	0	-40	-7	8	1.5	BRICKWORK	civile	58	5.01	10.84	11.11	10.84	0.003%	0.003%	0
59	0.5%	10.6	50	0.6	0	-50	-44	16	1.5	C.A.	civile	59	3.29	4.31	10.91	4.31		0.008%	0
60	0.5%	10.6	50	0.6	0	24	46	16	1.5	C.A.	civile	60	8.27	3.95	10.91	8.27	0.000%	0.004%	0
61	0.5%	10.6	52	0.6	0	-5	26	13	1.5	C.A.	civile	61	10.40	7.78	10.52	10.52	0.002%	0.000%	0
62	0.5%	10.6	52	0.6	0	40	50	16	1.5	C.A.	civile	62	5.15	3.45	10.52	5.15		0.006%	0
63	0.5%	10.6	50	0.6	0	18	58	16	1.5	C.A.	civile	63	9.34	2.17	10.91	9.34	0.001%	0.007%	0
64	0.5%	10.6	50	0.6	0	-32	8	12	1.5	C.A.	civile	64	6.67	10.58	10.91	10.91	0.003%	0.000%	0
64_hip2	0.5%	10.6	50	0.6	0	-32	8	9	4.5	C.A.	civile	64_hip2	6.66	11.16	11.55	11.55	0.003%	0.001%	0
64-1-2	0.5%	10.6	50	0.6	0	-32	-10	12	1.5	C.A.	civile	64-1/2	6.67	10.40	10.91	10.40	0.001%	0.000%	0
64-2-2	0.5%	10.6	50	0.6	0	-10	8	9	1.5	C.A.	civile	64-2/2	10.40	10.58	10.91	10.91	0.002%	0.000%	0
64-1-2_hip2	0.5%	10.6	50	0.6	0	-32	-10	9	4.5	C.A.		64-1/2_hip2	6.66	10.95	11.55	10.95	0.001%	0.001%	0
64-2-2_hip2	0.5%	10.6	50	0.6	0	-10	8	6	4.5	C.A.		64-2/2_hip2	10.95	11.16	11.55	11.55	0.002%	0.000%	0
65	0.5%	10.6	47	0.6	0	-66	-30	20	1.5	C.A.	civile	65	1.11	7.12	11.55	7.12	0.000%	0.008%	0
66	0.5%	10.6	47	0.6	0	-20	8	25	1.5	C.A.	civile	66	9.31	11.16	11.55	11.55	0.004%	0.000%	0
66_hip2	0.5%	10.6	47	0.6	0	-20	8	19	7.5	C.A.	civile	66_hip2	9.93	12.53	13.10	13.10	0.005%	0.000%	0
67	0.5%	10.6	47	0.6	0	15	32	16	4.5	C.A.	civile	67	10.71	6.59	12.28	10.71	0.001%	0.002%	0
68	0.5%	10.6	47	0.6	0	38	78	17	4.5	C.A.	civile	68	5.10	0.30	12.28	5.10		0.010%	0
69	0.5%	10.6	47	0.6	0	8	26	17	1.5	C.A.	civile	69	11.16	8.03	11.55	11.16	0.002%	0.000%	0
69_hip2	0.5%	10.6	47	0.6	0	8	26	14	4.5	C.A.	civile	69_hip2	11.81	8.14	12.28	11.81	0.002%	0.000%	0
70	0.5%	10.6	47	0.6	0	-54	-12	17	1.5	C.A.	civile	70	2.40	10.69	11.55	10.69	0.001%	0.007%	0
71	0.5%	10.6	47	0.6	0	7	42	20	1.5	C.A.	civile	71	11.25	4.47	11.55	11.25	0.002%	0.004%	0
72	0.5%	10.6	47	0.6	0	-26	-5	19	1.5	C.A.	civile	72	8.03	11.40	11.55	11.40	0.002%	0.000%	0
73	0.5%	10.6	46	0.6	0	-48	-16	22	1.5	C.A.	civile	73	3.24	10.21	11.78	10.21	0.001%	0.007%	0
73_hip2	0.5%	10.6	46	0.6	0	-48	-16	16	7.5	C.A.	civile	73_hip2	2.53	11.13	13.40	11.13	0.001%	0.010%	0
74	0.5%	10.6	46	0.6	0	20	10	15	1.5	C.A.	civile	74	9.42	11.14	11.78	11.14	0.001%	0.000%	0
74_hip2	0.5%	10.6	46	0.6	0	20	10	12	4.5	C.A.	civile	74_hip2	9.73	11.77	12.54	11.77	0.001%	0.000%	0
75	0.5%	10.6	48	0.6	0	-18	68	10	1.5	C.A.	civile	75	9.58	1.03	11.33	11.33	0.004%	0.008%	0
76	0.5%	10.6	66	0.6	0	-92	90	44	1.5	C.A.	civile	76	0.75	0.84	8.41	8.41	0.003%	0.004%	0
76_hip2	0.5%	10.6	66	0.6	0	-92	90	38	7.5	C.A.	civile	76_hip2	0.51	0.58	9.20	9.20	0.004%	0.005%	0
77	0.5%	10.6	40	0.6	0	38	62	14	1.5	C.A.	civile	77	4.71	0.83	13.40	4.71		0.013%	0
77_hip2	0.5%	10.6	40	0.6	0	38	62	8.5	7	C.A.	civile	77_hip2	3.90	0.40	15.32	3.90		0.014%	0
78	0.5%	10.6	50	0.6	0	9	64	28	1.5	C.A.	civile	78	10.49	1.53	10.91	10.49	0.001%	0.007%	0
79	0.5%	10.6	50	0.6	0	-24	4	13	1.5	C.A.	civile	79	8.27	10.82	10.91	10.91	0.003%	0.000%	0
80	0.5%	10.6	50	0.6	0	-44	-10	10	1.5	C.A.	civile	80	4.31	10.40	10.91	10.40	0.001%	0.004%	0
81	0.5%	10.6	40	0.6	0	-68	-42	22	1.5	C.A.	civile	81	0.47	3.74	13.40	3.74		0.011%	0
82	0.5%	10.6	41	0.6	0	-14	24	13	1.5	C.A.	civile	82	11.44	8.79	13.10	13.10	0.005%	0.000%	0
82_1-2	0.5%	10.6	41	0.6	0	-14	5	3	1.5	C.A.	civile	82_1/2	11.44	12.87	13.10	13.10	0.003%	0.000%	0
82_2-2	0.5%	10.6	41	0.6	0	5	24	13	1.5	C.A.	civile	82_2/2	12.87	8.79	13.10	12.87	0.002%	0.000%	0
83	0.5%	10.6	48	0.6	0	24	63	13	1.5	C.A.	civile	83	8.41	1.45	11.33	8.41	0.000%	0.008%	0
84	0.5%	10.6	48	0.6	0	-18	21	14	1.5	C.A.	civile	84	9.58	9.02	11.33	11.33	0.004%	0.000%	0
85	0.5%	10.6	54	0.6	0	-55	-44	14	1.5	C.A.	civile	85	2.89	4.54	10.15	4.54		0.006%	0
86	0.5%	10.6	54	0.6	0	-34	14	17	1.5	C.A.	civile	86	6.28	9.36	10.15	10.15	0.003%	0.000%	0
86_1-3	0.5%	10.6	54	0.6	0	-34	-24	3	1.5	C.A.	civile	86_1/3	6.28	7.99	10.15	7.99	0.000%	0.000%	0
86_2-3	0.5%	10.6	54	0.6	0	-24	-5	17	1.5	C.A.	civile	86_2/3	7.99	10.05	10.15	10.05	0.001%	0.000%	0
86_3-3	0.5%	10.6	54	0.6	0	-5	14	9	1.5	C.A.	civile	86_3/3	10.05	9.36	10.15	10.15	0.002%	0.000%	0
87	0.5%	10.6	23.4	0.6	0	15	56	17	4.5	C.A.	civile	87	14.22	0.01	24.25	14.22		0.029%	0
88	0.5%	10.6	6.7	0.6	0	-54	-28	15	1.5	C.A.	civile	88	0.00	0.00	55.88	0.00		0.000%	0
88_hip2	0.5%	10.6	6.7	0.6	0	-54	-28	12	4.5	C.A.	civile	88_hip2	0.00	0.00	78.22	0.00		0.000%	0


Vp=0.5% k= 0.6
Building number
Damage class
Damage Class (Boscardin&Cording)
0
1
2
3
4
1
2
3_hip2
5
6
7
9
11
12_hip2
14
16
17_hip2
19
21
23
26
28
30
32
34
36
38
40
42
44
46
47_hip2
49
50
52
54
56
58
60
62
64
64-1-2
64-1-2_hip2
65
66_hip2
68
69_hip2
71
73
74
75
76_hip2
77_hip2
79
81
82_1-2
83
85
86_1-3
86_3-3
88

DATI INPUT_SUBSIDENZE												DATI OUTPUT_SUBSIDENZE						
Buildings	VP	Diam	Copertura da p.c.	K	dist canne	A	B	altezza	fondazioni	BRICKWORK / C.A. /MIXED	destinazione	Buildings	Ced_A	Ced_B	Ced_max bacino	Ced_max edificio	ε SAGG	ε HOGG	Damage Class (Boscardin&Cording)
-	%	m	m	-	m	m	m	m	m	-	-	-	mm	mm	mm	mm	%	%	-
1	0.3%	10.6	13	0.6	0	30	68	23	1.5	C.A.	civile	1	0.25	0.00	20.96	0.25		0.004%	0
1_hip2	0.3%	10.6	13	0.6	0	30	68	17	7.5	C.A.	civile	1_hip2	0.00	0.00	32.60	0.00		0.000%	0
2	0.3%	10.6	13	0.6	0	-22	14	9	1.5	BRICKWORK	militare	2	VEDI APPROFONDIMENTO ANALISI FEM						
3	0.3%	10.6	12	0.6	0	34	69	19	1.5	C.A.	civile	3	0.04	0.00	22.28	0.04		0.001%	0
3_hip2	0.3%	10.6	12	0.6	0	34	69	16	4.5	C.A.	civile	3_hip2	0.00	0.00	27.50	0.00		0.000%	0
4	0.3%	10.6	12	0.6	0	-2	38	13	1.5	C.A.	militare	4	21.79	0.01	22.28	22.28	0.025%	0.040%	0
5	0.3%	10.6	16	0.6	0	40	50	17	1.5	C.A.	civile	5	0.06	0.00	17.78	0.06		0.001%	0
5_hip2	0.3%	10.6	16	0.6	0	40	50	14	4.5	C.A.	civile	5_hip2	0.01	0.00	20.96	0.01		0.000%	0
6	0.3%	10.6	13	0.6	0	-27	52	13	1.5	BRICKWORK	militare	6	VEDI APPROFONDIMENTO ANALISI FEM						
6_hip2	0.3%	10.6	13	0.6	0	-27	52	10	4.5	BRICKWORK	militare	6_hip2	VEDI APPROFONDIMENTO ANALISI FEM						
7	0.3%	10.6	16	0.6	0	20	30	3	1.5	C.A.	civile	7	4.31	0.73	17.78	4.31		0.034%	0
8	0.3%	10.6	20	0.6	0	-6	7	3	1.5	BRICKWORK	militare	8	13.54	13.12	14.79	14.79	0.016%	0.000%	0
9	0.3%	10.6	20	0.6	0	-52	-16	9	1.5	C.A.	militare	9	0.02	7.90	14.79	7.90		0.019%	0
10	0.3%	10.6	16	0.6	0	-50	-43	7	1.5	C.A.	militare	10	0.00	0.03	17.78	0.03		0.001%	0
11	0.3%	10.6	16	0.6	0	-50	-36	7	1.5	C.A.	militare	11	0.00	0.18	17.78	0.18		0.003%	0
12	0.3%	10.6	16	0.6	0	34	50	15	1.5	C.A.	civile	12	0.30	0.00	17.78	0.30		0.004%	0
12_hip2	0.3%	10.6	16	0.6	0	34	50	12	4.5	C.A.	civile	12_hip2	0.07	0.00	20.95	0.07		0.002%	0
13	0.3%	10.6	25	0.6	0	-42	-8	7	1.5	C.A.	civile	13	0.64	10.98	12.22	10.98	0.002%	0.016%	0
14	0.3%	10.6	24	0.6	0	-50	-42	13	1.5	C.A.	civile	14	0.14	0.53	12.66	0.53		0.007%	0
15	0.3%	10.6	25	0.6	0	-8	16	10	1.5	C.A.	civile	15	10.98	7.96	12.22	12.22	0.008%	0.000%	0
16	0.3%	10.6	24	0.6	0	-16	6	13	1.5	C.A.	civile	16	7.99	11.87	12.66	12.66	0.009%	0.000%	0
17	0.3%	10.6	25	0.6	0	42	50	15	1.5	C.A.	civile	17	0.64	0.19	12.22	0.64		0.008%	0
17_hip2	0.3%	10.6	25	0.6	0	42	50	12	4.5	C.A.	civile	17_hip2	0.34	0.07	13.65	0.34		0.005%	0
18	0.3%	10.6	24	0.6	0	34	45	13	1.5	C.A.	civile	18	1.59	0.33	12.66	1.59		0.013%	0
19	0.3%	10.6	24	0.6	0	4	24	13	1.5	C.A.	civile	19	12.30	4.50	12.66	12.30	0.004%	0.010%	0
20	0.3%	10.6	22	0.6	0	-33	-10	4	1.5	C.A.	civile	20	1.41	11.08	13.65	11.08	0.001%	0.020%	0
21	0.3%	10.6	20	0.6	0	-5	9	3	1.5	BRICKWORK	civile	21	13.91	12.13	14.79	14.79	0.016%	0.000%	0
22	0.3%	10.6	20	0.6	0	-50	-44	16	1.5	C.A.	civile	22	0.03	0.13	14.79	0.13		0.003%	0
23	0.3%	10.6	20	0.6	0	-24	-4	13	1.5	C.A.	civile	23	3.60	14.22	14.79	14.22	0.004%	0.018%	0
25	0.3%	10.6	20	0.6	0	-50	-31	10	1.5	C.A.	civile	25	0.03	1.40	14.79	1.40		0.010%	0
26	0.3%	10.6	20	0.6	0	-44	-24	3	1.5	C.A.	civile	26	0.13	3.60	14.79	3.60		0.020%	0
27	0.3%	10.6	19	0.6	0	-10	5	16	1.5	C.A.	civile	27	11.82	14.44	15.44	15.44	0.013%	0.000%	0
28	0.3%	10.6	19	0.6	0	17	48	13	1.5	C.A.	civile	28	7.13	0.03	15.44	7.13		0.020%	0
29	0.3%	10.6	20	0.6	0	35	44	13	1.5	C.A.	civile	29	0.73	0.13	14.79	0.73		0.009%	0
30	0.3%	10.6	20	0.6	0	42	50	13	1.5	C.A.	civile	30	0.20	0.03	14.79	0.20		0.004%	0
31	0.3%	10.6	21	0.6	0	-14	14	13	1.5	C.A.	civile	31	9.12	9.12	14.20	14.20	0.015%	0.000%	0
32	0.3%	10.6	21	0.6	0	6	16	2	1.5	C.A.	civile	32	13.09	7.96	14.20	13.09	0.002%	0.003%	0
33	0.3%	10.6	21	0.6	0	25	50	10	1.5	C.A.	civile	33	3.46	0.05	14.20	3.46		0.015%	0
34	0.3%	10.6	21	0.6	0	36	50	13	1.5	C.A.	civile	34	0.76	0.05	14.20	0.76		0.007%	0
35	0.3%	10.6	25	0.6	0	-5	50	3	1.5	C.A.	civile	35	11.72	0.19	12.22	12.22	0.006%	0.017%	0
36	0.3%	10.6	28	0.6	0	-50	-38	7	1.5	C.A.	civile	36	0.36	1.52	11.07	1.52		0.011%	0
37	0.3%	10.6	30	0.6	0	-48	-7	10	1.5	BRICKWORK	civile	37	0.63	9.81	10.42	9.81	0.002%	0.015%	0
38	0.3%	10.6	33	0.6	0	-48	-19	19	1.5	C.A.	civile	38	0.90	6.61	9.57	6.61	0.000%	0.009%	0
39	0.3%	10.6	33	0.6	0	4	16	6	1.5	C.A.	civile	39	9.41	7.36	9.57	9.41	0.002%	0.000%	0
40	0.3%	10.6	27	0.6	0	-5	30	16	1.5	C.A.	civile	40	11.02	3.06	11.43	11.43	0.007%	0.010%	0
41	0.3%	10.6	29	0.6	0	-32	10	19	1.5	C.A.	civile	41	2.86	9.43	10.73	10.73	0.007%	0.009%	0
42	0.3%	10.6	30	0.6	0	-50	-30	22	1.5	C.A.	civile	42	0.50	3.49	10.42	3.49		0.012%	0
43	0.3%	10.6	28	0.6	0	-5	32	20	1.5	C.A.	civile	43	10.70	2.71	11.07	11.07	0.006%	0.010%	0
44	0.3%	10.6	34	0.6	0	26	58	16	1.5	C.A.	civile	44	4.83	0.35	9.31	4.83		0.010%	0
45	0.3%	10.6	27	0.6	0	30	50	22	1.5	C.A.	civile	45	3.06	0.29	11.43	3.06		0.013%	0
46	0.3%	10.6	34	0.6	0	-50	-28	12	4.5	C.A.	civile	46	0.58	4.12	10.12	4.12		0.012%	0
47	0.3%	10.6	38	0.6	0	-46	-6	14	1.5	C.A.	civile	47	1.57	8.18	8.42	8.18	0.002%	0.007%	0
47_hip2	0.3%	10.6	38	0.6	0	-46	-6	11	4.5	C.A.	civile	47_hip2	1.29	8.78	9.07	8.78	0.002%	0.008%	0
48	0.3%	10.6	41	0.6	0	-26	11	16	4.5	C.A.	civile	48	4.92	7.65	8.42	8.42	0.004%	0.000%	0
49	0.3%	10.6	38	0.6	0	7	30	17	1.5	C.A.	civile	49	8.10	4.12	8.42	8.10	0.001%	0.002%	0
49_hip2	0.3%	10.6	38	0.6	0	7	30	14	4.5	C.A.	civile	49_hip2	8.67	3.96	9.07	8.67	0.002%	0.004%	0
50	0.3%	10.6	44	0.6	0	-50	-32	13	1.5	C.A.	civile	50	1.61	3.95	7.37	3.95		0.005%	0
51	0.3%	10.6	44	0.6	0	-12	8	17	1.5	C.A.	civile	51	6.75	7.08	7.37	7.37	0.002%	0.000%	0
52	0.3%	10.6	42	0.6	0	4	54	19	1.5	C.A.	civile	52	7.61	1.11	7.69	7.61	0.002%	0.006%	0
53	0.3%	10.6	41	0.6	0	34	50	13	1.5	C.A.	civile	53	3.53	1.39	7.86	3.53		0.007%	0
54	0.3%	10.6	47	0.6	0	-14	-5	7	1.5	C.A.	civile	54	6.24	6.84	6.93	6.84	0.001%	0.000%	0
55	0.3%	10.6	47	0.6	0	-6	10	10	1.5	C.A.	civile	55	6.80	6.57	6.93	6.93	0.001%	0.000%	0
56	0.3%	10.6	47	0.6	0	14	37	17	1.5	C.A.	civile	56	6.24	3.32	6.93	6.24	0.001%	0.002%	0
57	0.3%	10.6	47	0.6	0	36	50	19	1.5	C.A.	civile	57	3.45	1.80	6.93	3.45		0.005%	0
58	0.3%	10.6	49	0.6	0	-40	-7	8	1.5	BRICKWORK	civile	58	3.00	6.51	6.67	6.51	0.002%	0.002%	0
59	0.3%	10.6	50	0.6	0	-50	-44	16	1.5	C.A.	civile	59	1.97	2.58	6.54	2.58		0.005%	0
60	0.3%	10.6	50	0.6	0	24	46	16	1.5	C.A.	civile	60	4.96	2.37	6.54	4.96	0.000%	0.003%	0
61	0.3%	10.6	52	0.6	0	-5	26	13	1.5	C.A.	civile	61	6.24	4.67	6.31	6.31	0.001%	0.000%	0
62	0.3%	10.6	52	0.6	0	40	50	16	1.5	C.A.	civile	62	3.09	2.07	6.31	3.09		0.004%	0
63	0.3%	10.6	50	0.6	0	18	58	16	1.5	C.A.	civile	63	5.60	1.30	6.54	5.60	0.000%	0.004%	0
64	0.3%	10.6	50	0.6	0	-32	8	12	1.5	C.A.	civile	64	4.00	6.35	6.54	6.54	0.002%	0.000%	0
64_hip2	0.3%	10.6	50	0.6	0	-32	8	9	4.5	C.A.	civile	64_hip2	3.99	6.70	6.93	6.93	0.002%	0.000%	0
64-1-2	0.3%	10.6	50	0.6	0	-32	-10	12	1.5	C.A.	civile	64-1/2	4.00	6.24	6.54	6.24	0.001%	0.000%	0
64-2-2	0.3%	10.6	50	0.6	0	-10	8	9	1.5	C.A.	civile	64-2/2	6.24	6.35	6.54	6.54	0.001%	0.000%	0
64-1-2_hip2	0.3%	10.6	50	0.6	0	-32	-10	9	4.5	C.A.		64-1/2_hip2	3.99	6.57	6.93	6.57	0.001%	0.000%	0
64-2-2_hip2	0.3%	10.6	50	0.6	0	-10	8	6	4.5	C.A.		64-2/2_hip2	6.57	6.70	6.93	6.93	0.001%	0.000%	0
65	0.3%	10.6	47	0.6	0	-66	-30	20	1.5	C.A.	civile	65	0.66	4.27	6.93	4.27	0.000%	0.005%	0
66	0.3%	10.6	47	0.6	0	-20	8	25	1.5	C.A.	civile	66	5.59	6.70	6.93	6.93	0.002%	0.000%	0
66_hip2	0.3%	10.6	47	0.6	0	-20	8	19	7.5	C.A.	civile	66_hip2	5.96	7.52	7.86	7.86	0.003%	0.000%	0
67	0.3%	10.6	47	0.6	0	15	32	16	4.5	C.A.	civile	67	6.42	3.95	7.37	6.42	0.000%	0.001%	0
68	0.3%	10.6	47	0.6	0	38	78	17	4.5	C.A.	civile	68	3.06	0.18	7.37	3.06		0.006%	0
69	0.3%	10.6	47	0.6	0	8	26	17	1.5	C.A.	civile	69	6.70	4.82	6.93	6.70	0.001%	0.000%	0
69_hip2	0.3%	10.6	47	0.6	0	8	26	14	4.5	C.A.	civile	69_hip2	7.08	4.88	7.37	7.08	0.001%	0.000%	0
70	0.3%	10.6	47	0.6	0	-54	-12	17	1.5	C.A.	civile	70	1.44	6.41	6.93	6.41	0.001%	0.004%	0
71	0.3%	10.6	47	0.6	0	7	42	20	1.5	C.A.	civile	71	6.75	2.68	6.93	6.75	0.001%	0.003%	0
72	0.3%	10.6	47	0.6	0	-26	-5	19	1.5	C.A.	civile	72	4.82	6.84	6.93	6.84	0.001%	0.000%	0
73	0.3%	10.6	46	0.6	0	-48	-16	22	1.5	C.A.	civile	73	1.95	6.13	7.07	6.13	0.000%	0.004%	0
73_hip2	0.3%	10.6	46	0.6	0	-48	-16	16	7.5	C.A.	civile	73_hip2	1.52	6.68	8.04	6.68	0.000%	0.006%	0
74	0.3%	10.6	46	0.6	0	20	10	15	1.5	C.A.	civile	74	5.65	6.68	7.07	6.68	0.001%	0.000%	0
74_hip2	0.3%	10.6	46	0.6	0	20	10	12	4.5	C.A.	civile	74_hip2	5.84	7.06	7.52	7.06	0.001%	0.000%	0
75	0.3%	10.6	48	0.6	0	-18	68	10	1.5	C.A.	civile	75	5.75	0.62	6.80	6.80	0.002%	0.005%	0
76	0.3%	10.6	66	0.6	0	-92	90	44	1.5	C.A.	civile	76	0.45	0.50	5.04	5.04	0.002%	0.003%	0
76_hip2	0.3%	10.6	66	0.6	0	-92	90	38	7.5	C.A.	civile	76_hip2	0.31	0.35	5.52	5.52	0.002%	0.003%	0
77	0.3%	10.6	40	0.6	0	38	62	14	1.5	C.A.	civile	77	2.83	0.50	8.04	2.83		0.008%	0
77_hip2	0.3%	10.6	40	0.6	0	38	62	8.5	7	C.A.	civile	77_hip2	2.34	0.24	9.19	2.34		0.008%	0
78	0.3%	10.6	50	0.6	0	9	64	28	1.5	C.A.	civile	78	6.29	0.92	6.54	6.29	0.001%	0.004%	0
79	0.3%	10.6	50	0.6	0	-24	4	13	1.5	C.A.	civile	79	4.96	6.49	6.54	6.54	0.002%	0.000%	0
80	0.3%	10.6	50	0.6	0	-44	-10	10	1.5	C.A.	civile	80	2.58	6.24	6.54	6.24	0.001%	0.002%	0
81	0.3%	10.6	40	0.6	0	-68	-42	22	1.5	C.A.	civile	81	0.28	2.24	8.04	2.24		0.007%	0
82	0.3%	10.6	41	0.6	0	-14	24	13	1.5	C.A.	civile	82	6.86	5.28	7.86	7.86	0.003%	0.000%	0
82_1-2	0.3%	10.6	41	0.6	0	-14	5	3	1.5	C.A.	civile	82_1/2	6.86	7.72	7.86	7.86	0.002%	0.000%	0
82_2-2	0.3%	10.6	41	0.6	0	5	24	13	1.5	C.A.	civile	82_2/2	7.72	5.28	7.86	7.72	0.001%	0.000%	0
83	0.3%	10.6	48	0.6	0	24	63	13	1.5	C.A.	civile	83	5.04	0.87	6.80	5.04	0.000%	0.005%	0
84	0.3%	10.6	48	0.6	0	-18	21	14	1.5	C.A.	civile	84	5.75	5.41	6.80	6.80	0.002%	0.000%	0
85	0.3%	10.6	54	0.6	0	-55	-44	14	1.5	C.A.	civile	85	1.73	2.72	6.09	2.72		0.004%	0
86	0.3%	10.6	54	0.6	0	-34	14	17	1.5	C.A.	civile	86	3.77	5.61	6.09	6.09	0.002%	0.000%	0
86_1-3	0.3%	10.6	54	0.6	0	-34	-24	3	1.5	C.A.	civile	86_1/3	3.77	4.79	6.09	4.79	0.000%	0.000%	0
86_2-3	0.3%	10.6	54	0.6	0	-24	-5	17	1.5	C.A.	civile	86_2/3	4.79	6.03	6.09	6.03	0.001%	0.000%	0
86_3-3	0.3%	10.6	54	0.6	0	-5	14	9	1.5	C.A.	civile	86_3/3	6.03	5.61	6.09	6.09	0.001%	0.000%	0
87	0.3%	10.6	23.4	0.6	0	15	56	17	4.5	C.A.	civile	87	8.53	0.01	14.55	8.53		0.017%	0
88	0.3%	10.6	6.7	0.6	0	-54	-28	15	1.5	C.A.	civile	88	0.00	0.00	33.53	0.00		0.000%	0
88_hip2	0.3%	10.6	6.7	0.6	0	-54	-28	12	4.5	C.A.	civile	88_hip2	0.00	0.00	46.93	0.00		0.000%	0

Riepilogo risultati:

	Vp = 0.5% k= 0.4 - fondazioni dirette a quota <= 1.5 m						
	Classe di danno Boscardin						TOT
Classe	0	1	2	3	4	5	-
N° Edifici	102	4	3	0	0	0	109
% edifici	93%	4%	3%	0%	0%	0%	100%

	Vp = 0.3% k= 0.4 - fondazioni dirette a quota <= 1.5 m						
	Classe di danno Boscardin						TOT
Classe	0	1	2	3	4	5	-
N° Edifici	107	2	0	0	0	0	109
% edifici	96%	2%	0%	0%	0%	0%	100%

	Vp = 0.5 % k= 0.6 - fondazioni dirette a quota <= 1.5 m						
	Classe di danno Boscardin						TOT
Classe	0	1	2	3	4	5	-
N° Edifici	107	2	0	0	0	0	109
% edifici	96%	2%	0%	0%	0%	0%	100%

	Vp = 0.3% k= 0.6 - fondazioni dirette a quota <= 1.5 m						
	Classe di danno Boscardin						TOT
Classe	0	1	2	3	4	5	-
N° Edifici	109	0	0	0	0	0	109
% edifici	100%	0%	0%	0%	0%	0%	100%

Si può osservare come i fabbricati ricadenti in classe 3 sono solo tre e nel caso di volume perso pari allo 0.5% in presenza di un valore di K = 0.4, ovvero di dati di input in generale conservativi. Verranno comunque approfonditi con analisi agli elementi finiti.

Per gli edifici che presentano una distanza ridotta tra il piano di posa delle fondazioni e la galleria, ovvero per gli 88 edifici all'interno del dominio di interferenza, è stato predisposto un piano di monitoraggio specifico. Questo consentirà di misurare in fase di avanzamento dello scavo i cedimenti indotti e valutarne il loro impatto in termini strutturali e funzionali sulle strutture esistenti. I risultati dei monitoraggi andranno, in fase di scavo, interpretati alla luce delle modalità di avanzamento dello scavo e confrontati con le previsioni teoriche/numeriche. Per i dettagli sul piano di monitoraggio previsto si rimanda alla relazione specifica (doc. n. BIS2E-R-PMS00-RE02).

Si riportano in allegato le analisi di interferenza scavi-fabbricati con riferimento ai bacini di subsidenza trasversali determinati dallo scavo della galleria scolmatrice (risultati riferiti al caso Vp=0.3%, k=0.6 in quanto ritenuti maggiormente rappresentativi).

6 APPROFONDIMENTO DI STUDIO (FASE 2): ANALISI COMPARATIVA MEDIANTE MODELLI A ELEMENTI FINITI

Al fine di valutare i risultati ottenuti dalle analisi empiriche, sono state svolte analisi a elementi finiti 2D basate sui calcoli effettuati per il dimensionamento dei rivestimenti, Queste sezioni di calcolo non sono fatte su edifici specifici, come ad esempio quella fatta sui 2 edifici del Forte San Giuliano, ma sono utili per mettere in relazione i cedimenti e il bacino di subsidenza con la parametrizzazione geotecnica e con la modellazione del terreno visto come un continuo. Come si vedrà, si ottiene un regime di spostamento che è sensibilmente inferiore rispetto a quello previsto dalle valutazioni empiriche.

Per quanto riguarda la procedura operativa di analisi, si rimanda alle relazioni di calcolo BIS2E-R-OST00-RE02.

Per la valutazione degli effetti dello scavo in termini di subsidenze sulle preesistenze alle alte coperture non è stata svolta alcuna valutazione specifica in quanto il contesto geomeccanico e gli spessori di ricoprimento portano a valori di volume perso molto bassi e pertanto non rilevanti.

Questa osservazione è stata confermata dalle analisi svolte con coperture pari a 9÷10 diametri in cui si registrano cedimenti a piano campagna minimi come si evince dalle figure seguenti.

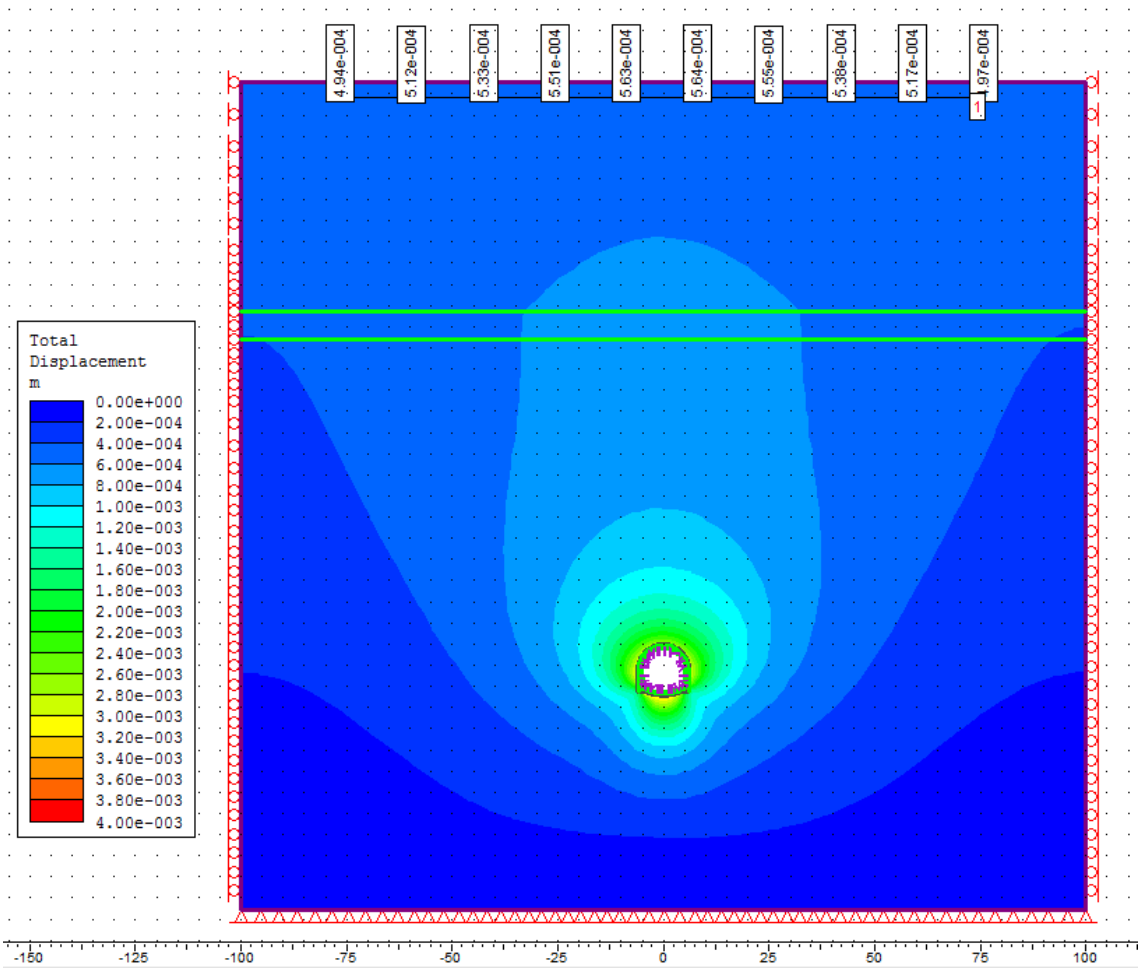


Figura 6-1 – Cedimenti superficiali – sezione 2 (Massima Copertura)

In particolare si osserva che il cedimento massimo in superficie risulta inferiore a 1 mm.

Per quanto riguarda le interferenze più critiche individuate nelle zone di imbocco, le analisi numeriche condotte hanno consentito di stimare i cedimenti attesi confermando l'adeguatezza della soluzione proposta. Per i dettagli relativi al calcolo si rimanda alla relazione BIS2E-R-OST00-RE02. Si riporta nel seguito la figura che rappresenta i cedimenti a piano campagna nella fase corrispondente all'installazione del rivestimento definitivo per le sezioni a basse coperture analizzate nella relazione tecnica e di calcolo dello scavo in tradizionale.

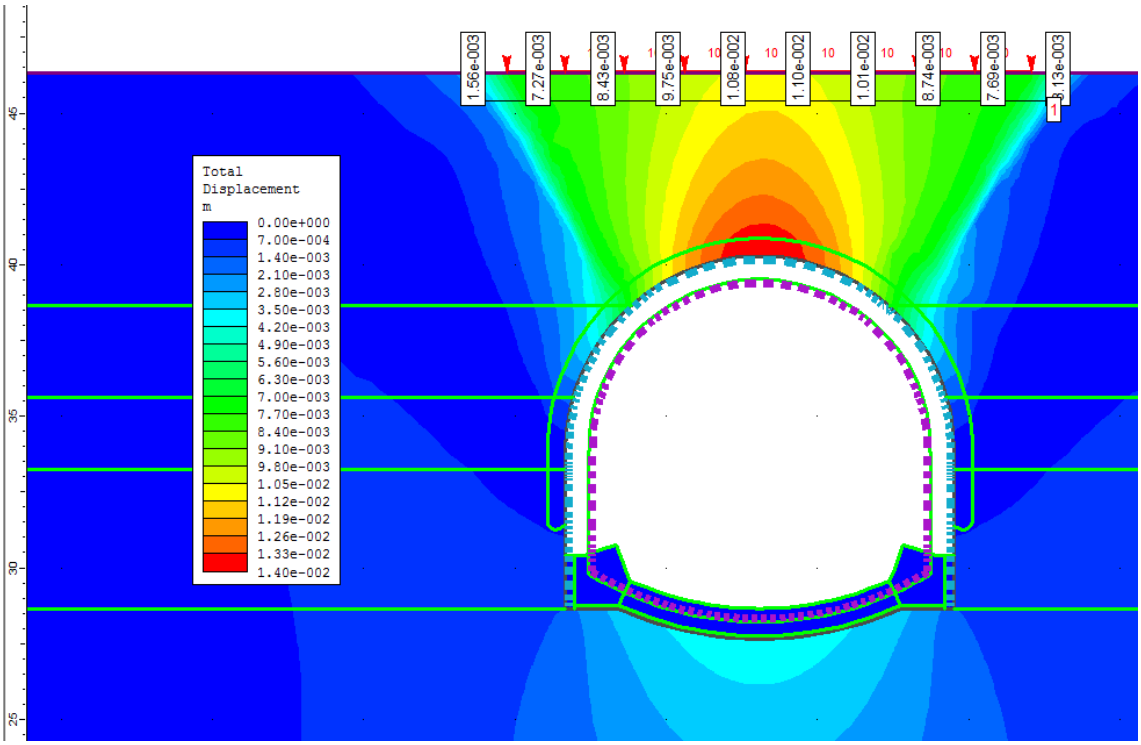


Figura 6-2 – Cedimenti superficiali – sezione 1 (Via Adamoli)

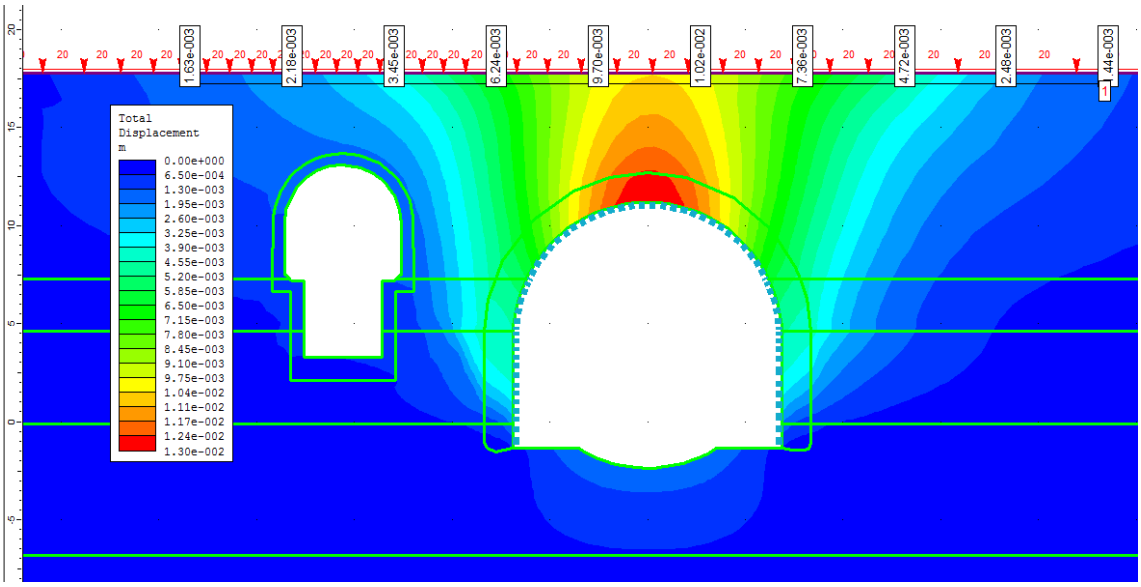
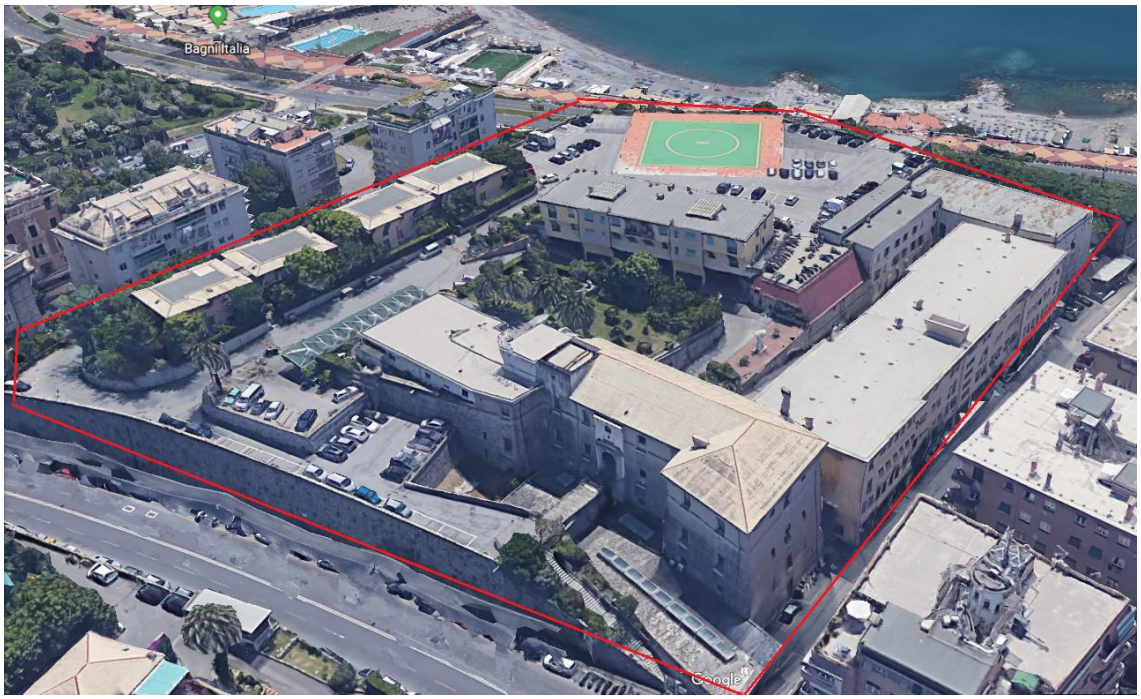


Figura 6-3 – Cedimenti superficiali – sezione 3 (C.so Italia)

Dalle figure sopra riportate si osserva che il cedimento massimo in superficie risulta sempre dell'ordine di 1 cm contro i 3.5÷5.0 cm delle analisi con metodo empirico. A tali fabbricati risultano quindi associate classi di danno decisamente più ridotte.

7 APPROFONDIMENTO DI STUDIO (FASE 2): IL FORTE SAN GIULIANO

Il Forte è un complesso costituito da 9 edifici principali ad uso militare che si trova nella zona tra corso Italia e via Pietro Gobetti all'altezza di via Forte di S. Giuliano. Dei 9 edifici del Forte, solo 7 sono situati all'interno del dominio di interferenza, in particolare gli edificinr. 2, 4, 6, 8, 9, 10, 11.



Dalle analisi empiriche condotte, risulta che gli edifici nr. 2, 4 e 6 siano quelli più critici, pertanto su questi sono stati svolti approfondimenti mediante analisi di fase 2.

Sezione 1 – pk0+194 – Caserma Nord Forte San Giuliano (edificio 6)

La sezione di analisi si caratterizza per la copertura ridotta (17 m da p.c.) e lo scavo al di sotto del complesso principale del Forte San Giuliano (entrata via Gobetti) risalente a meta '800 (identificato con il numero 6 nella planimetria del Progetto Esecutivo).

Il fabbricato si divide in due parti, quella ad Ovest rispetto alla galleria e costituita da quattro livelli con un'altezza dal piano di fondazione (18 m s.l.m. circa) pari a 21 m ed e realizzata interamente in muratura;la parte ad Est della galleria e stata eretta successivamente, e posta su di un terrapieno e raggiunge un'altezza di 3 m (d'ora in avanti con edificio 6 si farà riferimento alla parte sinistra in sezione e con edifico

6 bis alla parte destra del fabbricato in sezione). Come evidenziato in precedenza sono presenti dei local isotterranei alla quota del piano di fondazione del complesso.

La galleria del canale del Fereggiano corre accanto alla galleria dello Scolmatore del Bisagno (distanza trai rispettivi assi pari a 39.5 m). Nella analisi numerica e stato simulato lo scavo della galleria del Fereggiano per rappresentare al meglio lo stato tenso-deformativo dell'ammasso antecedente allo scavo della presente galleria.

Sezione 2 – pk0+100 – Caserma Forte San Giuliano – Mensa (edificio 2)

La sezione di analisi si caratterizza per la bassa copertura (12 m da p.c.) e lo scavo al di sotto degli edifici denominati "mensa" del complesso del Forte San Giuliano (identificati con il numero 4 e 2 nella planimetria del Progetto Esecutivo). Entrambi gli edifici sono realizzati in c.a. con solai in latero-cemento.

La galleria del canale del Fereggiano corre accanto alla galleria dello Scolmatore del Bisagno (distanza trai rispettivi assi pari a 17.2 m). Durante l'analisi numerica e stato simulato lo scavo della galleria del Fereggiano per rappresentare al meglio lo stato tenso-deformativo dell'ammasso antecedente allo scavo della presente galleria.



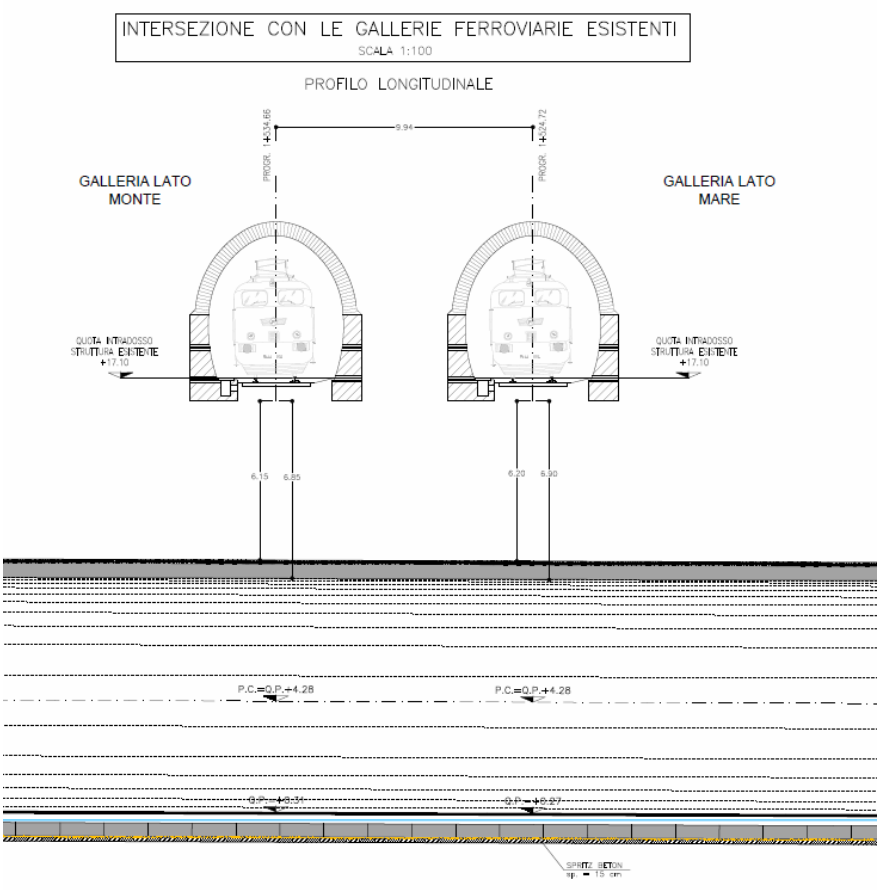
I dettagli delle analisi numeriche, svolte sia in presenza che in assenza di accoppiamento fluido meccanico, sono riportati in una specifica relazione di Progetto Esecutivo cui si rimanda (BIS2E-R-PMS00-RE04). I cedimenti verticali massimi, sono sempre inferiori al centimetro (7 mm) a differenza dei 35÷50 mm (Vp 0.3 % ÷ Vp 0.5%) calcolati con metodi empirici; questo ad ulteriore conferma della cautela dei risultati, in termini di cedimento, ricavati con approcci teorici/empirici.

I contenuti valori di cedimento e distorsione (inferiori allo 0.0002% nella zona di hogging e 0.0019% nella zona di sagging), determinano un declassamento dell'edificio, e quindi una diminuzione del rischio di danneggiamento, da classe di danno 2 alta a classe di danno 0. Si ribadisce che il monitoraggio di superficie e sugli edifici è di fondamentale importanza per confermare le ipotesi e le valutazioni progettuali e per tarare i parametri di avanzamento della macchina ed eventuali altri interventi di sostegno e presostegno in presenza di interferenze superficiali.

8 APPROFONDIMENTO DI STUDIO (FASE 2): INTERFERENZA CON LINEA FERROVIARIA ESISTENTE

8.1 Note generali

Alla progressiva 1+534, la galleria scolmatrice del Torrente Bisagno sottopassa la gallerie ferroviarie della linea RFI Genova – La Spezia realizzate negli anni '60 del secolo XIX (doppia canna a singolo binario). Lo scavo della galleria scolmatrice, nella tratta in oggetto, avviene con sistema meccanizzato. Le gallerie presentano rivestimenti definitivi in bolognini in roccia a livello di piedritti e mattoni nei settori di reni e calotta. La distanza fra estradosso del rivestimento definitivo della galleria scolmatrice (in chiave calotta) e la quota di imposta dei piedritti (desunta dalle sezioni delle gallerie ferroviarie rappresentate negli elaborati tecnici del Progetto Definitivo) è nell'ordine dei 6 m (si veda figura sottostante).



L'avanzamento dello scavo della galleria Bisagno nella tratta di sotto-attraversamento delle gallerie RFI avverrà mediante l'applicazione della sezione tipo di avanzamento MAc2v, ovvero prevedendo la messa in opera di interventi di sostegno e presostegno del cavo quali: bullonatura radiale, centinatura full-round, ombrello di tubi metallici iniettati e valvolati a costituire una coronella di consolidamento armata al contorno del cavo nel settore di calotta. Tali interventi, aventi lo scopo di limitare i fenomeni deformativi al contorno ed al fronte della galleria, preservando quindi l'infrastruttura soprastante, sono stati sviluppati secondo geometrie non interferenti con le gallerie ferroviarie stesse (con particolare riferimento alla bullonatura radiale installata dalla galleria scavata con sistema meccanizzato).

Ai fini della valutazione dei possibili effetti dello scavo della galleria scolmatrice sulle gallerie ferroviarie esistenti si sono effettuate analisi numeriche su modelli ad elementi finiti, assumendo ipotesi ampiamente cautelative in termini di proprietà fisico-meccaniche dell'ammasso roccioso interferito dalle opere medesime. Al successivo paragrafo 8.2.1 è fornito quadro di sintesi delle suddette proprietà : la

conservatività delle assunzioni risiede in particolare nella definizione di un indice GSI corrispondente al minimo del range di variazione individuato in sede di caratterizzazione geomeccanica del Flysch del Monte Antola, cui si associa il minimo valore del modulo dell'ammasso (cfr. range di variazione del modulo elastico espresso nel profilo geomeccanico della galleria scolmatrice). Sempre con approccio cautelativo non si è proceduto alla modellazione degli interventi di pre-consolidamento al contorno del cavo operati dalla galleria (tubi metallici iniettati e valvolati).

La galleria scolmatrice sottopassa le opere ferroviarie con tracciato sostanzialmente perpendicolare alle stesse. La geometria del problema si configura pertanto come tridimensionale. Con approccio semplificativo ancorché cautelativo, si sono sviluppati due modelli complementari ai fini della valutazione dei possibili effetti indotti sui manufatti pre-esistenti, ovvero:

- ✓ modello piano con simulazione dello scavo della galleria scolmatrice e valutazione del campo deformativo risentito alla quota di +6 m rispetto alla calotta della galleria medesima, quota corrispondente all'imposta dei piedritti delle gallerie ferroviarie;

- ✓ modello piano con simulazione dello scavo della galleria scolmatrice, in presenza di un fornice ferroviario posto in posizione coassiale rispetto alla prima.

Da ultimo si precisa come, per ciascuno dei modelli sopra citati, si siano implementate due analisi considerando l'assenza di fenomeni di filtrazione verso lo scavo aperto della galleria scolmatrice (condizioni non drenate), ovvero la completa mobilitazione degli stessi corrispondente al regime stazionario di lungo termine (condizioni completamente drenate, stabilizzate). Trattasi di condizioni idrauliche rappresentative di limiti di comportamento entro i quali si collocherà la risposta dell'ammasso e dell'acquifero alle operazioni di scavo.

Si è quindi verificato come il campo deformativo indotto dallo scavo della galleria scolmatrice al livello soprastante di imposta dei piedritti delle gallerie ferroviarie esprima cedimenti nell'ordine del millimetro (con debole incremento, come da attese, passando dalle condizioni non drenate a completamente drenate). Tale riscontro è fornito da entrambe le geometrie di modellazione del problema sviluppate nell'ambito dello studio condotto.

8.2 Descrizione dei modelli numerici

Al fine di indagare l'effetto dello scavo della galleria scolmatrice su quelle esistenti sono stati realizzati 2 modelli a elementi finiti, come inquadrato al precedente paragrafo, mirati all'analisi dei fenomeni di interazione galleria scolmatrice – gallerie ferroviarie, mediante la riproduzione di geometrie semplificative della reale condizione tridimensionale del problema:

- Il primo modello ha lo scopo di valutare numericamente il bacino di subsidenza indotto a 6 metri sopra la chiave calotta, con l'ipotesi che lo stato di sforzo iniziale non dipenda dallo scavo delle gallerie ferroviarie. A favore di sicurezza non viene simulato l'irrigidimento del continuo dovuto alla presenza della galleria ferroviaria rivestita; si trascura, in questo modello, la storia di carico (e scarico) ed eventuali stati di plasticizzazione nella roccia per effetto delle operazione di scavo delle gallerie esistenti;

- Il secondo modello prevede la galleria esistente e la galleria dello Scolmatore su tracciati coassiali.

8.3 Descrizione modelli a EF per lo studio dell'interferenza con la ferrovia

8.3.1 *Caratteristiche fisico-meccaniche dell'ammasso roccioso*

La qualità geomeccanica dell'ammasso interagente con lo scavo è stata definita sulla scorta della campagne di indagini e prove di laboratorio condotte nel corso dell'iter progettuale complessivo (dal PP al PE), con particolare riferimento alla formazione litoide del Flysch del Monte Antola. All'interno dei range di variazione dei parametri che caratterizzano il comportamento dell'ammasso roccioso, previsti e riportati sul profilo geomeccanico, è stata ipotizzata una combinazione di tali parametri assai cautelativa (GSI e Erm minimi dell'intervallo riportato sul profilo geomeccanico) in modo da rappresentare, con buon margine, le condizioni geomeccaniche reali in situ.

Entrambi i modelli presentano uno strato omogeneo di formazione rocciosa del Flysch del Monte Antola. Si considera un coefficiente di spinta a riposo pari a 1.

Formazione	GSI	σ C	mi	MR	γ	Erm
	[-]	[MPa]	[-]	[-]	[kN/m3]	[MPa]
FMA	45	45	12	400	26	4026

Tabella 8-1 - Parametri geomeccanici assunti per la sezione di studio (Interferenza RFI)

8.3.2 *Condizioni idrogeologiche*

Da considerazioni svolte in sede di PP e PE, si è assunto un valore di conducibilità idraulica di 10^{-7} m/s per la formazione del Flysch del Monte Antola.

In presenza di acqua sono state svolte analisi accoppiate considerando moti di filtrazione in regime stazionari utilizzando il software Phase2 con le seguenti condizioni al contorno:

- Total head sui bordi laterali del dominio (15ms.l.m);
- A lungo termine si considera l'abbattimento del 70 % del carico idraulico originario (Total head Long term: 5 m s.l.m).
- Pressione relativa nulla al fronte della galleria dello Scolmatore del Bisagno durante lo scavo fino al getto del rivestimento definitivo;
- Pressione relativa dell'acqua interstiziale nulla al fronte della galleria RFI durante lo scavo e a lungo termine. Si suppone il mantenimento del drenaggio attivo nel tempo (modello 2).

8.3.3 *Procedura operativa di analisi*

La sezione, rappresentativa dell'interferenza in esame è stata analizzata mediante due modelli ad elementi finiti bidimensionali, come specificato sopra. L'analisi numerica è articolata secondo stage successivi di calcolo, a simulare le fasi di scavo e posa in opera degli interventi di sostegno provvisorio e definitivo del cavo.

Si sono introdotte, secondo la consueta procedura operativa, un sistema di forze fittizie di scavo agenti in direzione ortogonale al profilo di scavo medesimo, di entità progressivamente ridotta secondo una taratura basata sul profilo longitudinale di spostamento, ottenuto dal modello numerico assial-simmetrico specificatamente sviluppato per tale sezione, e la curva caratteristica del cavo non rivestito.

Gli elementi strutturali che costituiscono rivestimenti definitivi e prerivestimenti sono stati modellati coerentemente alle loro reali caratteristiche geometriche (Vedi Relazione tecnica e di calcolo – tratta in meccanizzato).

8.3.4 *Modellazione dei rivestimenti*

In accordo con il Progetto Esecutivo, è stata scelta una sezione tipo centinata e bullonata con un presostegno in calotta dato dalla posa in pera di 16 tubi metallici iniettati ad alta pressione (MAc2v). Nei modelli di calcolo il presostegno al contorno non è stato cautelativamente modellato.

Per tutti i dettagli della sezione si veda la relazione tecnica di riferimento, di seguito vengono riportate le caratteristiche e gli spessori degli interventi inseriti nel modello di calcolo:

Spritz beton		
Classe	c28/35	
Rck	35	MPa
Spessore	0.15	m
fctk	2.33	MPa
E	32588	MPa

Swellex/Split-setbolt		
Tensilecapacity	0.2	MN
Residualtensilecapacity	0	MN
Area tributary	480.42	mm2
E_bolt	210	GPa
Bond strength	0.3	MN/m
Residual Bond Strength	0.3	MN/m
Bond ShearStiffness	200	MN/m/m
Out-of-planespacing	1.5	m
Face plates	attached	
Pre-tensioning	0	
Pre-tensioninforce	costant in install stage	
BoltModel	Plastic	
Allow Joint to shear bolt	yes	
Length	4.5	m

Centine - HEB140		
J	1.51E-05	m^4
Area	0.004296	m^2
Sectiondepth	0.14	m
Compressive Strength	275	MPa
TensileStrength	275	MPa
passo	1.5	m
E	210000	MPa

Rivestimento definitivo		
Classe	c35/45	
Rck	45	MPa
Spessore	0.55	m
fctk	2.66	MPa
E	34500	MPa
v	0.2	-

Tabella 8-2 - Tabelle riassuntive interventi

8.3.5 Fasi di calcolo

Si propone, a seguire, la sequenza tipica degli step di calcolo per le sezioni in oggetto:

1. Inizializzazione dello stato tensionale entro l'ammasso;

2. Simulazione scavo galleria RFI e installazione dei rivestimenti definitivi. Pressione dell'acqua nulla sul contorno del cavo nelle analisi di filtrazione mantenuta anche negli step successivi di calcolo;
3. Rimozione del terreno all'interno del profilo di scavo dello Scolmatore del Bisagno e contestuale applicazione, sul contorno, delle forze fittizie di scavo (pressioni), di entità pari allo stato tensionale locale in situ, in corrispondenza del profilo di scavo medesimo – al termine di tale step di calcolo è imposto il reset del campo di spostamento entro l'ammasso, mantenendo il tasso tenso-deformativo all'interno dell'ammasso di riferimento.
4. Apertura del fronte di scavo, con relativa riduzione delle forze fittizie di scavo (30% relax). Pressione dell'acqua nulla sul contorno del cavo nelle analisi di filtrazione.
5. Installazione degli ancoraggi radiali (superswellex pm24) e centine metalliche (80% relax);
6. Gettospritz-beton (98% relax);
7. Maturazionespritz-beton (total relax);
8. Installazione rivestimento definitivo (condizione di lungo termine). Rimozione della condizione al contorno idraulica di pressione relativa nulla sul cavo in ragione dell'abbattimento del carico idraulico del 70%.

8.3.6 Modelli di calcolo

Entrambi i modelli di calcolo hanno dimensioni 200m*150m e sono stati discretizzati con una mesh triangolare di 6 nodi per elemento (Modello1: n° nodi: 12674, n° elementi 6222; Modello2: n° nodi: 13741, n° elementi 6730).

Le condizioni al contorno imposte sono le seguenti:

- spostamenti laterali impediti lungo i bordi laterali del dominio ;
- spostamenti verticali e laterali impediti lungo il bordo inferiore del dominio;
- condizioni al contorno idrauliche descritte in precedenza.

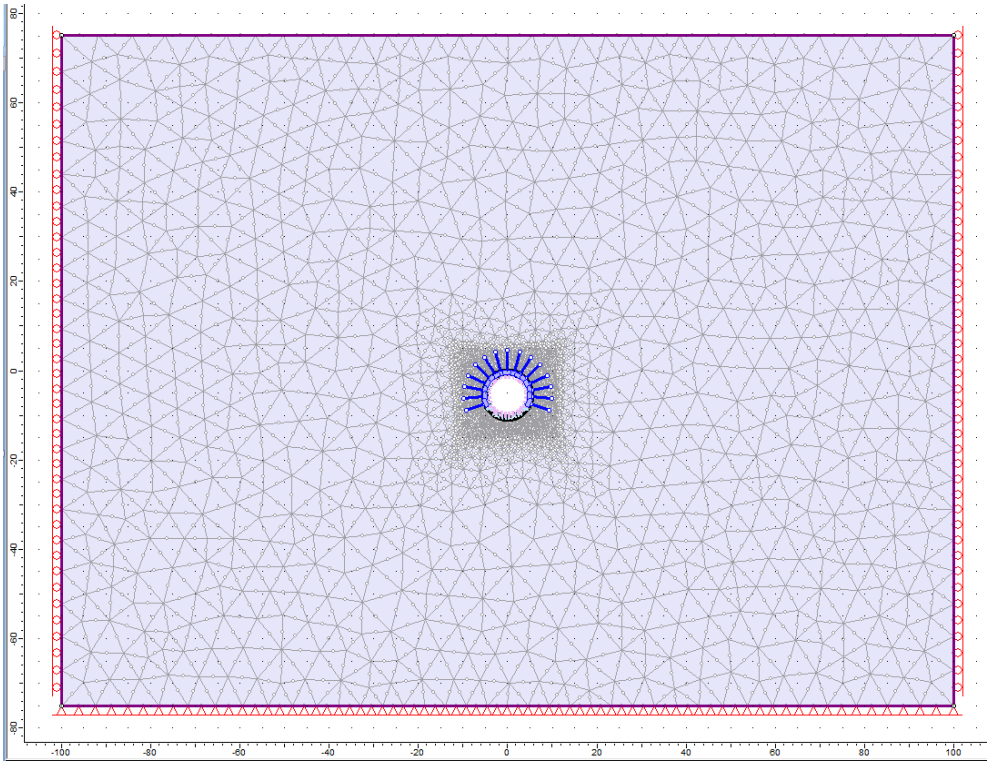


Figura 8-1 Modello 1 – vista di insieme

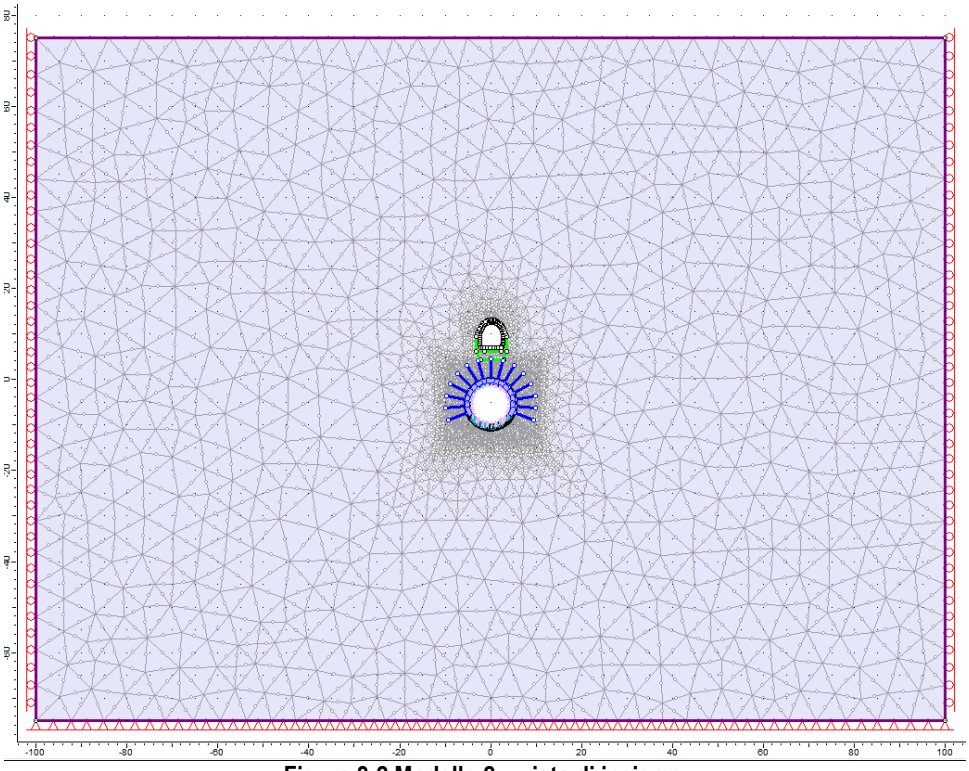


Figura 8-2 Modello 2 – vista di insieme

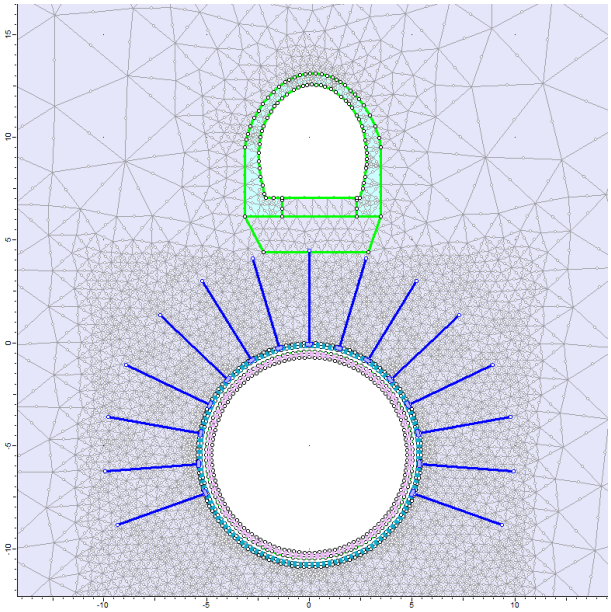


Figura 8-3 Modello 2 – Particolare della galleria

8.4 Risultati della modellazione

Si riportano i risultati dell'analisi in termini di plasticizzazioni e spostamenti in corrispondenza della fase di relax 100% e dell'istallazione del rivestimento definitivo (fase di lungo termine) per i due modelli di calcolo rispettivamente in assenza di falda (analisi statica) e in presenza di falda (analisi accoppiata).

Non vengono riportate le verifiche strutturali dei prerivestimenti e dei rivestimenti definitivi della galleria in quanto esulano gli scopi di questo documento.

8.4.1 Modello di calcolo 1

L'estensione delle plasticizzazioni al contorno del cavo è contenuta in una fascia di spessore max 100 cm omogeneamente estesa nell'intorno del cavo sia per l'analisi in condizioni non drenate che per l'analisi in condizioni drenate - accoppiata. Si rileva come i fenomeni di plasticizzazione siano connessi al superamento della resistenza a taglio e puntualmente a trazione.

In corrispondenza del livello della sezione di galleria esistente RFI si calcolano cedimenti inferiori a 2 mm nel caso dell'analisi in condizioni non drenate e non superiori ai 3.5 mm nel caso dell'analisi che considera il fenomeno di filtrazione. Si fa presente che tale risultato è legato al fenomeno sopracitato, in quanto l'abbassamento del livello di falda determina una variazione del regime di pressioni interstiziali e conseguente campo tensionale efficace litostatico (in aumento) cui si associano locali incrementi delle convergenze nella pozione superiore del cavo. Tale condizione, numericamente, si traduce in maggiori cedimenti a livello di imposta dei piedritti della galleria RFI.

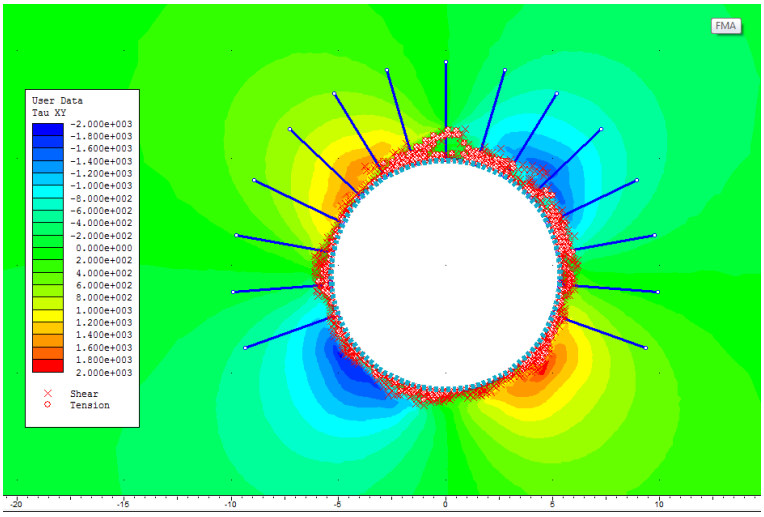


Figura 8-4 Sforzi di taglio con indicazione dei punti elasticizzati (ANALISI NON DRENATA –1)

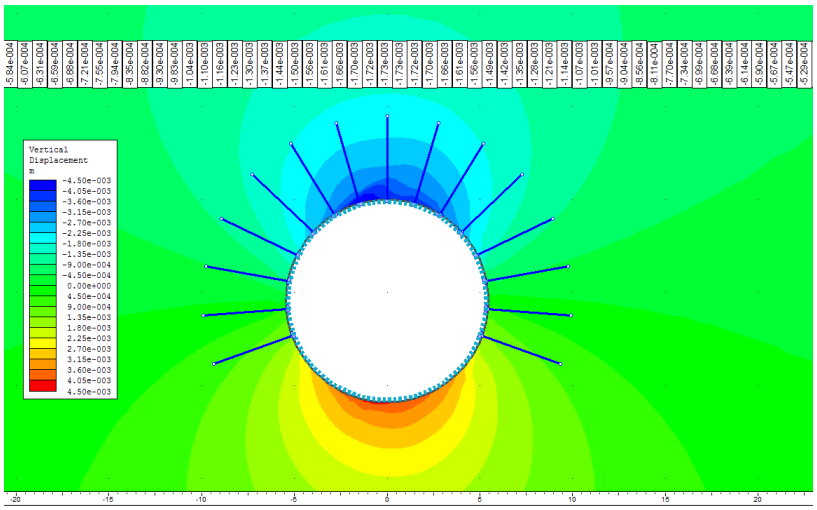


Figura 8-5 Andamento dei cedimenti al livello della sezione RFI (ANALISI NON DRENATA –1)

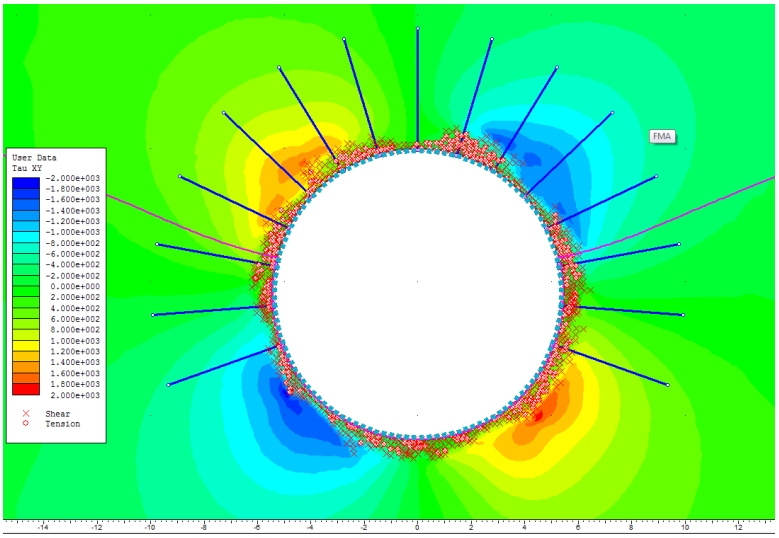


Figura 8-6Sforzi di taglio con indicazione dei punti elasticizzati (ANALISI DRENATA– modello 1)

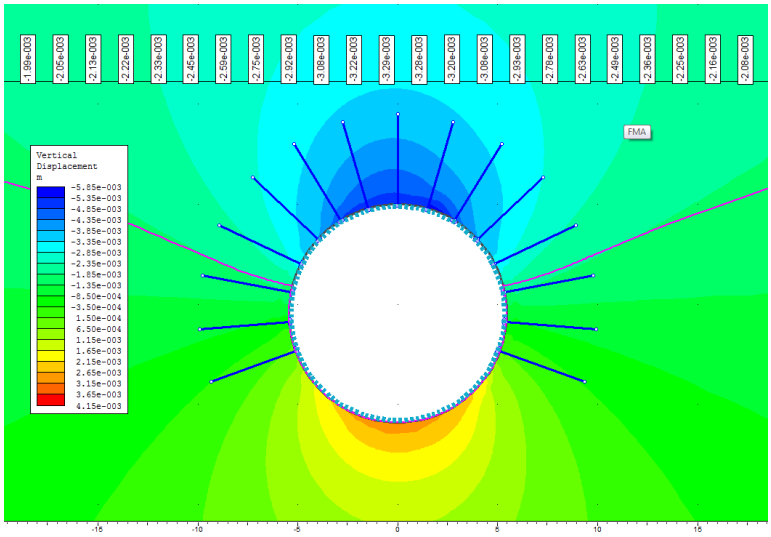


Figura 8-7 Andamento dei cedimenti al livello della sezione RFI (ANALISI DRENATA– modello 1)

8.4.2 *Modello di calcolo 2*

Grazie alla modellazione dello scavo della galleria RFI, lo stato tenso-deformativo del modello 2 risente di tale scavo in termini di deformazioni volumetriche e plasticizzazioni accumulate in arco rovescio della sezione di galleria esistente.Nell'intorno del cavo della galleria scolmareixe queste ultime risultano essere omogeneamente distribuite in una fascia di spessore max 100 cm (analisi statica e accoppiata).

Il campo di spostamenti ottenuto nel modello 2, in corrispondenza del livello della sezione di galleria esistente RFI, risulta essere similare a quello riportato dal modello precedente. Sia nella fase di totale relax che nel lungo termine si accumulano cedimentiinferioriai 2 mm nel caso dell'analisi statica e non superiori ai 3.5 mm nel caso dell'analisi che considera il fenomeno di filtrazione. Come detto in precedenza, i maggiori spostamenti verticali ottenuti nella analisi accoppiata sono legati alla variazione del regime di pressioni interstiziali e al conseguente aumento del campo tensionale efficace, che si traduce in convergenze maggiori della porzione superiore del cavo e del sedime al di sopra di esso.

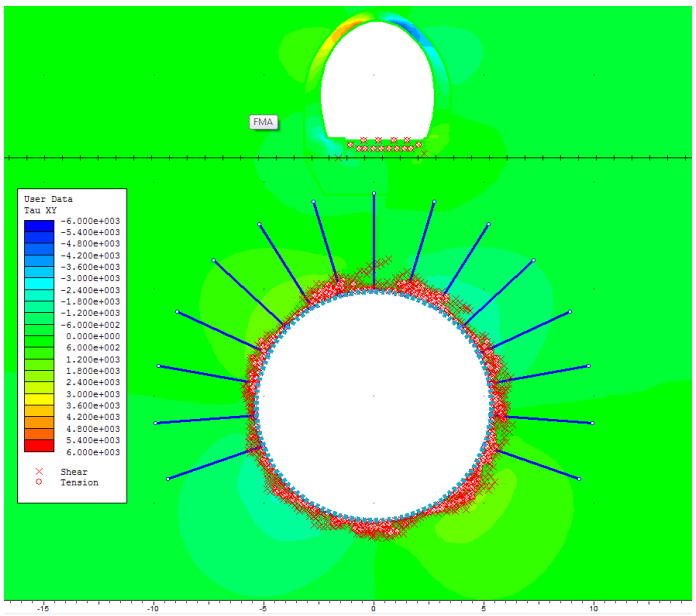


Figura 8-8Sforzi di taglio con indicazione dei punti plasticizzati (ANALISI NON DRENATA –2)

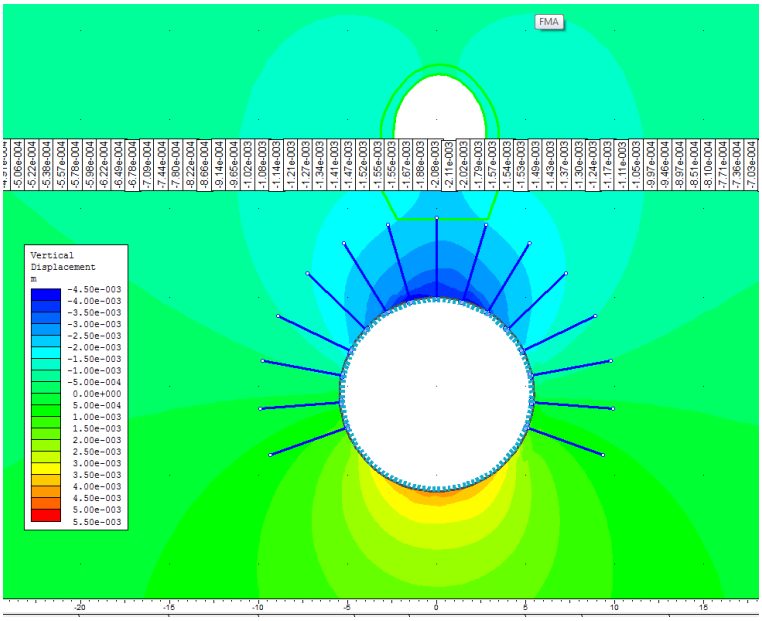


Figura 8-9 Andamento dei cedimenti al livello della sezione RFI (ANALISI NON DRENATA –2)

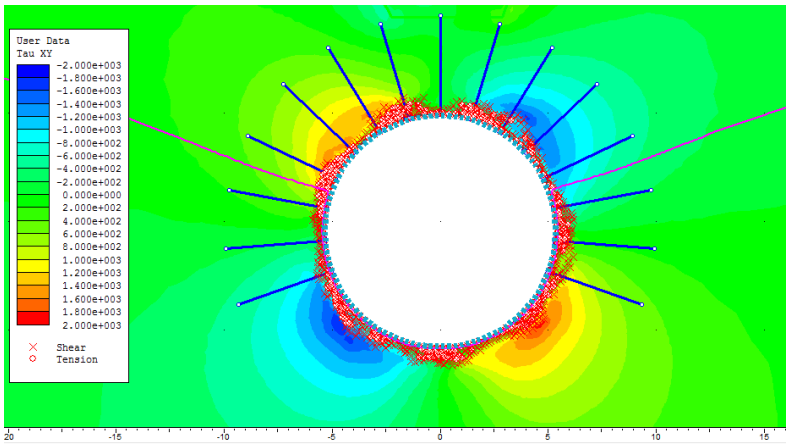


Figura 8-10Sforzi di taglio con indicazione dei punti elasticizzati (ANALISI DRENATA- – modello 2)

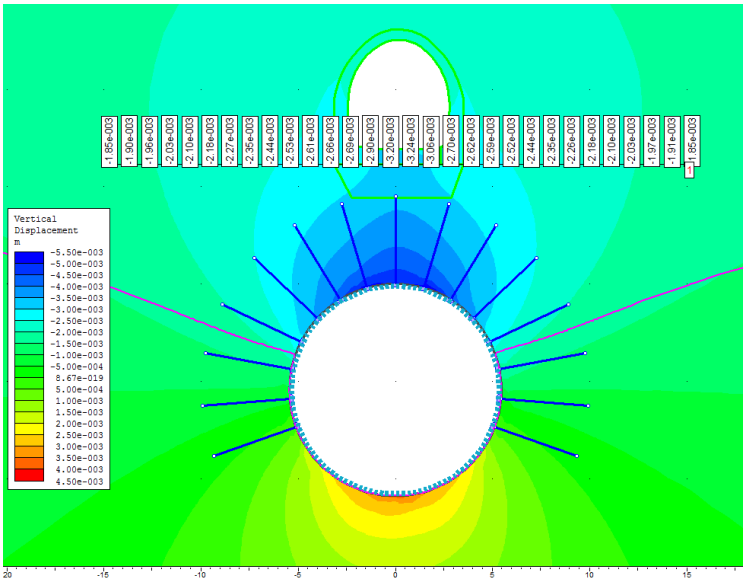


Figura 8-11 Andamento dei cedimenti al livello della sezione RFI (ANALISI DRENATA – modello 2)

8.4.3 *Analisi comparata dei risultati (Modello 1 – Modello 2)*

I grafici seguenti mostrano il confronto tra i due scenari estremi descritti in precedenza (assenza e presenza di falda), mettendo in evidenza il campo di spostamenti verticali misurato per i due modelli 1 e 2 in corrispondenza della parte inferiore della sezione della galleria esistente valutato nelle fasi di totale rilassamento del cavo e condizione di lungo termine con la presenza del rivestimento definitivo (si trascura il contributo dei presostegni).

É possibile notare come:

- considerando il modello 2, il sedime posto al di sopra della calotta risente della storia tensionale subita ed ha la tendenza ad accumulare cedimenti sensibilmente superiori in asse galleria;
- il campo di spostamenti verticali misurati in condizioni completamente drenate é sempre leggermente superiore a quello registrato nel breve termine (condizioni non drenate), in corrispondenza del totale rilassamento del cavo: il massimo cedimento calcolato, in condizioni drenate, sul modello 2 (gallerie coassiali), è compreso nell'intervallo 3-4 mm.
- Le analisi condotte, sebbene basate su ipotesi significativamente conservative, restituiscono in definitiva un'alterazione minima del campo tenso deformativo agente sulle gallerie ferroviarie esistenti.

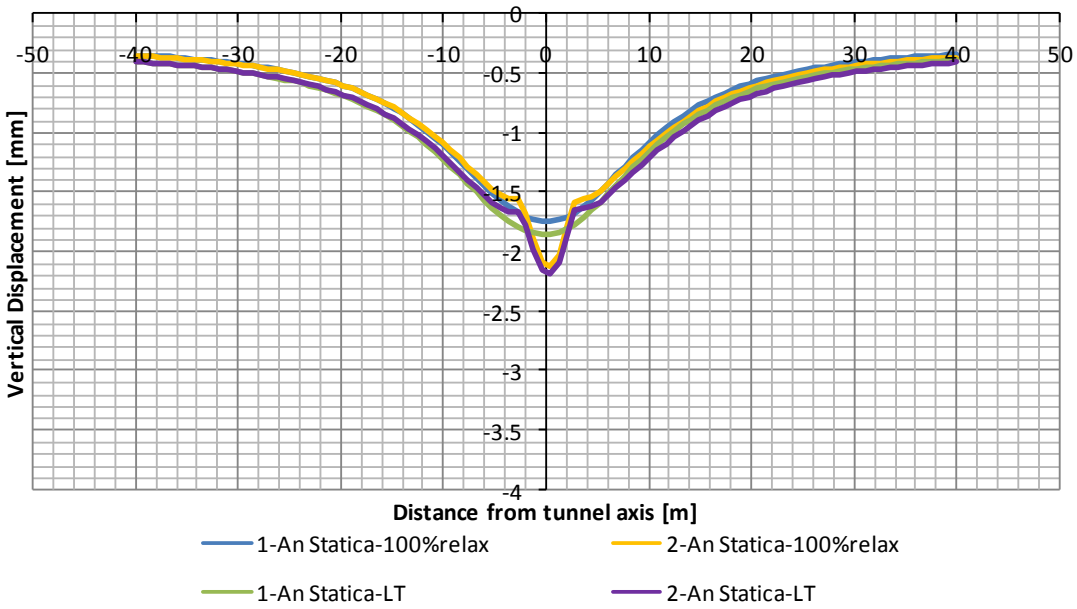


Figura 8-12 Spostamenti verticali misurati nelle analisi statiche non drenate in corrispondenza della parte inferiore della galleria esistente nel modello 1 e 2 nelle fasi di total relax e lungo termine.

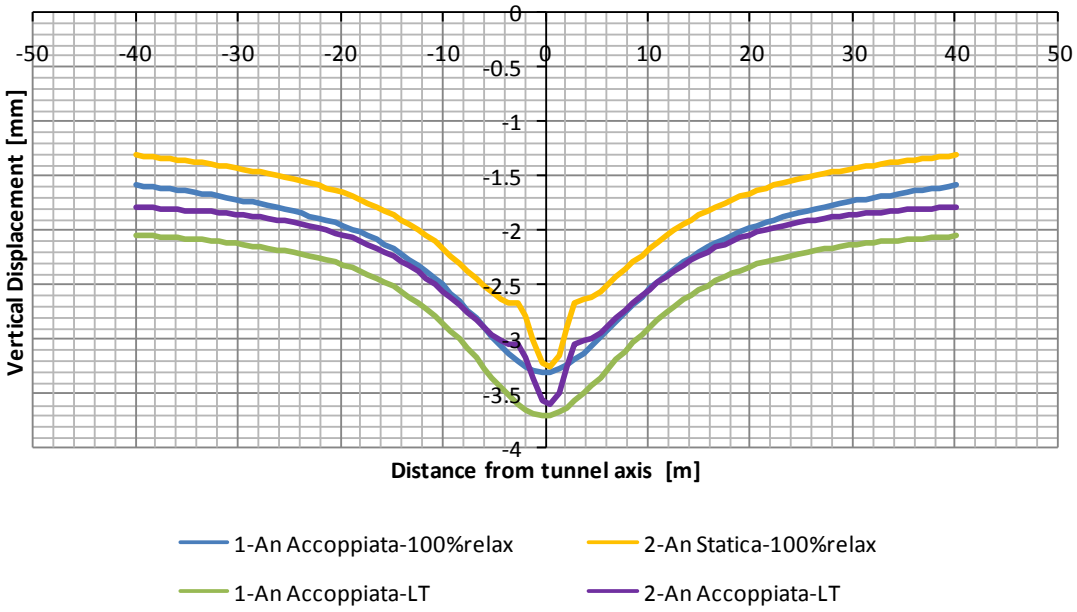


Figura 8-13 Spostamenti verticali misurati nelle analisi accoppiate in corrispondenza della parte inferiore della galleria esistente nel modello 1 e 2 nelle fasi di total relax e lungo termine.

9 CONCLUSIONI

La presente Relazione Tecnica e di Calcolo fa parte dei documenti previsti nell'ambito del Progetto Esecutivo del 2° Lotto dei lavori per la realizzazione della galleria scolmatrice del torrente Bisagno, in comune di Genova.

L'intervento oggetto dell'affidamento di progettazione esecutiva comprende nello specifico il complesso delle opere di presa e sistemazione dell'alveo Bisagno, la galleria scolmatrice con sviluppo complessivo di 6500 m circa da scavarsi con sistema meccanizzato e gli interventi connessi allo sbocco a mare presso la spiaggia di San Giuliano, con il completamento del manufatto di convergenza della galleria Bisagno sulla galleria scolmatrice del torrente Fereggiano, i cui lavori sono in corso di completamento.

L'oggetto della relazione è lo studio delle interferenze tra scavo della galleria e fabbricati/opere esistenti, in particolare nelle zone di bassa copertura. Nei seguenti capitoli si riporta la procedura operativa seguita per la valutazione del bacino di subsidenza e la determinazione delle classi di danno dei fabbricati classificati come interferenti; in particolare verrà definito il campo di applicazione, ovvero in dominio di terreno (offset in superficie per la copertura critica) entro cui si stima che lo scavo si propaghi con effetti ingegneristicamente apprezzabili; verranno definite le modalità di analisi in più fasi e con più metodologie (fase 1 empirica, fase 2 di approfondimento con metodi numerici), definite le classi di danno sui fabbricati e infine presentate le analisi. I risultati delle analisi empiriche, riportati per primi, hanno fornito un quadro generale su tutti gli edifici, mettendo in evidenza i casi che saranno studiati mediante analisi a elementi finiti. Verranno inoltre presentate alcune analisi agli elementi finiti al fine di valutare i cedimenti a piano campagna ed evidenziare come la scelta di adottare gli approcci empirici risulti in generale conservativa. Successivamente verranno presentate le analisi di fase 2 relative al Forte di San Giuliano, rimandando per i dettagli ad una relazione specificatamente redatta, e i risultati delle analisi sull'interferenza con le gallerie della linea ferroviaria esistente.

Dalle analisi condotte e dalle informazioni ad oggi disponibili, si ritiene che lo scavo della galleria non induca cedimenti differenziali e distorsioni sui fabbricati esistenti tali da provocarne danni sia sulle strutture portanti che su quelle non strutturali, se non, al limite fessure sottili agli intonaci delle pareti di entità ≤ 1mm (corrispondente alla classe di danno 1 di Boscardin e Cording). Il presente documento così come i suoi contenuti sono comunque da considerate come un completamento del piano di monitoraggio di superficie, che prevede un estensiva campagna di monitoraggio del piano campagna, degli edifici e della galleria ferroviaria in corso d'opera.

10 ALLEGATI

- **Allegato 1** – schede analisi di subsidenza e classe di danno con metodi empirici

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

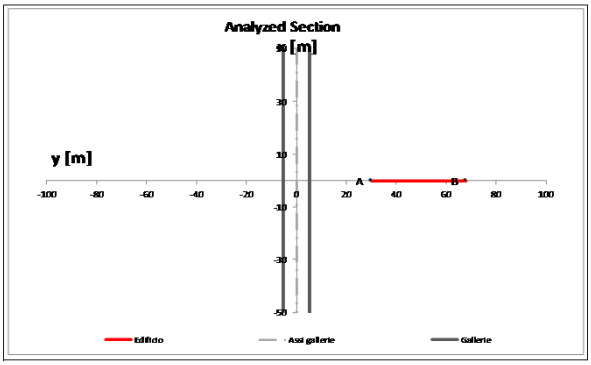
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	1

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	23.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	24.5	[m]
Length in the analyzed directio	L	38.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	11.5	11.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	30
B	0	68

Settlements	
Point	w [mm]
A	0.25
B	0.00

Direction analysys	A	B

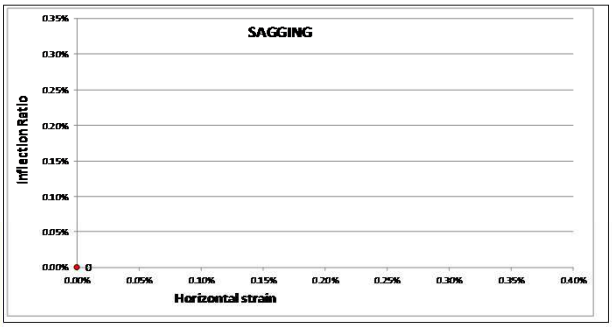
DAMAGE CLASS EVALUATION

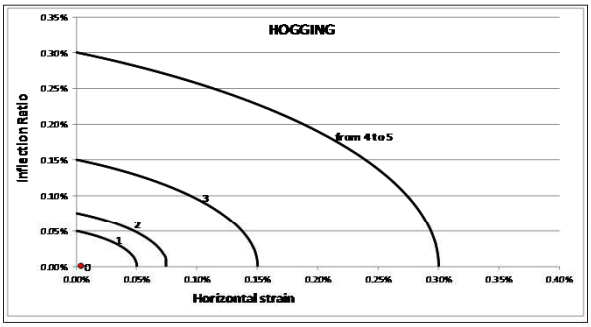
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	20.96
Max. Settlement of the building [mm]	$w_{building}$	0.25

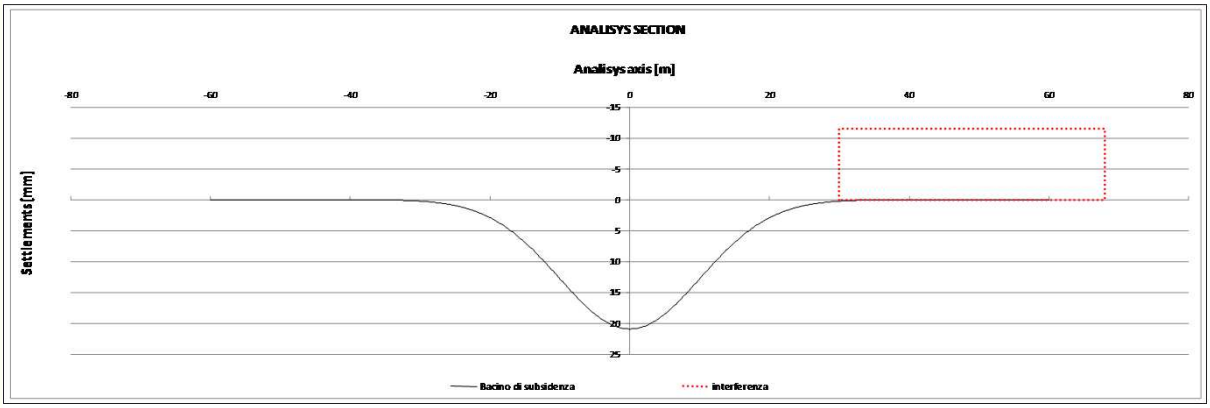
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.31E-05	1/13685
Maximum Angular Distortion	β	6.65E-05	1/15039

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

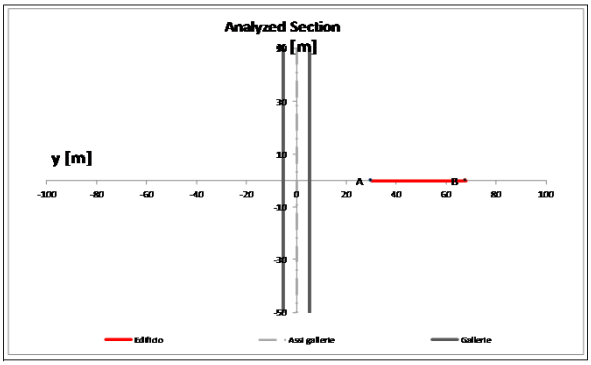
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	1_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	7.5	[m]
Total Height	H	24.5	[m]
Length in the analyzed directio	L	38.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	5.5	5.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	30
B	0	68

Settlements	
Point	w [mm]
A	0.00
B	0.00

Direction analysys	A	B

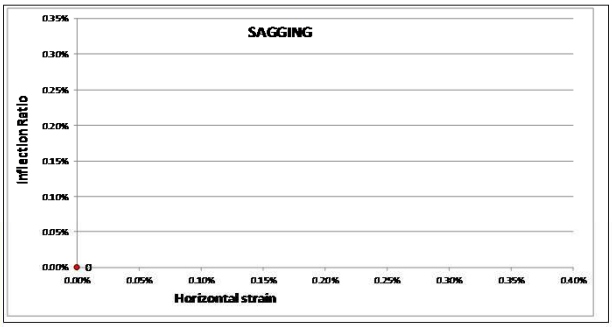
DAMAGE CLASS EVALUATION

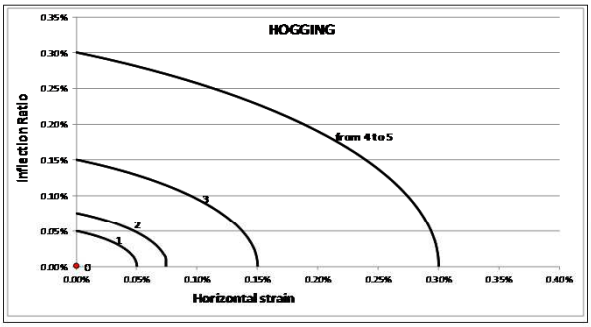
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	32.60
Max. Settlement of the building [mm]	$w_{building}$	0.00

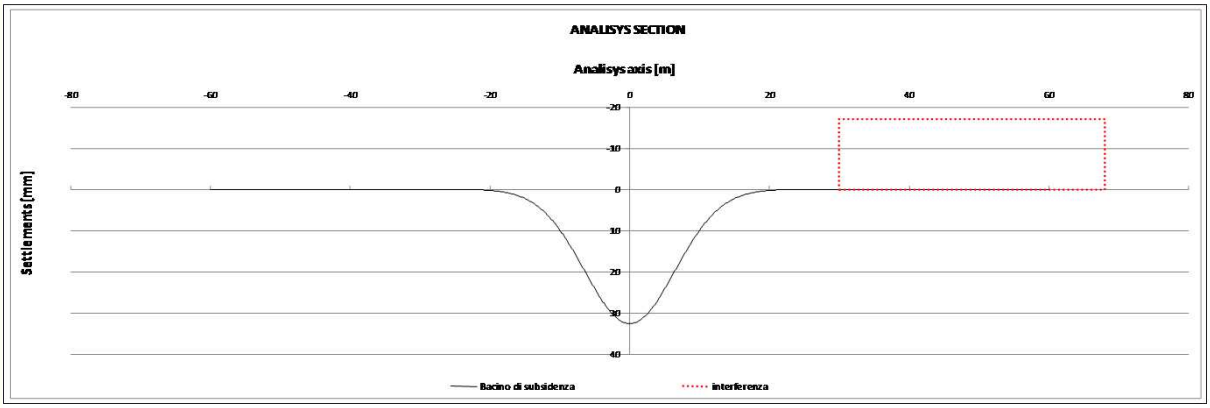
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.03E-07	1/1987294
Maximum Angular Distortion	β	4.84E-07	1/2065357

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

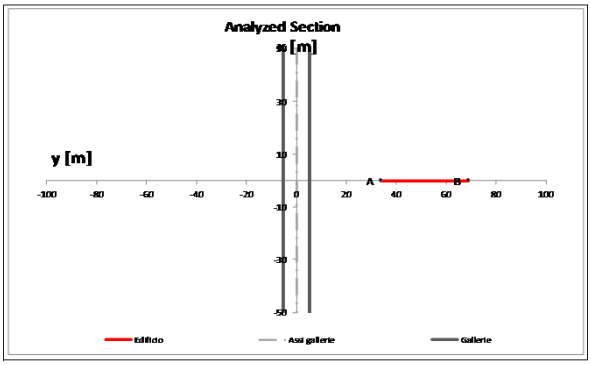
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	3

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	35.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	10.5	10.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	69

Settlements	
Point	w [mm]
A	0.04
B	0.00

Direction analysys	A	B

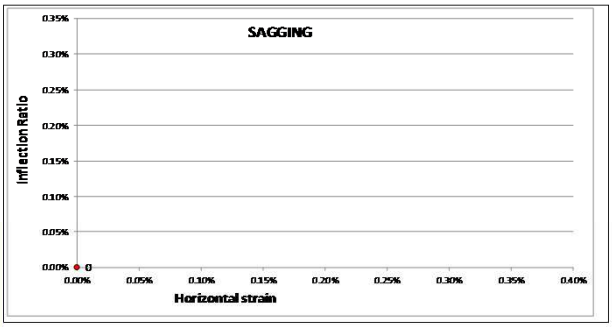
DAMAGE CLASS EVALUATION

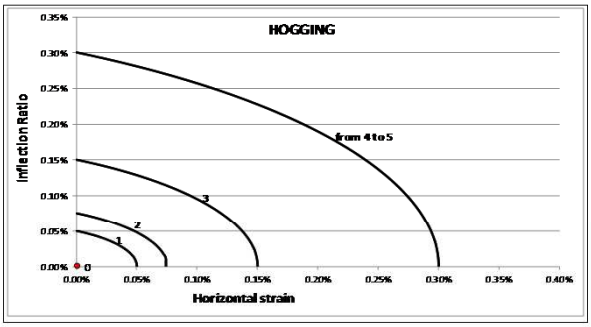
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	22.28
Max. Settlement of the building [mm]	$w_{building}$	0.04

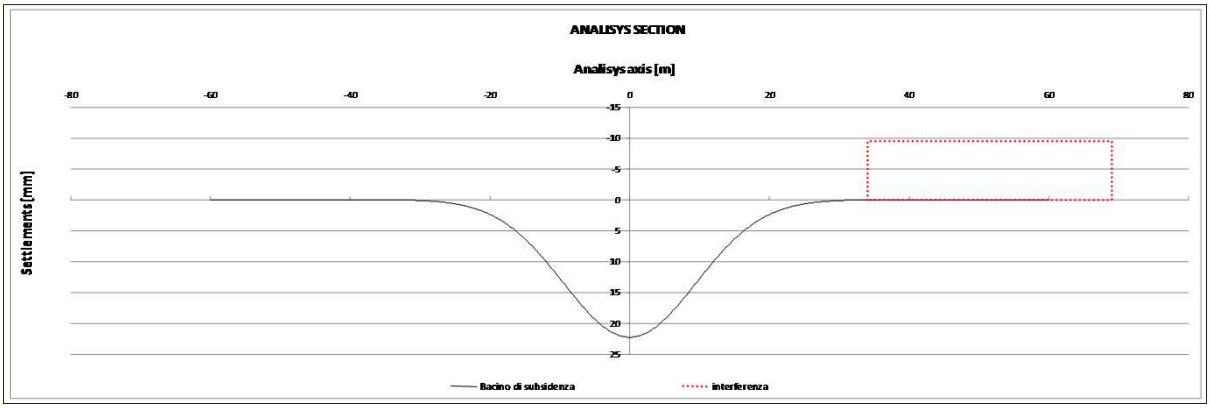
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.34E-05	1/74583
Maximum Angular Distortion	β	1.24E-05	1/80756

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.001%
Total strain	ε_{max}	0.001%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

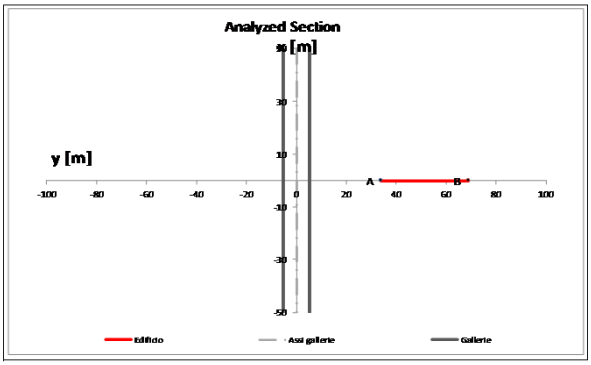
Building N°	3_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	35.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	7.5	7.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6

Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	69

Settlements	
Point	w [mm]
A	0.00
B	0.00



Direction analysys	A	B

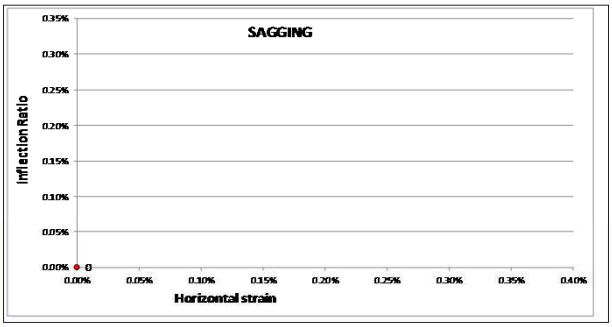
DAMAGE CLASS EVALUATION

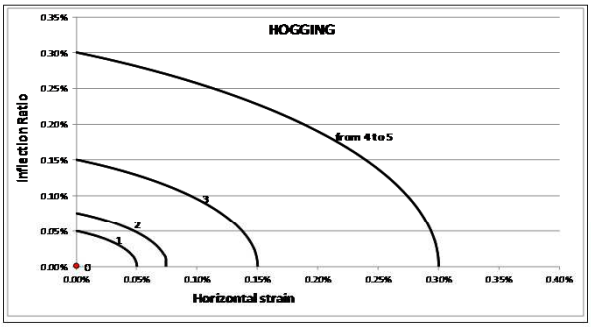
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	27.50
Max. Settlement of the building [mm]	$w_{building}$	0.00

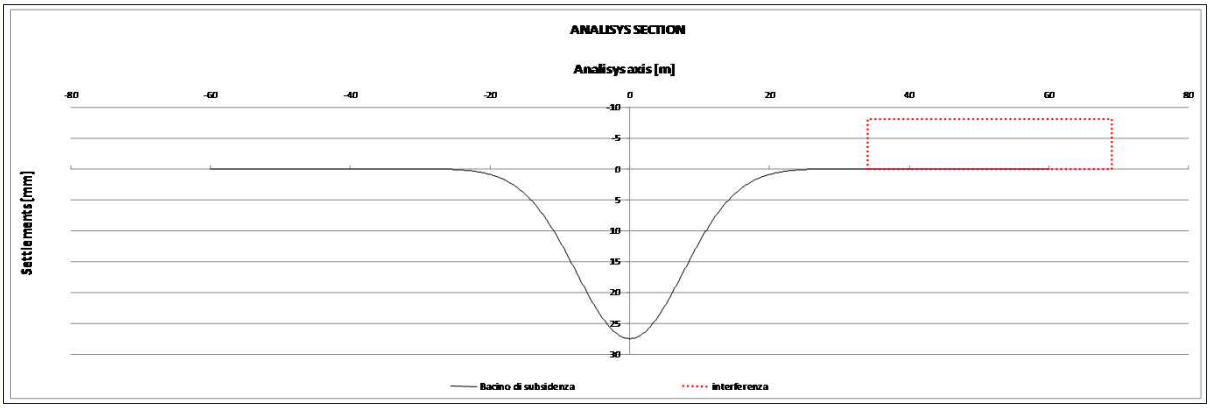
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	8.63E-07	1/1158830
Maximum Angular Distortion	β	8.19E-07	1/1220491

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

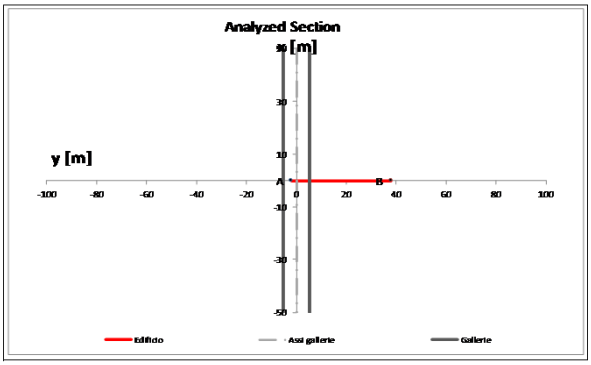
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	4

Building Features			
Function	militare		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	10.5	10.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-2
B	0	38

Settlements	
Point	w [mm]
A	21.79
B	0.01

Direction analysys	A	B

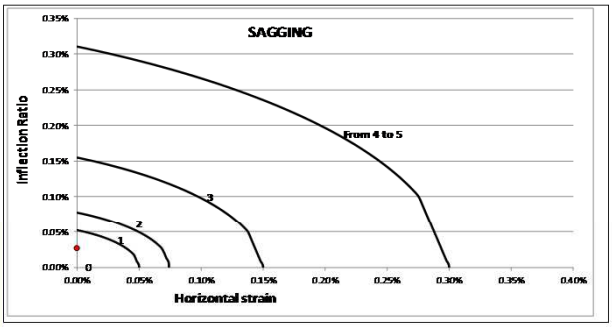
DAMAGE CLASS EVALUATION

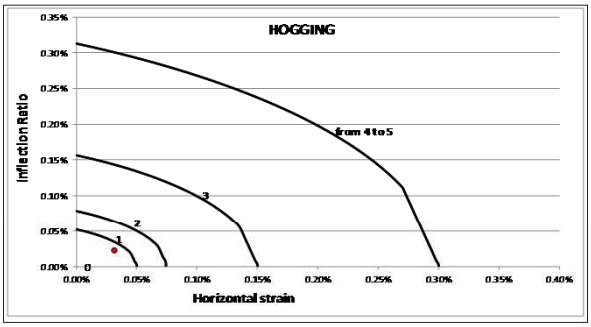
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	22.28
Max. Settlement of the building [mm]	$w_{building}$	22.28

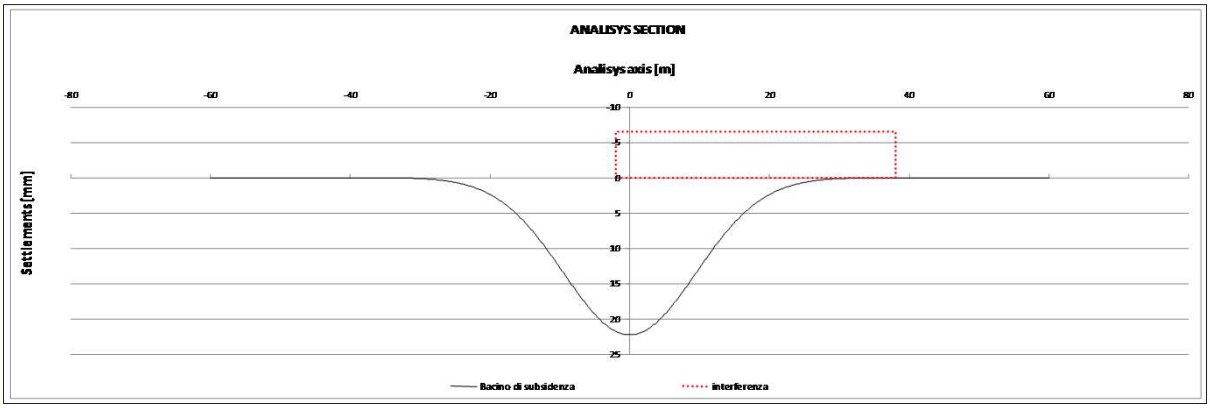
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.43E-03	1/701
Maximum Angular Distortion	β	1.02E-03	1/980

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.026%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.025%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.022%
Horizontal strain	ε_h	0.032%
Total strain	ε_{max}	0.040%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

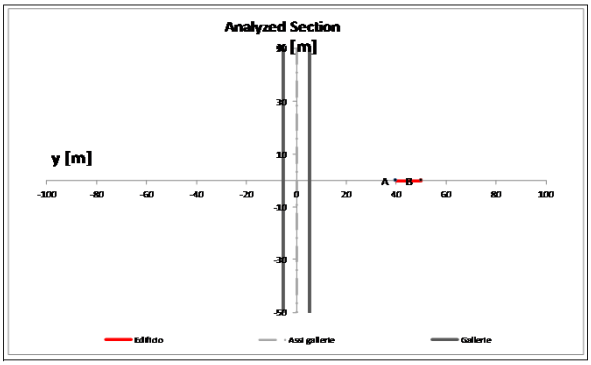
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	5

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	14.5	14.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	40
B	0	50

Settlements	
Point	w [mm]
A	0.06
B	0.00

Direction analysys	A	B

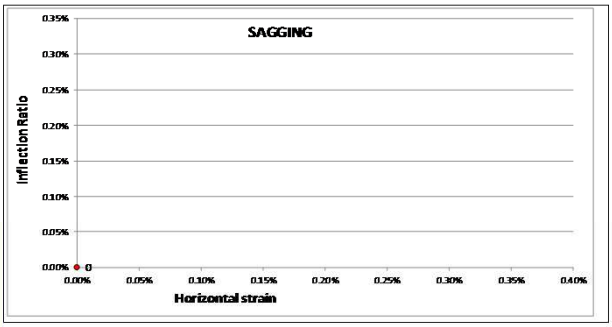
DAMAGE CLASS EVALUATION

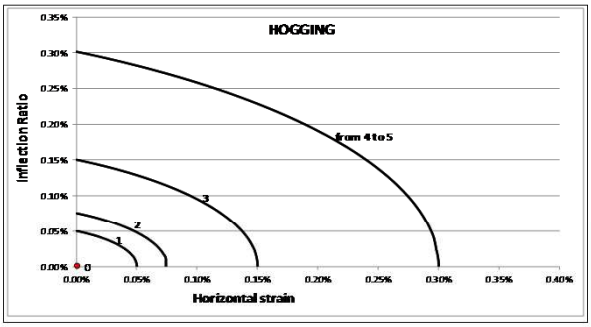
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	17.78
Max. Settlement of the building [mm]	$w_{building}$	0.06

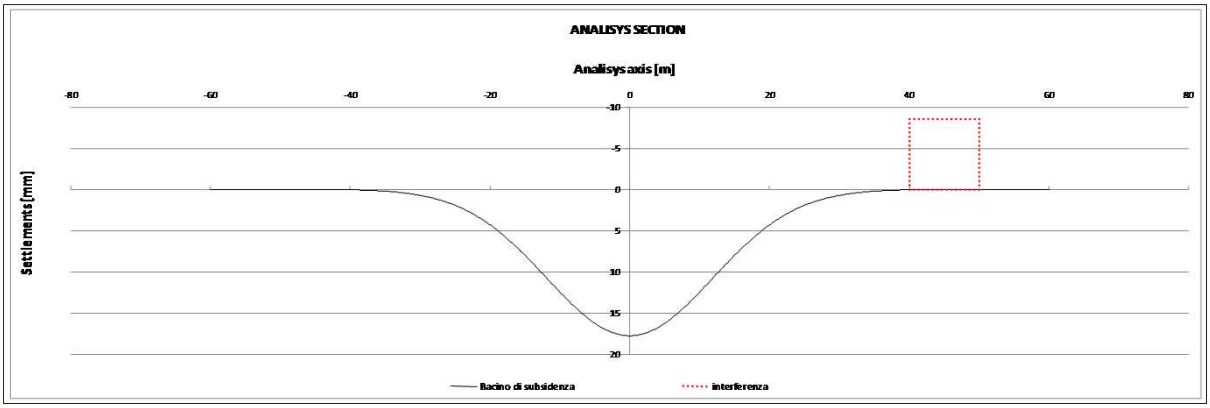
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.74E-05	1/57608
Maximum Angular Distortion	β	1.15E-05	1/87174

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.001%
Total strain	ε_{max}	0.001%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

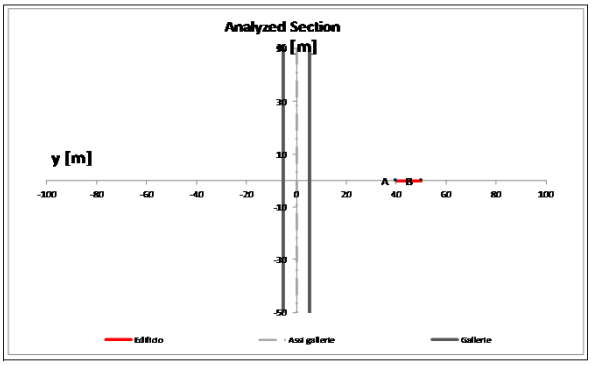
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	5_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	11.5	11.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	40
B	0	50

Settlements	
Point	w [mm]
A	0.01
B	0.00

Direction analysys	A	B

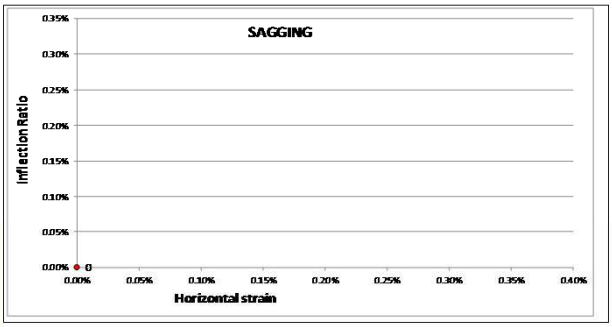
DAMAGE CLASS EVALUATION

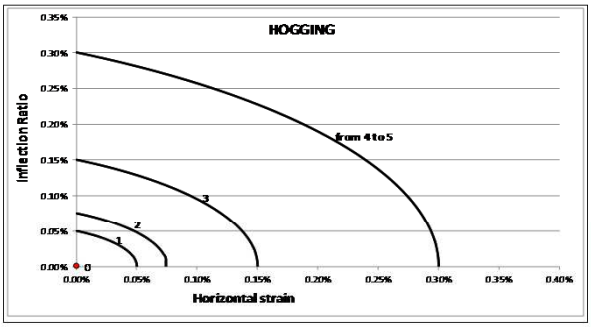
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	20.96
Max. Settlement of the building [mm]	$w_{building}$	0.01

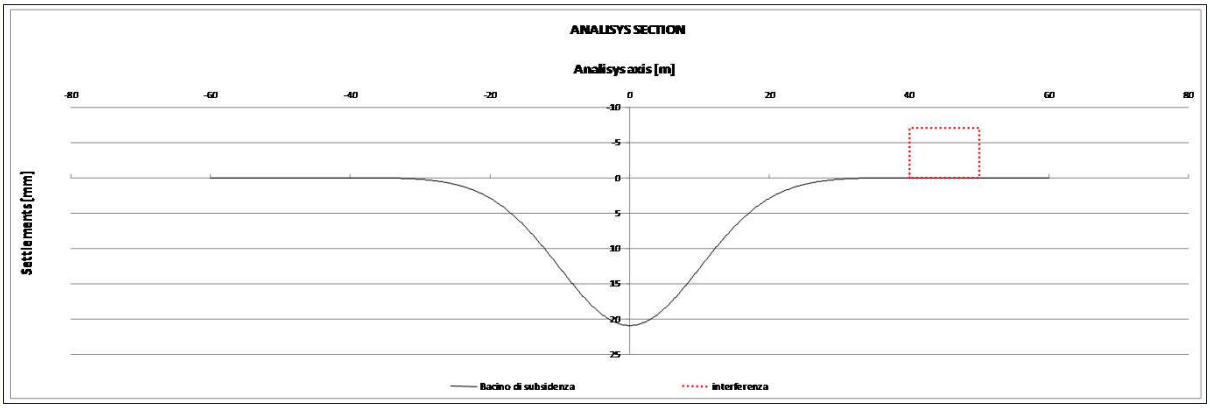
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.13E-06	1/319584
Maximum Angular Distortion	β	2.34E-06	1/427202

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

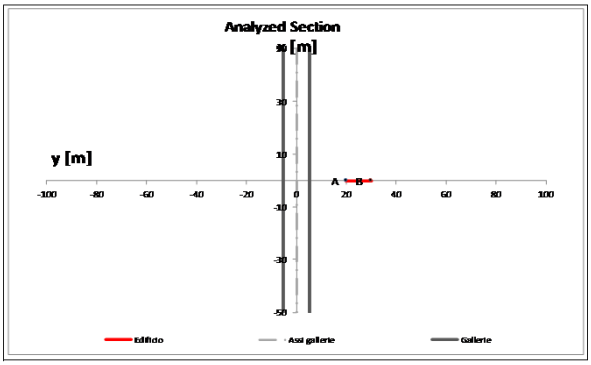
Building N°	7

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	14.5	14.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6

Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	20
B	0	30

Settlements	
Point	w [mm]
A	4.31
B	0.73



Direction analysys	A	B

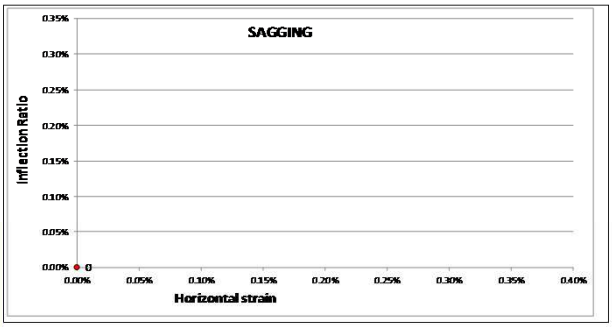
DAMAGE CLASS EVALUATION

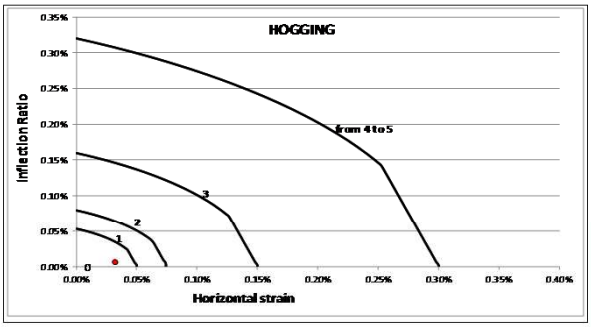
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	17.78
Max. Settlement of the building [mm]	$w_{building}$	4.31

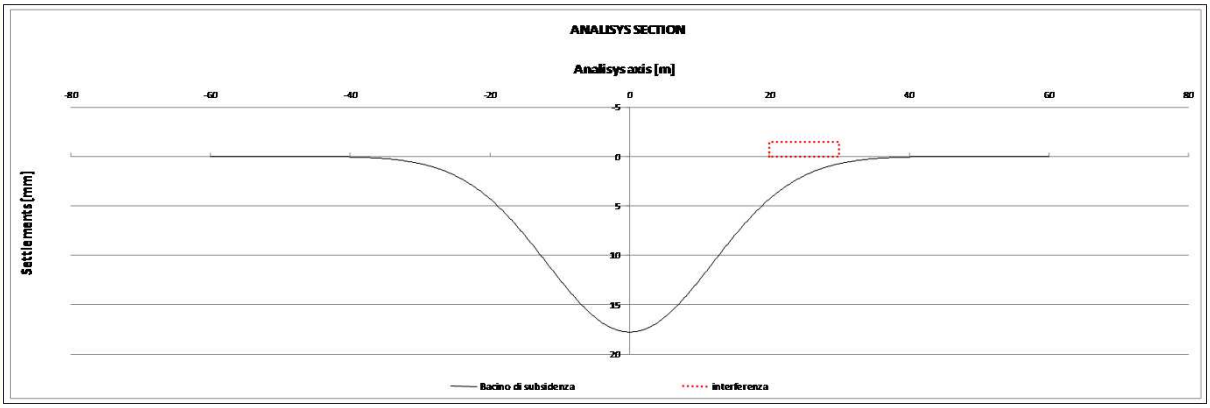
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.10E-04	1/1639
Maximum Angular Distortion	β	2.53E-04	1/3960

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.006%
Horizontal strain	ε_h	0.032%
Total strain	ε_{max}	0.034%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

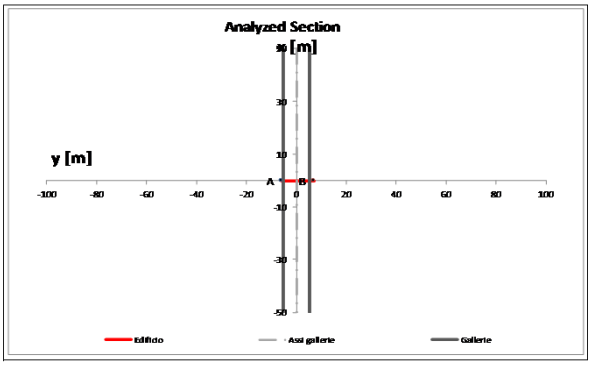
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	8

Building Features			
Function	militare		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	BRICKWORK		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	13.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-6
B	0	7

Settlements	
Point	w [mm]
A	13.54
B	13.12

Direction analysys	A	B

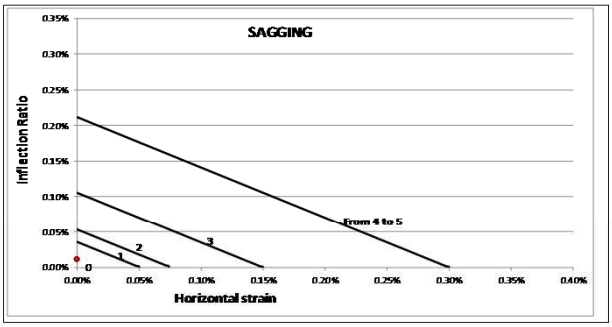
DAMAGE CLASS EVALUATION

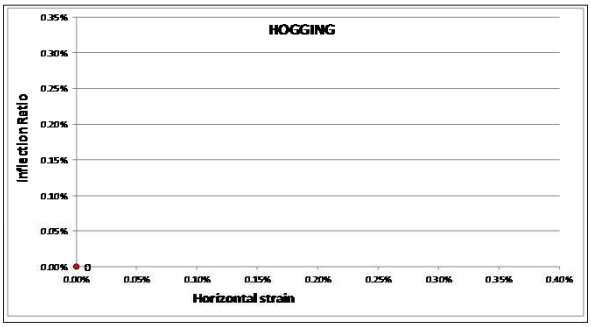
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	14.79

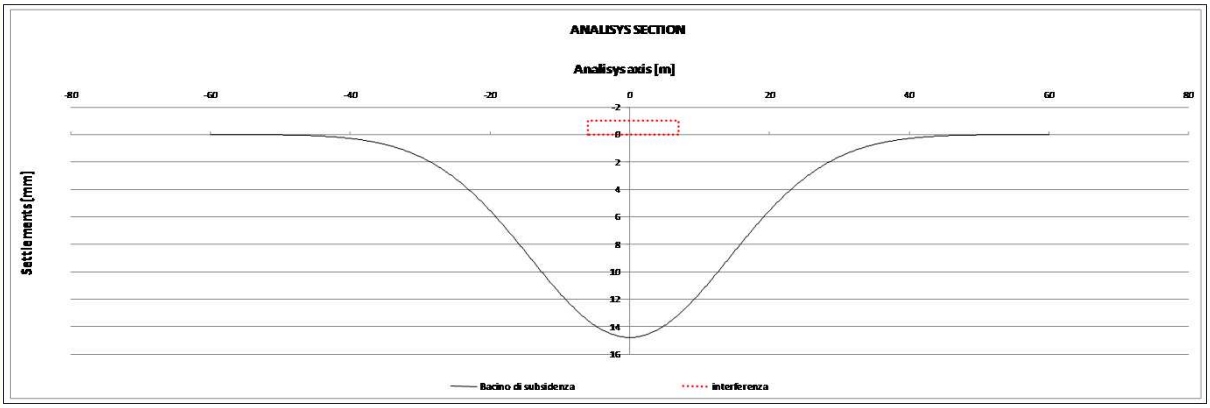
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.50E-04	1/2224
Maximum Angular Distortion	β	4.30E-04	1/2323

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.011%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.016%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

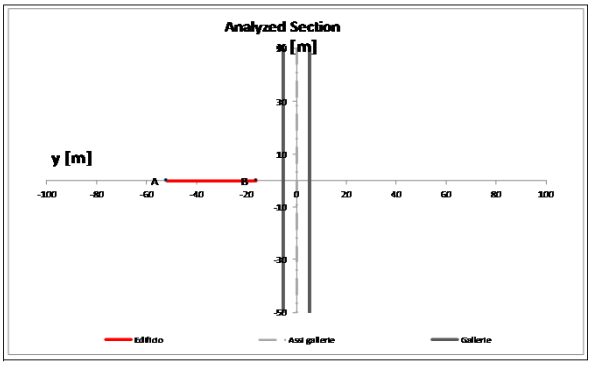
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	9

Building Features			
Function	militare		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	9.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	10.5	[m]
Length in the analyzed directio	L	36.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-52
B	0	-16

Settlements	
Point	w [mm]
A	0.02
B	7.90

Direction analysys	A	B

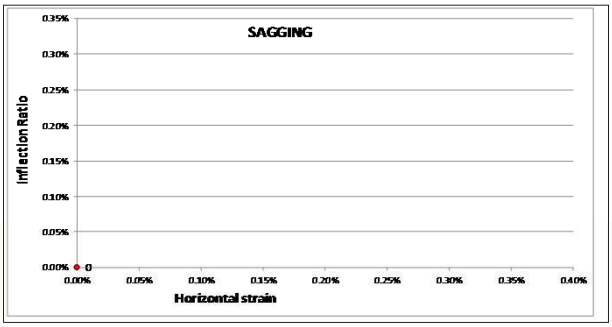
DAMAGE CLASS EVALUATION

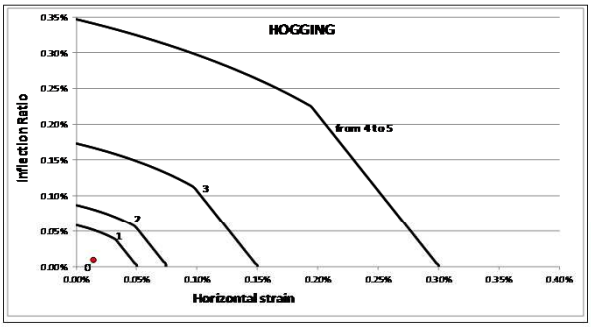
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	7.90

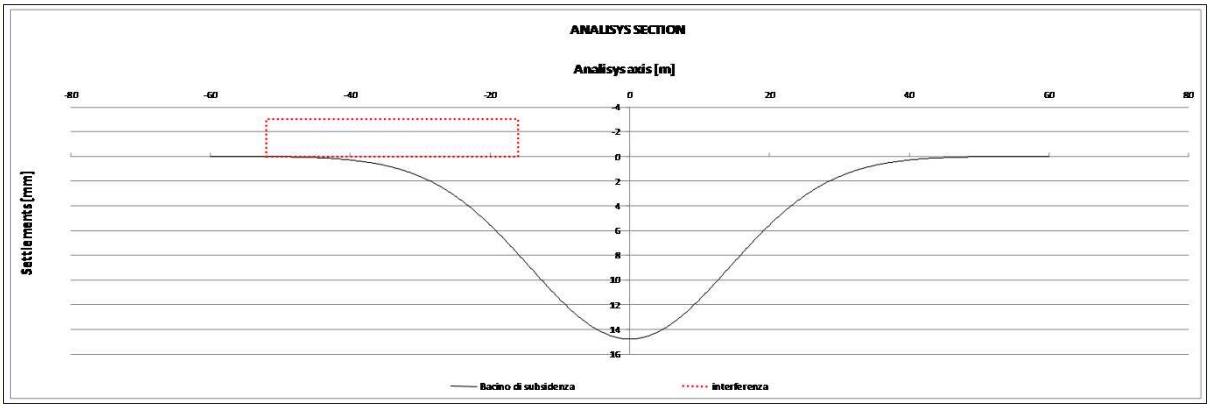
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.19E-04	1/1615
Maximum Angular Distortion	β	4.00E-04	1/2497

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.009%
Horizontal strain	ε_h	0.015%
Total strain	ε_{max}	0.019%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

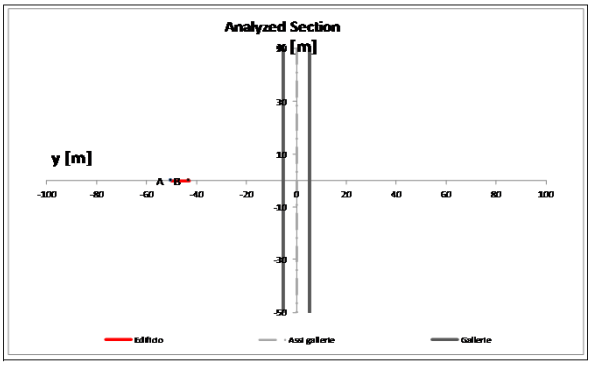
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	10

Building Features			
Function	militare		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	7.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	8.5	[m]
Length in the analyzed directio	L	7.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	14.5	14.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-43

Settlements	
Point	w [mm]
A	0.00
B	0.03

Direction analysys	A	B

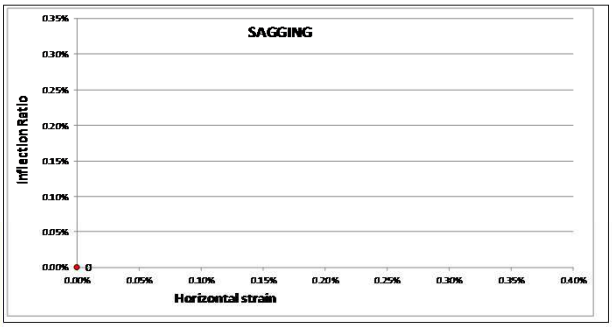
DAMAGE CLASS EVALUATION

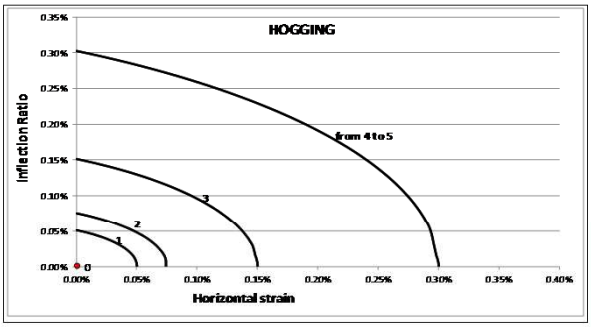
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	17.78
Max. Settlement of the building [mm]	$w_{building}$	0.03

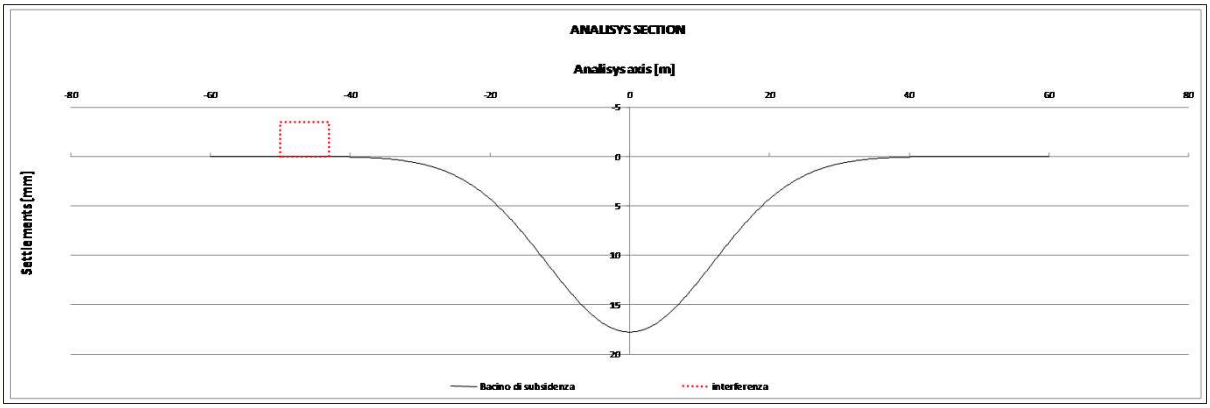
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.73E-06	1/129395
Maximum Angular Distortion	β	4.46E-06	1/224256

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.001%
Total strain	ε_{max}	0.001%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

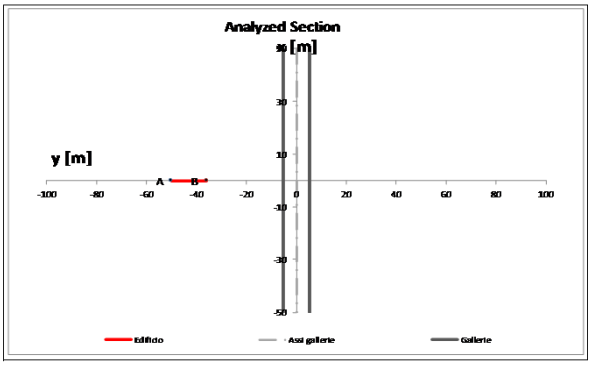
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	11

Building Features			
Function	militare		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	7.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	8.5	[m]
Length in the analyzed directio	L	14.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	14.5	14.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-36

Settlements	
Point	w [mm]
A	0.00
B	0.18

Direction analysys	A	B

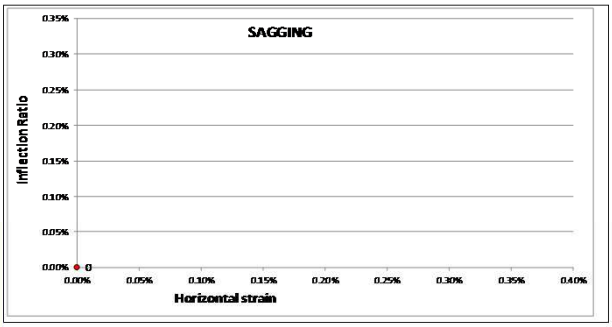
DAMAGE CLASS EVALUATION

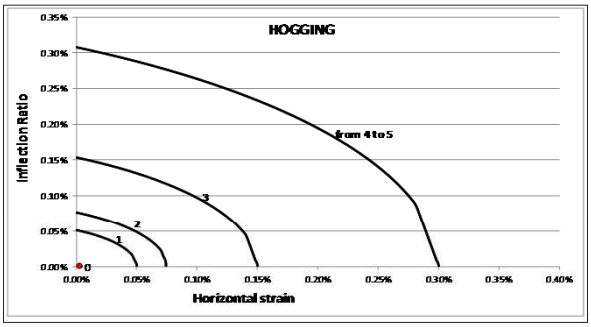
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	17.78
Max. Settlement of the building [mm]	$w_{building}$	0.18

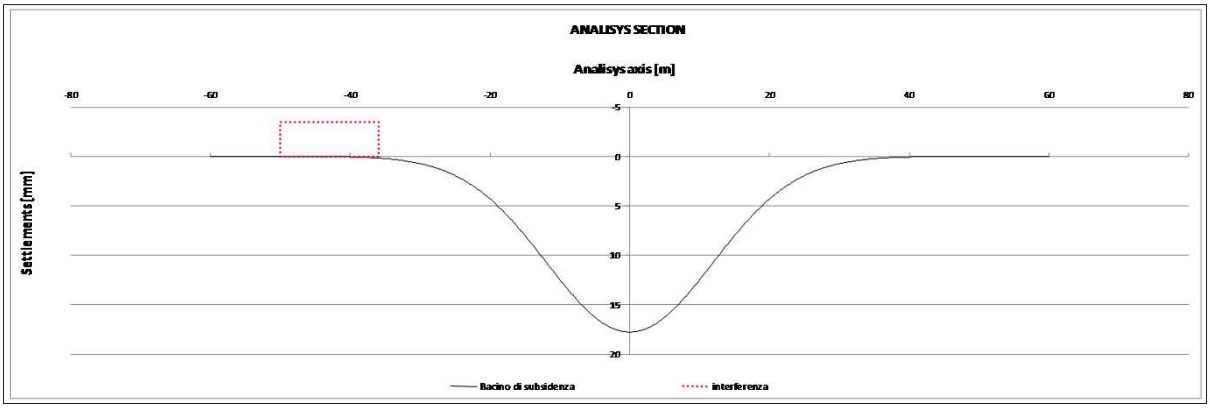
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.58E-05	1/21816
Maximum Angular Distortion	β	3.31E-05	1/30173

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

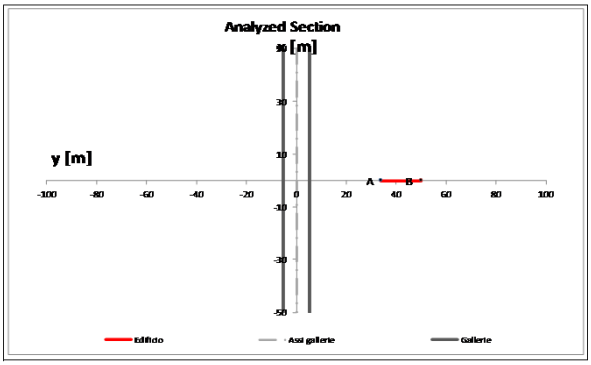
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	12

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	15.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	16.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	14.5	14.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	50

Settlements	
Point	w [mm]
A	0.30
B	0.00

Direction analysys	A	B

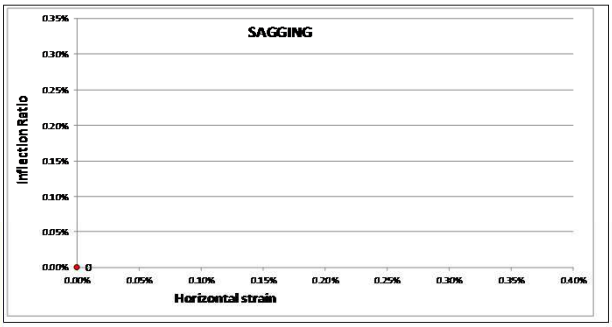
DAMAGE CLASS EVALUATION

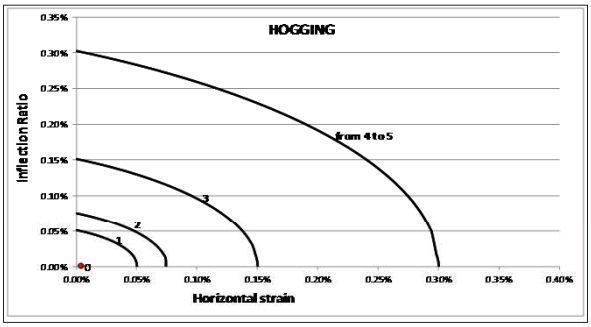
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	17.78
Max. Settlement of the building [mm]	$w_{building}$	0.30

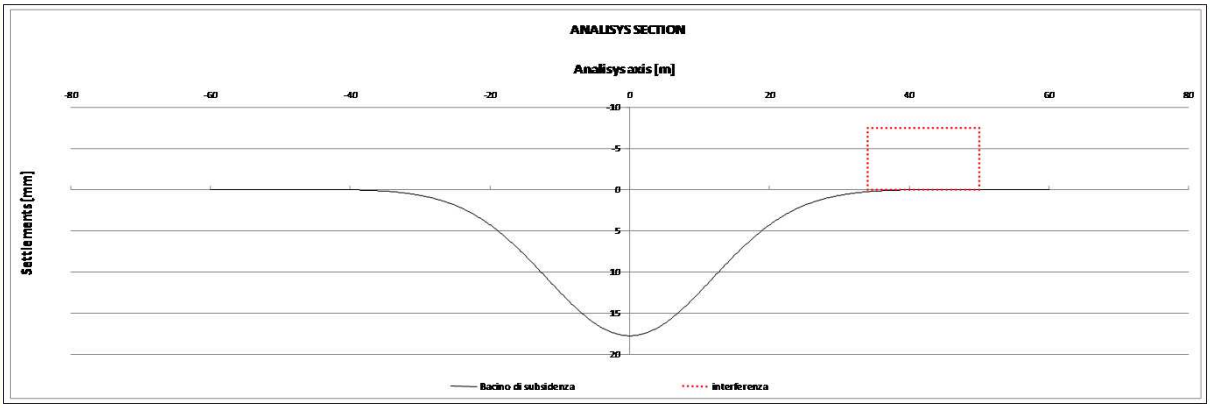
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.11E-05	1/14070
Maximum Angular Distortion	β	5.27E-05	1/18964

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

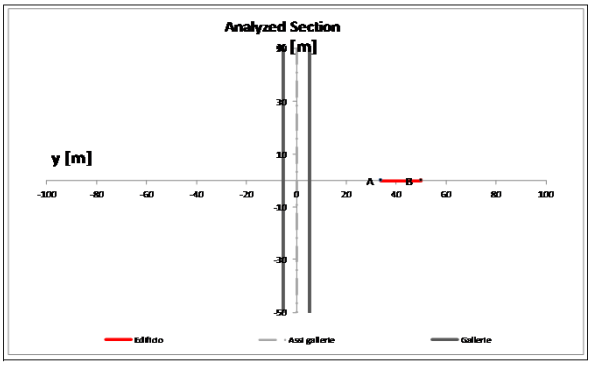
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	12_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	16.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	11.5	11.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	50

Settlements	
Point	w [mm]
A	0.07
B	0.00

Direction analysys	A	B

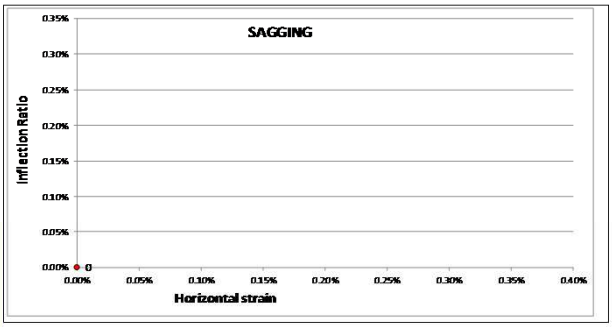
DAMAGE CLASS EVALUATION

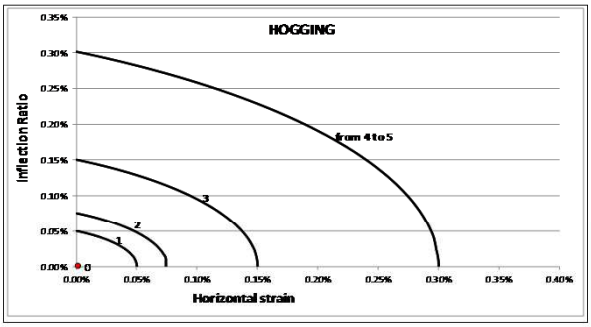
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	20.95
Max. Settlement of the building [mm]	$w_{building}$	0.07

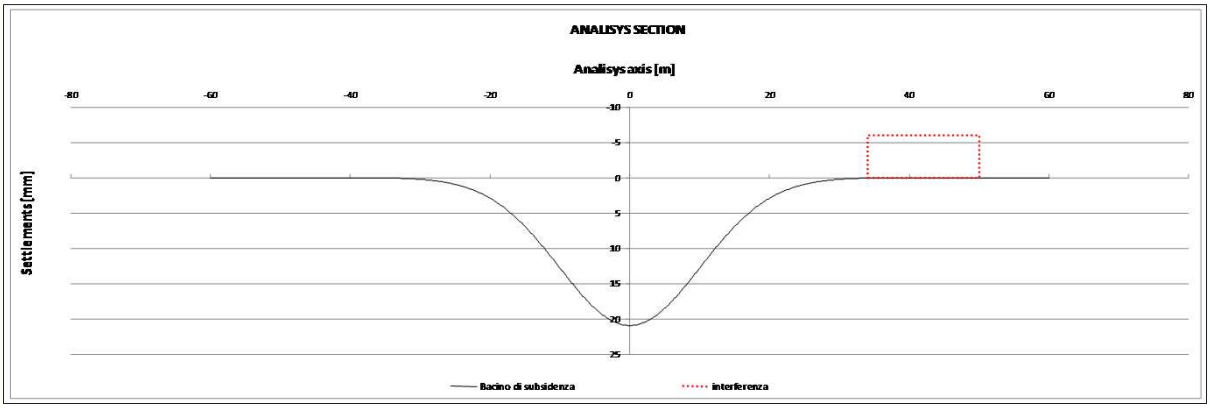
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.36E-05	1/42344
Maximum Angular Distortion	β	1.92E-05	1/52112

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.001%
Total strain	ε_{max}	0.002%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

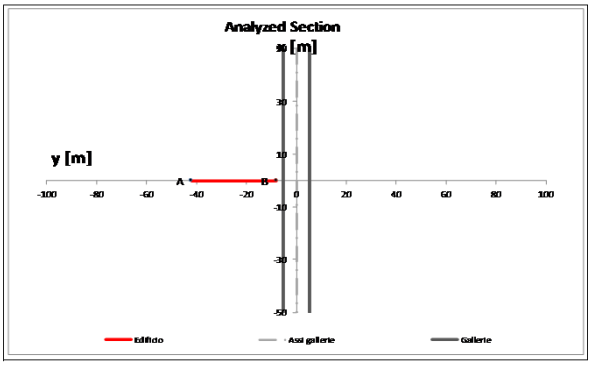
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	13

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	7.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	8.5	[m]
Length in the analyzed directio	L	34.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	23.5	23.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-42
B	0	-8

Settlements	
Point	w [mm]
A	0.64
B	10.98

Direction analysys	A	B

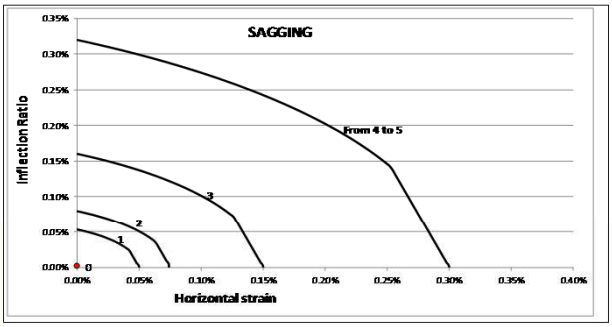
DAMAGE CLASS EVALUATION

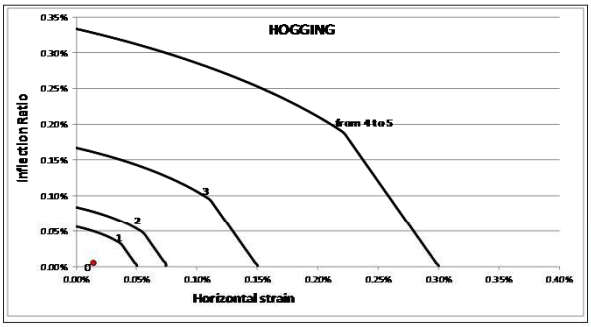
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.22
Max. Settlement of the building [mm]	$w_{building}$	10.98

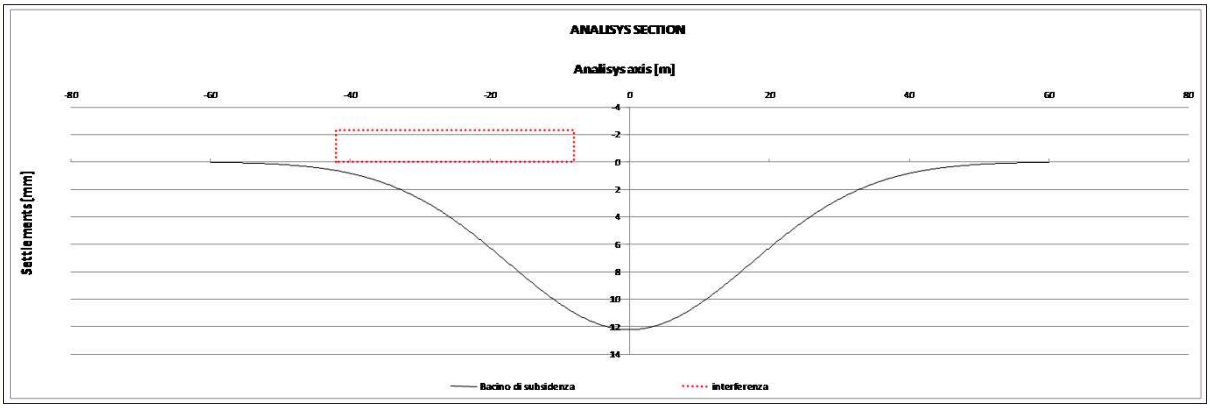
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.29E-04	1/2331
Maximum Angular Distortion	β	2.14E-04	1/4668

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.014%
Total strain	ε_{max}	0.016%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

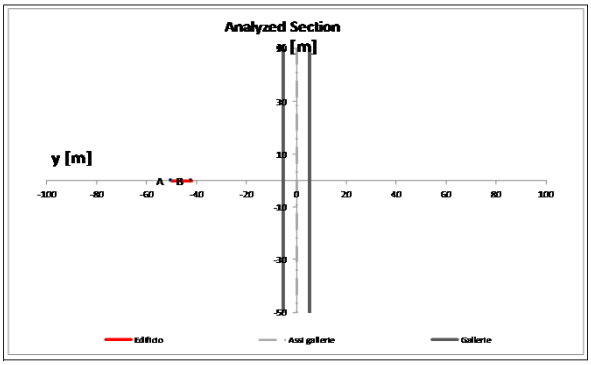
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	14

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	8.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	22.5	22.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-42

Settlements	
Point	w [mm]
A	0.14
B	0.53

Direction analysys	A	B

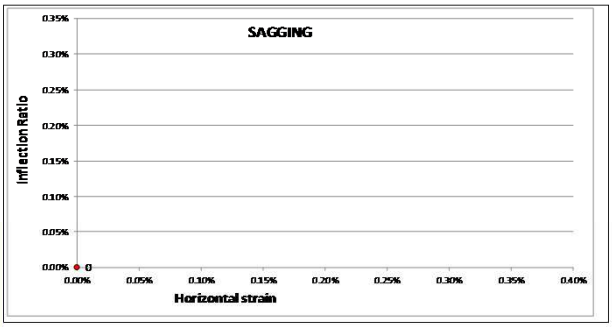
DAMAGE CLASS EVALUATION

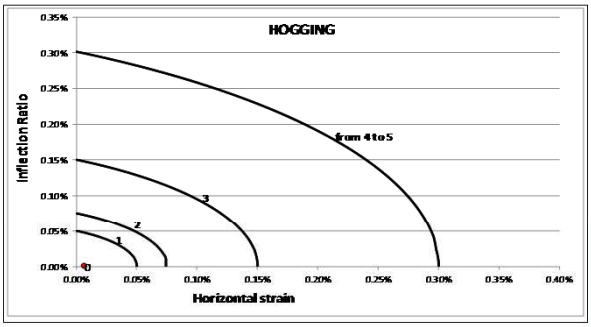
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.66
Max. Settlement of the building [mm]	$w_{building}$	0.53

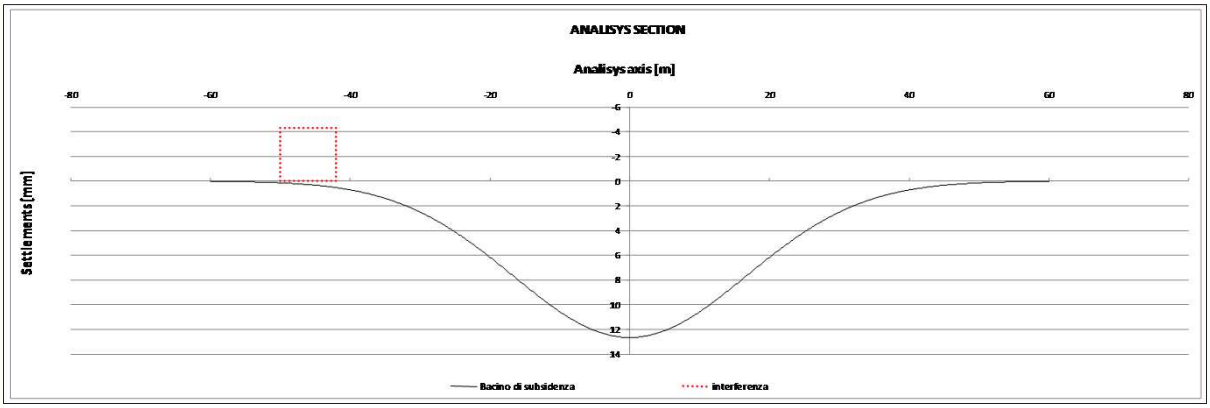
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	8.02E-05	1/12468
Maximum Angular Distortion	β	3.14E-05	1/31810

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.007%
Total strain	ε_{max}	0.007%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

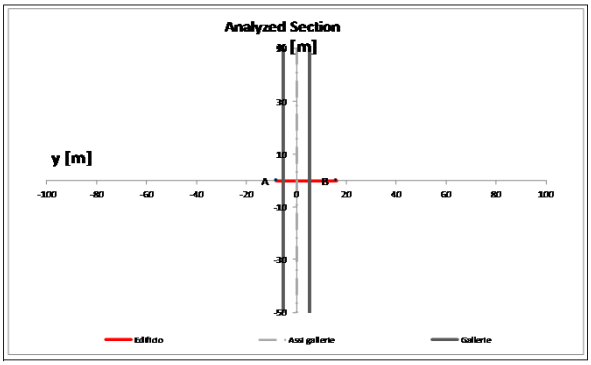
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	15

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	24.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	23.5	23.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-8
B	0	16

Settlements	
Point	w [mm]
A	10.98
B	7.96

Direction analysys	A	B

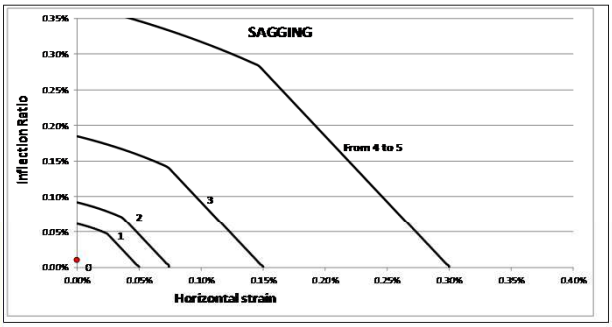
DAMAGE CLASS EVALUATION

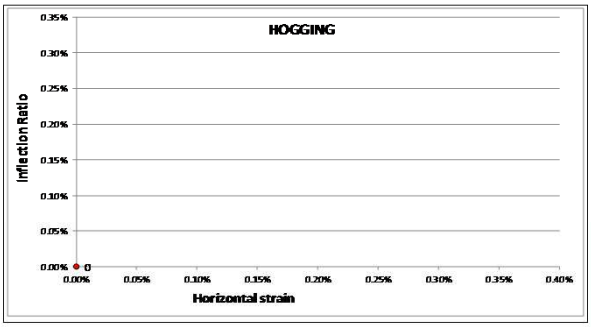
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.22
Max. Settlement of the building [mm]	$w_{building}$	12.22

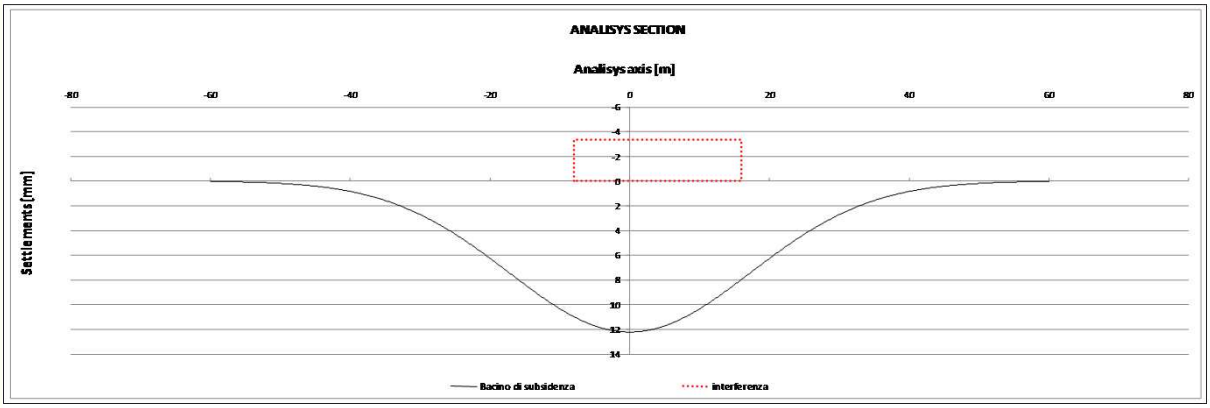
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.27E-04	1/2344
Maximum Angular Distortion	β	4.19E-04	1/2385

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.010%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.008%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

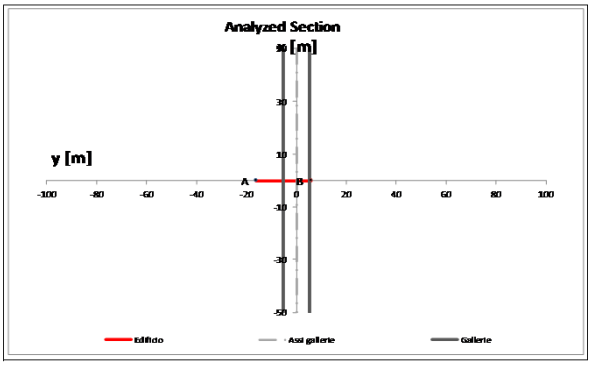
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	16

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	22.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	22.5	22.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-16
B	0	6

Settlements	
Point	w [mm]
A	7.99
B	11.87

Direction analysys	A	B

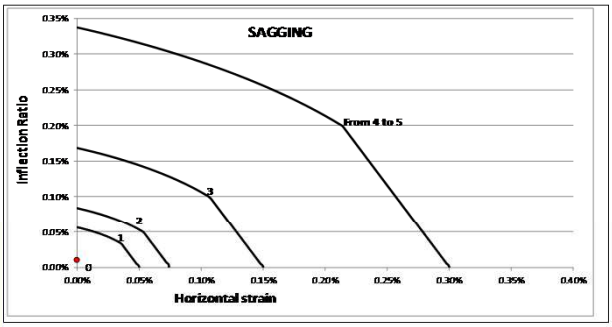
DAMAGE CLASS EVALUATION

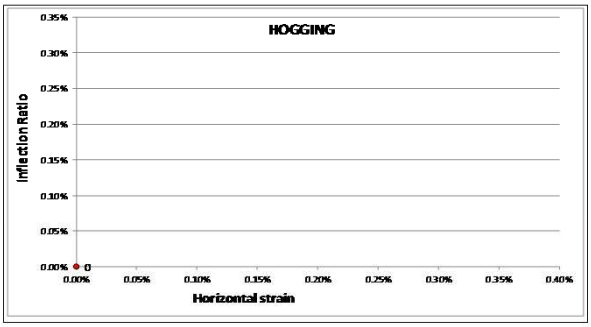
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.66
Max. Settlement of the building [mm]	$w_{building}$	12.66

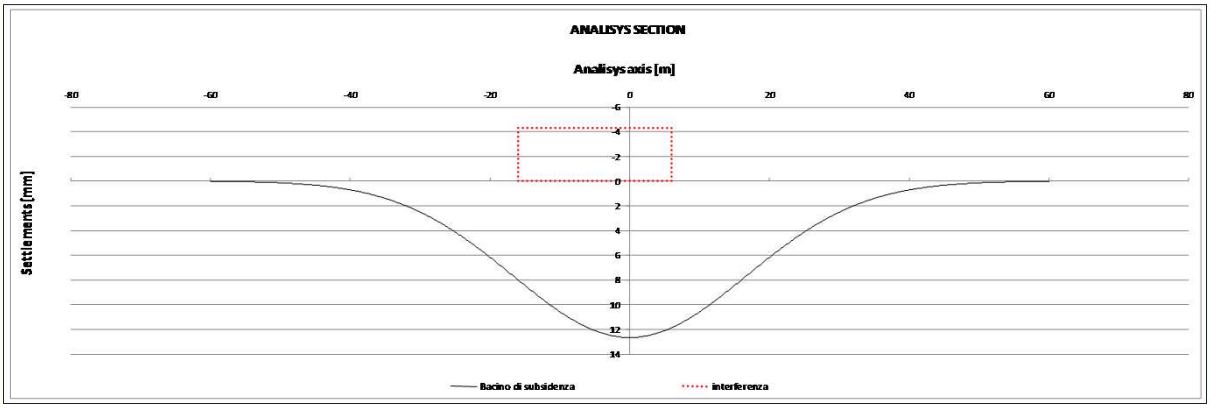
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.60E-04	1/2175
Maximum Angular Distortion	β	4.31E-04	1/2318

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.010%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.009%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

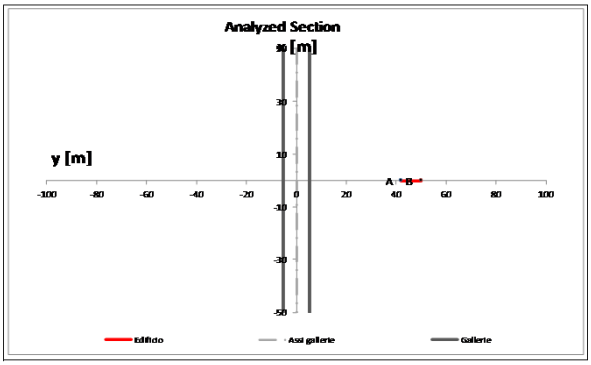
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	17

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	15.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	8.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	23.5	23.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	42
B	0	50

Settlements	
Point	w [mm]
A	0.64
B	0.19

Direction analysys	A	B

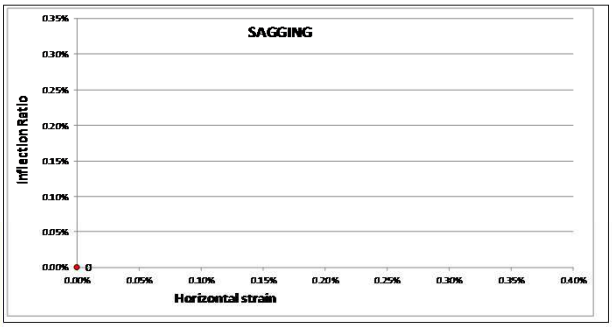
DAMAGE CLASS EVALUATION

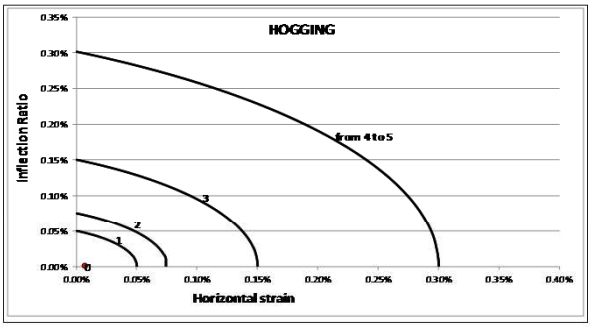
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.22
Max. Settlement of the building [mm]	$w_{building}$	0.64

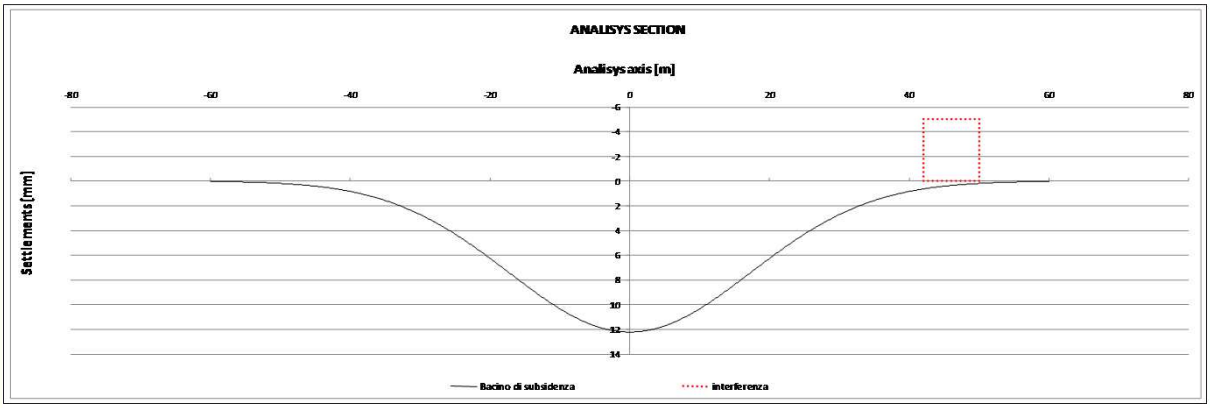
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	8.96E-05	1/11165
Maximum Angular Distortion	β	3.31E-05	1/30187

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.008%
Total strain	ε_{max}	0.008%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

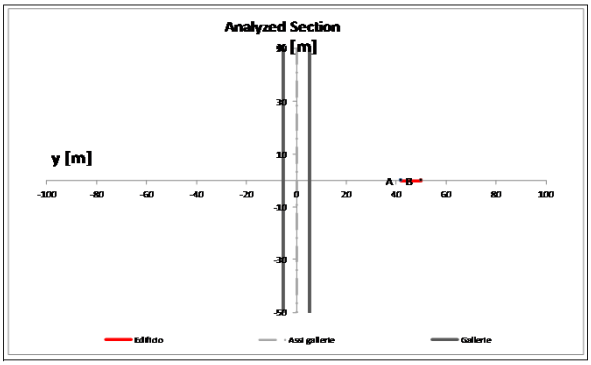
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	17_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	8.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	20.5	20.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	42
B	0	50

Settlements	
Point	w [mm]
A	0.34
B	0.07

Direction analysys	A	B

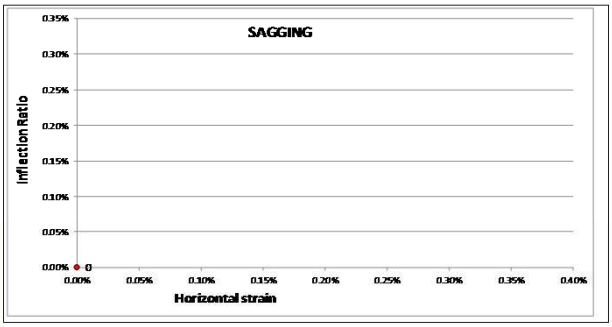
DAMAGE CLASS EVALUATION

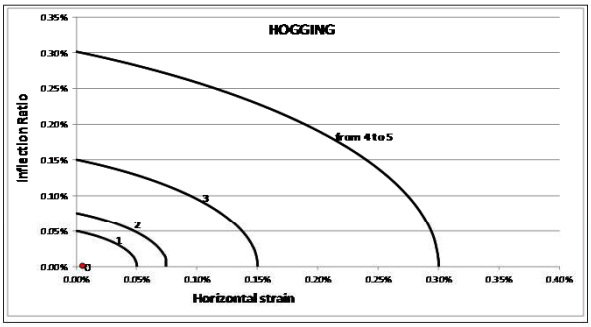
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	13.65
Max. Settlement of the building [mm]	$w_{building}$	0.34

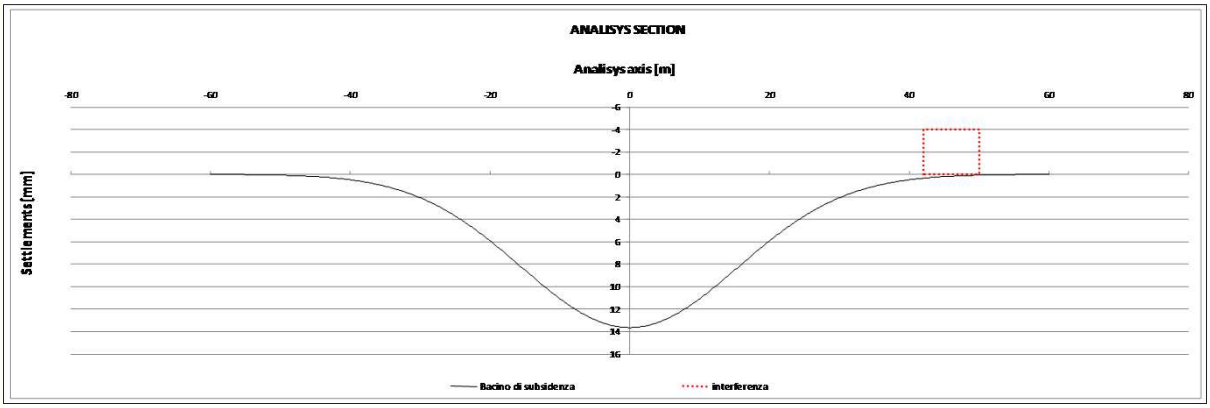
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.02E-05	1/16608
Maximum Angular Distortion	β	2.65E-05	1/37772

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

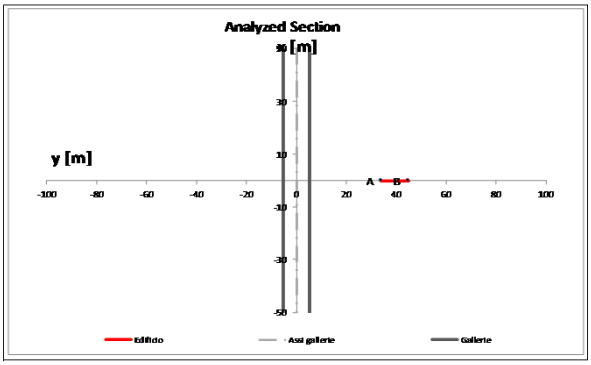
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	18

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	11.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	22.5	22.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	45

Settlements	
Point	w [mm]
A	1.59
B	0.33

Direction analysys	A	B

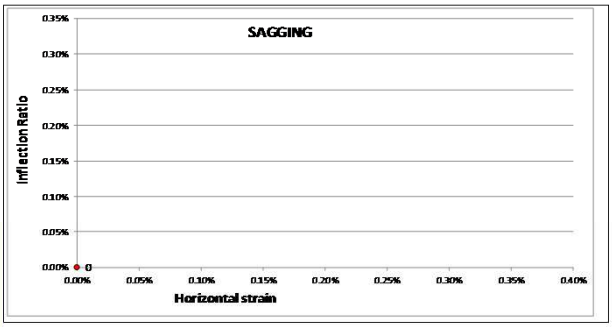
DAMAGE CLASS EVALUATION

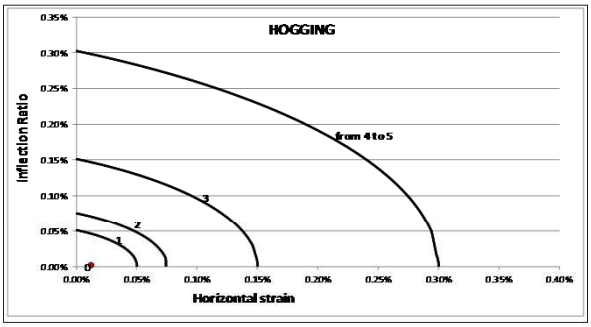
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.66
Max. Settlement of the building [mm]	$w_{building}$	1.59

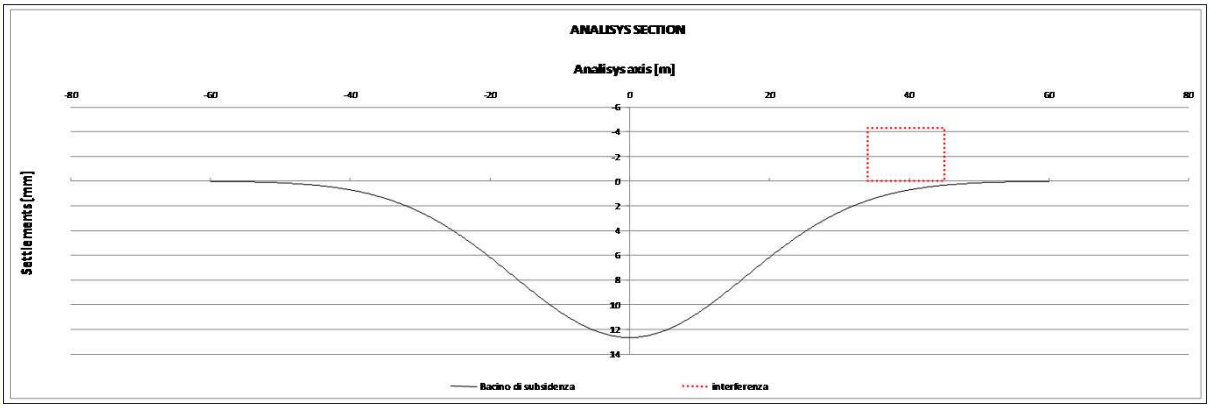
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.94E-04	1/5164
Maximum Angular Distortion	β	7.97E-05	1/12549

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.013%
Total strain	ε_{max}	0.013%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

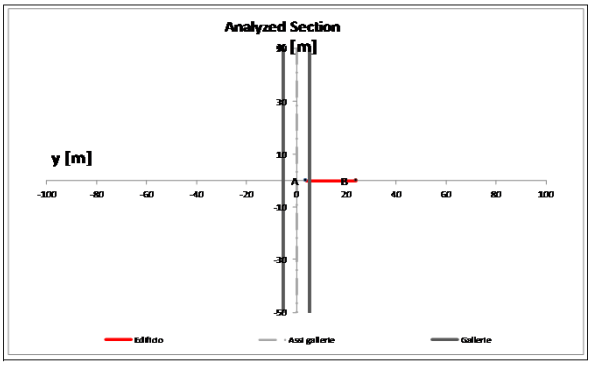
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	19

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	22.5	22.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	4
B	0	24

Settlements	
Point	w [mm]
A	12.30
B	4.50

Direction analysys	A	B

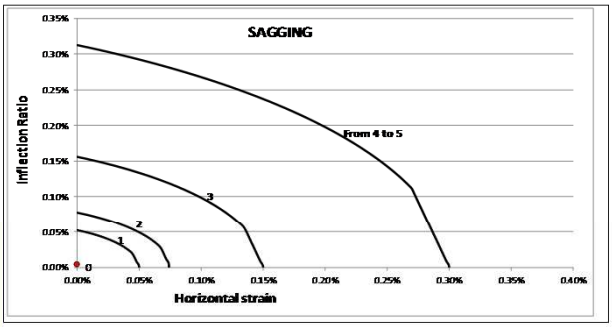
DAMAGE CLASS EVALUATION

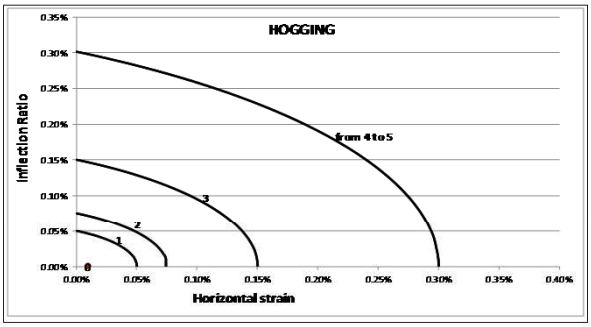
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.66
Max. Settlement of the building [mm]	$w_{building}$	12.30

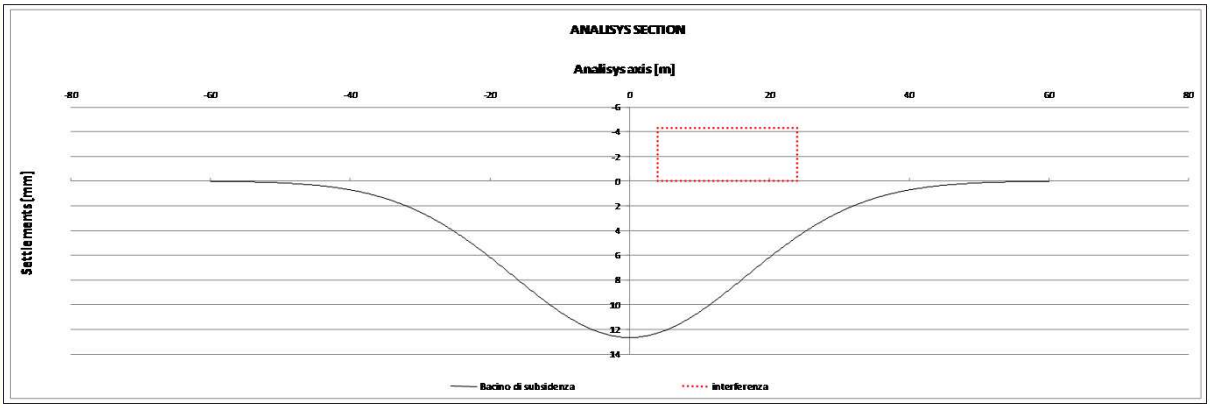
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.60E-04	1/2172
Maximum Angular Distortion	β	2.13E-04	1/4703

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.004%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.004%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.010%
Total strain	ε_{max}	0.010%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

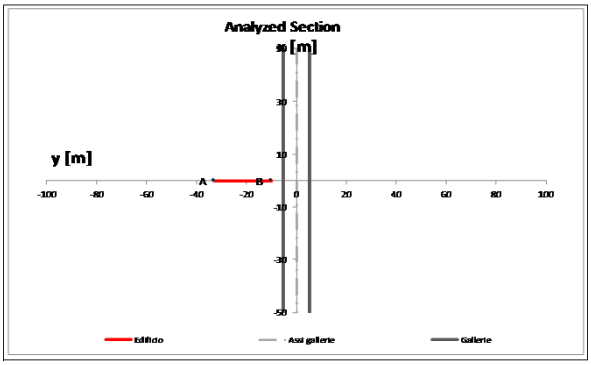
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	20

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	4.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	5.5	[m]
Length in the analyzed directio	L	23.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	20.5	20.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-33
B	0	-10

Settlements	
Point	w [mm]
A	1.41
B	11.08

Direction analysys	A	B

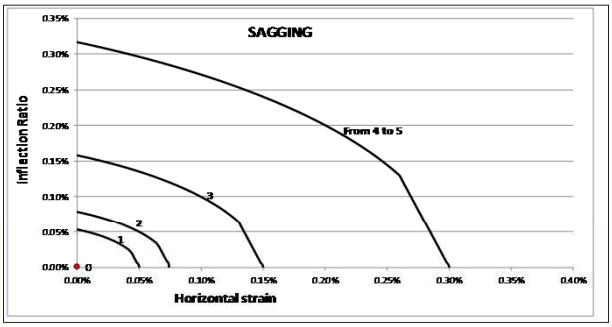
DAMAGE CLASS EVALUATION

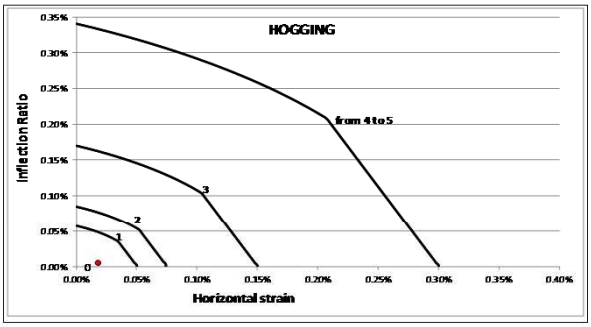
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	13.65
Max. Settlement of the building [mm]	$w_{building}$	11.08

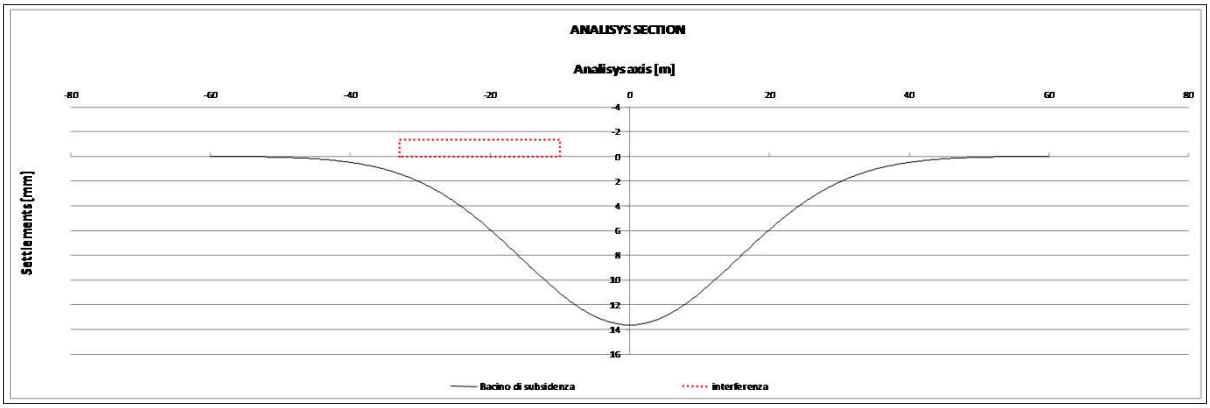
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.35E-04	1/1870
Maximum Angular Distortion	β	2.26E-04	1/4421

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.018%
Total strain	ε_{max}	0.020%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

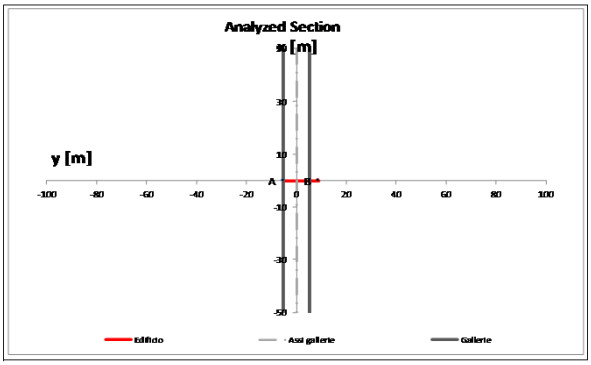
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	21

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	BRICKWORK		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	14.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	9

Settlements	
Point	w [mm]
A	13.91
B	12.13

Direction analysys	A	B

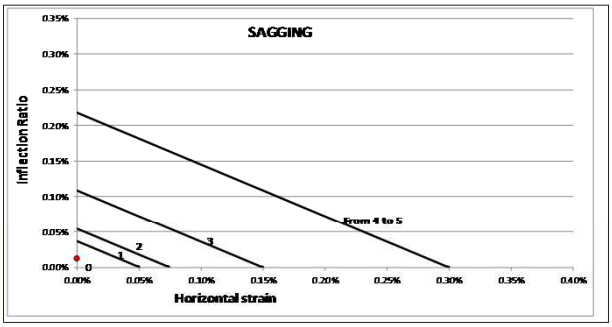
DAMAGE CLASS EVALUATION

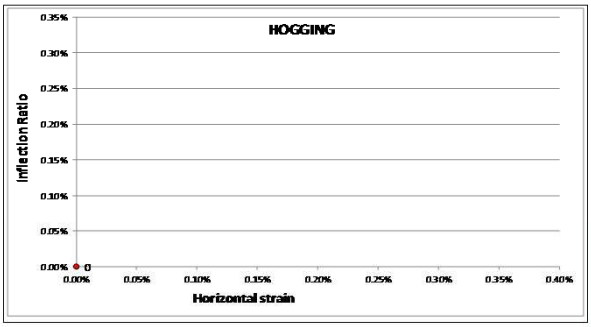
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	14.79

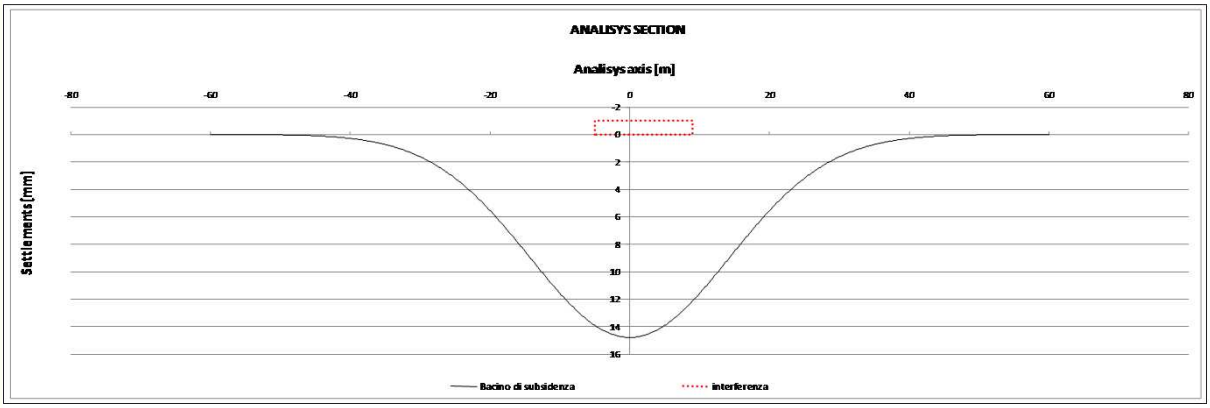
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.35E-04	1/1870
Maximum Angular Distortion	β	4.68E-04	1/2138

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.012%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.016%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

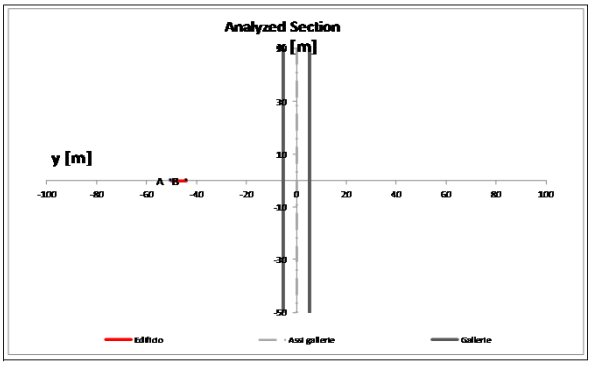
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	22

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	6.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-44

Settlements	
Point	w [mm]
A	0.03
B	0.13

Direction analysys	A	B

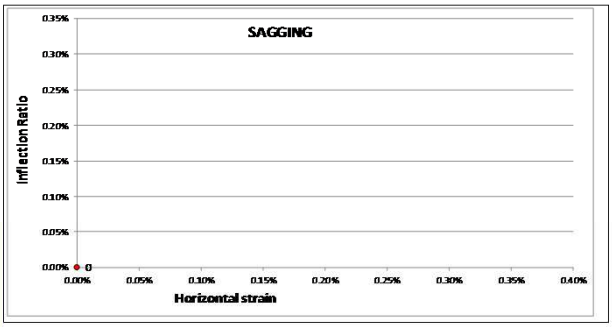
DAMAGE CLASS EVALUATION

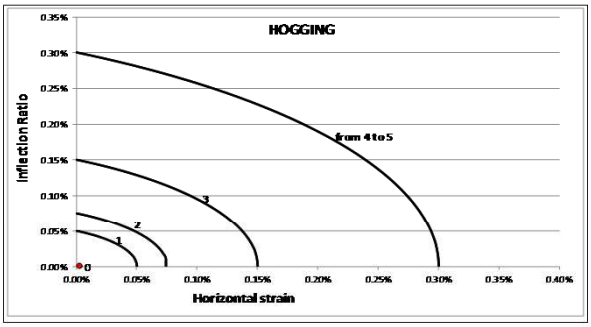
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	0.13

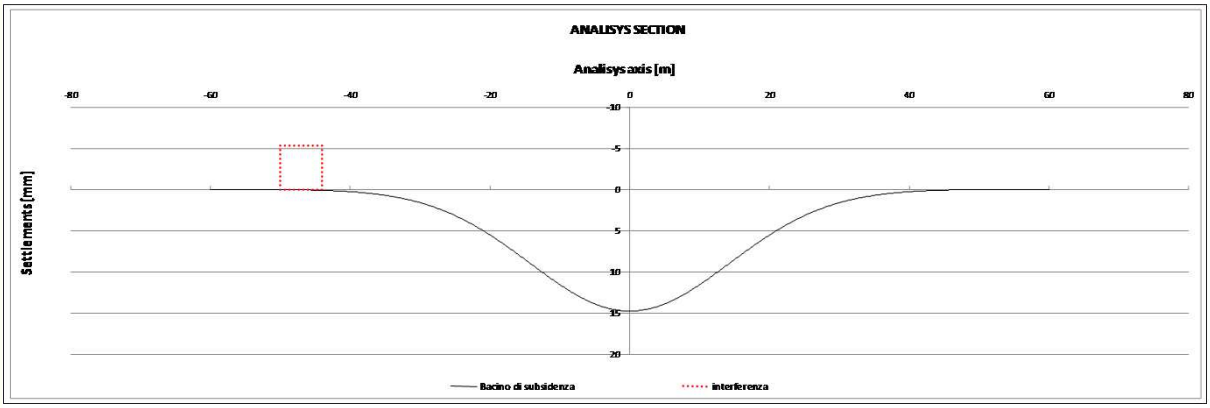
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.77E-05	1/36147
Maximum Angular Distortion	β	1.16E-05	1/85926

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

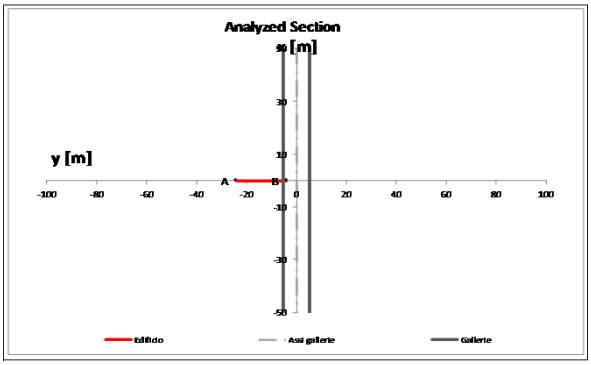
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	23

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-24
B	0	-4

Settlements	
Point	w [mm]
A	3.60
B	14.22

Direction analysys	A	B

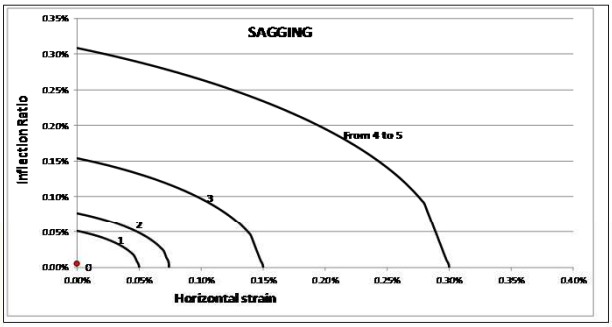
DAMAGE CLASS EVALUATION

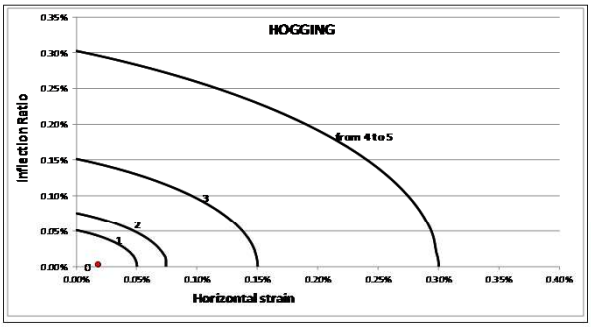
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	14.22

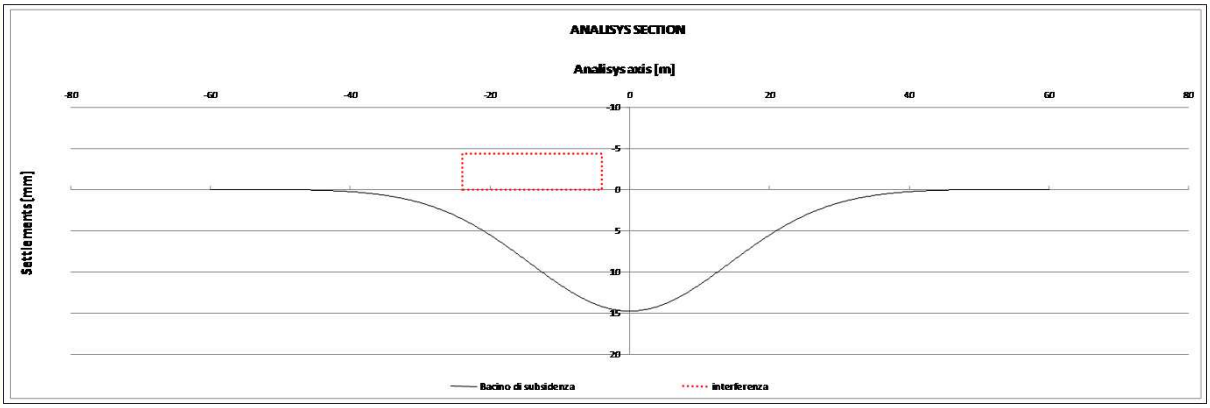
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.28E-04	1/1592
Maximum Angular Distortion	β	2.51E-04	1/3988

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.004%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.018%
Total strain	ε_{max}	0.018%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

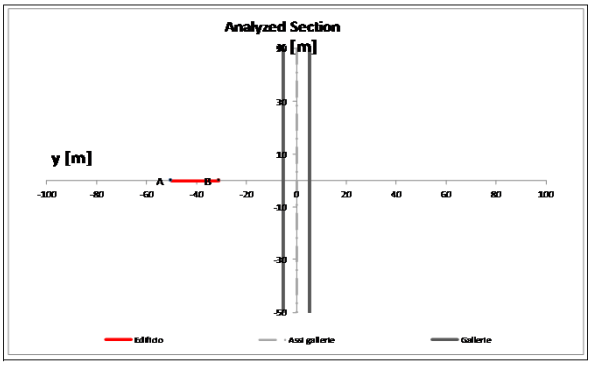
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	25

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	19.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-31

Settlements	
Point	w [mm]
A	0.03
B	1.40

Direction analysys	A	B

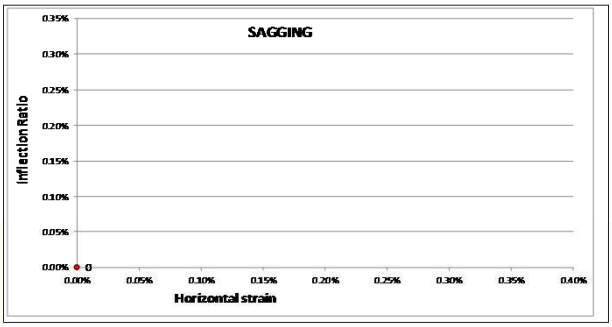
DAMAGE CLASS EVALUATION

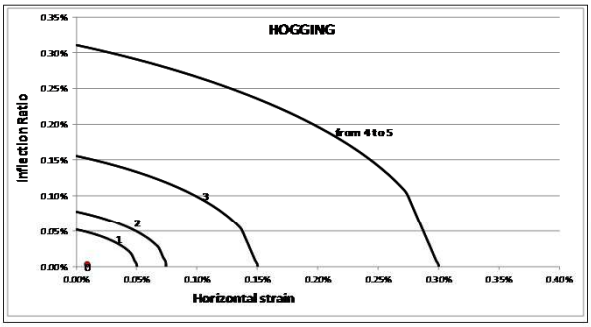
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	1.40

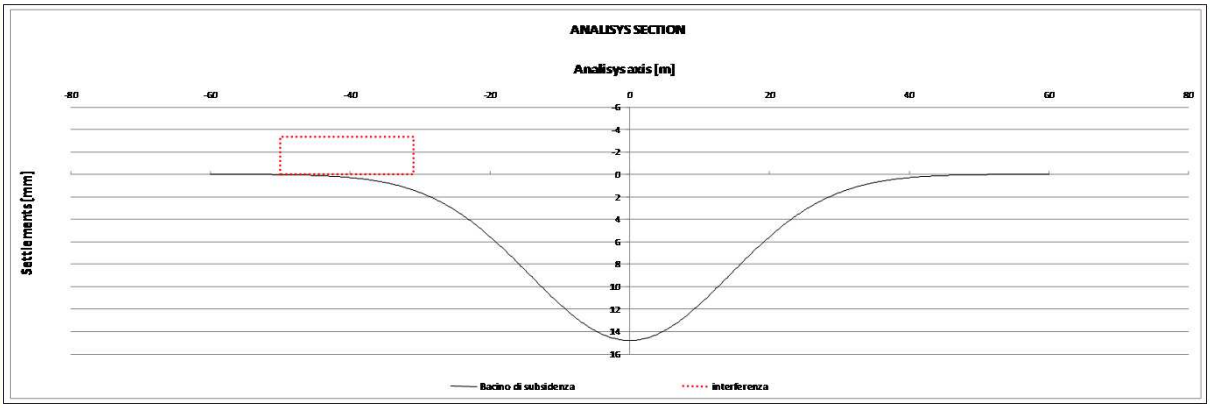
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.13E-04	1/4703
Maximum Angular Distortion	β	1.41E-04	1/7116

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.009%
Total strain	ε_{max}	0.010%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

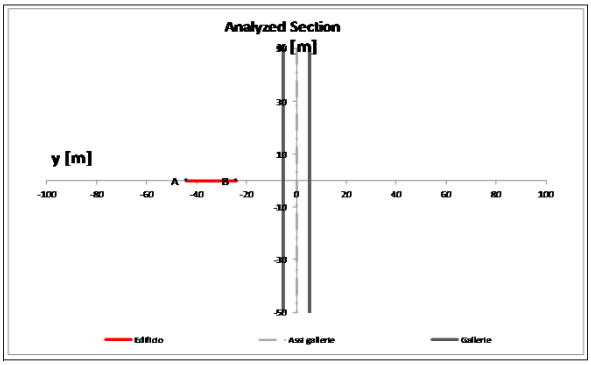
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	26

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-44
B	0	-24

Settlements	
Point	w [mm]
A	0.13
B	3.60

Direction analysys	A	B

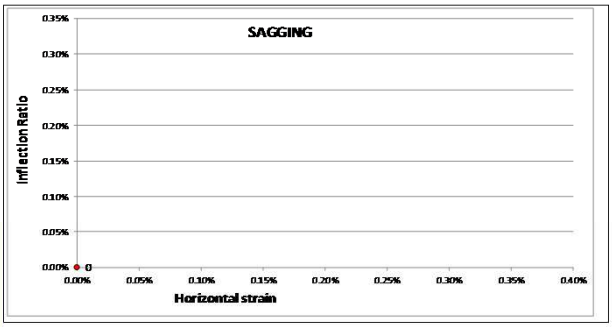
DAMAGE CLASS EVALUATION

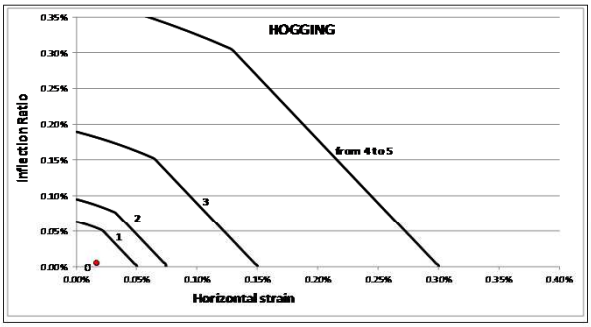
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	3.60

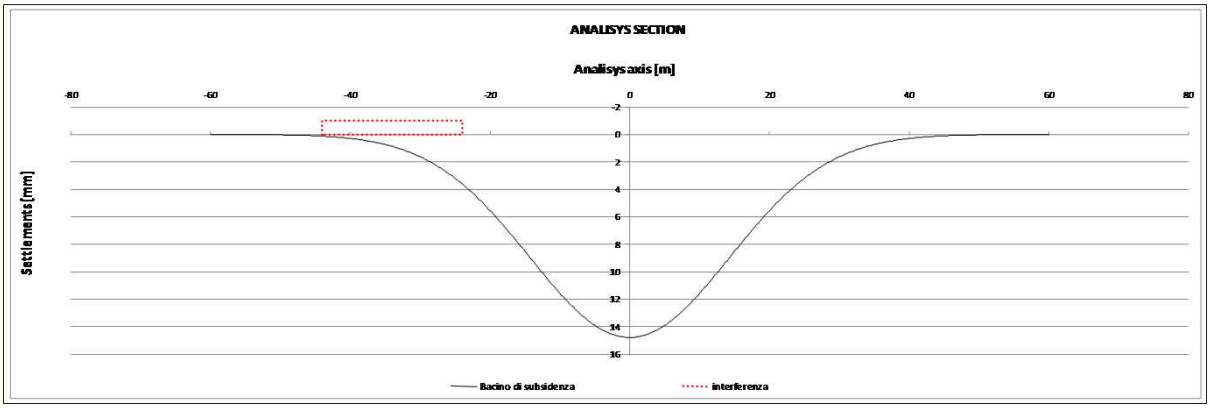
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.23E-04	1/2362
Maximum Angular Distortion	β	2.50E-04	1/4005

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.017%
Total strain	ε_{max}	0.020%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

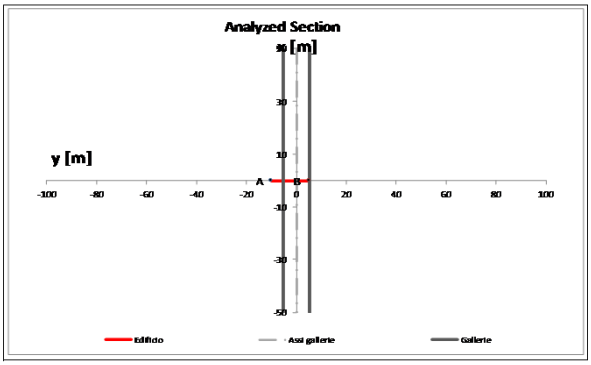
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	27

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	15.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	17.5	17.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-10
B	0	5

Settlements	
Point	w [mm]
A	11.82
B	14.44

Direction analysys	A	B

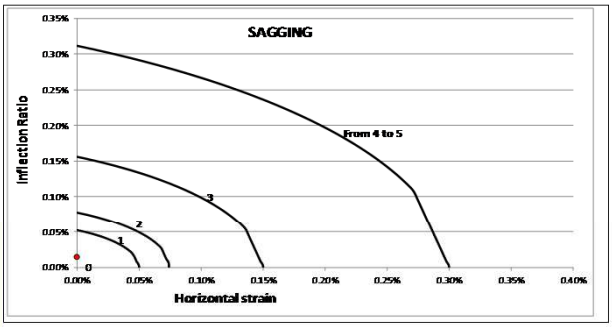
DAMAGE CLASS EVALUATION

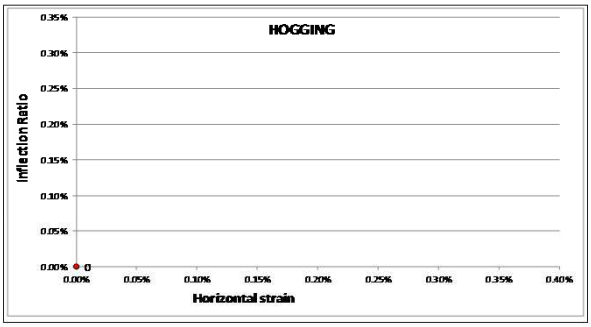
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	15.44
Max. Settlement of the building [mm]	$w_{building}$	15.44

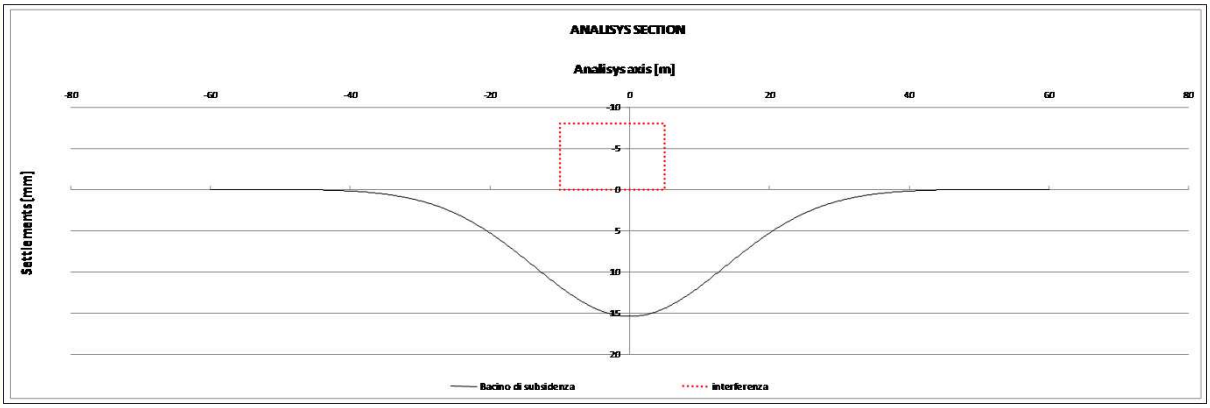
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.31E-04	1/1584
Maximum Angular Distortion	β	5.60E-04	1/1787

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.014%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.013%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

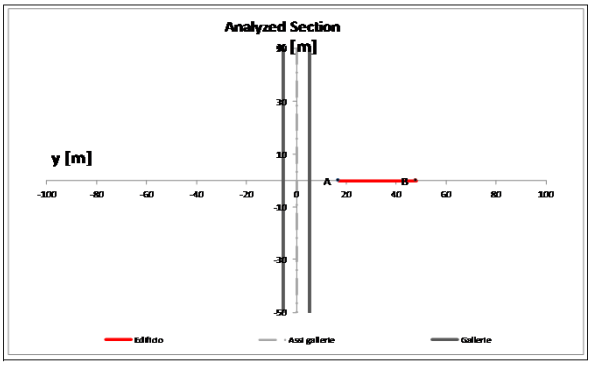
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	28

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	31.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	17.5	17.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	17
B	0	48

Settlements	
Point	w [mm]
A	7.13
B	0.03

Direction analysys	A	B

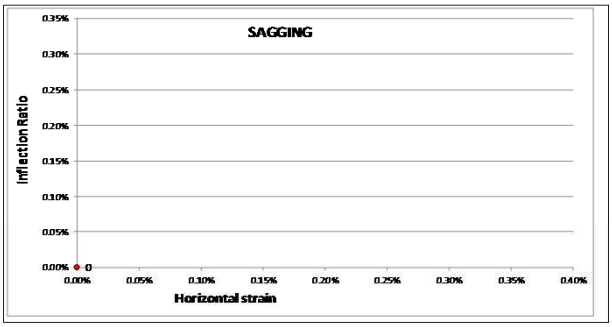
DAMAGE CLASS EVALUATION

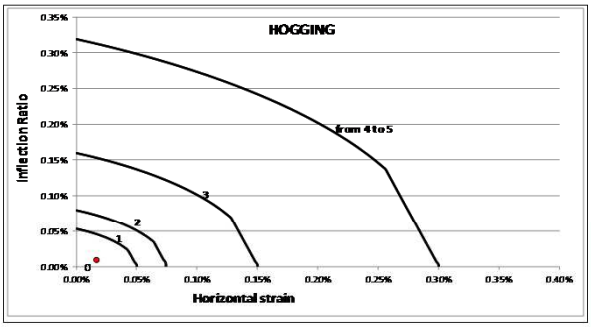
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	15.44
Max. Settlement of the building [mm]	$w_{building}$	7.13

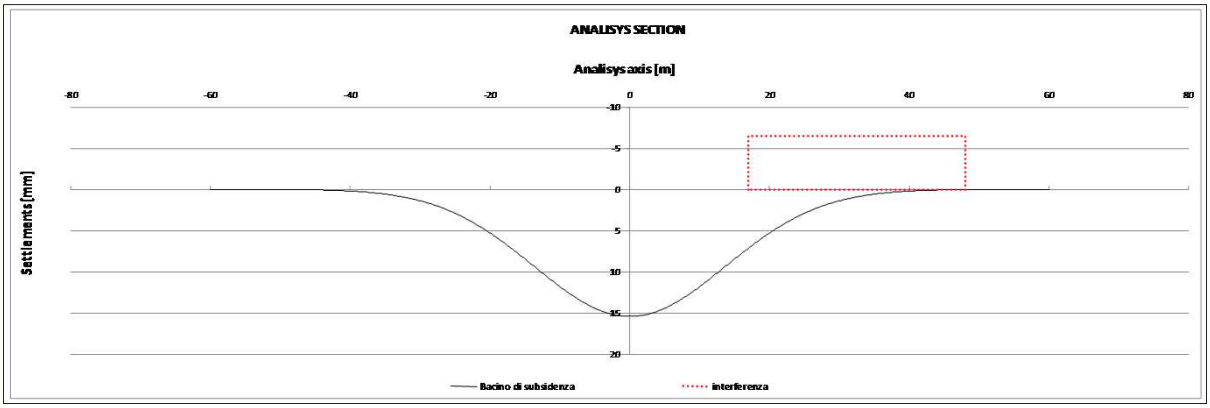
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.47E-04	1/1545
Maximum Angular Distortion	β	4.18E-04	1/2390

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.009%
Horizontal strain	ε_h	0.017%
Total strain	ε_{max}	0.020%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

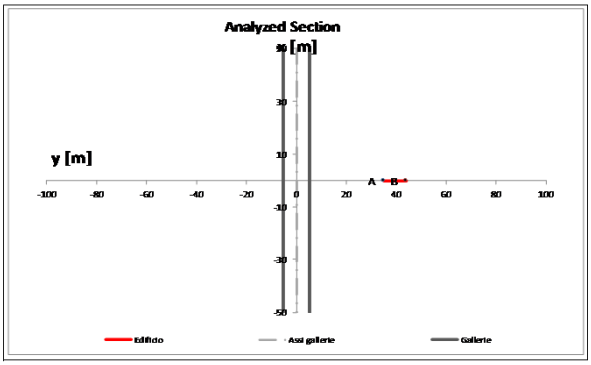
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	29

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	9.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	35
B	0	44

Settlements	
Point	w [mm]
A	0.73
B	0.13

Direction analysys	A	B

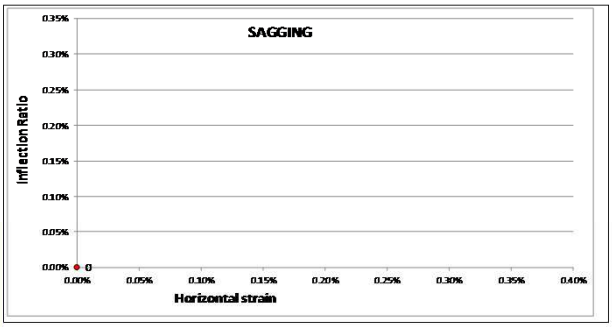
DAMAGE CLASS EVALUATION

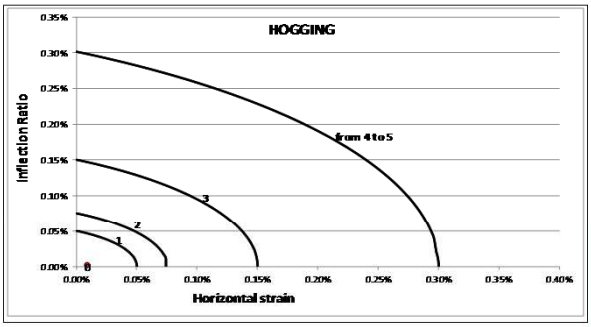
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	0.73

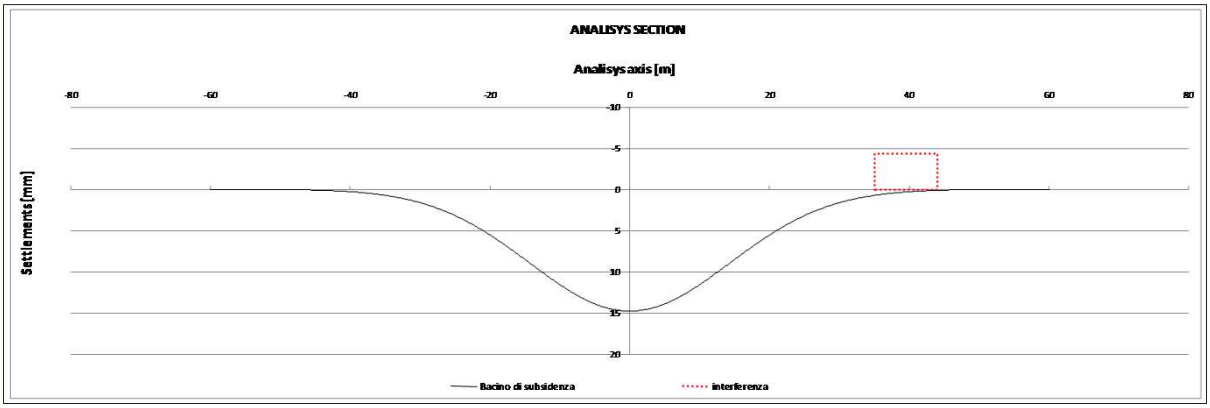
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.26E-04	1/7950
Maximum Angular Distortion	β	5.85E-05	1/17090

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.009%
Total strain	ε_{max}	0.009%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

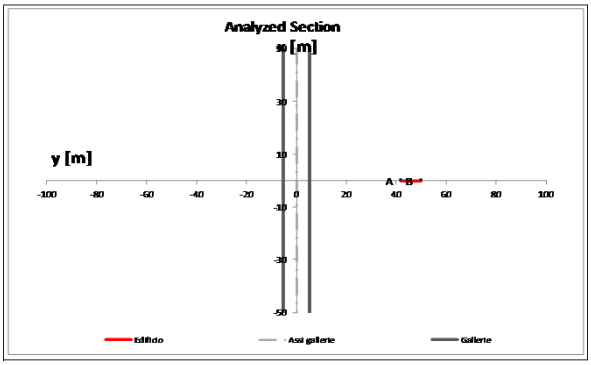
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	30

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	8.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.5	18.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	42
B	0	50

Settlements	
Point	w [mm]
A	0.20
B	0.03

Direction analysys	A	B

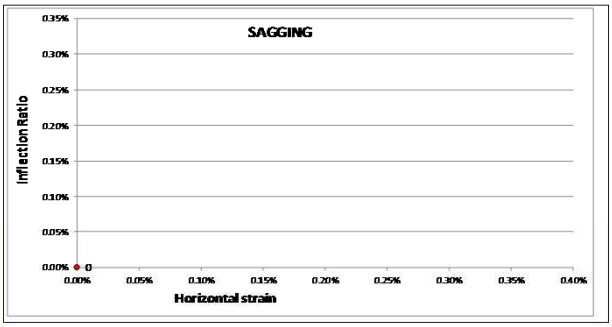
DAMAGE CLASS EVALUATION

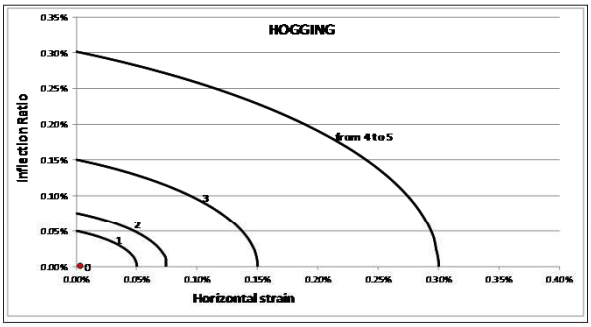
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.79
Max. Settlement of the building [mm]	$w_{building}$	0.20

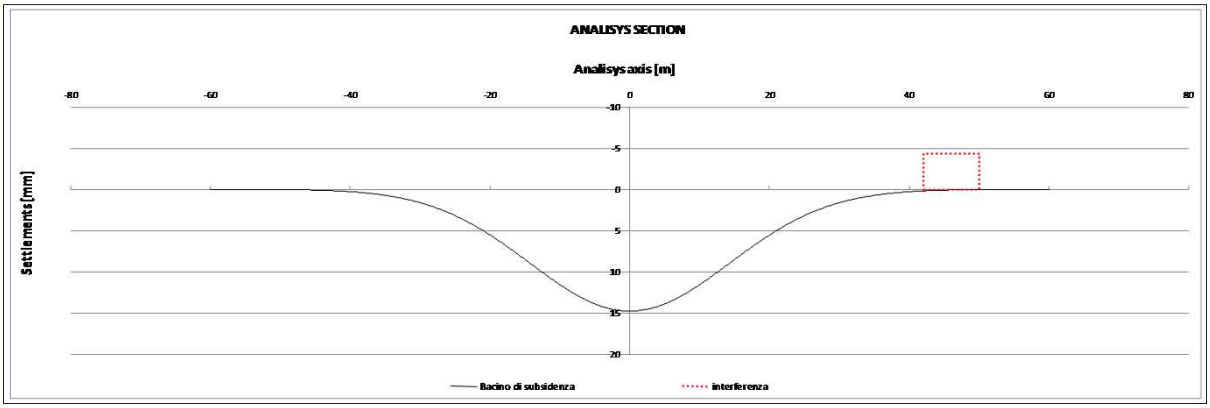
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.02E-05	1/24845
Maximum Angular Distortion	β	1.98E-05	1/50476

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

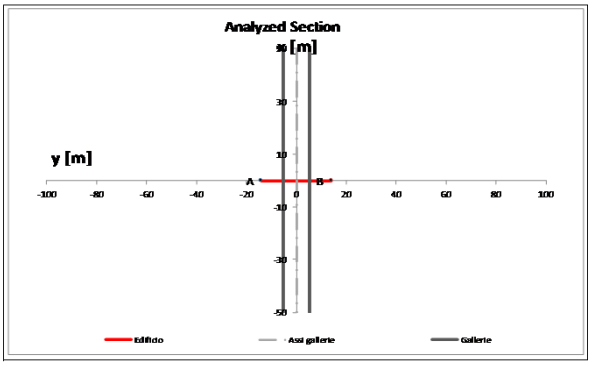
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	31

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	28.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	19.5	19.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-14
B	0	14

Settlements	
Point	w [mm]
A	9.12
B	9.12

Direction analysys	A	B

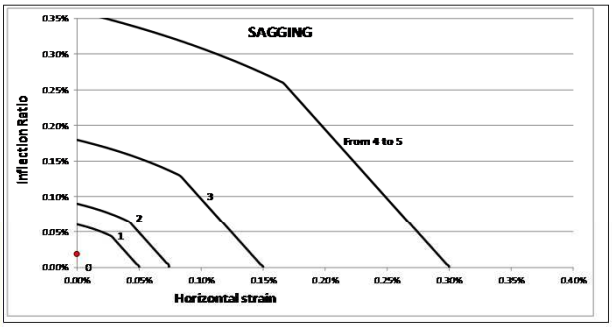
DAMAGE CLASS EVALUATION

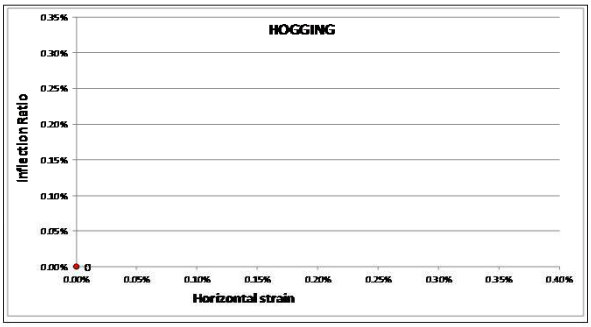
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.20
Max. Settlement of the building [mm]	$w_{building}$	14.20

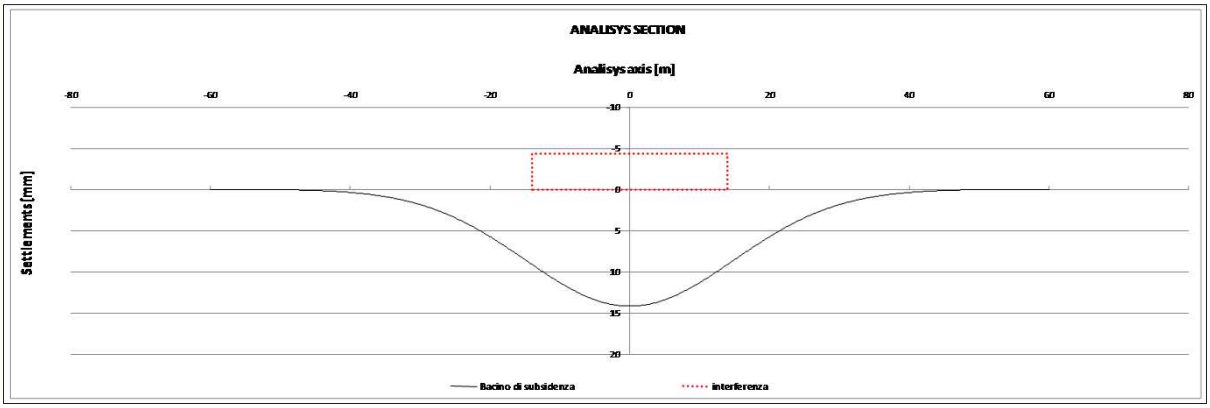
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.76E-04	1/1735
Maximum Angular Distortion	β	5.76E-04	1/1735

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.018%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.015%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

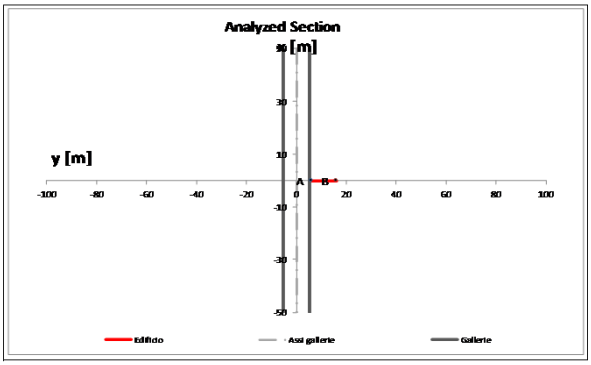
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	32

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	2.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	3.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	19.5	19.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	6
B	0	16

Settlements	
Point	w [mm]
A	13.09
B	7.96

Direction analysys	A	B

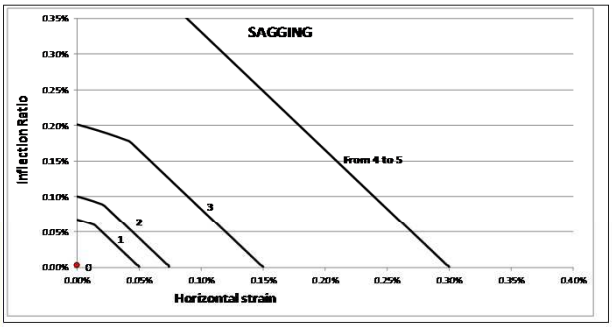
DAMAGE CLASS EVALUATION

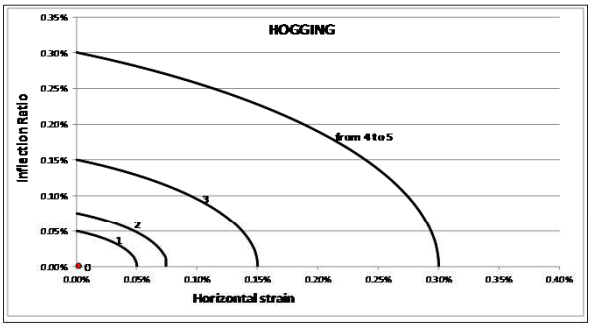
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.20
Max. Settlement of the building [mm]	$w_{building}$	13.09

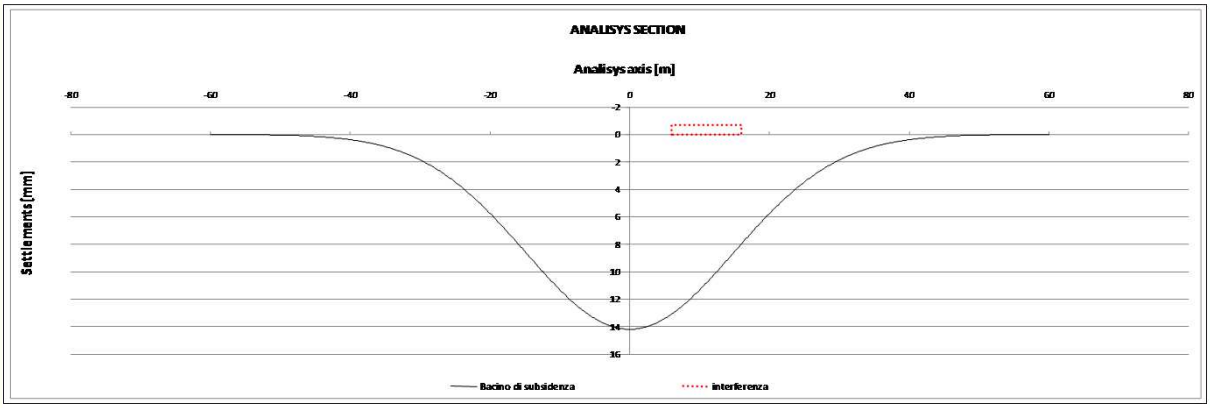
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.79E-04	1/1728
Maximum Angular Distortion	β	1.57E-04	1/6359

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

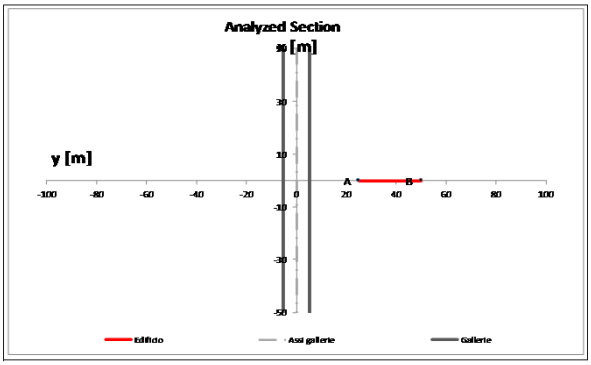
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	33

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	25.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	19.5	19.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	25
B	0	50

Settlements	
Point	w [mm]
A	3.46
B	0.05

Direction analysys	A	B

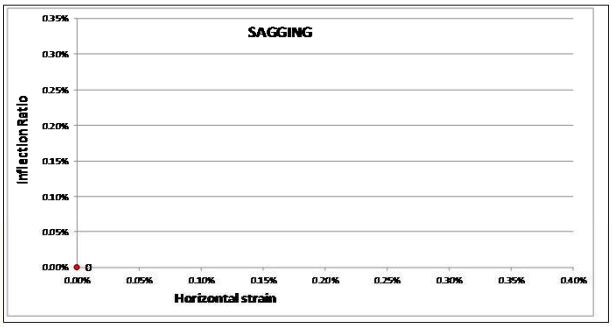
DAMAGE CLASS EVALUATION

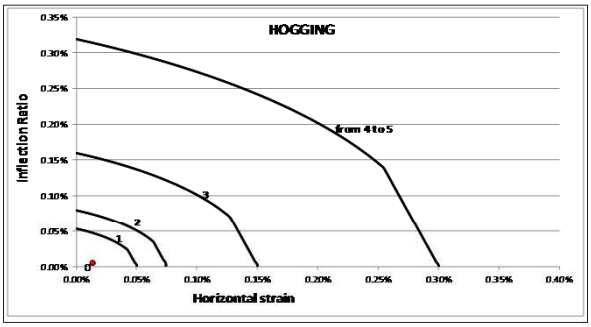
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.20
Max. Settlement of the building [mm]	$w_{building}$	3.46

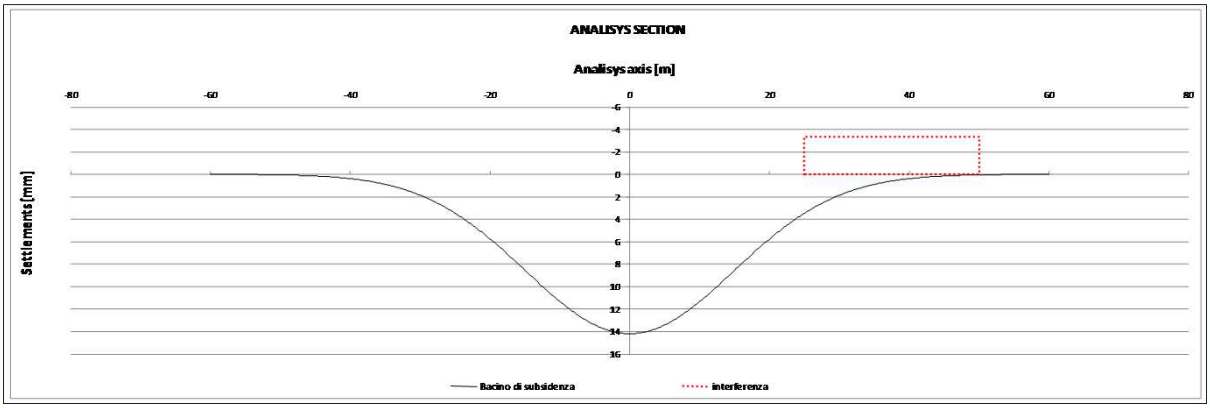
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.90E-04	1/2564
Maximum Angular Distortion	β	2.54E-04	1/3943

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.014%
Total strain	ε_{max}	0.015%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

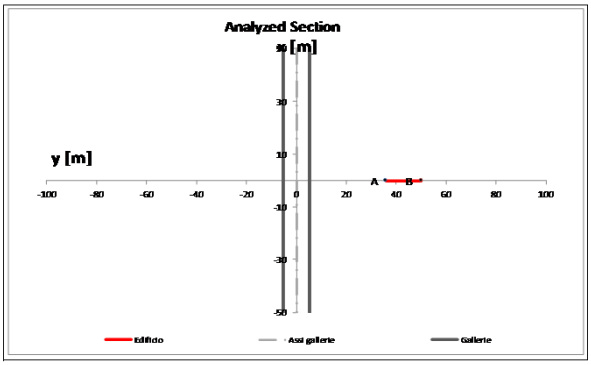
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	34

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	14.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	19.5	19.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	36
B	0	50

Settlements	
Point	w [mm]
A	0.76
B	0.05

Direction analysys	A	B

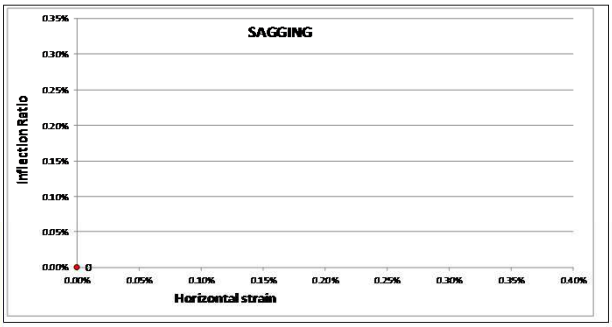
DAMAGE CLASS EVALUATION

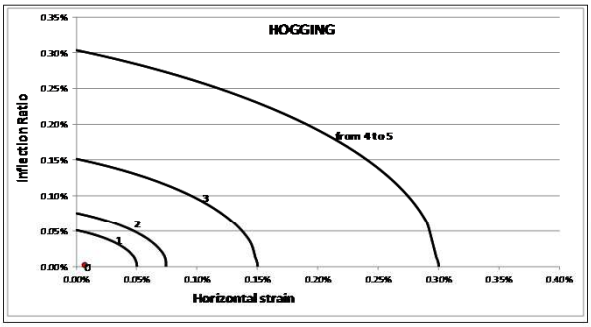
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.20
Max. Settlement of the building [mm]	$w_{building}$	0.76

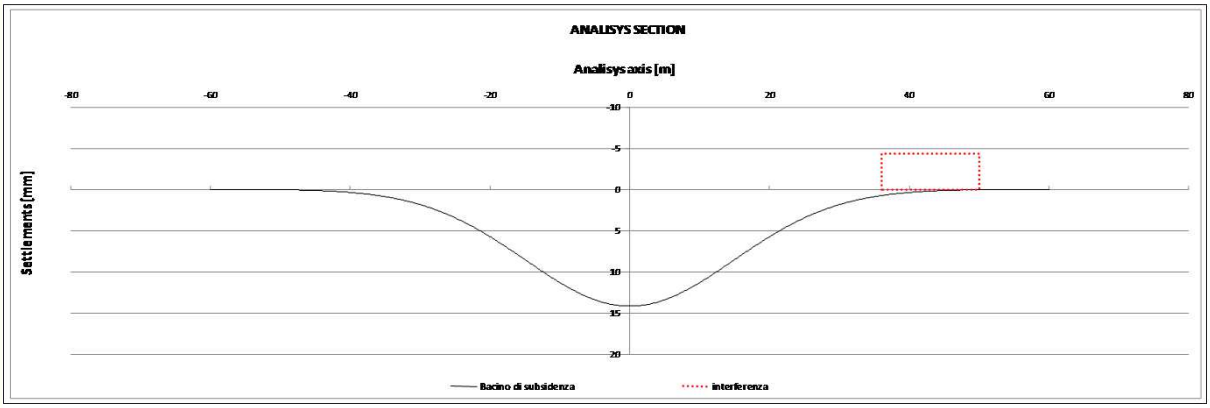
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8102
Maximum Angular Distortion	β	7.27E-05	1/13758

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.007%
Total strain	ε_{max}	0.007%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

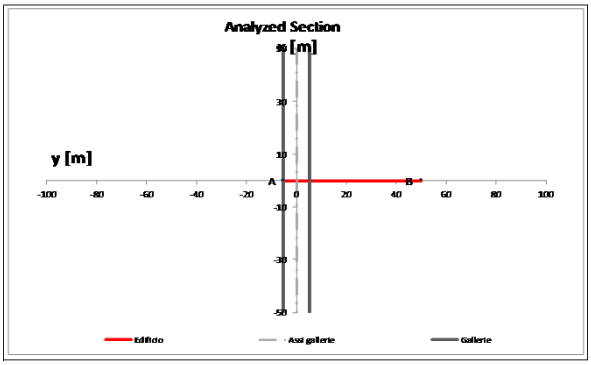
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	35

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	55.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	23.5	23.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	50

Settlements	
Point	w [mm]
A	11.72
B	0.19

Direction analysys	A	B

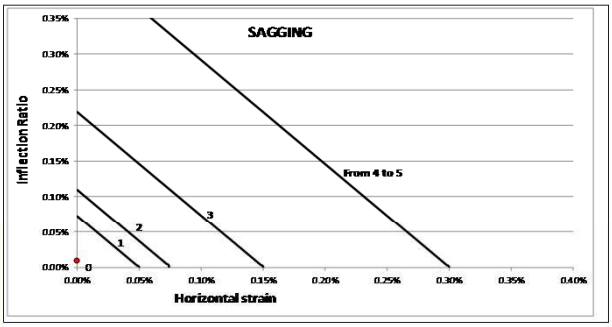
DAMAGE CLASS EVALUATION

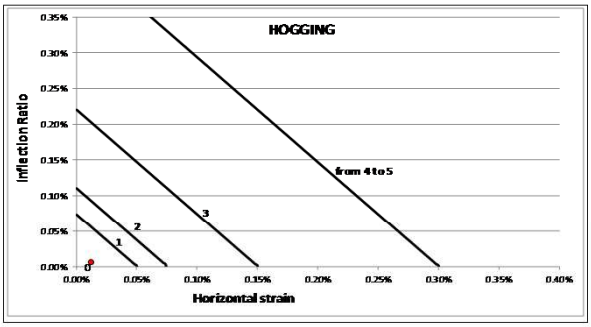
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	12.22
Max. Settlement of the building [mm]	$w_{building}$	12.22

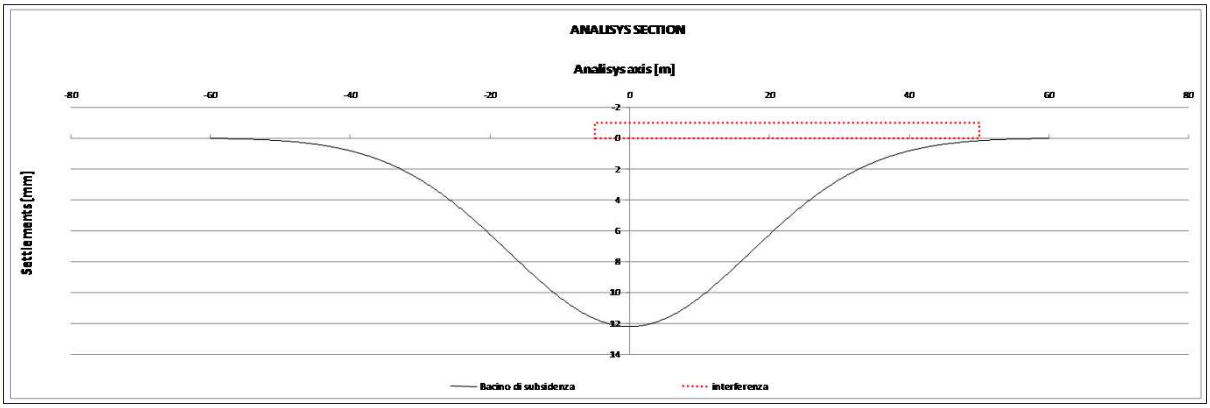
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	4.29E-04	1/2331
Maximum Angular Distortion	β	4.04E-04	1/2475

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.009%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.006%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.006%
Horizontal strain	ε_h	0.013%
Total strain	ε_{max}	0.017%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

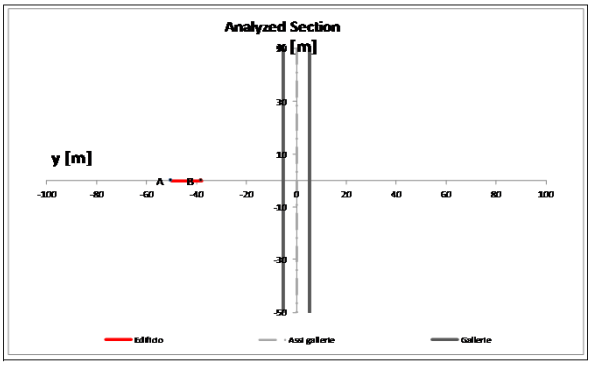
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	36

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	7.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	8.5	[m]
Length in the analyzed directio	L	12.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	26.5	26.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-38

Settlements	
Point	w [mm]
A	0.36
B	1.52

Direction analysys	A	B

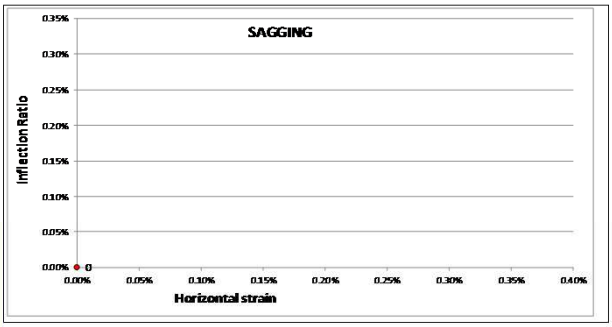
DAMAGE CLASS EVALUATION

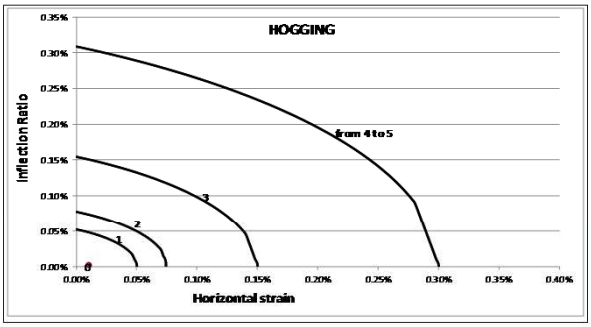
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	11.07
Max. Settlement of the building [mm]	$w_{building}$	1.52

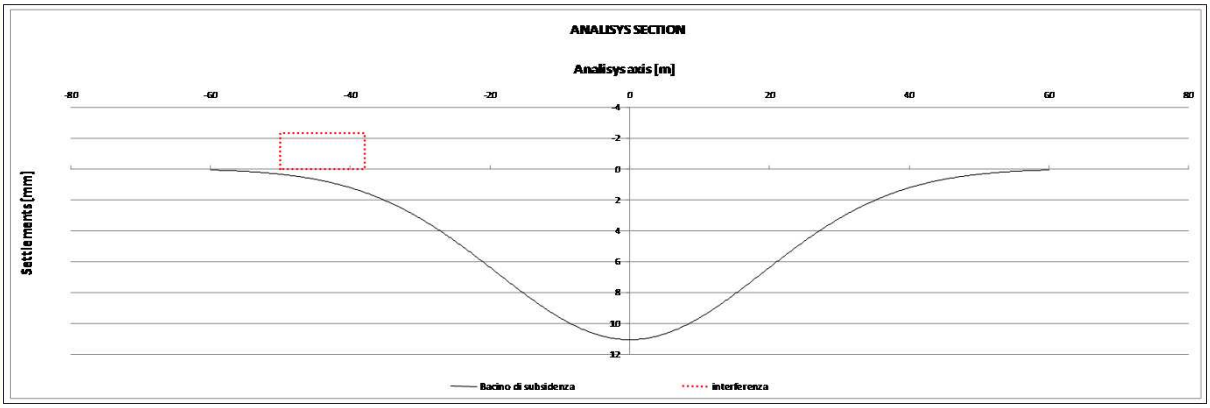
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.59E-04	1/6294
Maximum Angular Distortion	β	6.17E-05	1/16210

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.010%
Total strain	ε_{max}	0.011%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

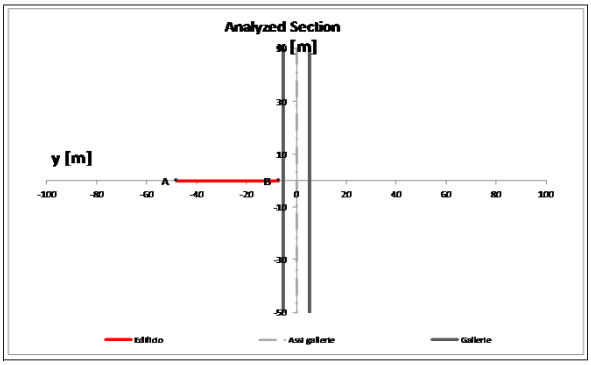
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	37

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	BRICKWORK		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	41.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	28.5	28.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-48
B	0	-7

Settlements	
Point	w [mm]
A	0.63
B	9.81

Direction analysys	A	B

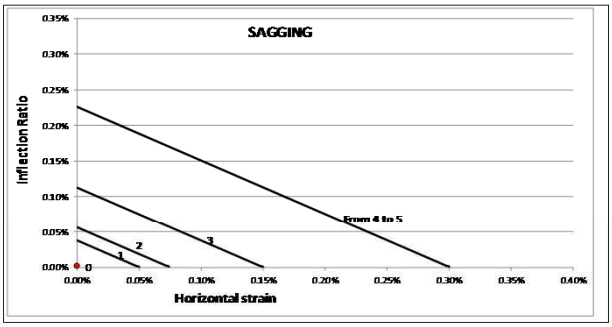
DAMAGE CLASS EVALUATION

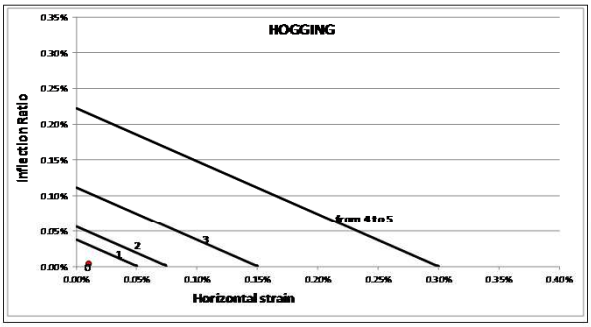
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	10.42
Max. Settlement of the building [mm]	$w_{building}$	9.81

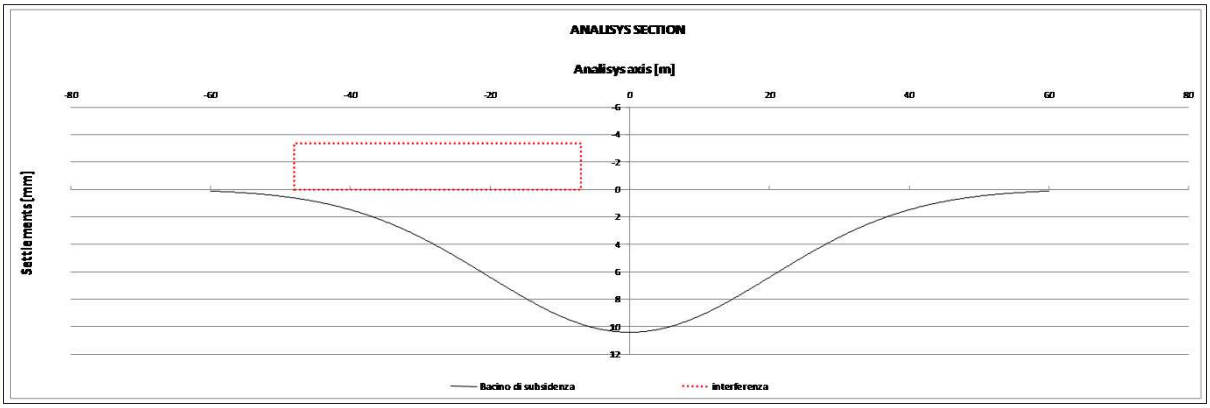
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.12E-04	1/3210
Maximum Angular Distortion	β	1.50E-04	1/6676

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.011%
Total strain	ε_{max}	0.015%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

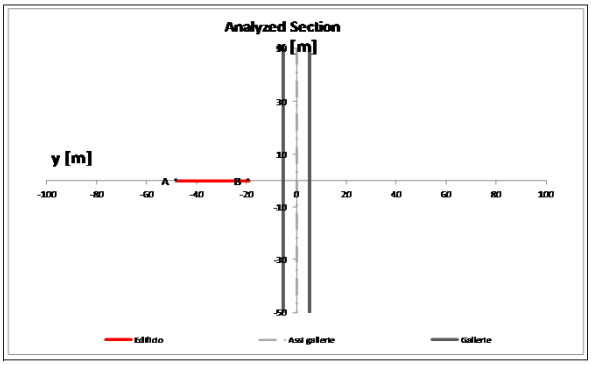
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	38

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	29.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	31.5	31.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-48
B	0	-19

Settlements	
Point	w [mm]
A	0.90
B	6.61

Direction analysys	A	B

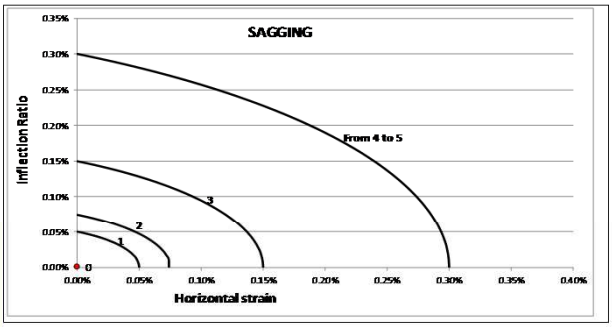
DAMAGE CLASS EVALUATION

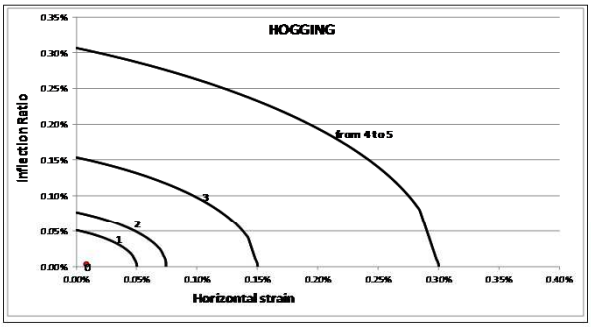
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.57
Max. Settlement of the building [mm]	$w_{building}$	6.61

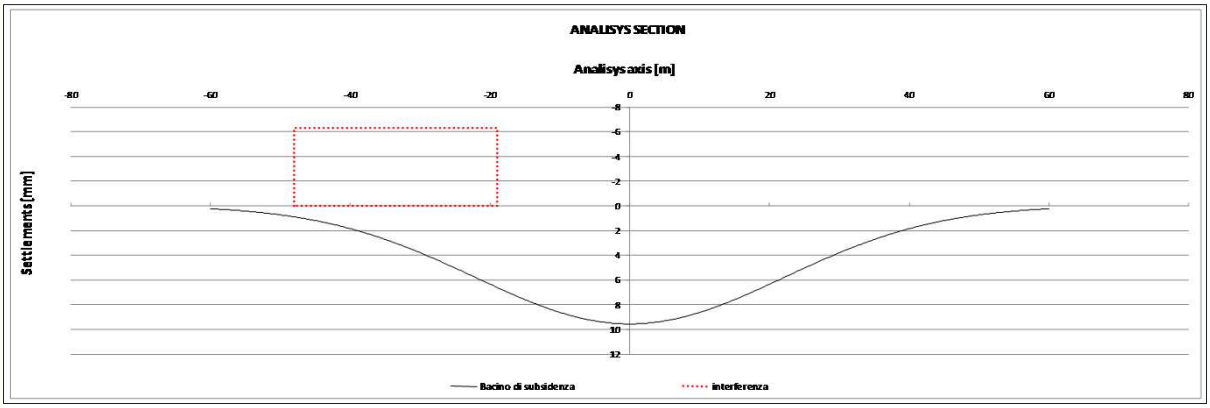
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.63E-04	1/3805
Maximum Angular Distortion	β	1.08E-04	1/9269

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.009%
Total strain	ε_{max}	0.009%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

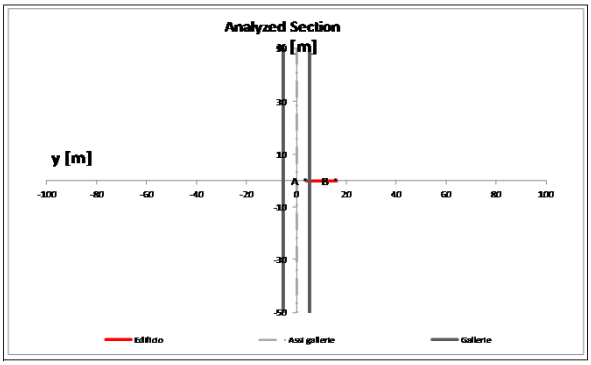
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	39

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	6.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	7.5	[m]
Length in the analyzed directio	L	12.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	31.5	31.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	4
B	0	16

Settlements	
Point	w [mm]
A	9.41
B	7.36

Direction analysys	A	B

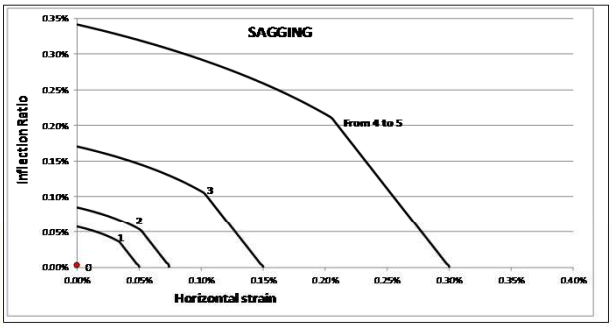
DAMAGE CLASS EVALUATION

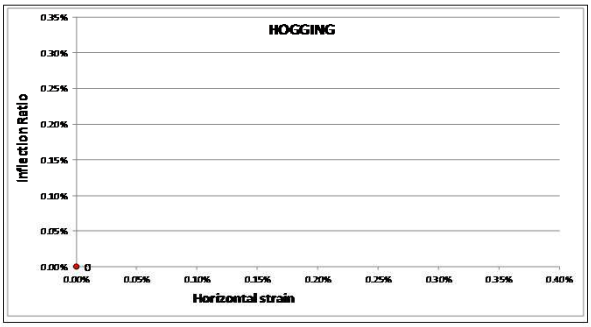
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.57
Max. Settlement of the building [mm]	$w_{building}$	9.41

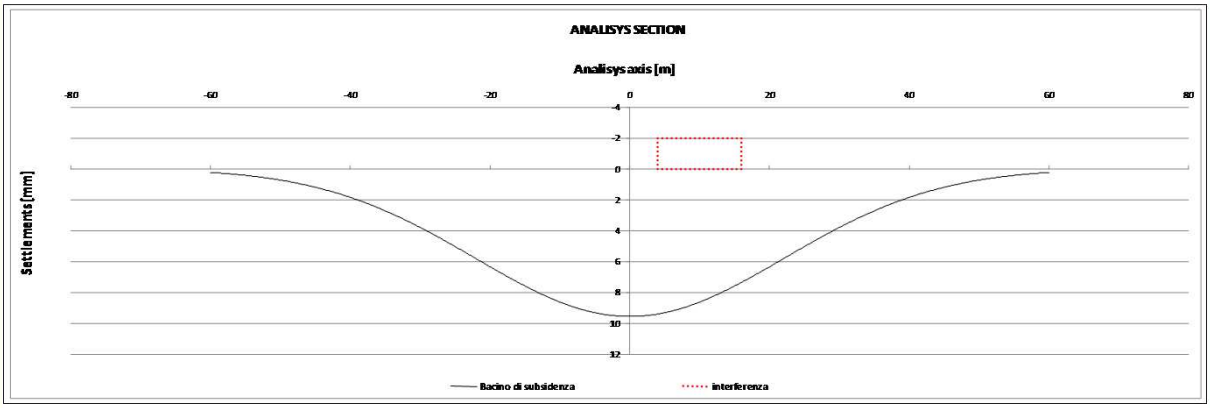
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.41E-04	1/4143
Maximum Angular Distortion	β	9.37E-05	1/10675

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

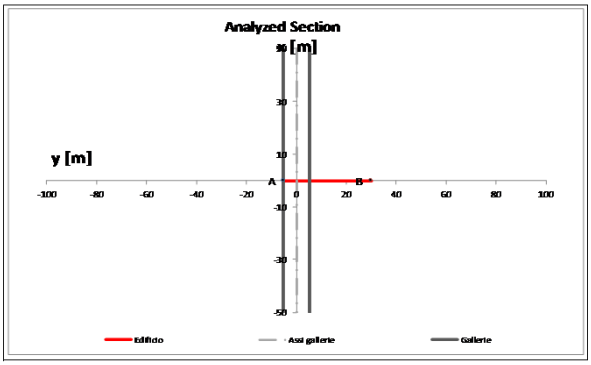
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	40

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	35.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	25.5	25.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	30

Settlements	
Point	w [mm]
A	11.02
B	3.06

Direction analysys	A	B

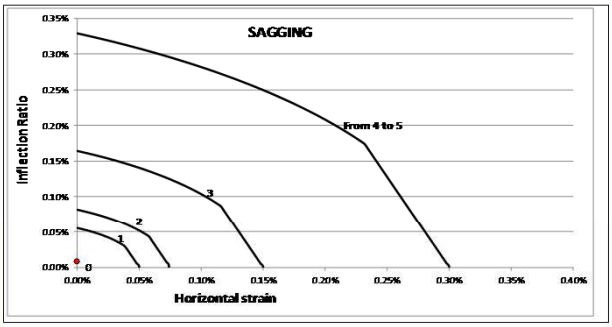
DAMAGE CLASS EVALUATION

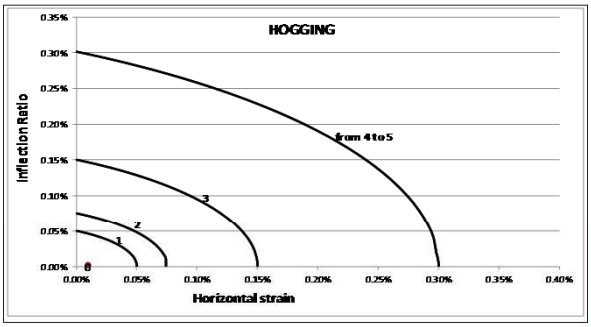
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	11.43
Max. Settlement of the building [mm]	$w_{building}$	11.43

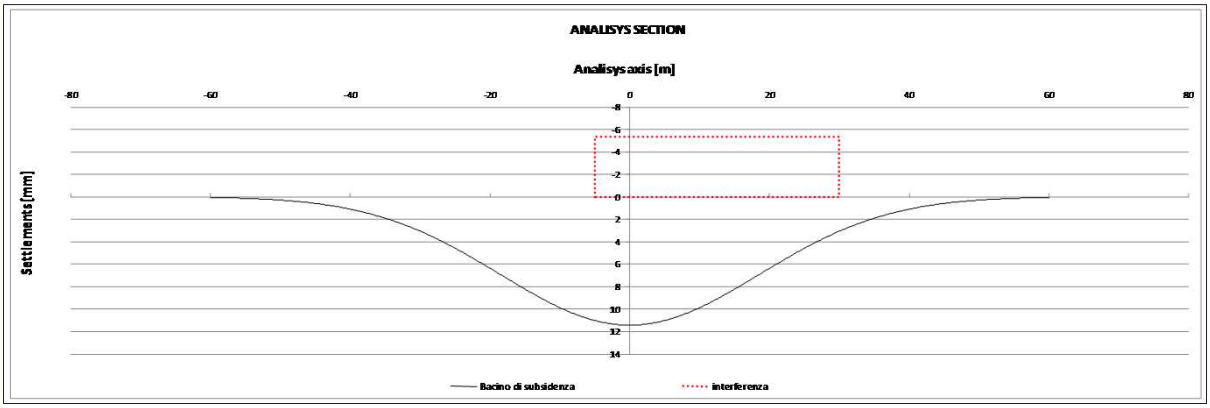
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.75E-04	1/2666
Maximum Angular Distortion	β	3.88E-04	1/2579

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.007%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.007%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.010%
Total strain	ε_{max}	0.010%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

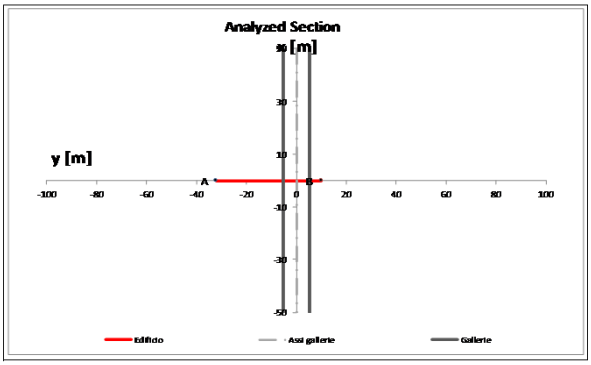
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	41

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	42.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	27.5	27.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-32
B	0	10

Settlements	
Point	w [mm]
A	2.86
B	9.43

Direction analysys	A	B

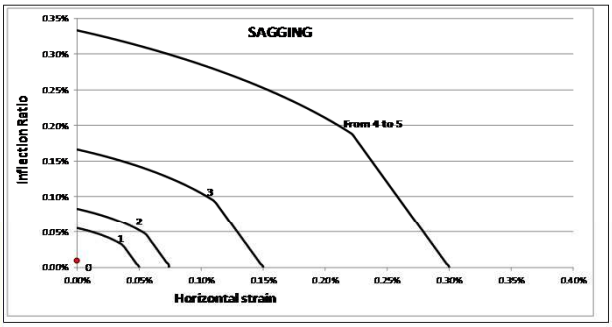
DAMAGE CLASS EVALUATION

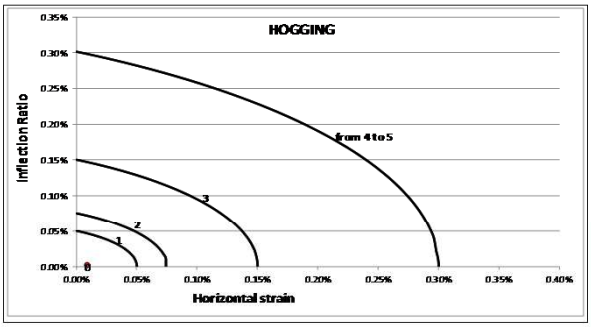
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	10.73
Max. Settlement of the building [mm]	$w_{building}$	10.73

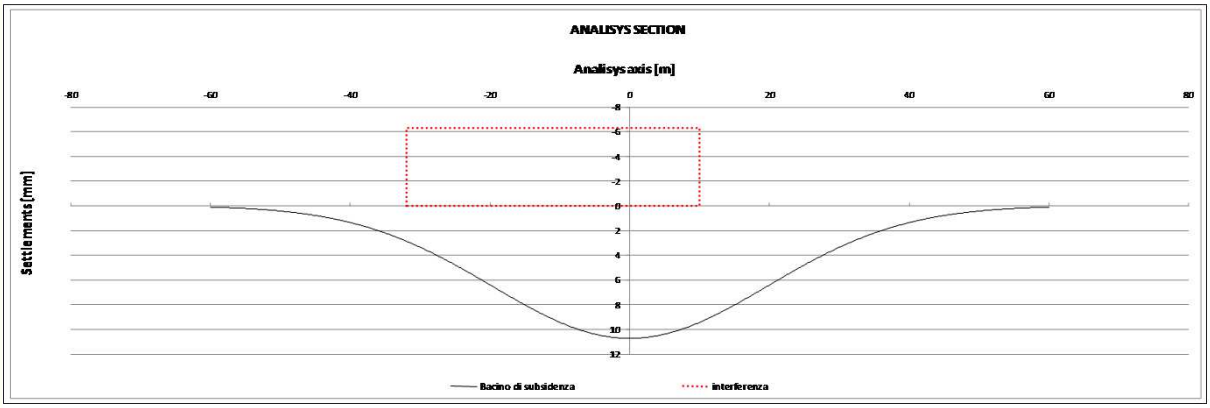
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.31E-04	1/3023
Maximum Angular Distortion	β	3.99E-04	1/2505

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.008%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.007%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.009%
Total strain	ε_{max}	0.009%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

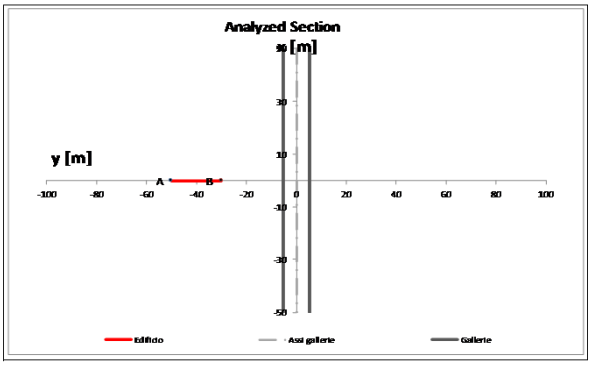
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	42

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	22.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	23.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	28.5	28.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-30

Settlements	
Point	w [mm]
A	0.50
B	3.49

Direction analysys	A	B

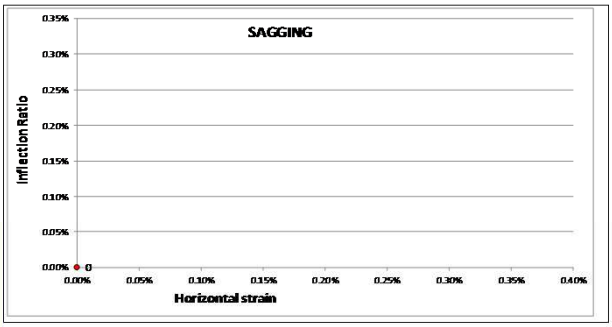
DAMAGE CLASS EVALUATION

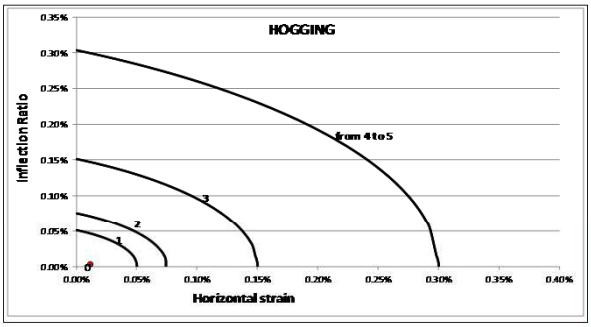
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	10.42
Max. Settlement of the building [mm]	$w_{building}$	3.49

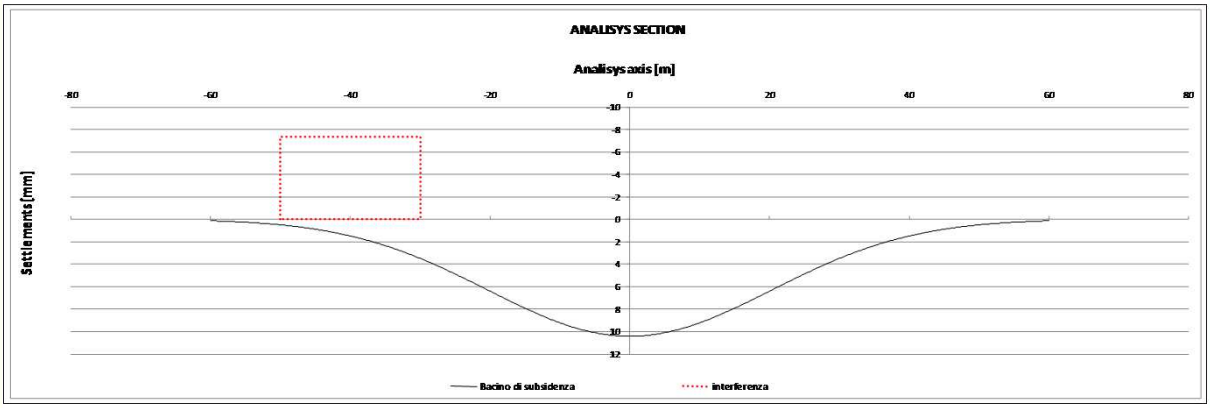
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.54E-04	1/3934
Maximum Angular Distortion	β	1.05E-04	1/9547

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.012%
Total strain	ε_{max}	0.012%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

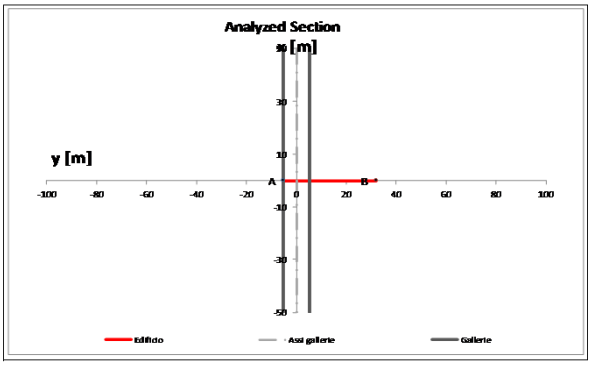
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	43

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	20.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	21.5	[m]
Length in the analyzed directio	L	37.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	26.5	26.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	32

Settlements	
Point	w [mm]
A	10.70
B	2.71

Direction analysys	A	B

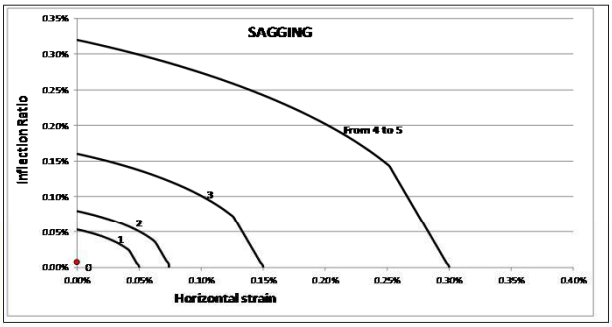
DAMAGE CLASS EVALUATION

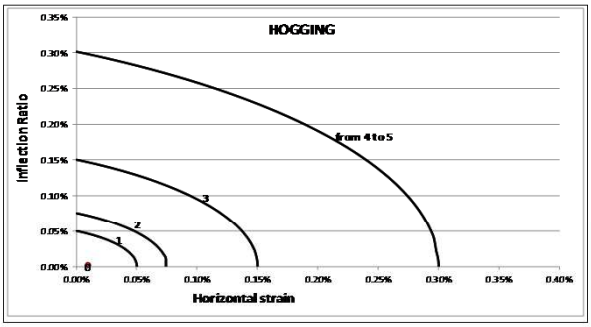
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	11.07
Max. Settlement of the building [mm]	$w_{building}$	11.07

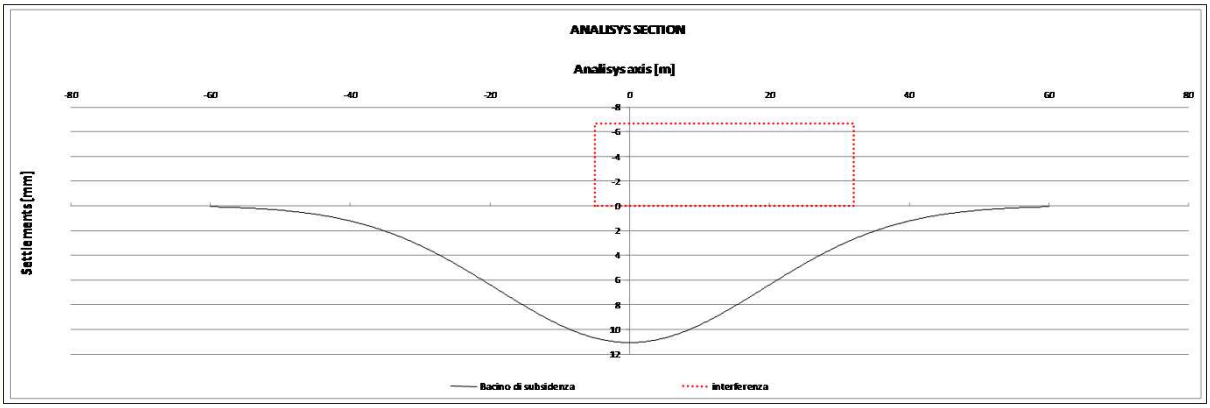
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	3.52E-04	1/2841
Maximum Angular Distortion	β	3.62E-04	1/2765

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.007%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.006%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.010%
Total strain	ε_{max}	0.010%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

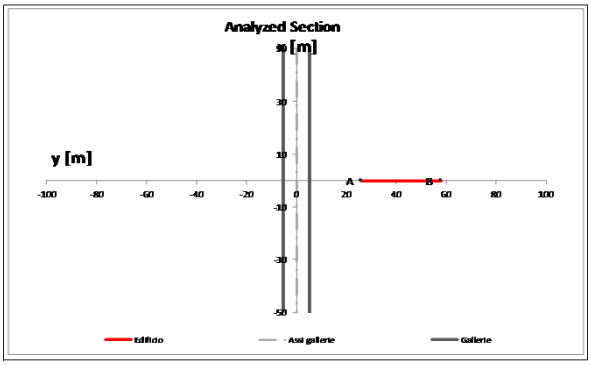
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	44

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	32.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	32.5	32.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	26
B	0	58

Settlements	
Point	w [mm]
A	4.83
B	0.35

Direction analysys	A	B

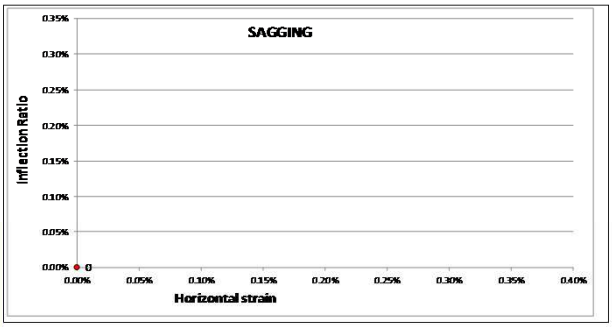
DAMAGE CLASS EVALUATION

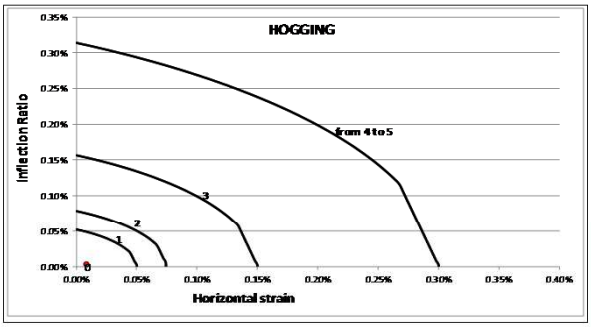
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.31
Max. Settlement of the building [mm]	$w_{building}$	4.83

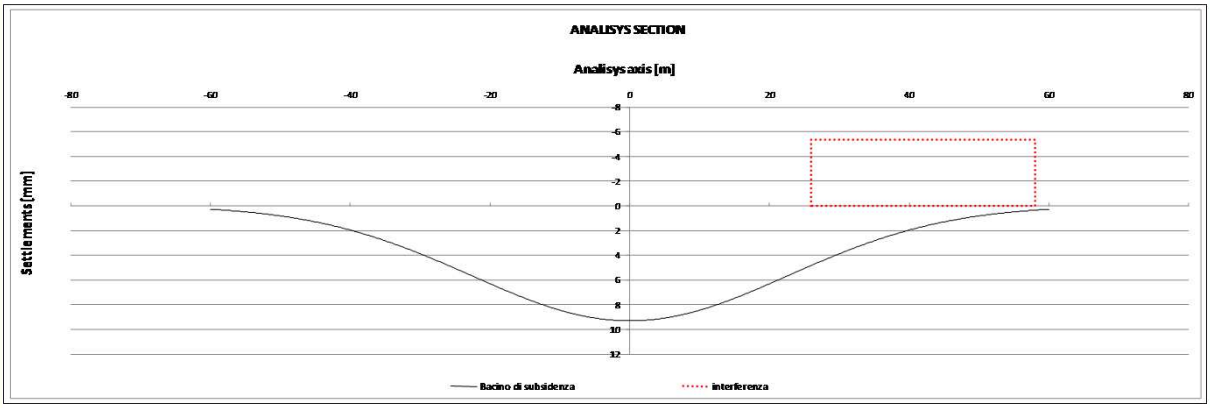
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.44E-04	1/4100
Maximum Angular Distortion	β	1.04E-04	1/9604

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.009%
Total strain	ε_{max}	0.010%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

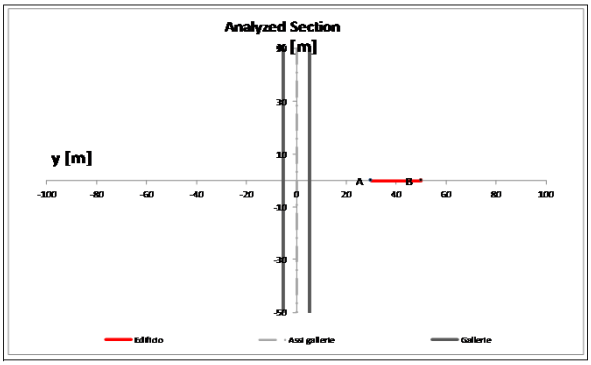
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	45

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	22.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	23.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	25.5	25.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	30
B	0	50

Settlements	
Point	w [mm]
A	3.06
B	0.29

Direction analysys	A	B

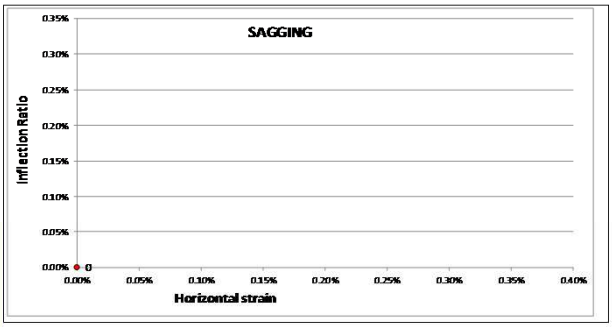
DAMAGE CLASS EVALUATION

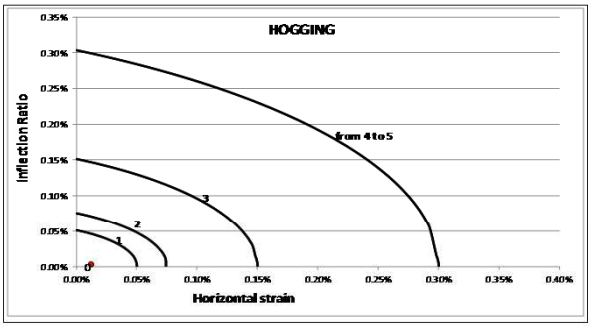
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	11.43
Max. Settlement of the building [mm]	$w_{building}$	3.06

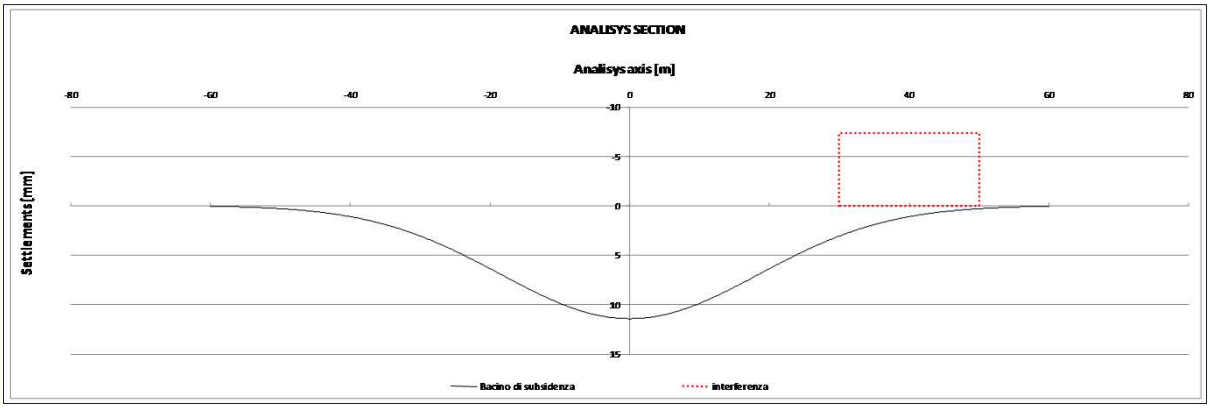
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.69E-04	1/3724
Maximum Angular Distortion	β	1.30E-04	1/7678

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.013%
Total strain	ε_{max}	0.013%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

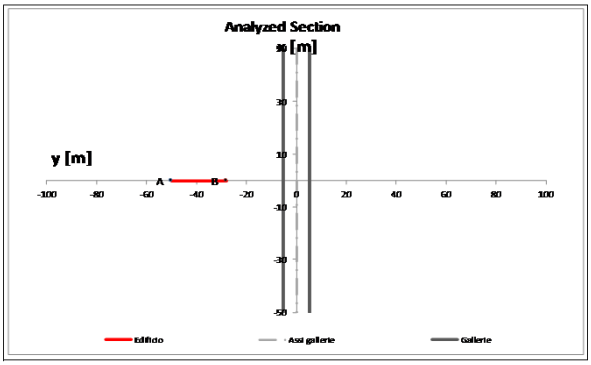
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	46

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	22.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	29.5	29.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-28

Settlements	
Point	w [mm]
A	0.58
B	4.12

Direction analysys	A	B

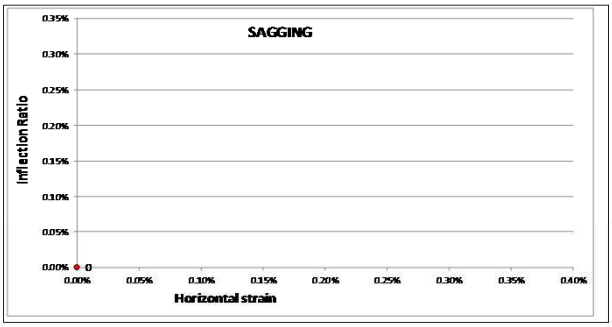
DAMAGE CLASS EVALUATION

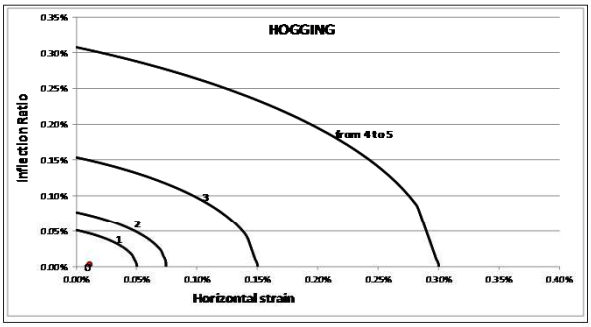
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	10.12
Max. Settlement of the building [mm]	$w_{building}$	4.12

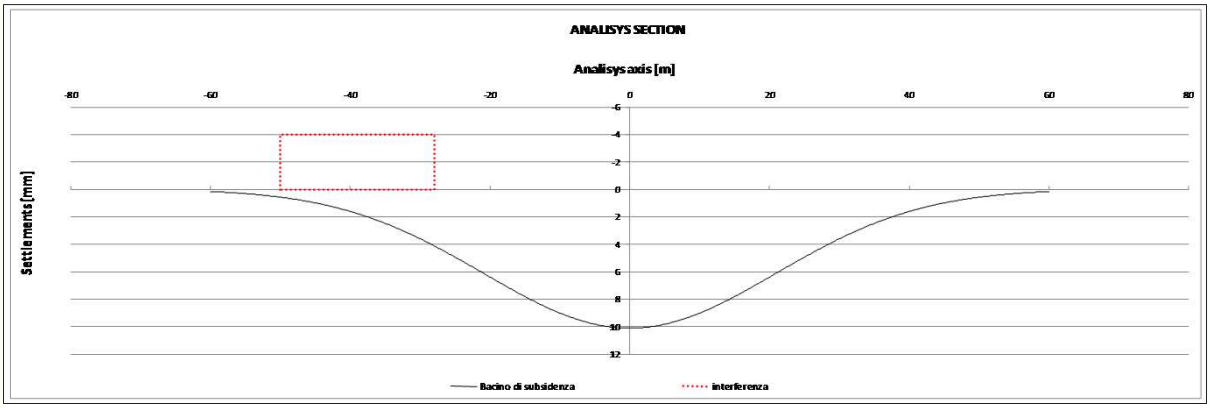
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.64E-04	1/3785
Maximum Angular Distortion	β	1.03E-04	1/9685

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.011%
Total strain	ε_{max}	0.012%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

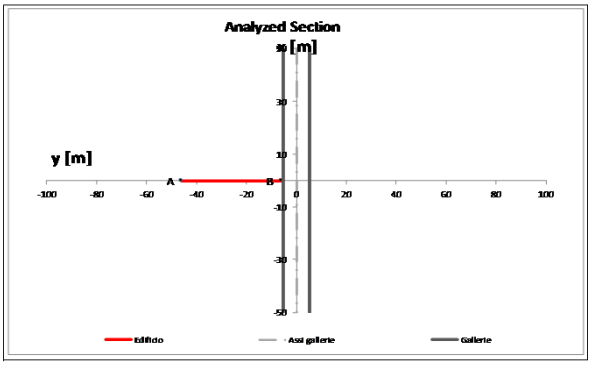
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	47

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	36.5	36.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-46
B	0	-6

Settlements	
Point	w [mm]
A	1.57
B	8.18

Direction analysys	A	B

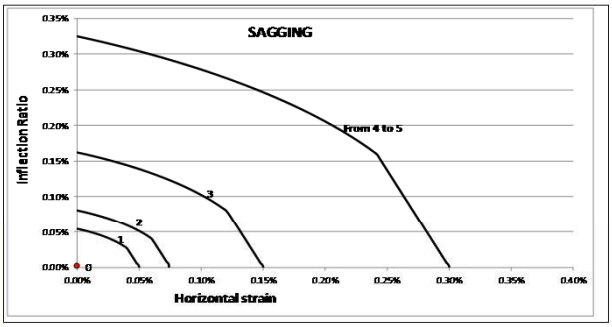
DAMAGE CLASS EVALUATION

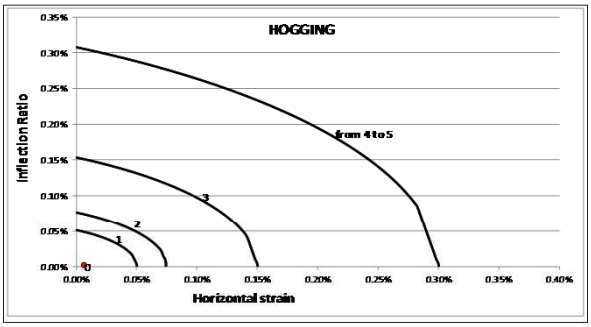
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.42
Max. Settlement of the building [mm]	$w_{building}$	8.18

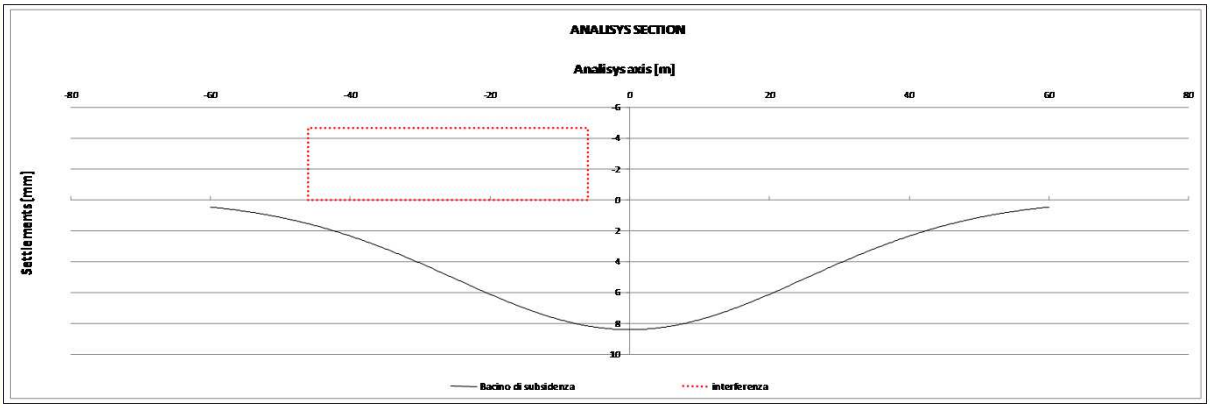
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.04E-04	1/4910
Maximum Angular Distortion	β	8.69E-05	1/11509

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.006%
Total strain	ε_{max}	0.007%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

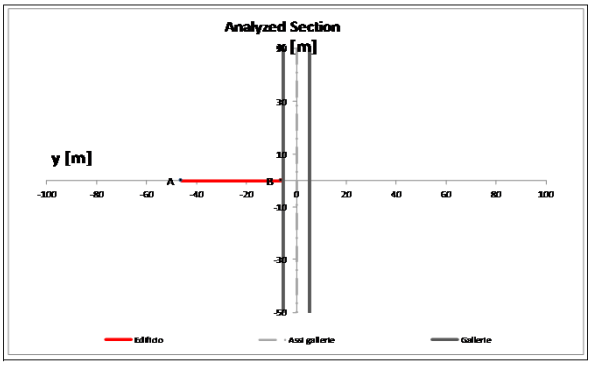
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	47_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	11.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	33.5	33.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-46
B	0	-6

Settlements	
Point	w [mm]
A	1.29
B	8.78

Direction analysys	A	B

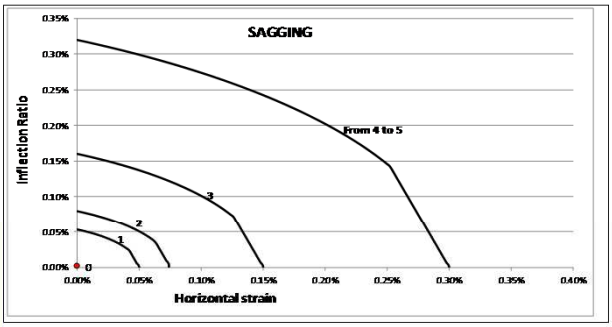
DAMAGE CLASS EVALUATION

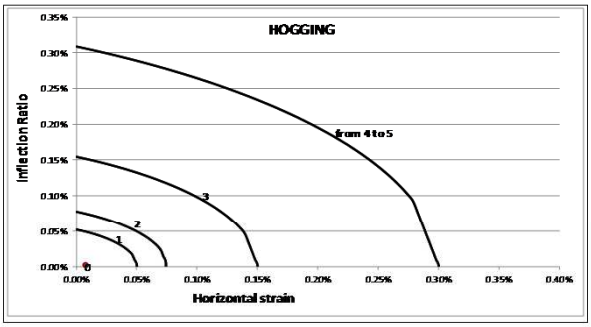
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.07
Max. Settlement of the building [mm]	$w_{building}$	8.78

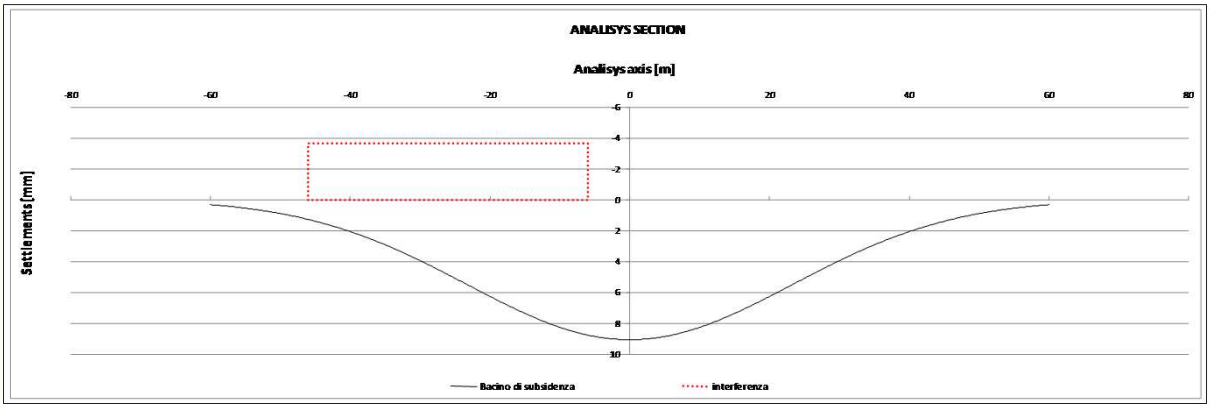
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.36E-04	1/4230
Maximum Angular Distortion	β	8.95E-05	1/11179

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.008%
Total strain	ε_{max}	0.008%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

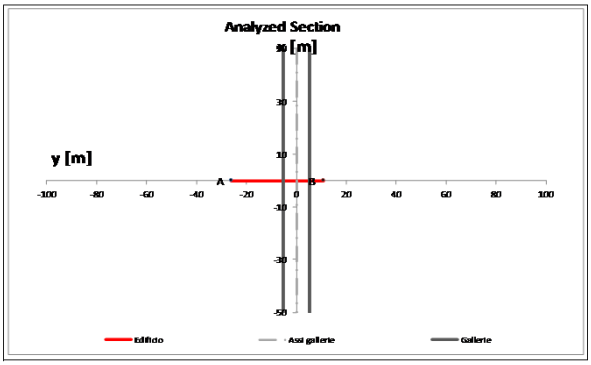
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	48

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	37.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	36.5	36.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-26
B	0	11

Settlements	
Point	w [mm]
A	4.92
B	7.65

Direction analysys	A	B

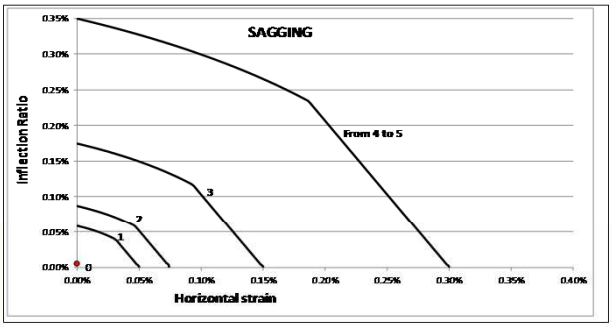
DAMAGE CLASS EVALUATION

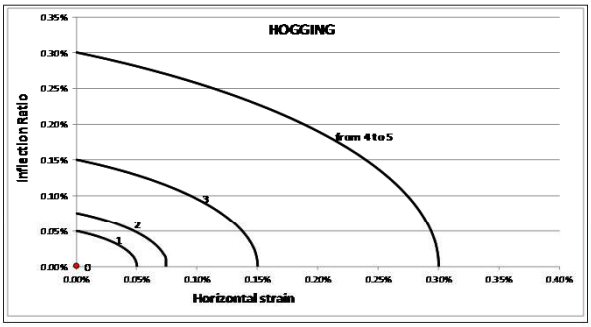
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.42
Max. Settlement of the building [mm]	$w_{building}$	8.42

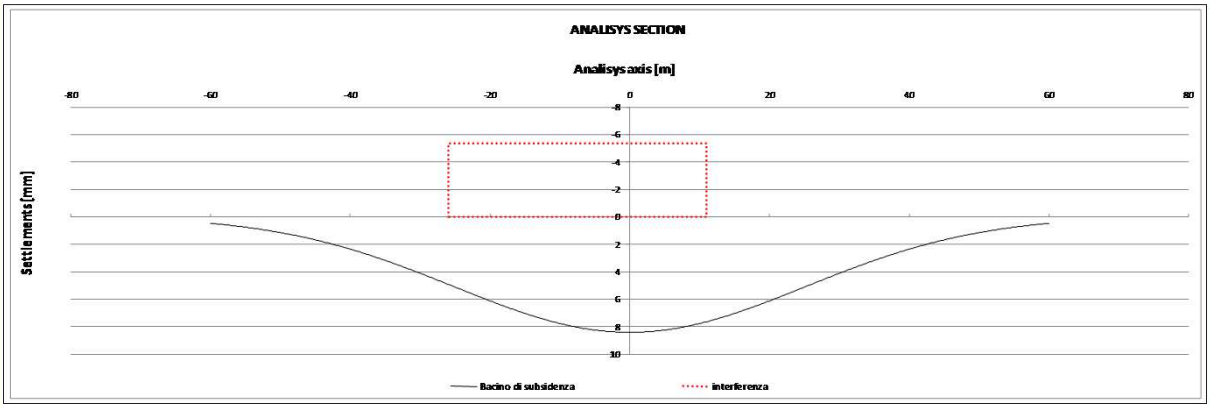
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.04E-04	1/4910
Maximum Angular Distortion	β	2.07E-04	1/4827

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.005%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.004%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

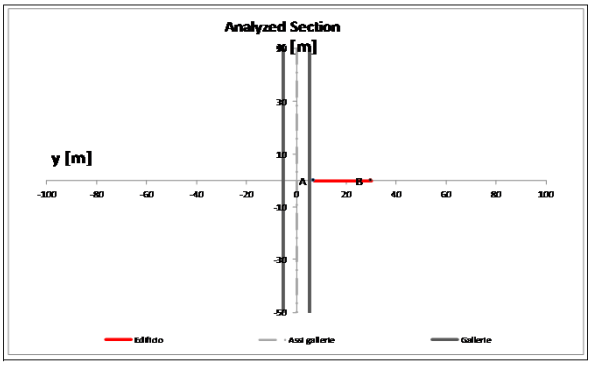
Building N°	49

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	23.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	36.5	36.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6

Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	7
B	0	30

Settlements	
Point	w [mm]
A	8.10
B	4.12



Direction analysys	A	B

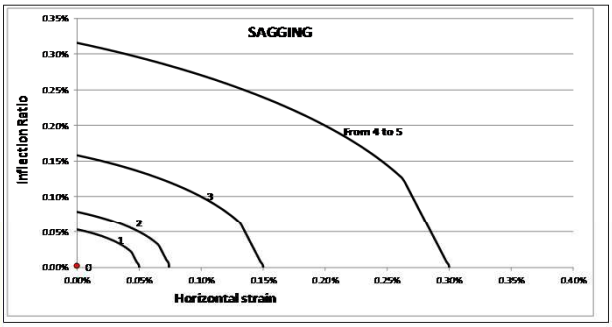
DAMAGE CLASS EVALUATION

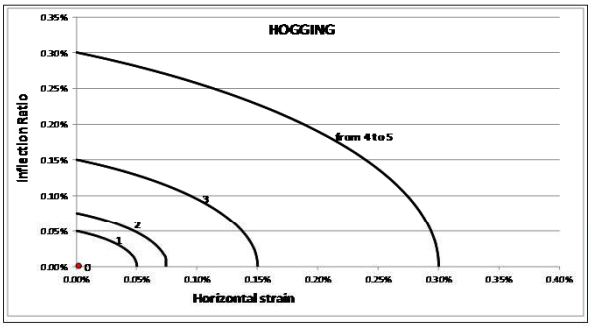
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.42
Max. Settlement of the building [mm]	$w_{building}$	8.10

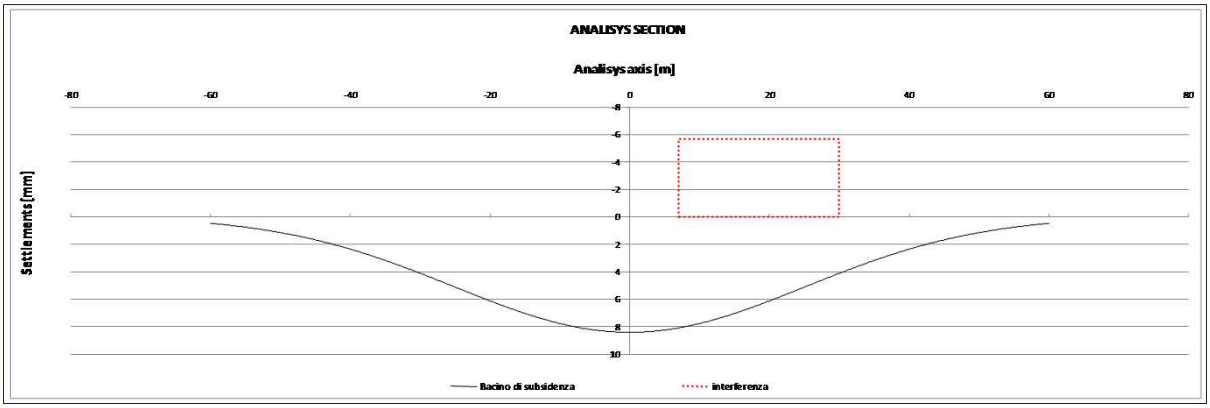
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.04E-04	1/4910
Maximum Angular Distortion	β	8.27E-05	1/12090

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.002%
Total strain	ε_{max}	0.002%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

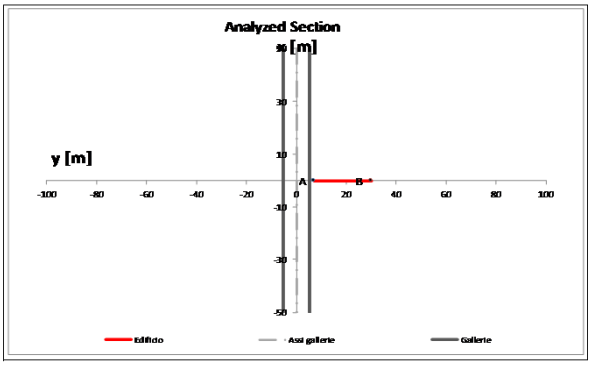
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	49_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	23.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	33.5	33.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	7
B	0	30

Settlements	
Point	w [mm]
A	8.67
B	3.96

Direction analysys	A	B

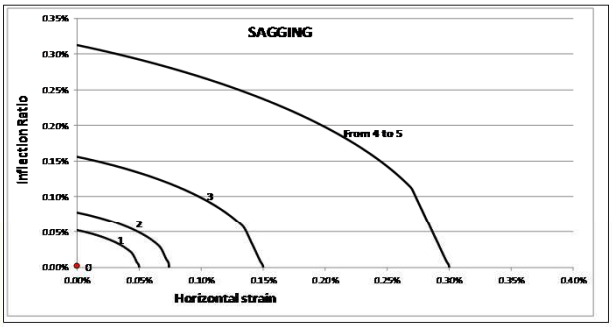
DAMAGE CLASS EVALUATION

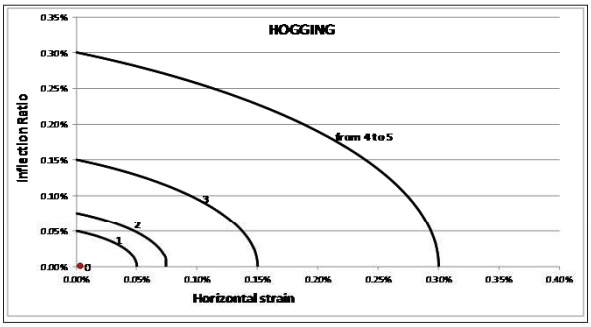
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.07
Max. Settlement of the building [mm]	$w_{building}$	8.67

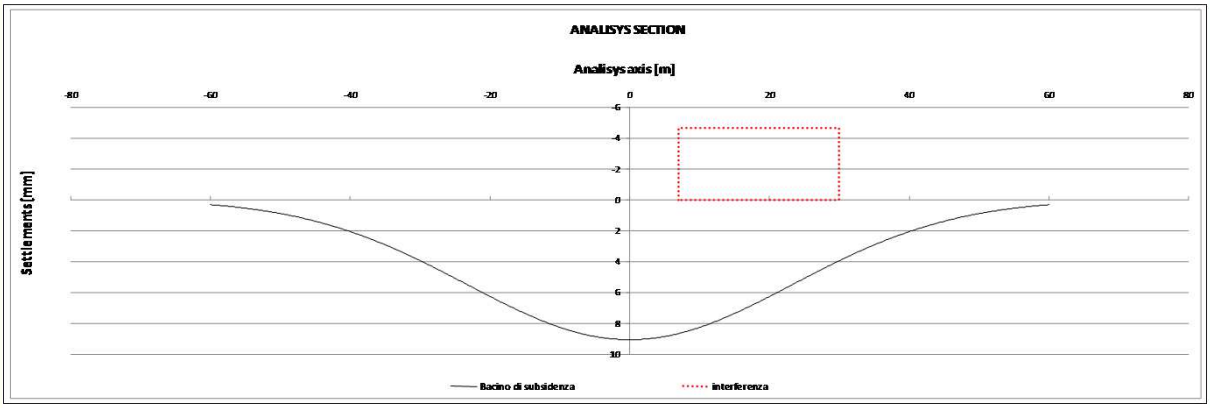
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.36E-04	1/4230
Maximum Angular Distortion	β	9.27E-05	1/10782

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

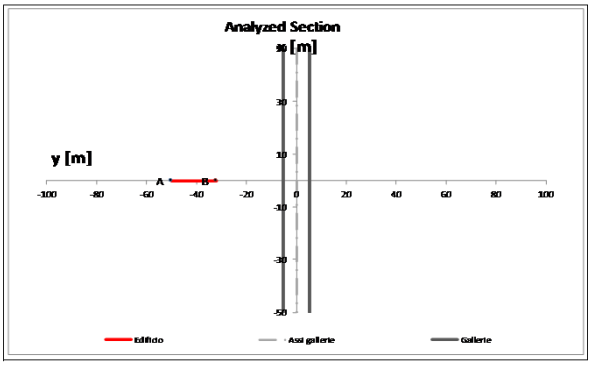
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	50

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	18.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	42.5	42.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-32

Settlements	
Point	w [mm]
A	1.61
B	3.95

Direction analysys	A	B

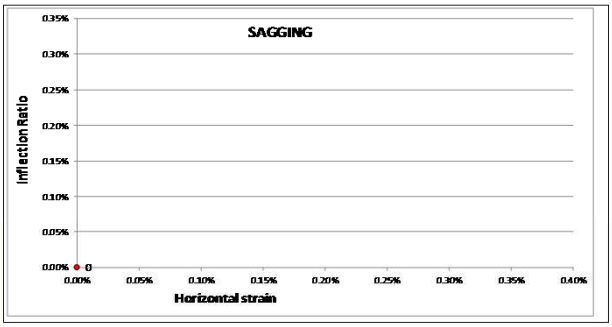
DAMAGE CLASS EVALUATION

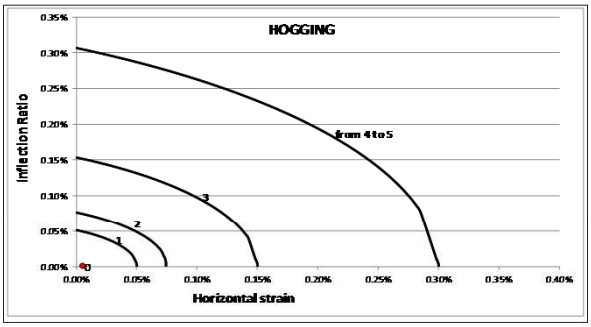
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.37
Max. Settlement of the building [mm]	$w_{building}$	3.95

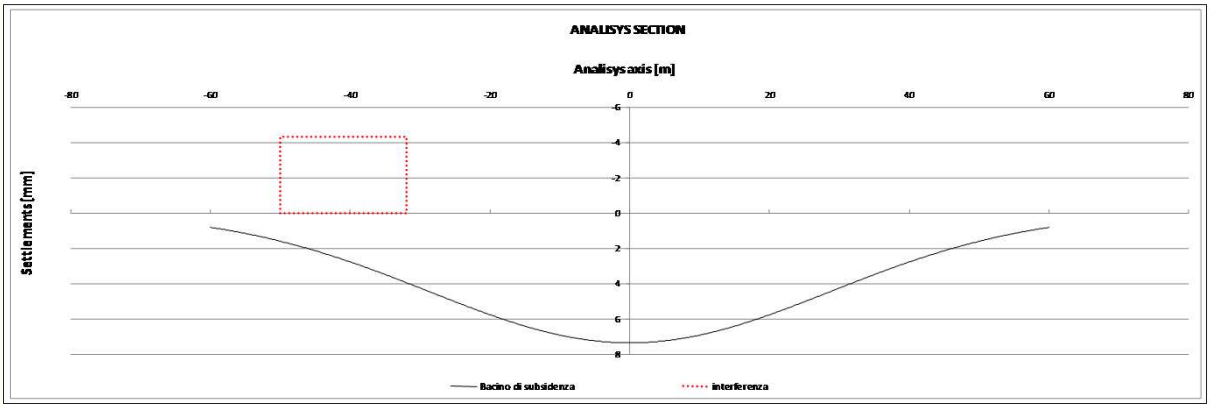
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.54E-04	1/6505
Maximum Angular Distortion	β	3.20E-05	1/31220

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

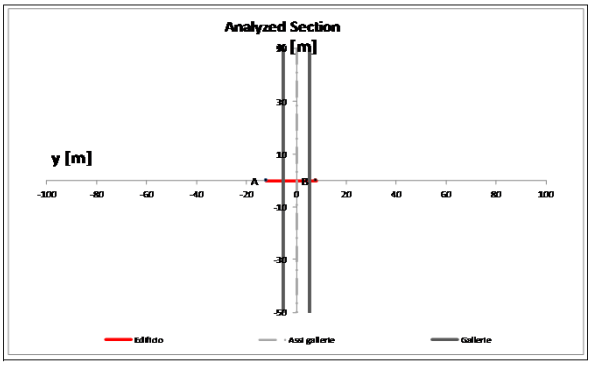
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	51

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	20.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	42.5	42.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-12
B	0	8

Settlements	
Point	w [mm]
A	6.75
B	7.08

Direction analysys	A	B

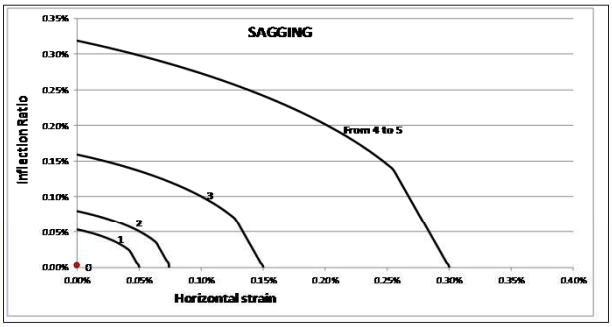
DAMAGE CLASS EVALUATION

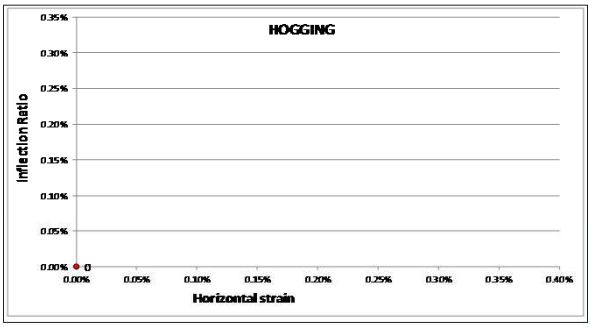
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.37
Max. Settlement of the building [mm]	$w_{building}$	7.37

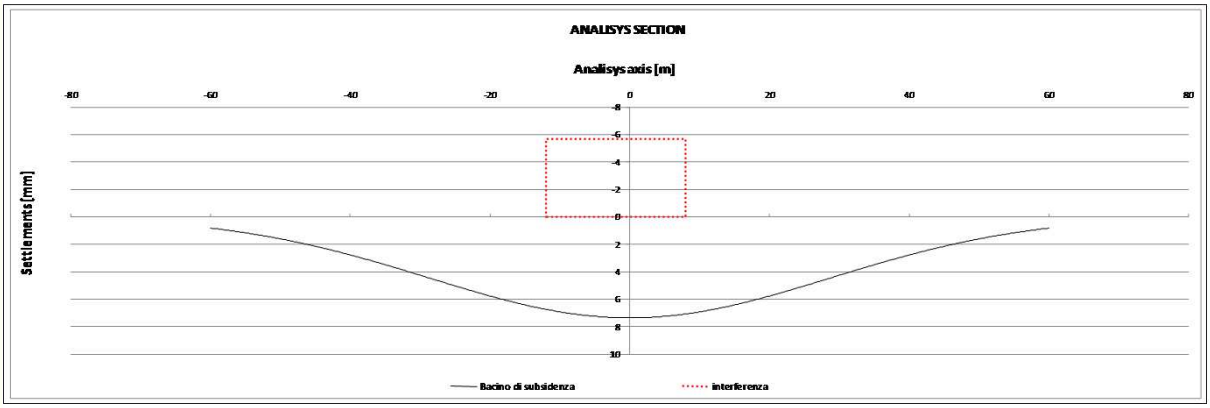
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	9.83E-05	1/10172
Maximum Angular Distortion	β	8.56E-05	1/11689

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

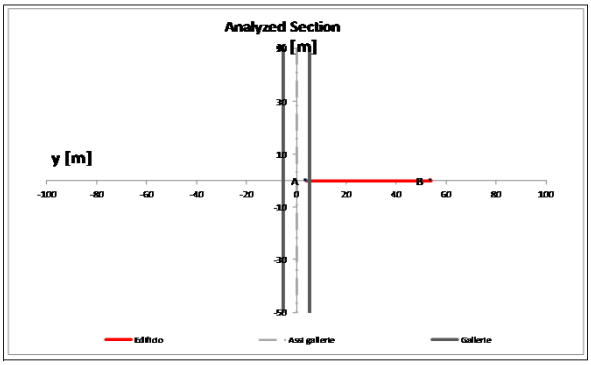
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	52

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	50.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	40.5	40.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	4
B	0	54

Settlements	
Point	w [mm]
A	7.61
B	1.11

Direction analysys	A	B

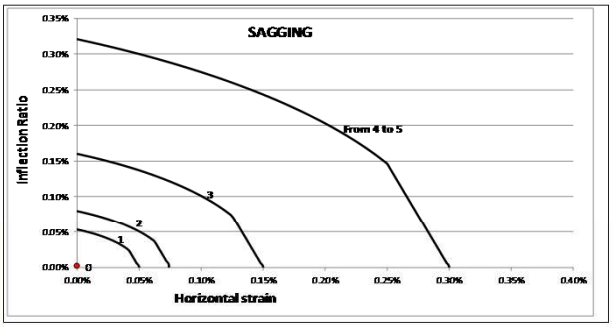
DAMAGE CLASS EVALUATION

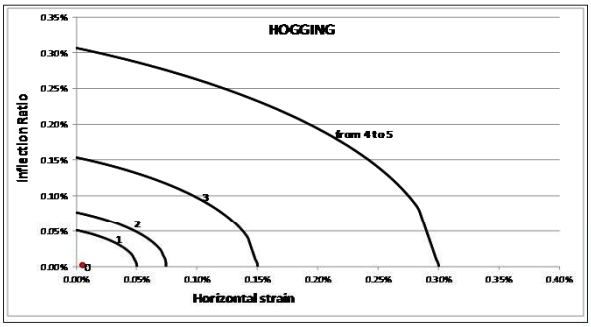
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.69
Max. Settlement of the building [mm]	$w_{building}$	7.61

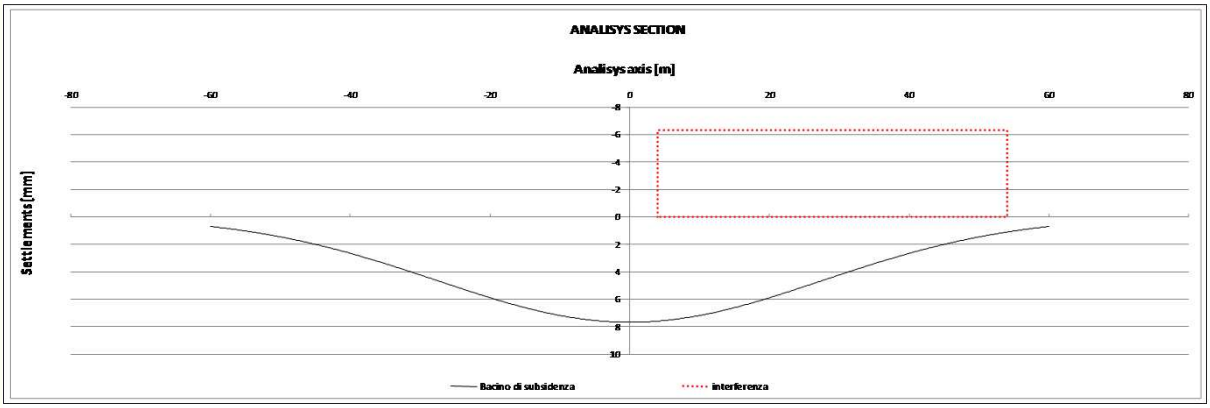
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.70E-04	1/5894
Maximum Angular Distortion	β	8.90E-05	1/11231

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.006%
Total strain	ε_{max}	0.006%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

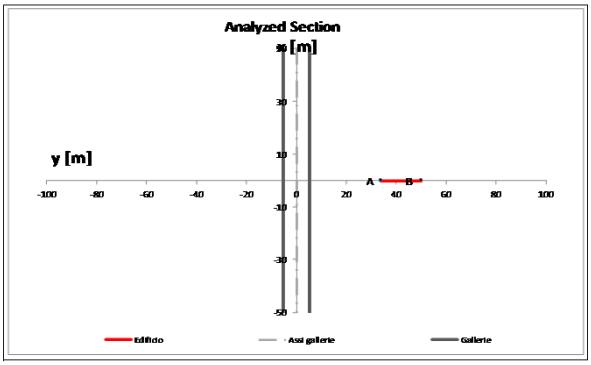
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	53

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	16.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	39.5	39.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	34
B	0	50

Settlements	
Point	w [mm]
A	3.53
B	1.39

Direction analysys	A	B

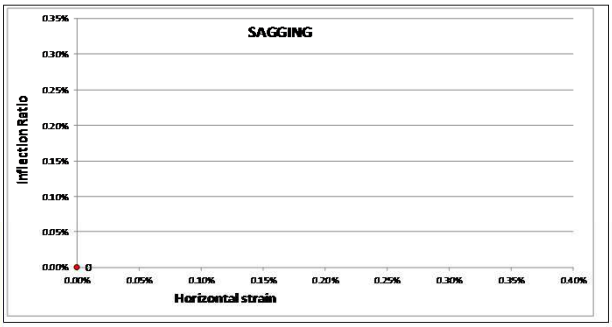
DAMAGE CLASS EVALUATION

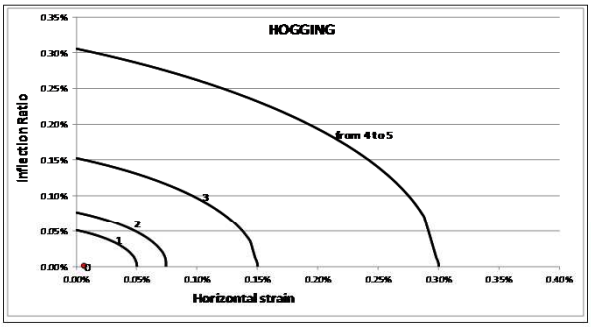
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.86
Max. Settlement of the building [mm]	$w_{building}$	3.53

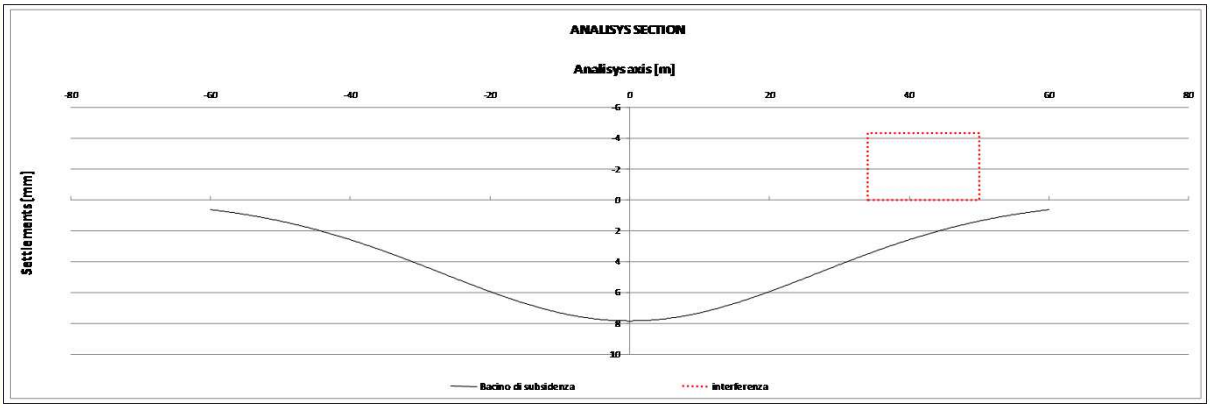
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.66E-04	1/6020
Maximum Angular Distortion	β	3.71E-05	1/26923

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.007%
Total strain	ε_{max}	0.007%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

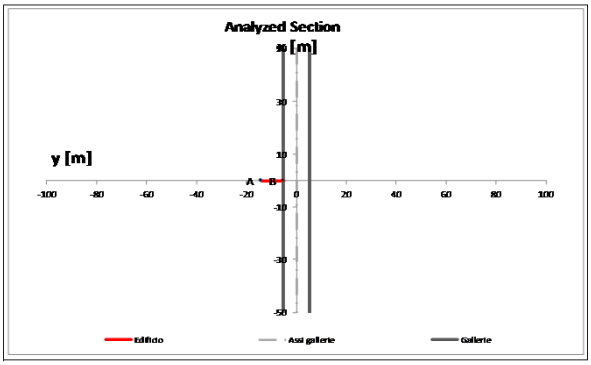
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	54

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	7.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	8.5	[m]
Length in the analyzed directio	L	9.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-14
B	0	-5

Settlements	
Point	w [mm]
A	6.24
B	6.84

Direction analysys	A	B

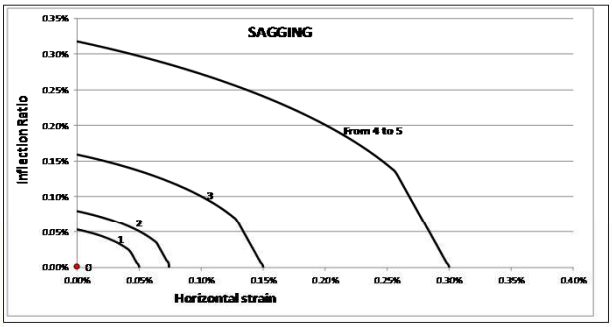
DAMAGE CLASS EVALUATION

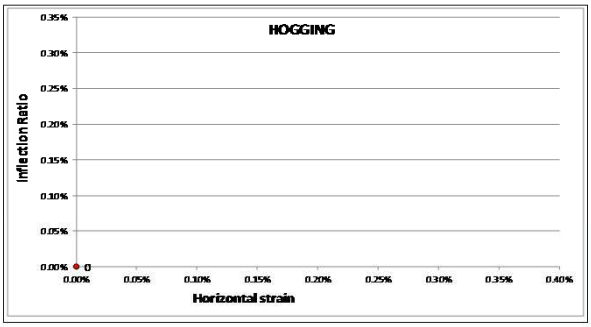
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.84

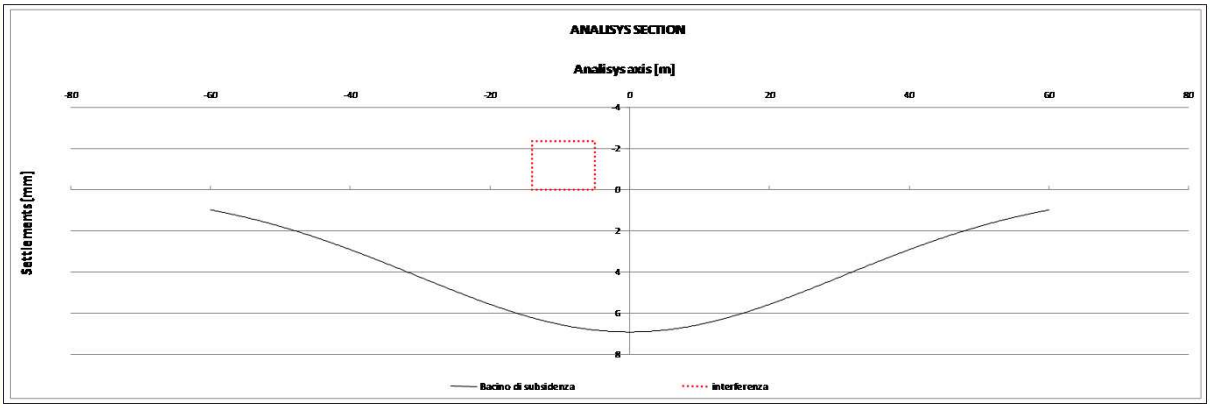
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	9.39E-05	1/10646
Maximum Angular Distortion	β	2.99E-05	1/33406

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

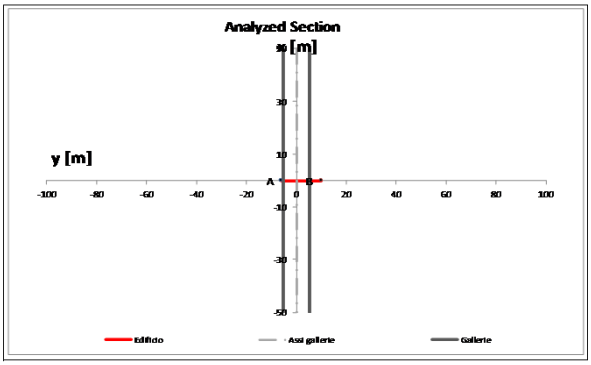
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	55

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	16.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-6
B	0	10

Settlements	
Point	w [mm]
A	6.80
B	6.57

Direction analysys	A	B

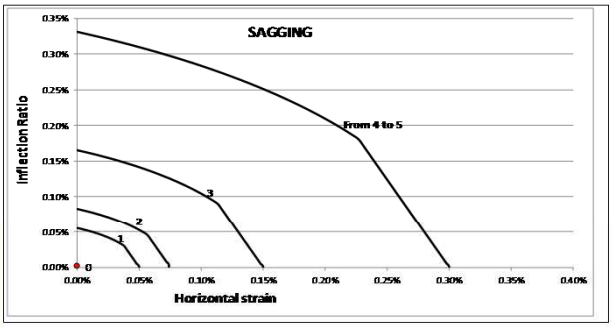
DAMAGE CLASS EVALUATION

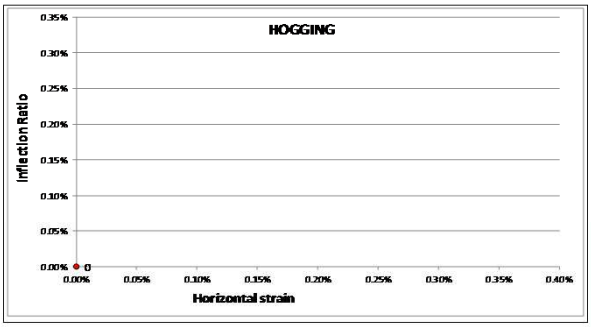
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.93

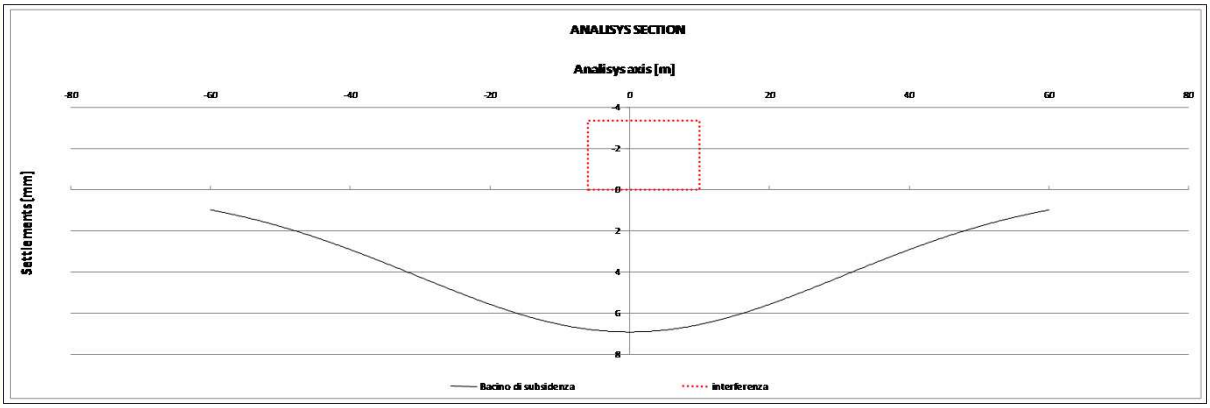
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.06E-05	1/14167
Maximum Angular Distortion	β	5.82E-05	1/17191

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

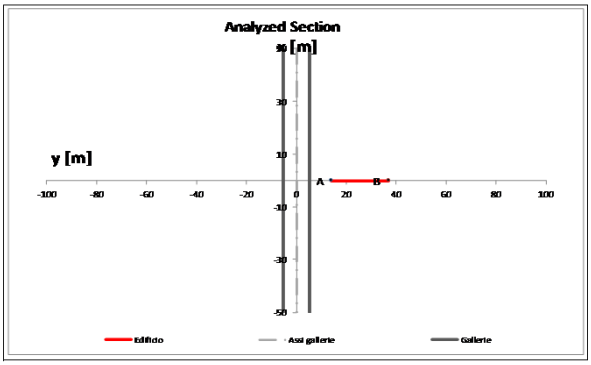
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	56

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	23.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	14
B	0	37

Settlements	
Point	w [mm]
A	6.24
B	3.32

Direction analysys	A	B

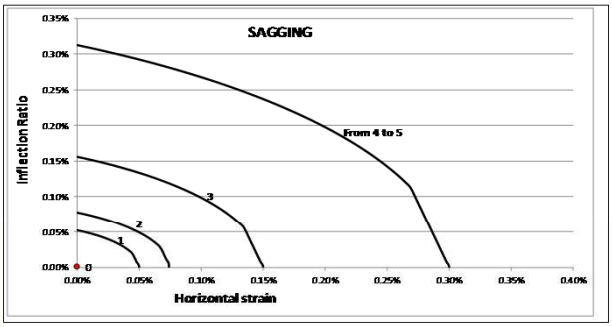
DAMAGE CLASS EVALUATION

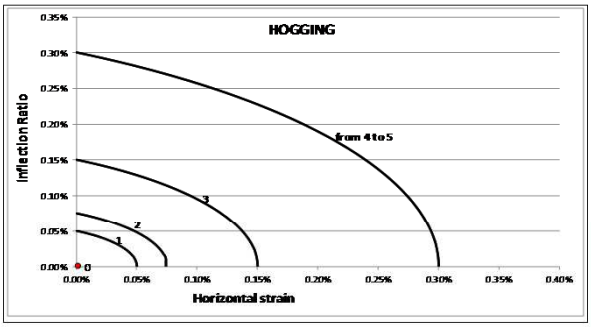
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.24

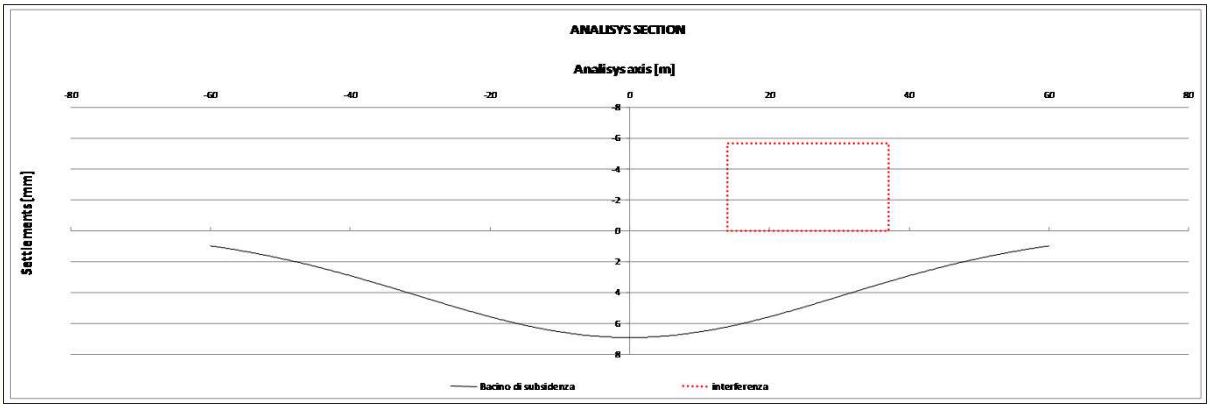
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	3.28E-05	1/30466

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.002%
Total strain	ε_{max}	0.002%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

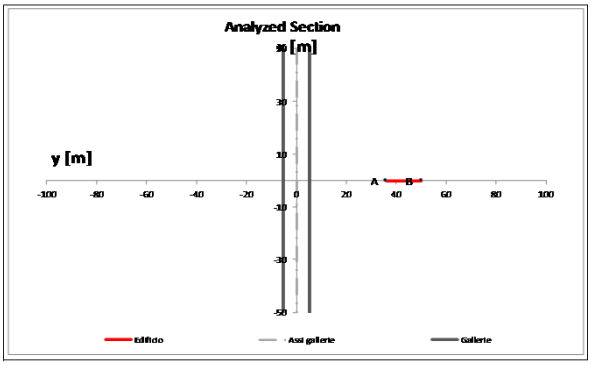
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	57

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	14.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	36
B	0	50

Settlements	
Point	w [mm]
A	3.45
B	1.80

Direction analysys	A	B

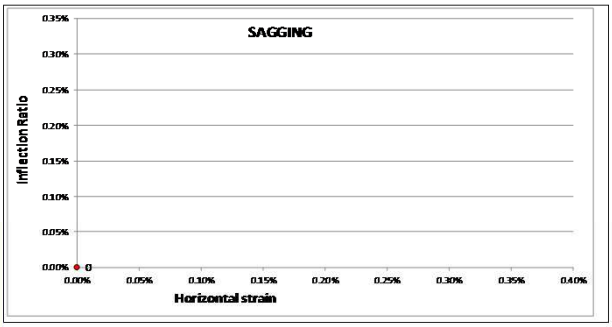
DAMAGE CLASS EVALUATION

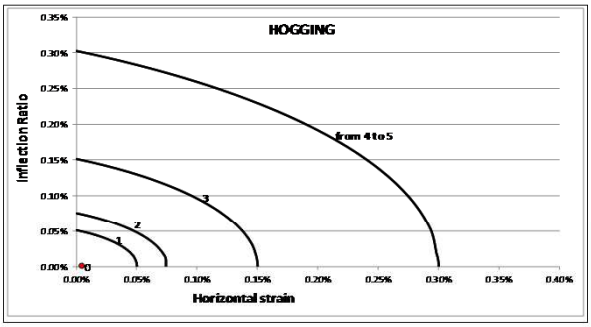
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	3.45

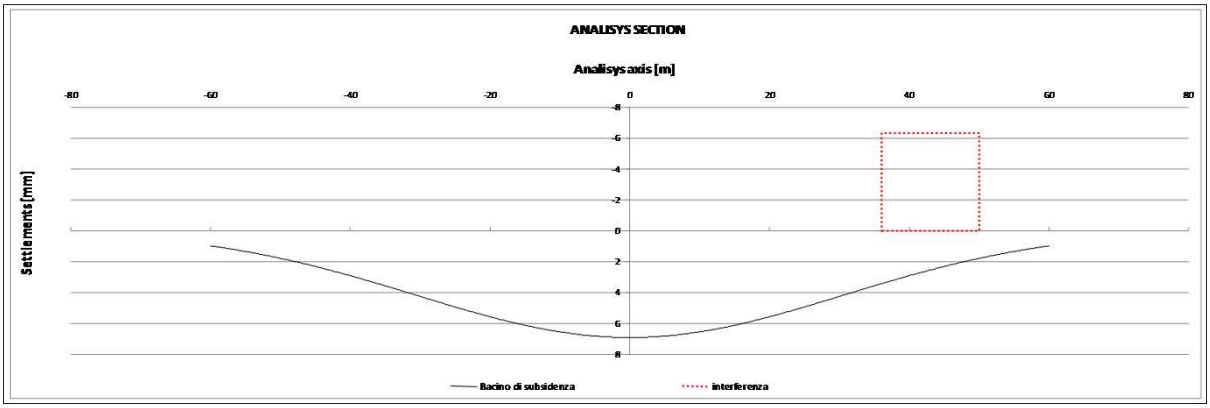
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.34E-04	1/7481
Maximum Angular Distortion	β	2.03E-05	1/49142

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

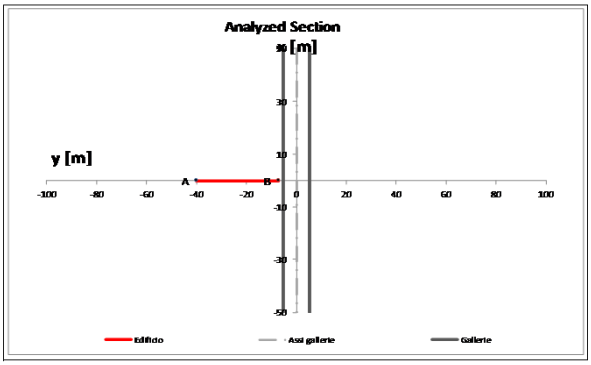
Building N°	58

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	BRICKWORK		
Foundation Type	-		
Conservation state	-		
Height from ground	h	8.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	9.5	[m]
Length in the analyzed directio	L	33.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	47.5	47.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6

Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-40
B	0	-7

Settlements	
Point	w [mm]
A	3.00
B	6.51



Direction analysys	A	B

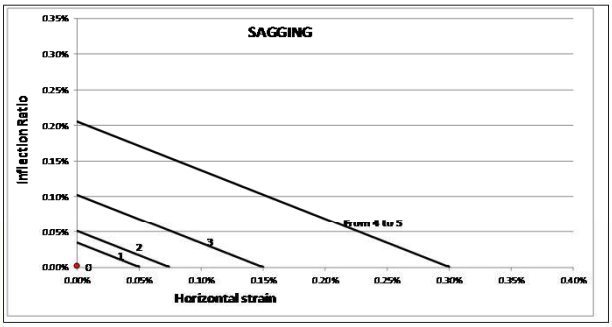
DAMAGE CLASS EVALUATION

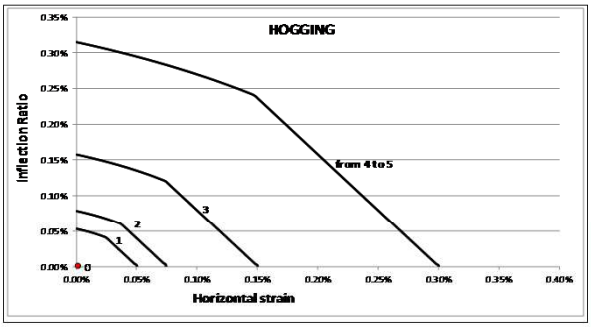
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.67
Max. Settlement of the building [mm]	$w_{building}$	6.51

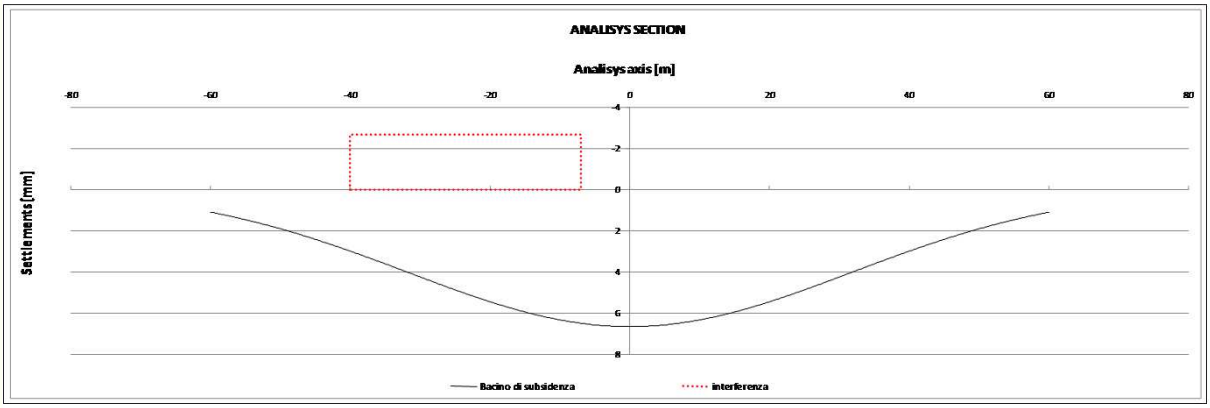
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.28E-04	1/7833
Maximum Angular Distortion	β	6.05E-05	1/16518

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.002%
Total strain	ε_{max}	0.002%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

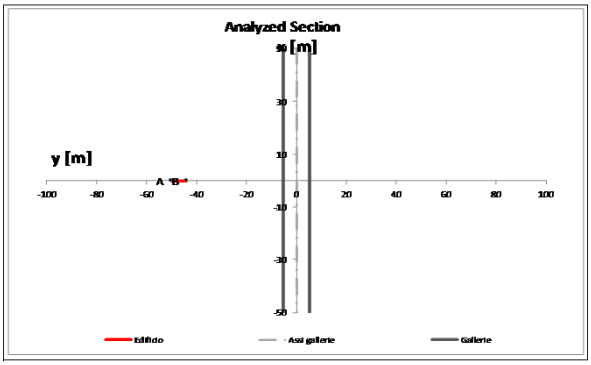
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	59

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	6.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-50
B	0	-44

Settlements	
Point	w [mm]
A	1.97
B	2.58

Direction analysys	A	B

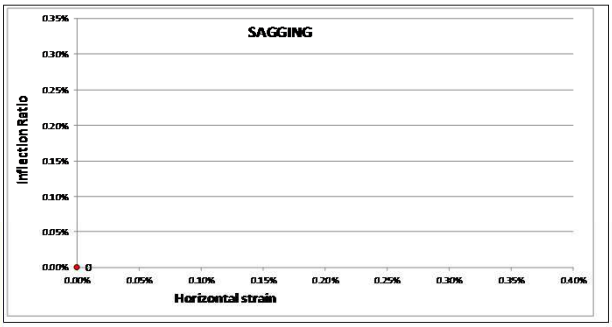
DAMAGE CLASS EVALUATION

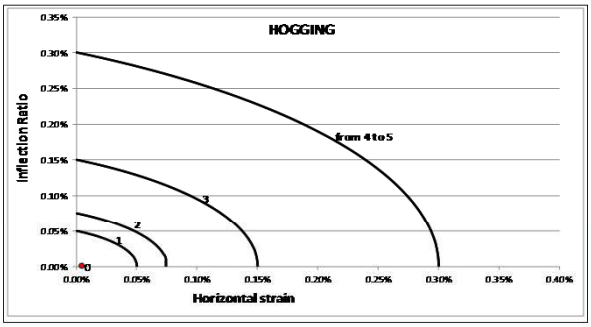
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	2.58

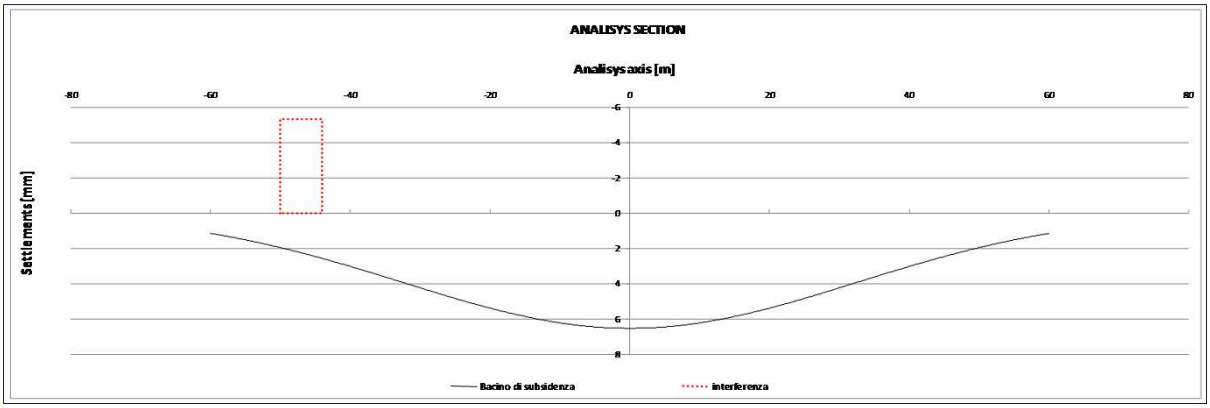
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.09E-04	1/9164
Maximum Angular Distortion	β	7.51E-06	1/133243

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

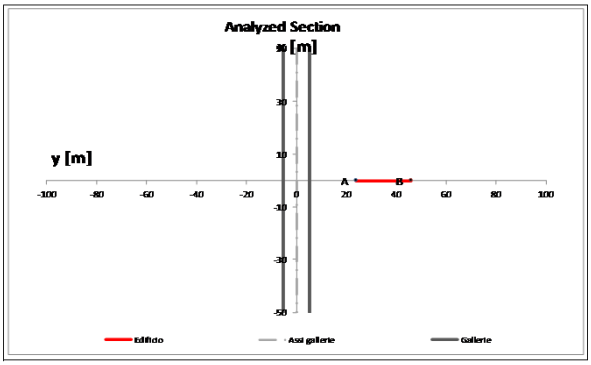
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	60

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	22.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	24
B	0	46

Settlements	
Point	w [mm]
A	4.96
B	2.37

Direction analysys	A	B

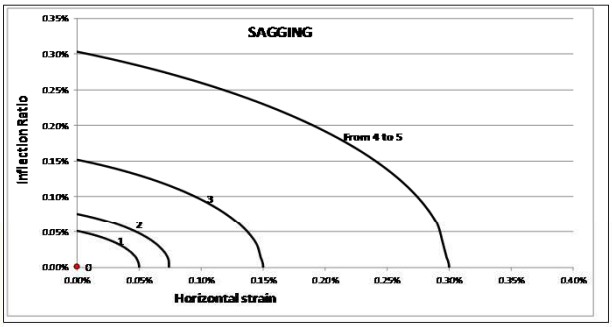
DAMAGE CLASS EVALUATION

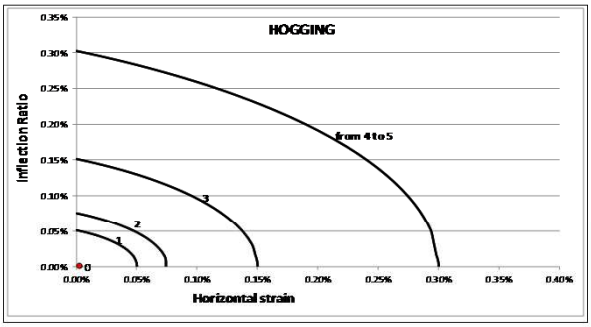
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	4.96

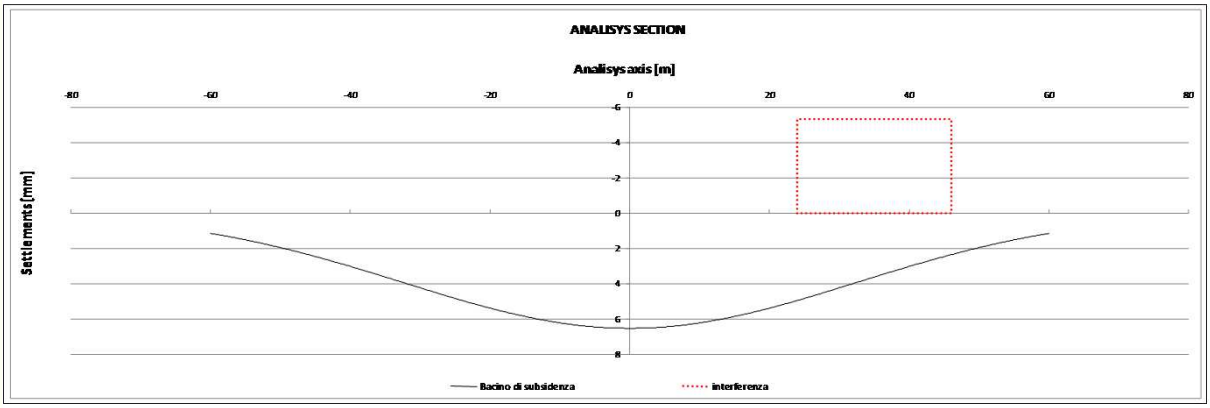
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8133
Maximum Angular Distortion	β	1.32E-05	1/76019

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

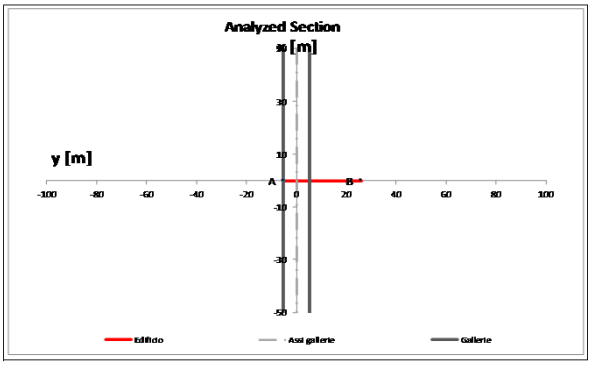
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	61

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	31.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	50.5	50.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	26

Settlements	
Point	w [mm]
A	6.24
B	4.67

Direction analysys	A	B

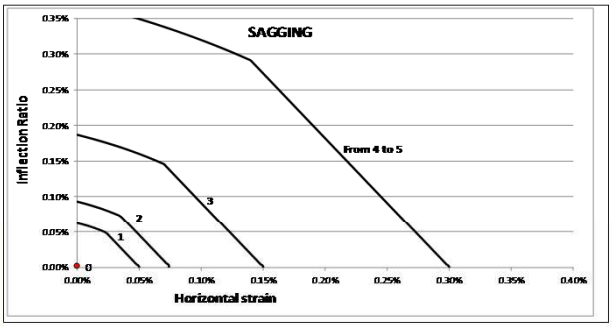
DAMAGE CLASS EVALUATION

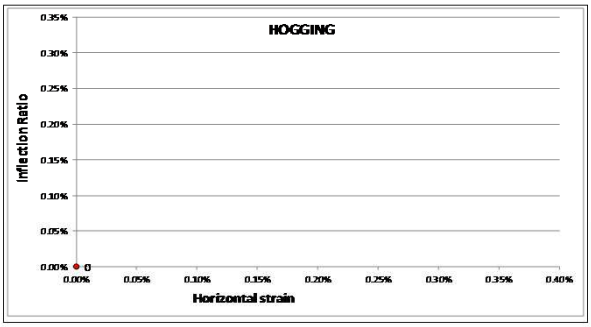
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.31
Max. Settlement of the building [mm]	$w_{building}$	6.31

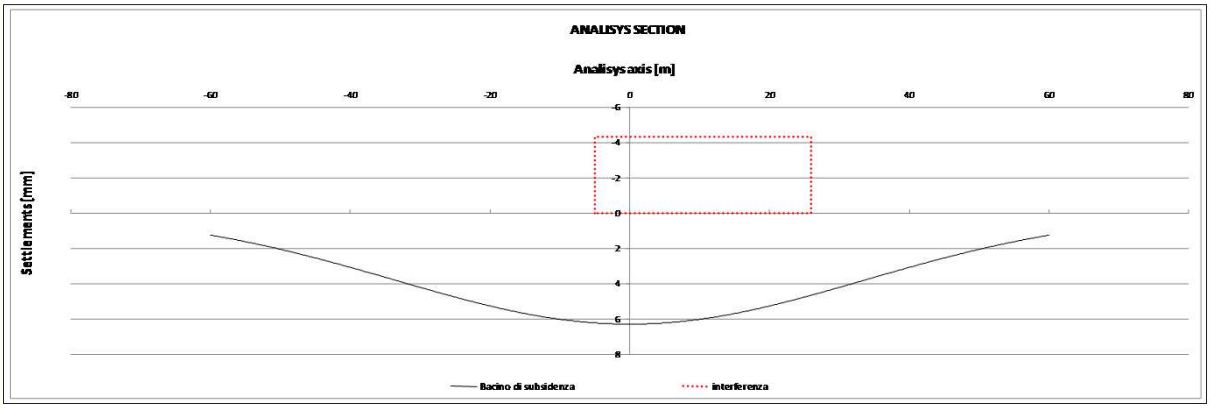
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.08E-04	1/9242
Maximum Angular Distortion	β	7.84E-05	1/12757

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

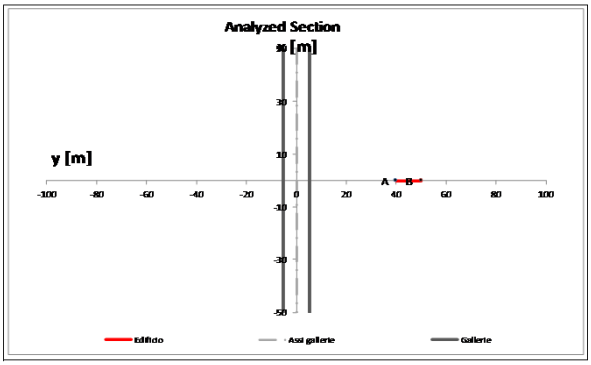
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	62

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	50.5	50.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	40
B	0	50

Settlements	
Point	w [mm]
A	3.09
B	2.07

Direction analysys	A	B

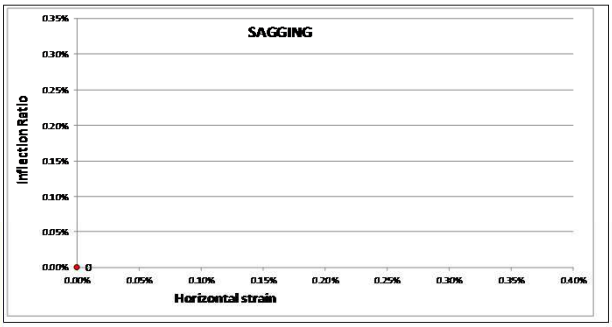
DAMAGE CLASS EVALUATION

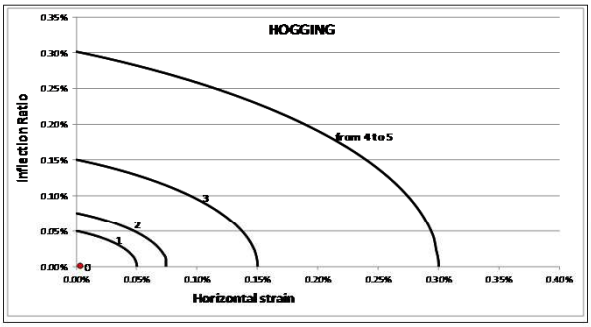
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.31
Max. Settlement of the building [mm]	$w_{building}$	3.09

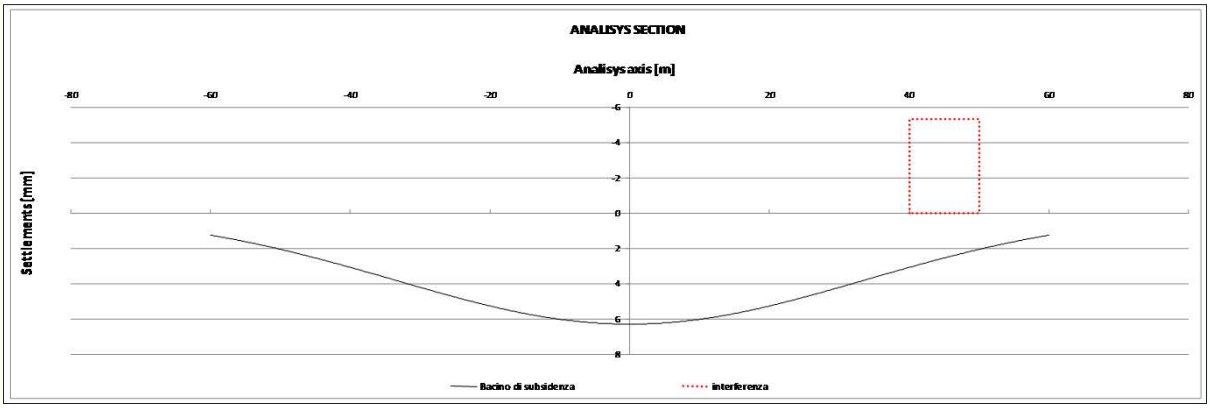
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.10E-04	1/9069
Maximum Angular Distortion	β	9.89E-06	1/101077

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

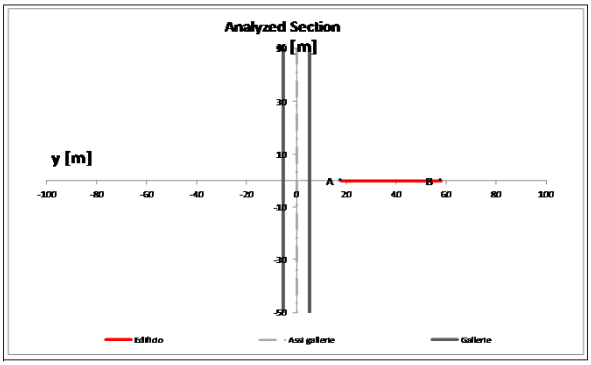
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	63

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	17.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	18
B	0	58

Settlements	
Point	w [mm]
A	5.60
B	1.30

Direction analysys	A	B

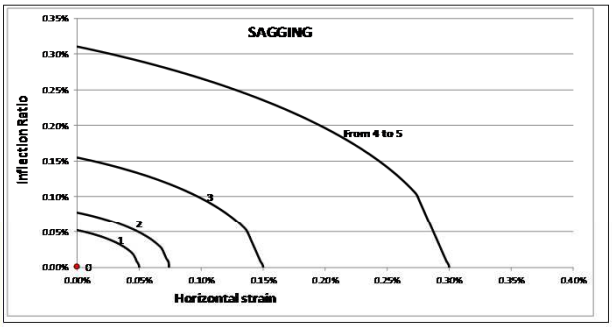
DAMAGE CLASS EVALUATION

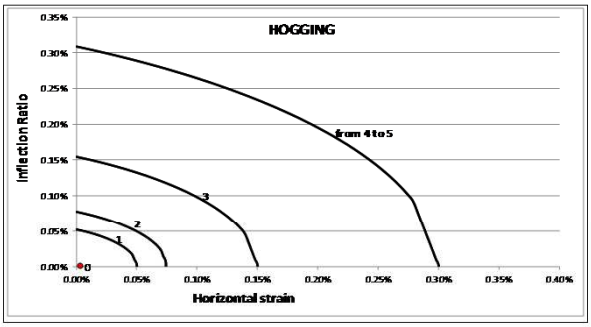
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	5.60

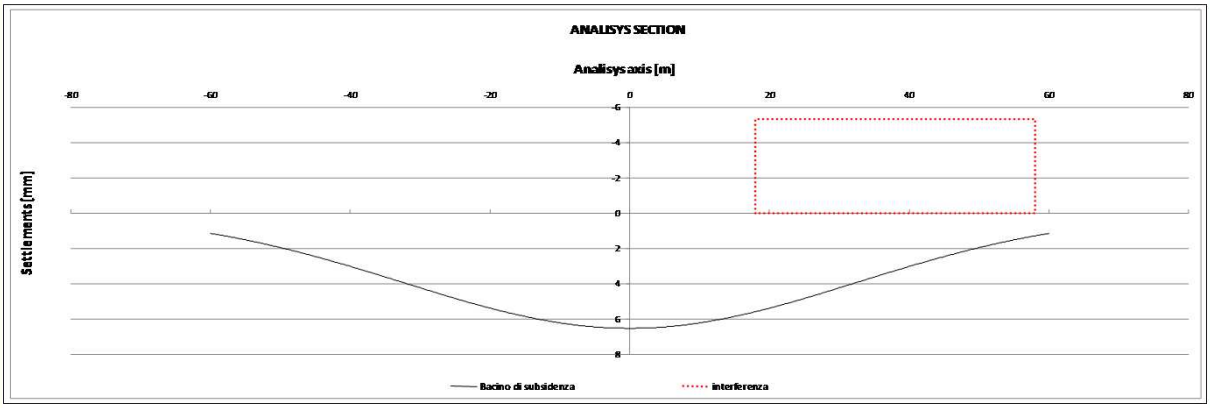
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8133
Maximum Angular Distortion	β	3.49E-05	1/28684

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

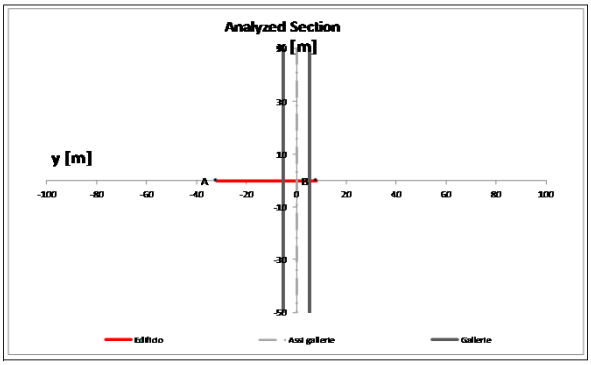
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	13.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-32
B	0	8

Settlements	
Point	w [mm]
A	4.00
B	6.35

Direction analysys	A	B

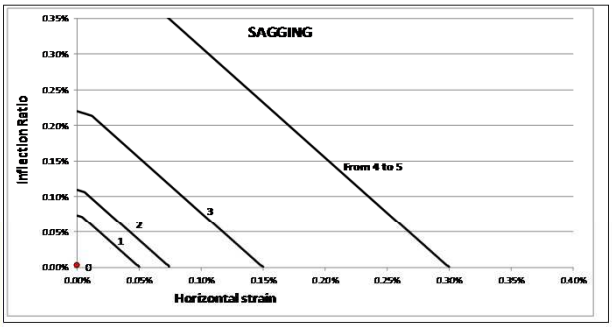
DAMAGE CLASS EVALUATION

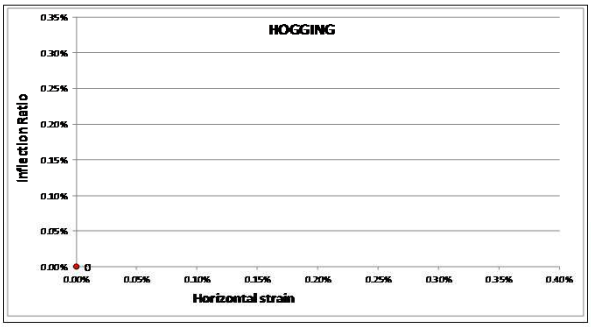
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.54

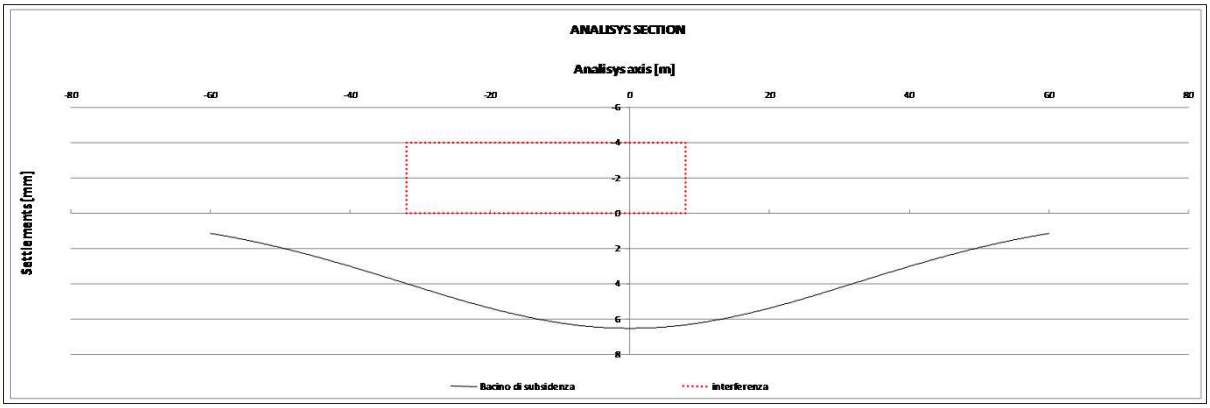
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8134
Maximum Angular Distortion	β	1.07E-04	1/9341

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

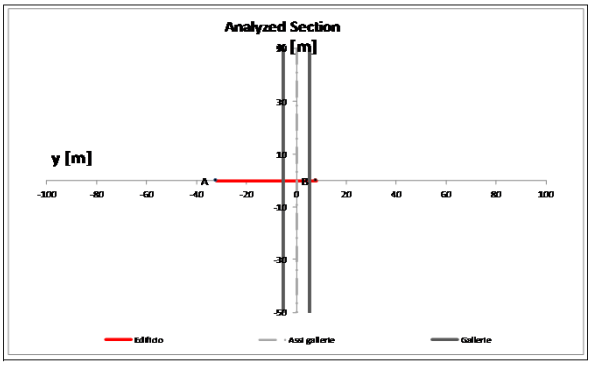
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	9.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	13.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-32
B	0	8

Settlements	
Point	w [mm]
A	3.99
B	6.70

Direction analysys	A	B

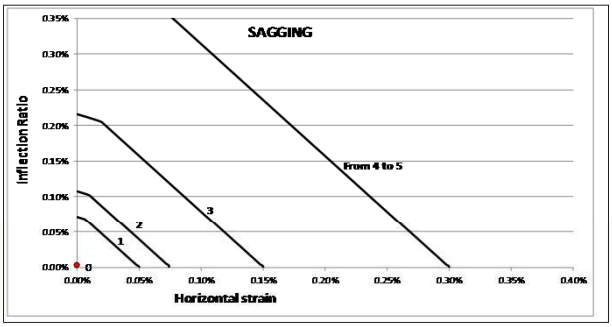
DAMAGE CLASS EVALUATION

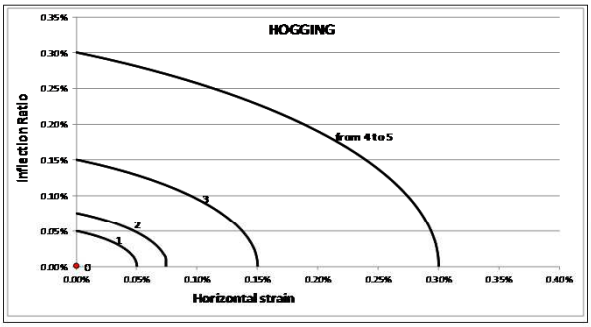
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.93

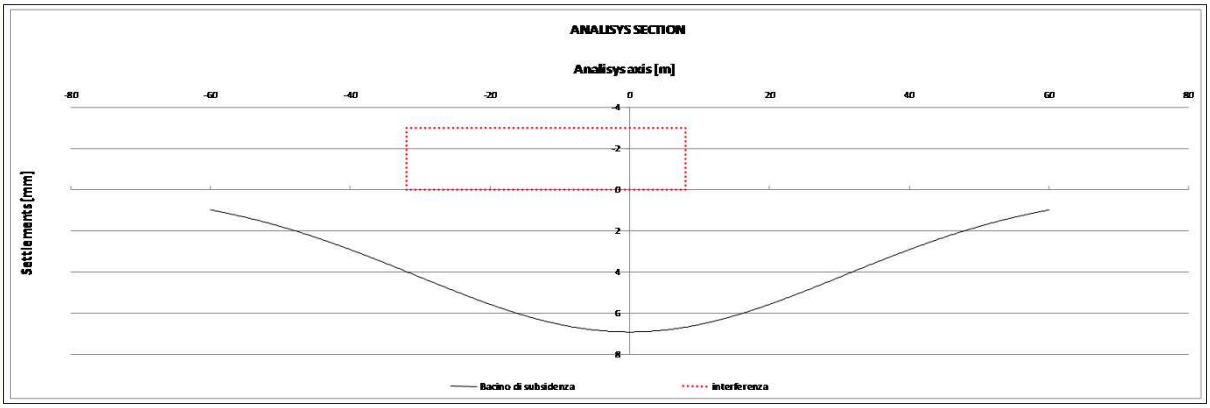
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	1.25E-04	1/8005

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

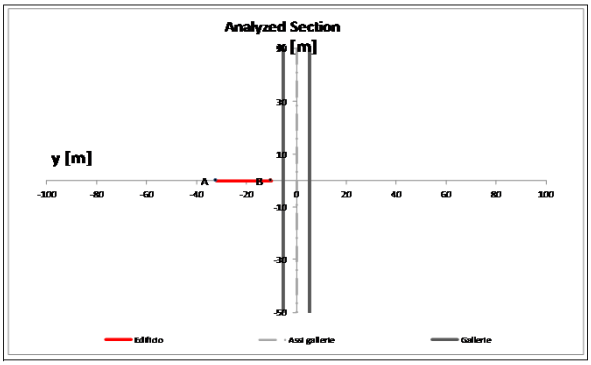
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64-1-2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	13.5	[m]
Length in the analyzed directio	L	22.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-32
B	0	-10

Settlements	
Point	w [mm]
A	4.00
B	6.24

Direction analysys	A	B

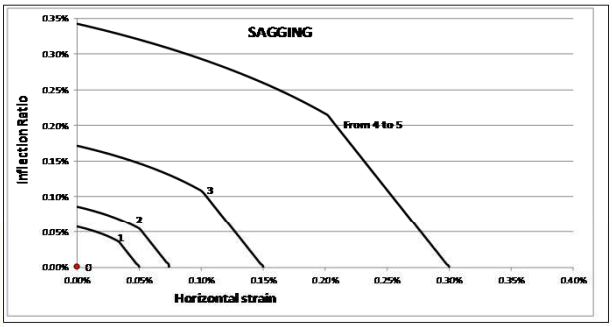
DAMAGE CLASS EVALUATION

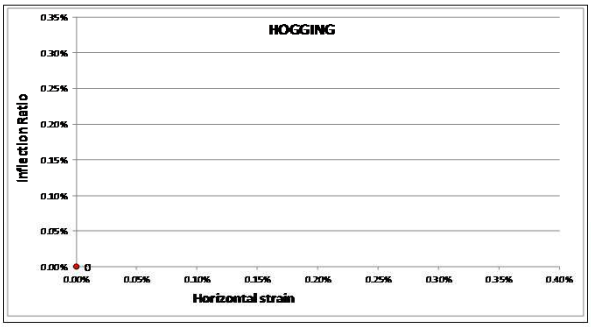
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.24

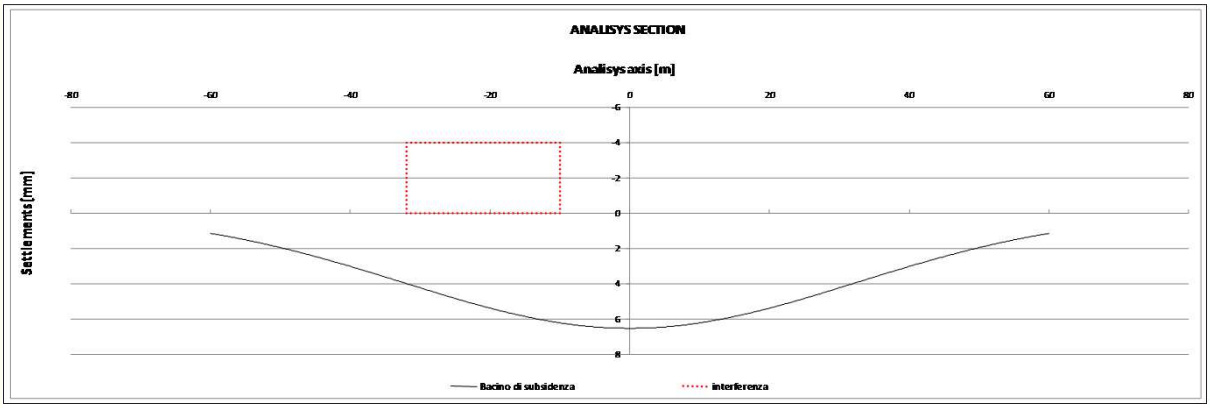
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8134
Maximum Angular Distortion	β	4.16E-05	1/24063

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

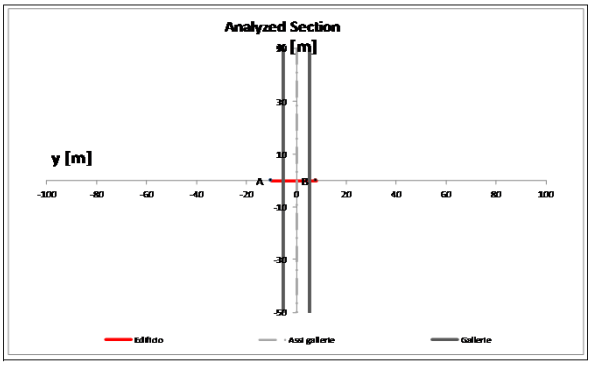
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64-2-2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	9.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	10.5	[m]
Length in the analyzed directio	L	18.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-10
B	0	8

Settlements	
Point	w [mm]
A	6.24
B	6.35

Direction analysys	A	B

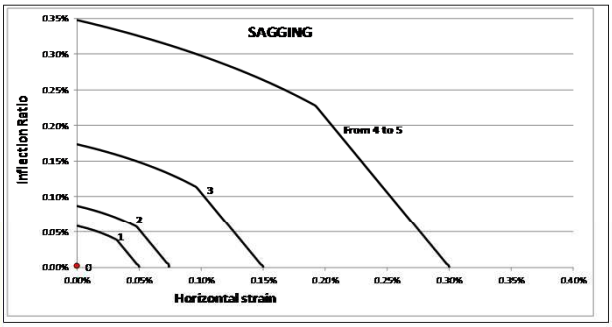
DAMAGE CLASS EVALUATION

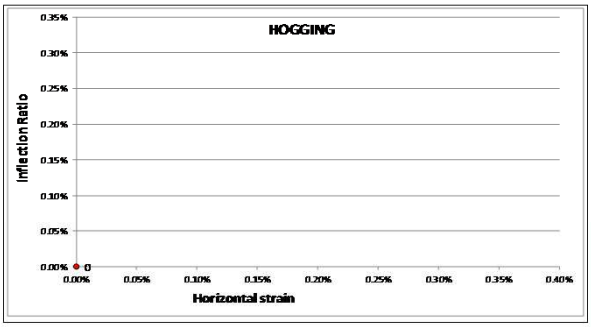
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.54

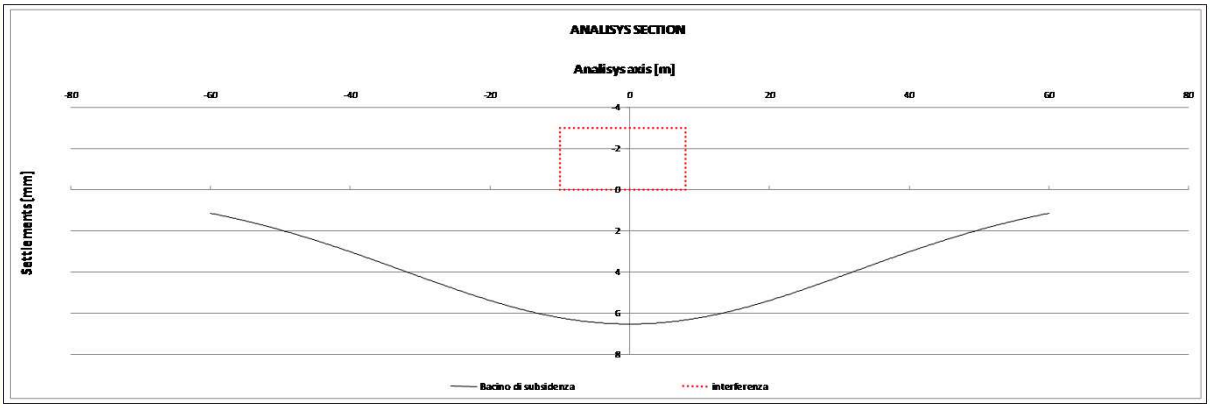
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	5.98E-05	1/16733
Maximum Angular Distortion	β	5.47E-05	1/18296

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

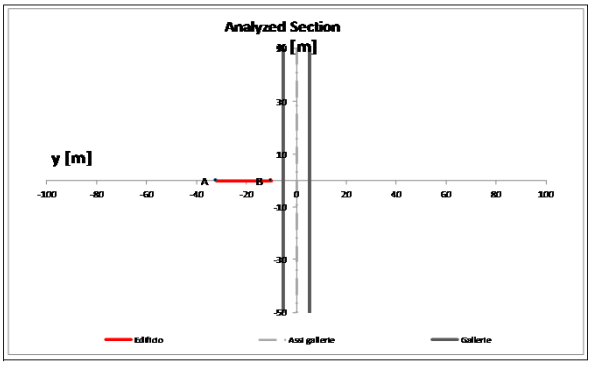
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64-1-2_hip2

Building Features			
Function			
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	9.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	13.5	[m]
Length in the analyzed directio	L	22.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-32
B	0	-10

Settlements	
Point	w [mm]
A	3.99
B	6.57

Direction analysys	A	B

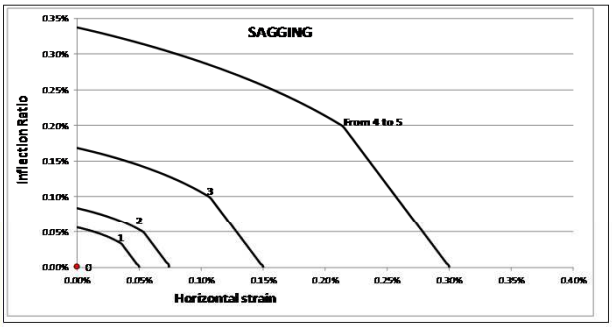
DAMAGE CLASS EVALUATION

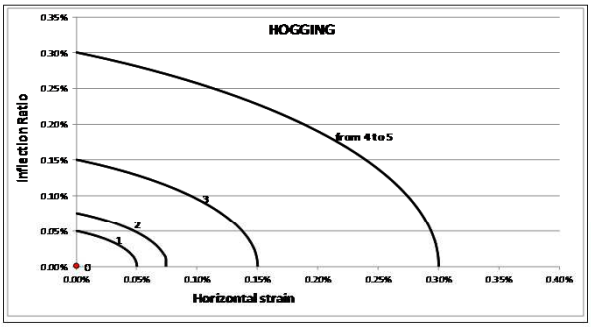
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.57

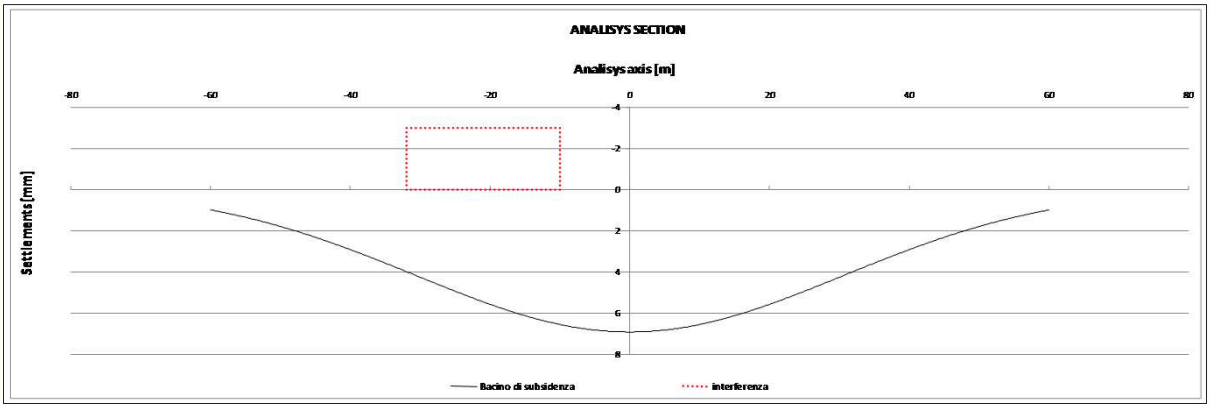
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	4.61E-05	1/21675

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

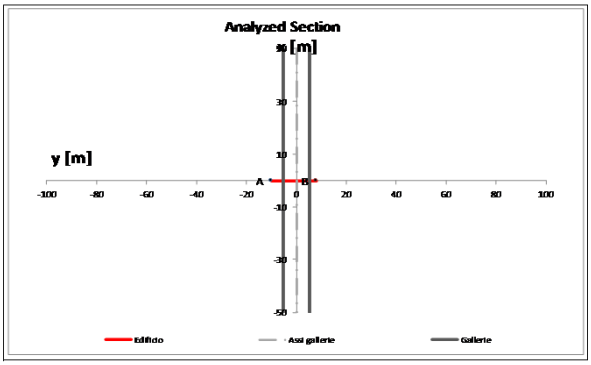
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	64-2-2_hip2

Building Features			
Function			
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	6.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	10.5	[m]
Length in the analyzed directio	L	18.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-10
B	0	8

Settlements	
Point	w [mm]
A	6.57
B	6.70

Direction analysys	A	B

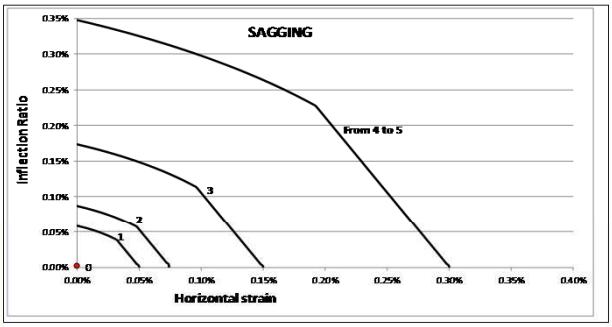
DAMAGE CLASS EVALUATION

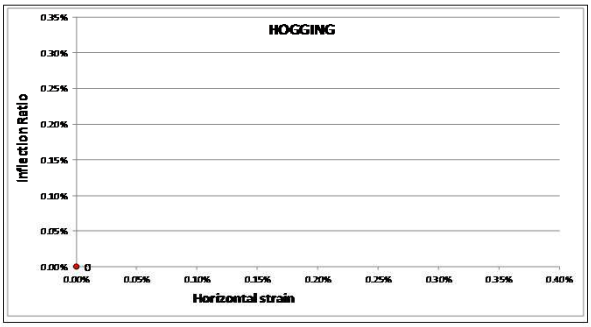
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.93

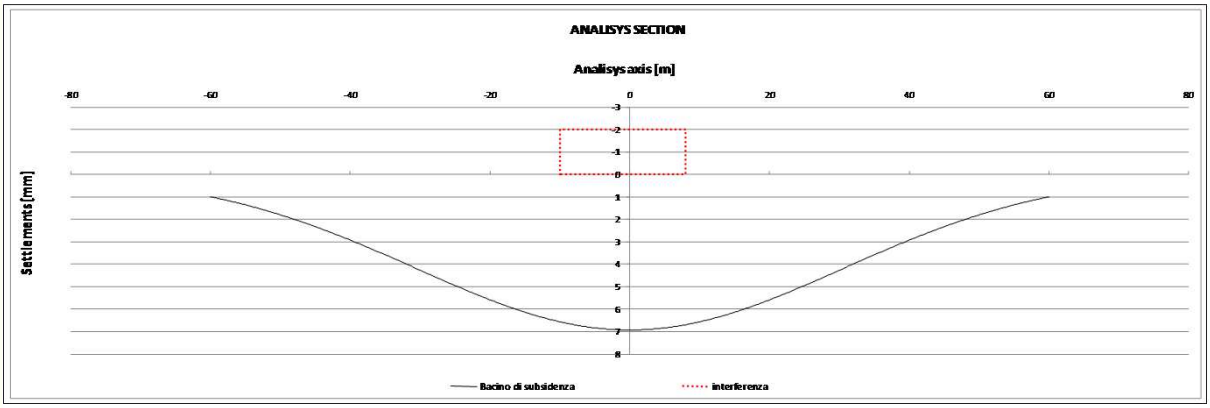
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.06E-05	1/14169
Maximum Angular Distortion	β	6.47E-05	1/15462

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

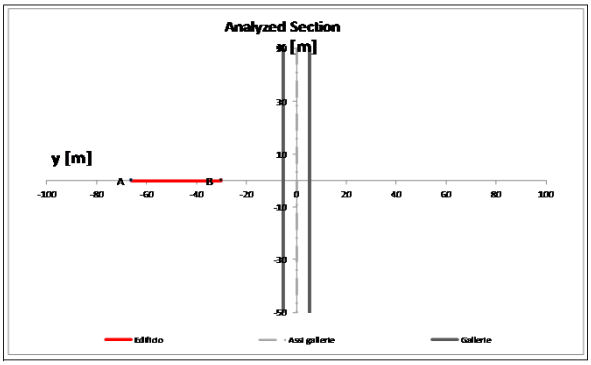
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	65

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	20.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	21.5	[m]
Length in the analyzed directio	L	36.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-66
B	0	-30

Settlements	
Point	w [mm]
A	0.66
B	4.27

Direction analysys	A	B

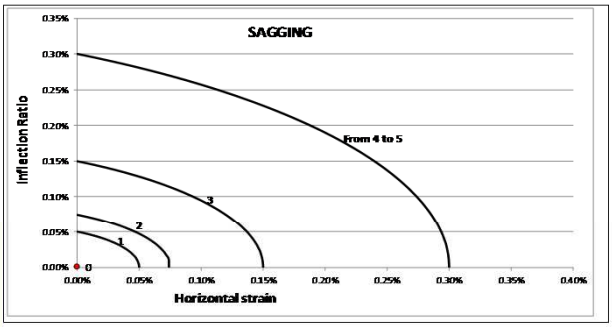
DAMAGE CLASS EVALUATION

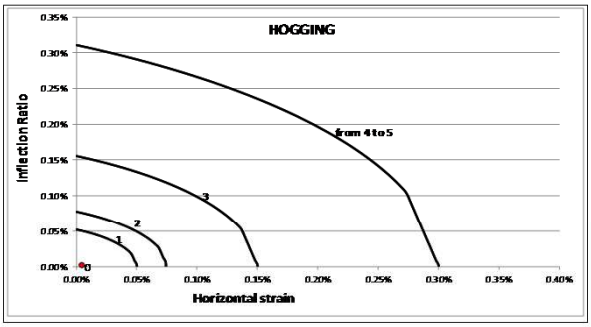
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	4.27

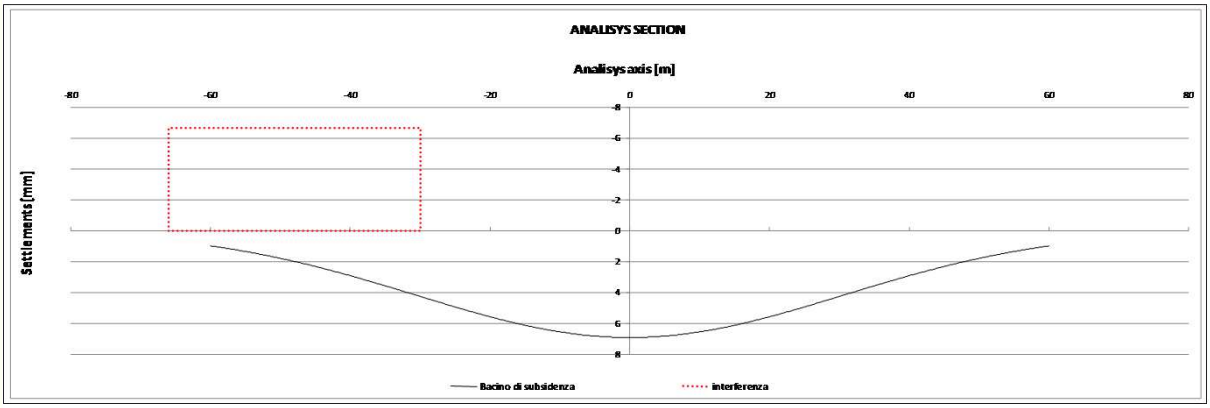
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	5.28E-05	1/18931

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

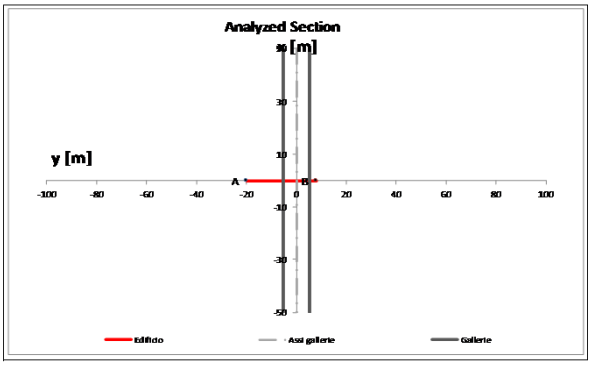
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	66

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	25.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	26.5	[m]
Length in the analyzed directio	L	28.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-20
B	0	8

Settlements	
Point	w [mm]
A	5.59
B	6.70

Direction analysys	A	B

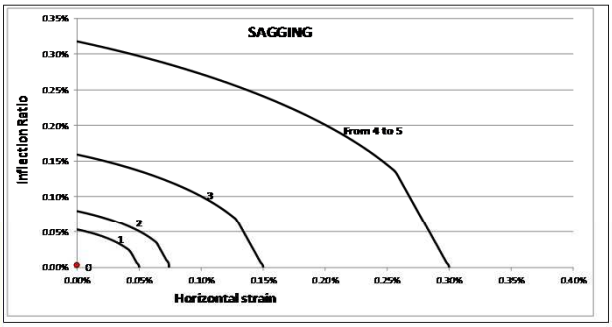
DAMAGE CLASS EVALUATION

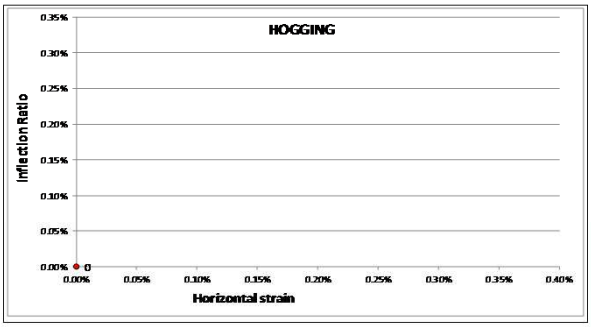
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.93

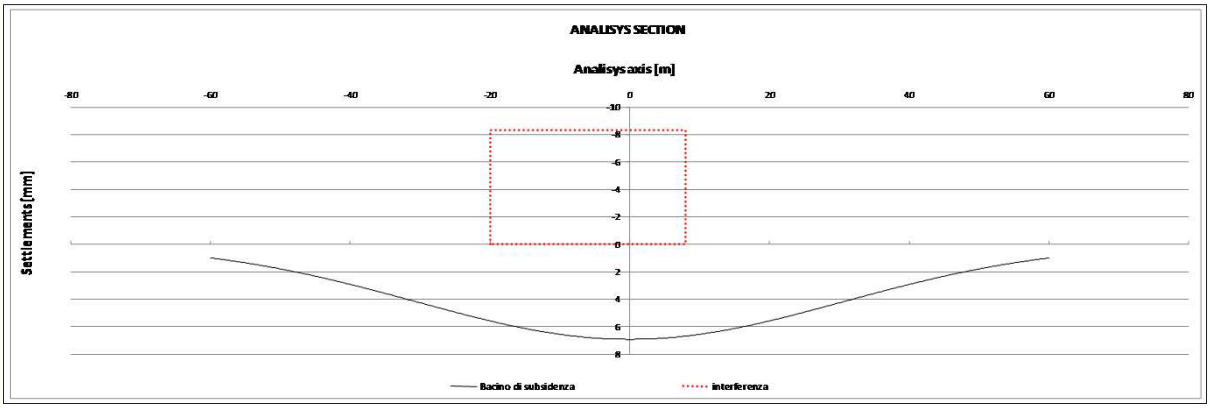
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.20E-04	1/8319
Maximum Angular Distortion	β	9.70E-05	1/10306

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

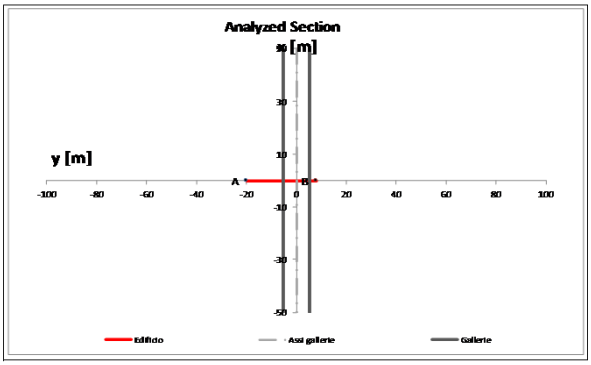
Building N°	66_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	7.5	[m]
Total Height	H	26.5	[m]
Length in the analyzed directio	L	28.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	39.5	39.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6

Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-20
B	0	8

Settlements	
Point	w [mm]
A	5.96
B	7.52



Direction analysys	A	B

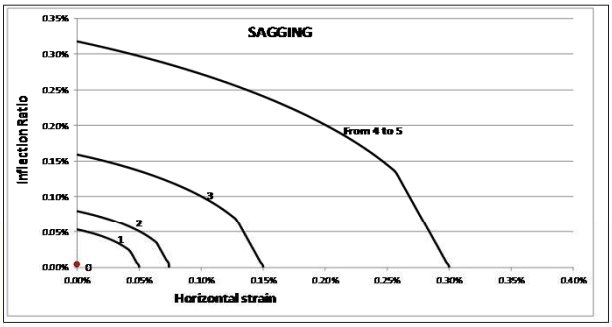
DAMAGE CLASS EVALUATION

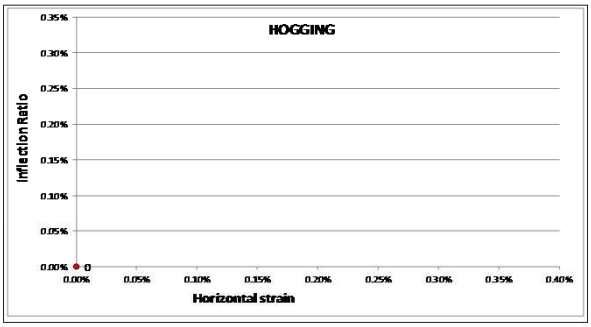
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.86
Max. Settlement of the building [mm]	$w_{building}$	7.86

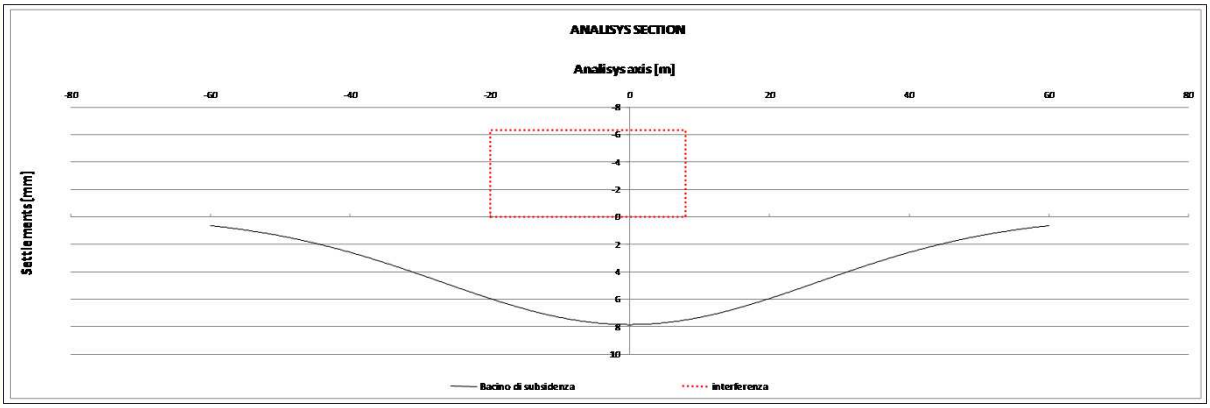
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.65E-04	1/6067
Maximum Angular Distortion	β	1.39E-04	1/7211

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.003%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

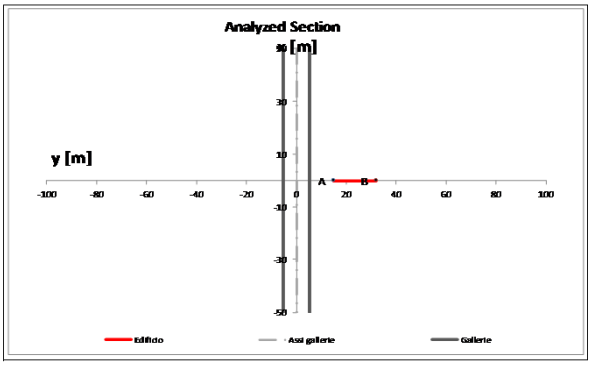
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	67

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	17.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	42.5	42.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	15
B	0	32

Settlements	
Point	w [mm]
A	6.42
B	3.95

Direction analysys	A	B

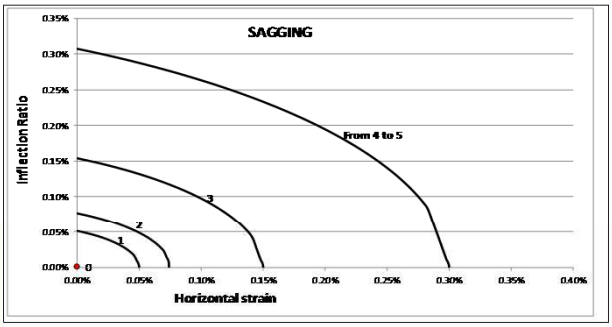
DAMAGE CLASS EVALUATION

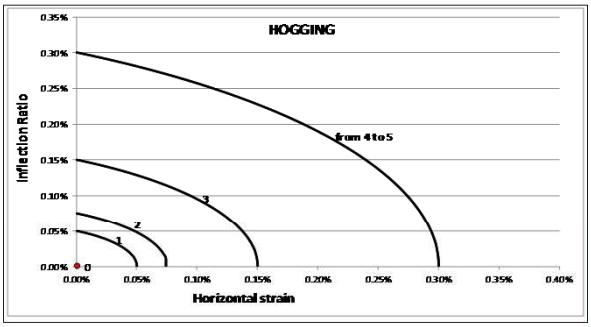
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.37
Max. Settlement of the building [mm]	$w_{building}$	6.42

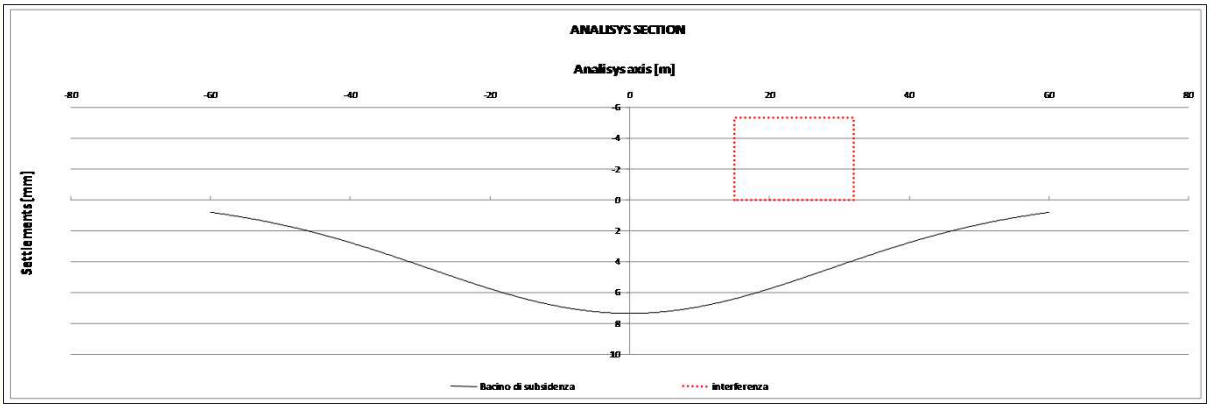
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.56E-04	1/6420
Maximum Angular Distortion	β	2.81E-05	1/35543

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.001%
Total strain	ε_{max}	0.001%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

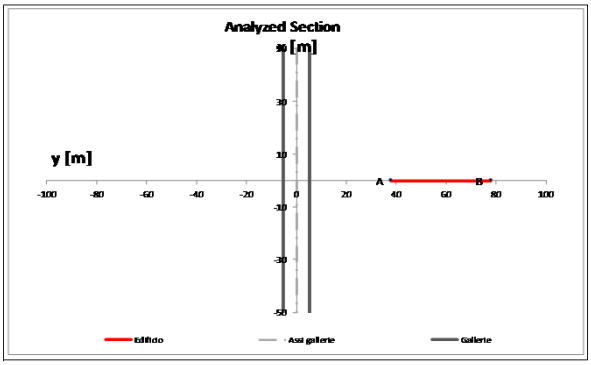
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	68

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	21.5	[m]
Length in the analyzed directio	L	40.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	42.5	42.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	38
B	0	78

Settlements	
Point	w [mm]
A	3.06
B	0.18

Direction analysys	A	B

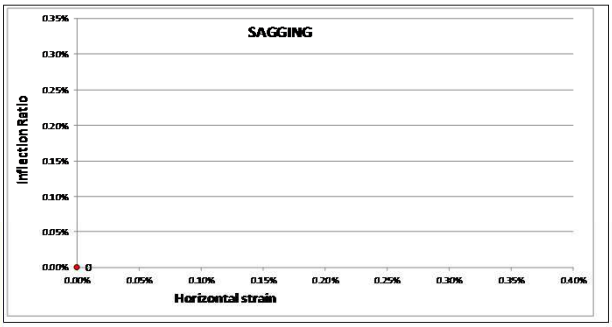
DAMAGE CLASS EVALUATION

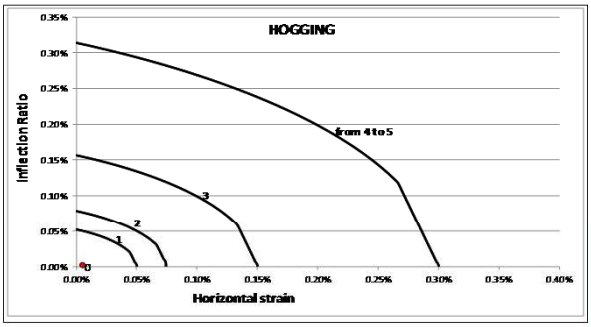
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.37
Max. Settlement of the building [mm]	$w_{building}$	3.06

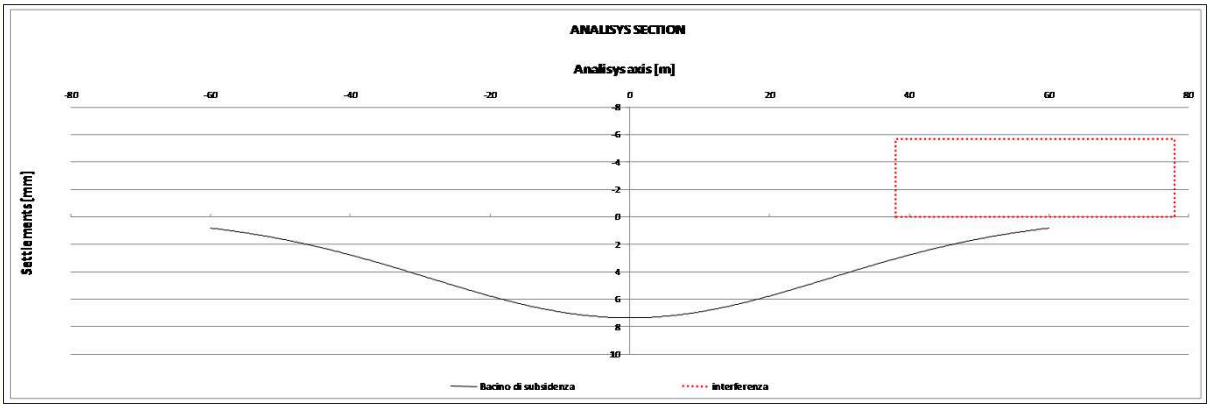
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.41E-04	1/7075
Maximum Angular Distortion	β	6.94E-05	1/14419

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.006%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

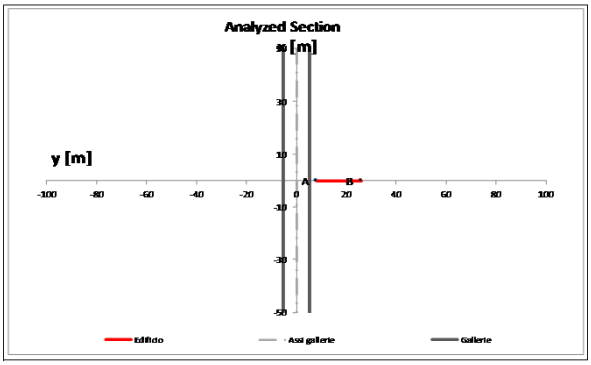
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	69

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	18.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	8
B	0	26

Settlements	
Point	w [mm]
A	6.70
B	4.82

Direction analysys	A	B

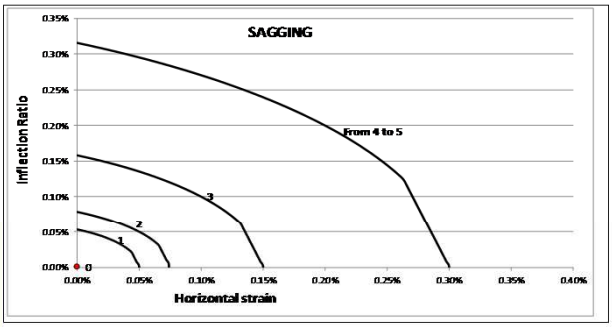
DAMAGE CLASS EVALUATION

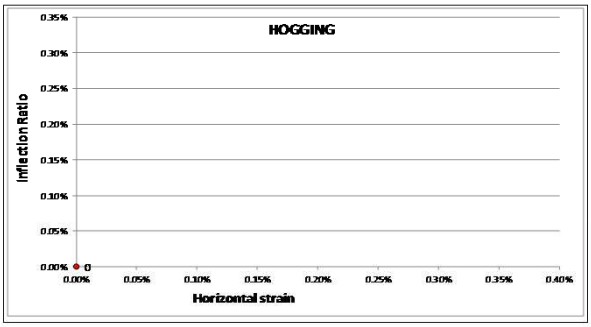
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.70

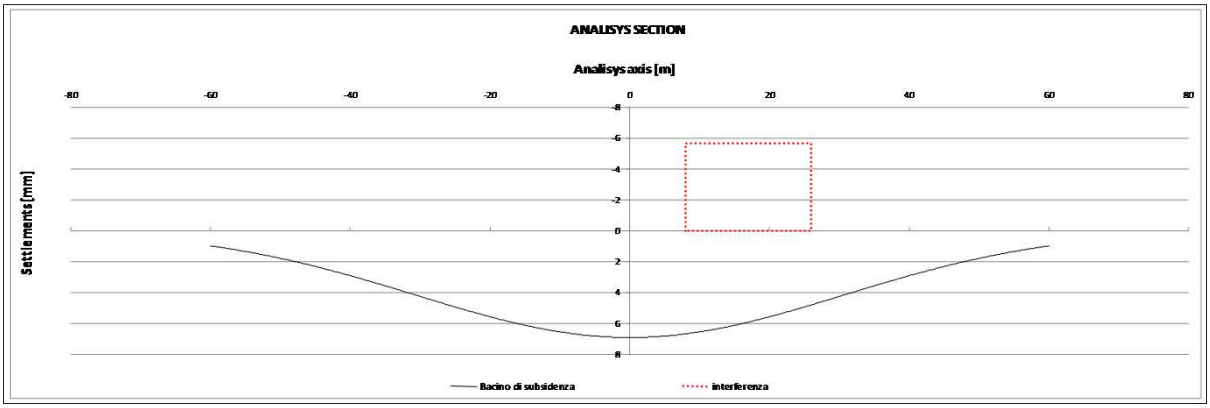
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.35E-04	1/7420
Maximum Angular Distortion	β	4.66E-05	1/21455

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

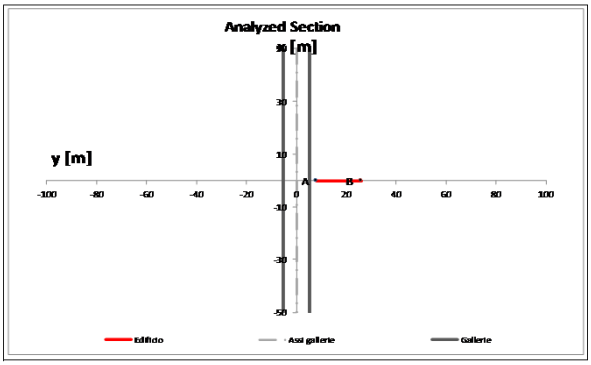
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	69_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	18.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	42.5	42.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	8
B	0	26

Settlements	
Point	w [mm]
A	7.08
B	4.88

Direction analysys	A	B

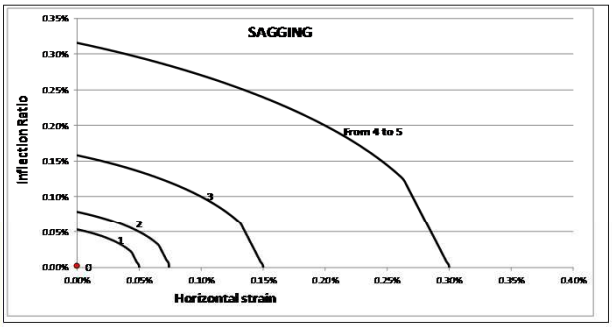
DAMAGE CLASS EVALUATION

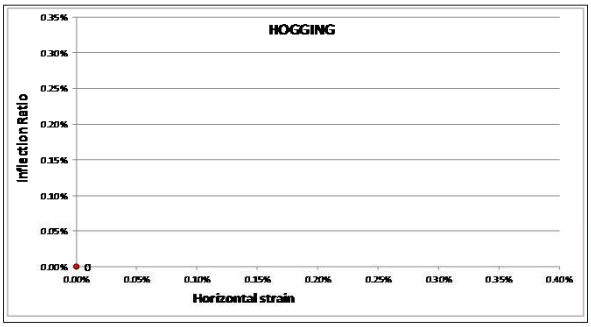
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.37
Max. Settlement of the building [mm]	$w_{building}$	7.08

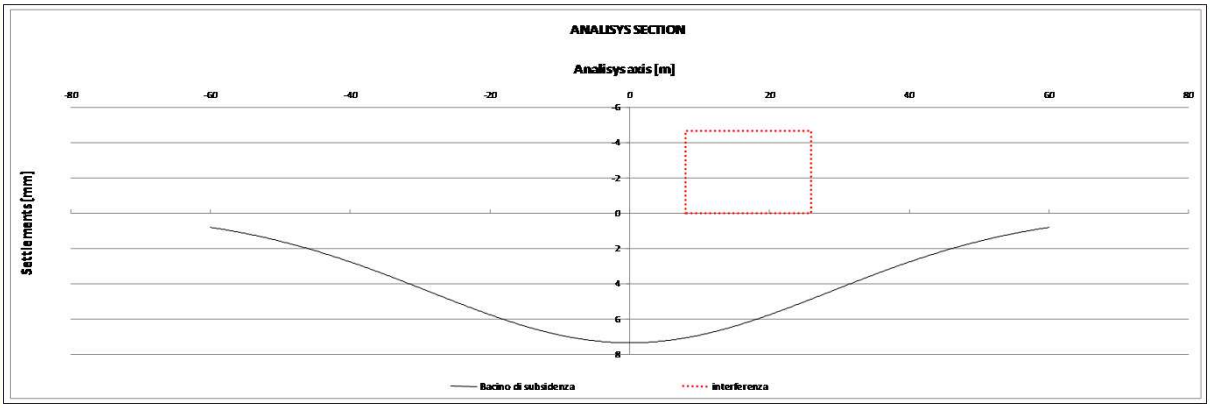
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.54E-04	1/6479
Maximum Angular Distortion	β	5.32E-05	1/18790

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

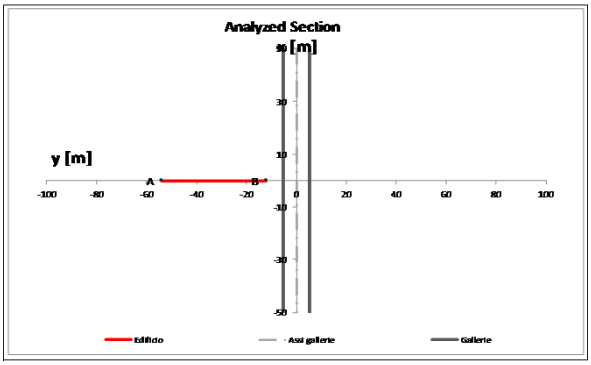
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	70

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	42.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-54
B	0	-12

Settlements	
Point	w [mm]
A	1.44
B	6.41

Direction analysys	A	B

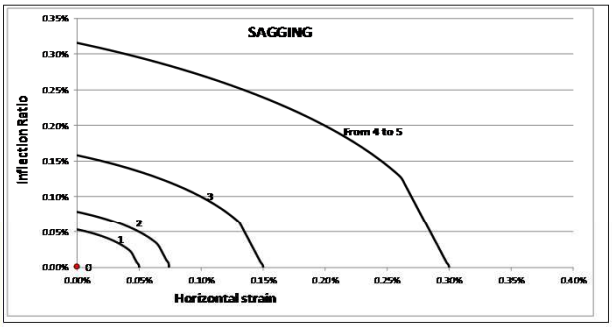
DAMAGE CLASS EVALUATION

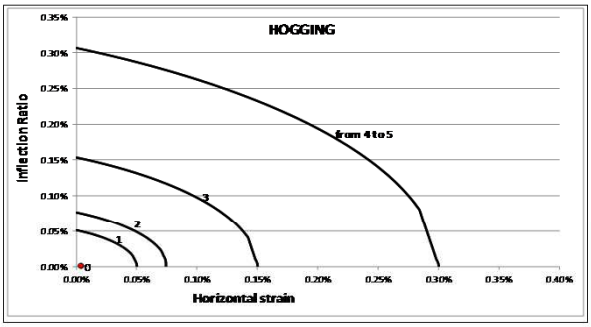
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.41

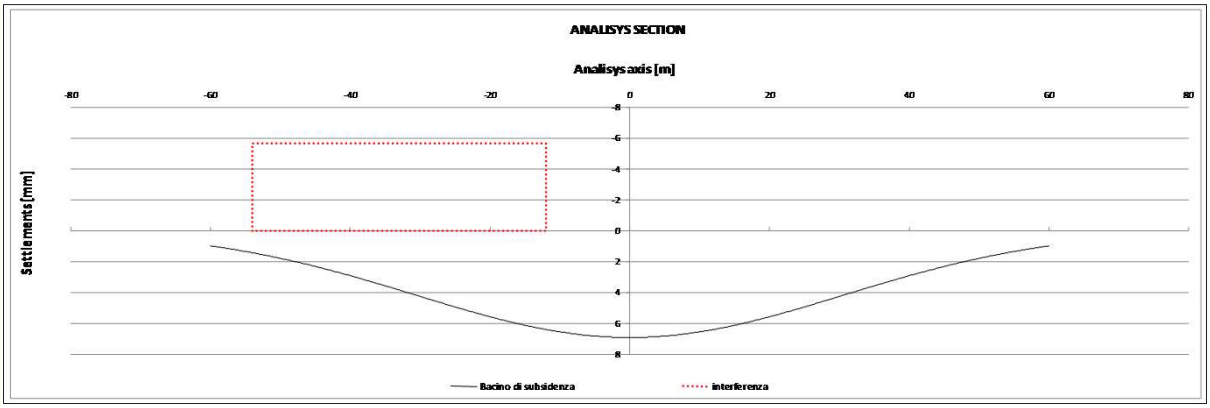
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	3.53E-05	1/28356

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

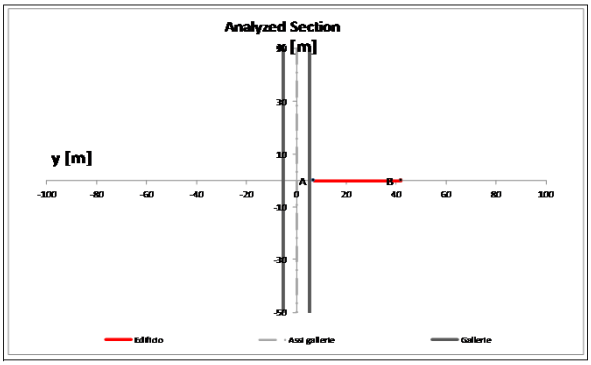
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	71

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	20.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	21.5	[m]
Length in the analyzed directio	L	35.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	7
B	0	42

Settlements	
Point	w [mm]
A	6.75
B	2.68

Direction analysys	A	B

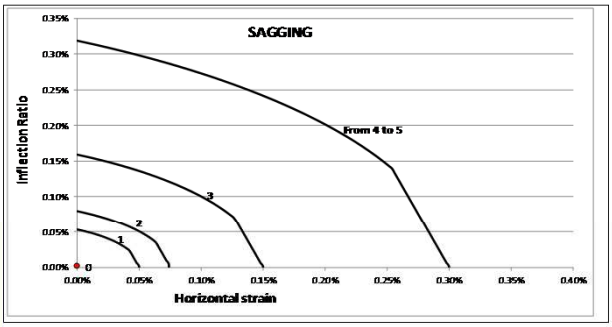
DAMAGE CLASS EVALUATION

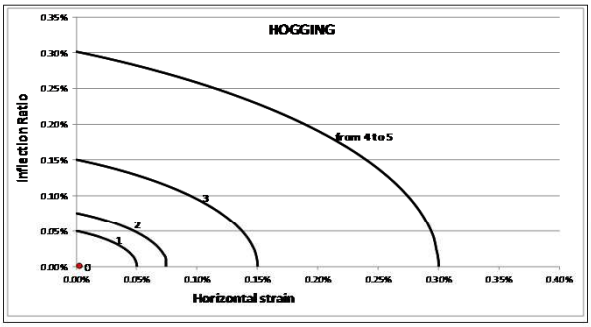
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.75

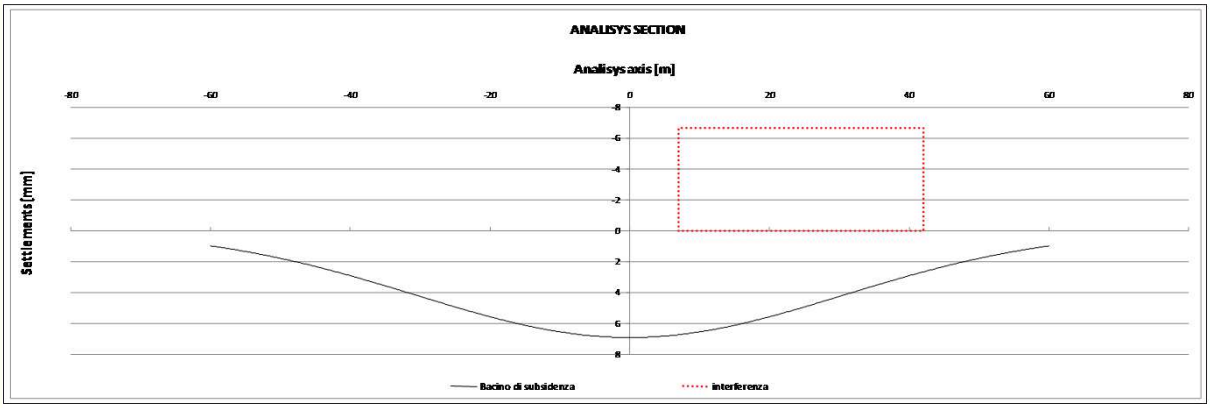
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.38E-04	1/7251
Maximum Angular Distortion	β	6.51E-05	1/15354

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

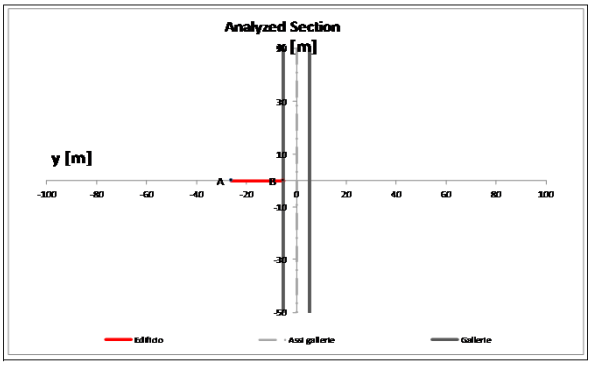
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	72

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	19.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	20.5	[m]
Length in the analyzed directio	L	21.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	45.5	45.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-26
B	0	-5

Settlements	
Point	w [mm]
A	4.82
B	6.84

Direction analysys	A	B

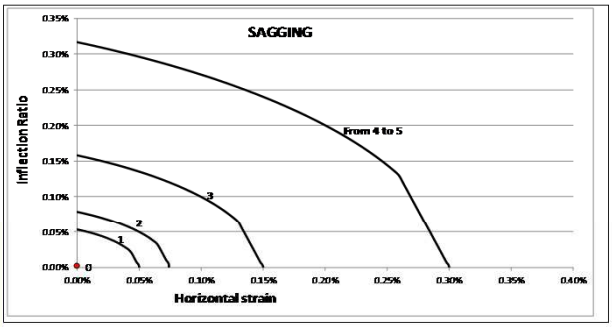
DAMAGE CLASS EVALUATION

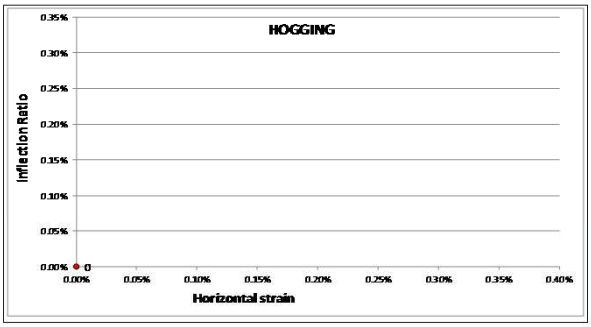
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.93
Max. Settlement of the building [mm]	$w_{building}$	6.84

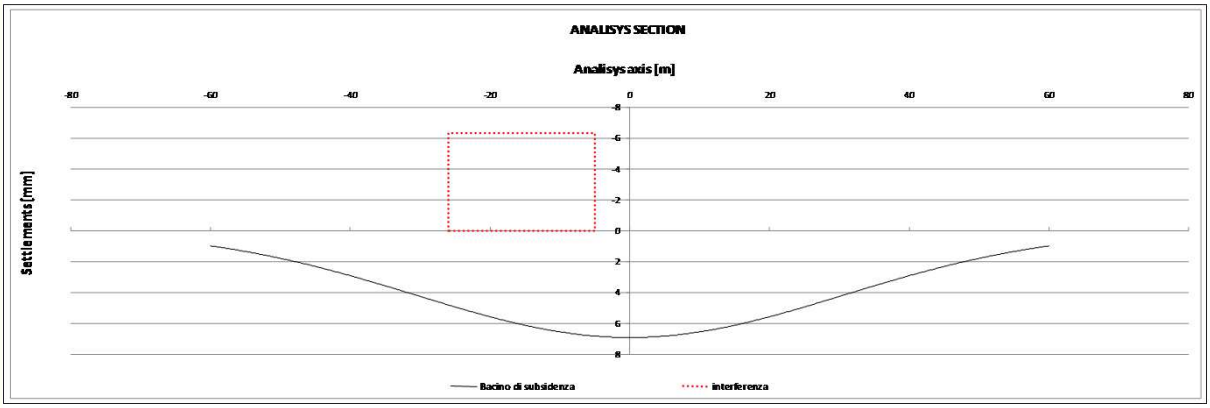
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.35E-04	1/7420
Maximum Angular Distortion	β	5.93E-05	1/16867

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

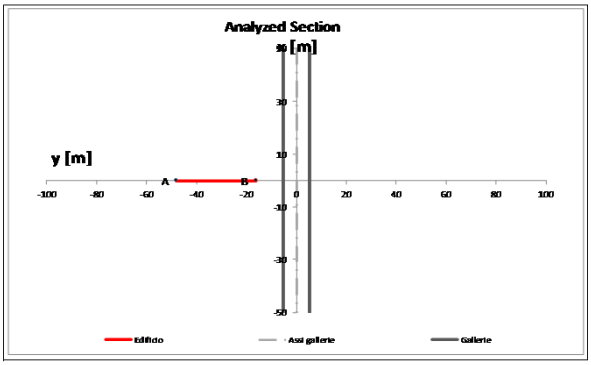
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	73

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	22.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	23.5	[m]
Length in the analyzed directio	L	32.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	44.5	44.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-48
B	0	-16

Settlements	
Point	w [mm]
A	1.95
B	6.13

Direction analysys	A	B

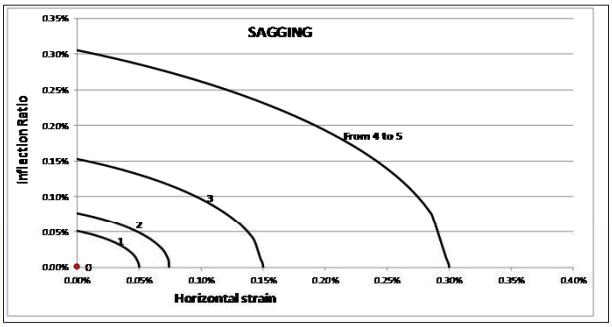
DAMAGE CLASS EVALUATION

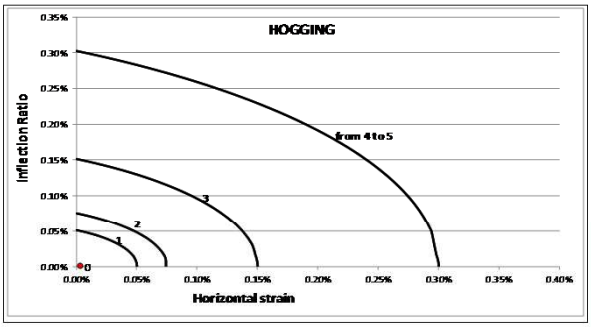
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.07
Max. Settlement of the building [mm]	$w_{building}$	6.13

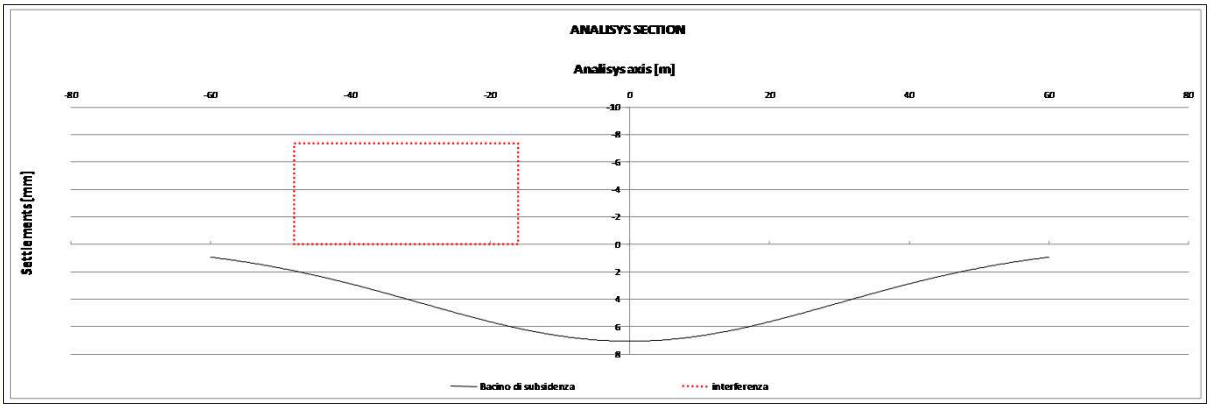
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.44E-04	1/6969
Maximum Angular Distortion	β	2.59E-05	1/38584

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

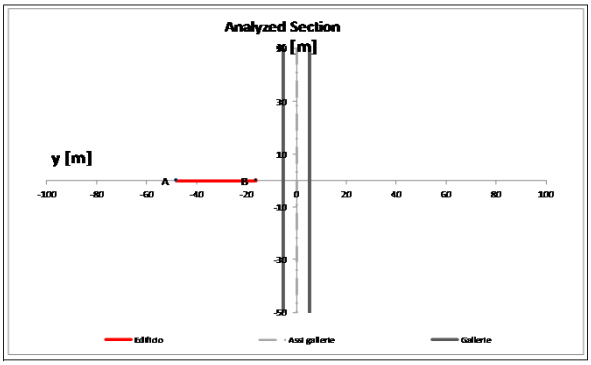
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	73_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	16.0	[m]
Max. Depth of foundation	z_f	7.5	[m]
Total Height	H	23.5	[m]
Length in the analyzed directio	L	32.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	38.5	38.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-48
B	0	-16

Settlements	
Point	w [mm]
A	1.52
B	6.68

Direction analysys	A	B

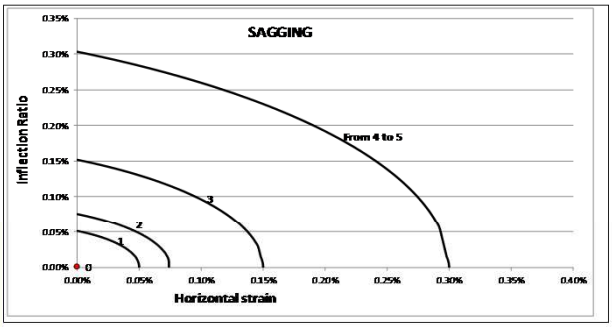
DAMAGE CLASS EVALUATION

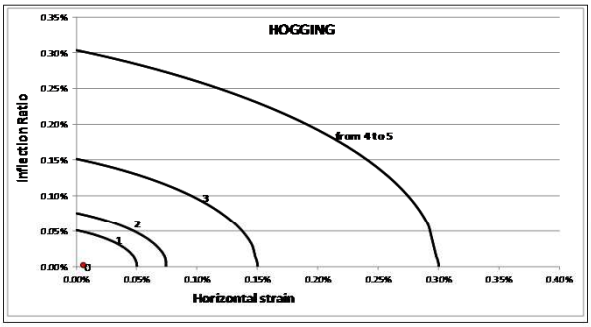
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.04
Max. Settlement of the building [mm]	$w_{building}$	6.68

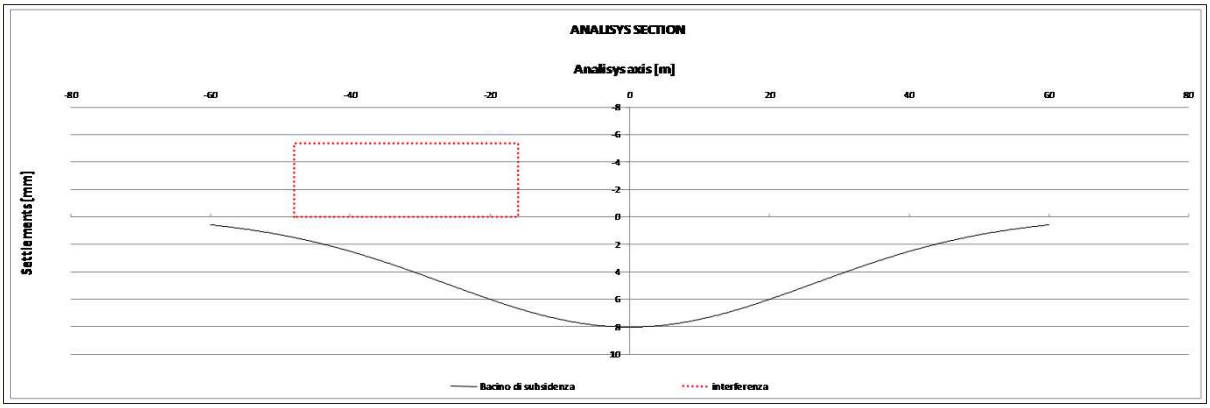
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.86E-04	1/5391
Maximum Angular Distortion	β	5.58E-05	1/17929

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.006%
Total strain	ε_{max}	0.006%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

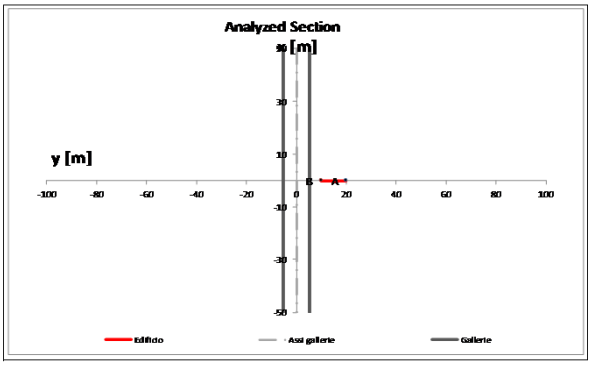
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	74

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	15.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	44.5	44.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	20
B	0	10

Settlements	
Point	w [mm]
A	5.65
B	6.68

Direction analysys	A	B

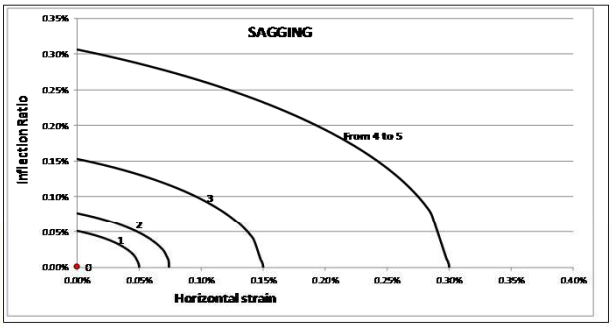
DAMAGE CLASS EVALUATION

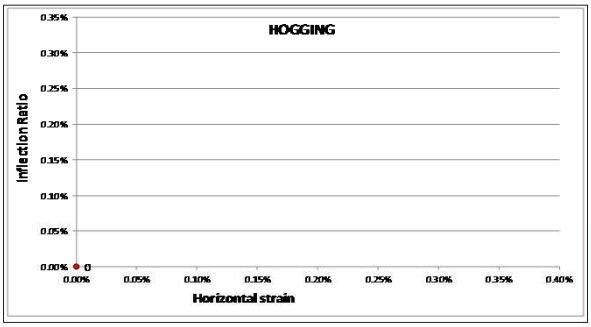
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.07
Max. Settlement of the building [mm]	$w_{building}$	6.68

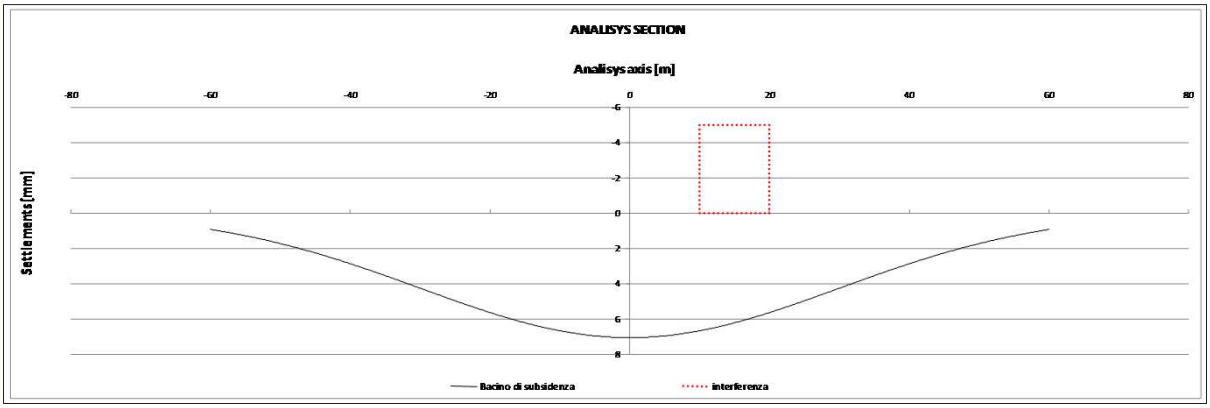
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.27E-04	1/7902
Maximum Angular Distortion	β	2.84E-05	1/35161

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

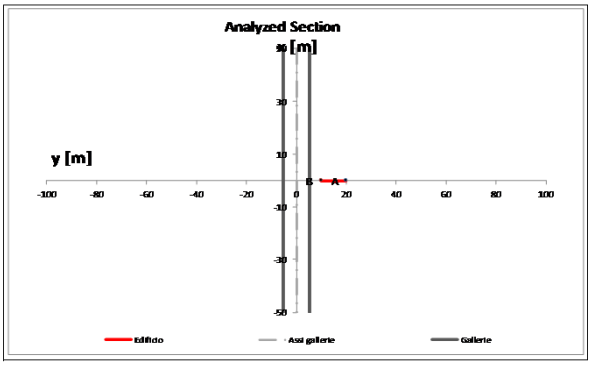
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	74_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	41.5	41.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	20
B	0	10

Settlements	
Point	w [mm]
A	5.84
B	7.06

Direction analysys	A	B

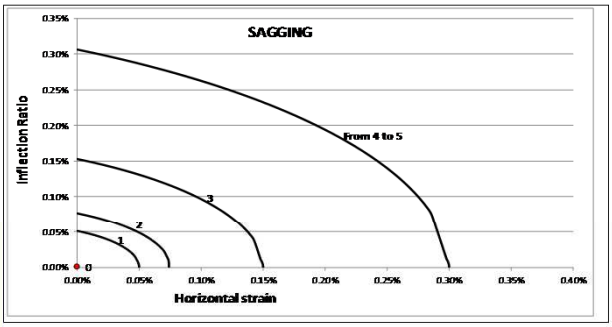
DAMAGE CLASS EVALUATION

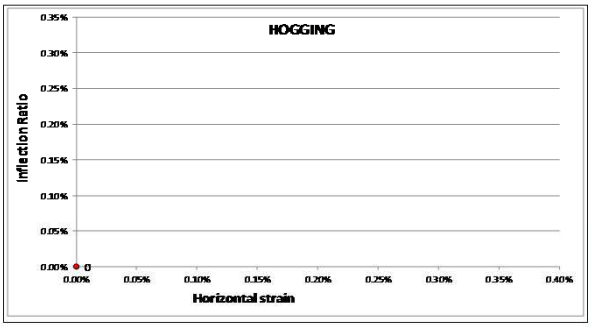
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.52
Max. Settlement of the building [mm]	$w_{building}$	7.06

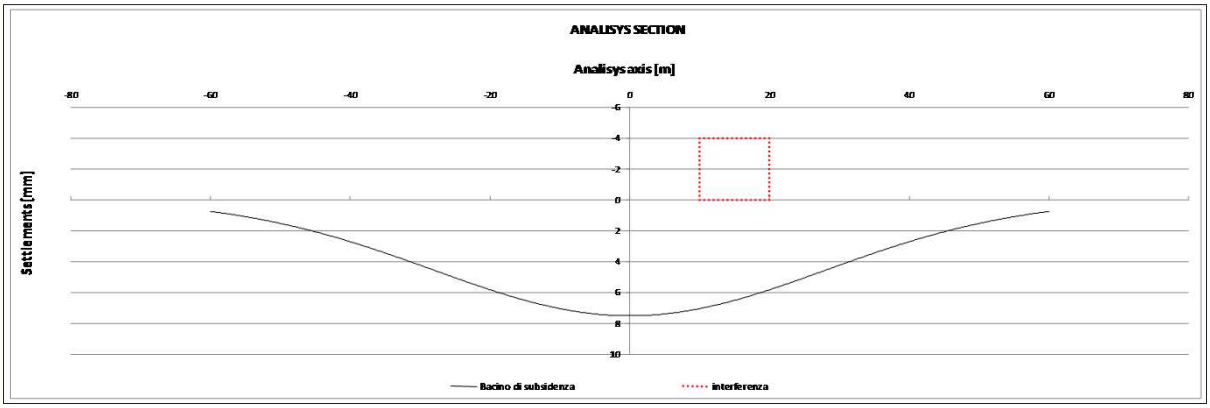
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.48E-04	1/6756
Maximum Angular Distortion	β	3.27E-05	1/30590

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

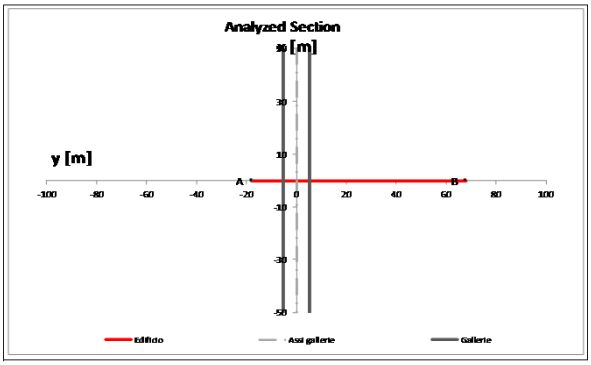
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	75

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	86.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	46.5	46.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-18
B	0	68

Settlements	
Point	w [mm]
A	5.75
B	0.62

Direction analysys	A	B

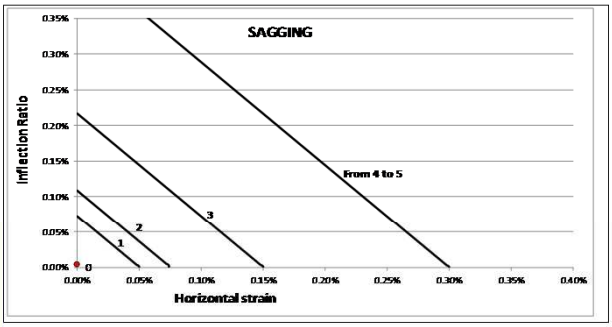
DAMAGE CLASS EVALUATION

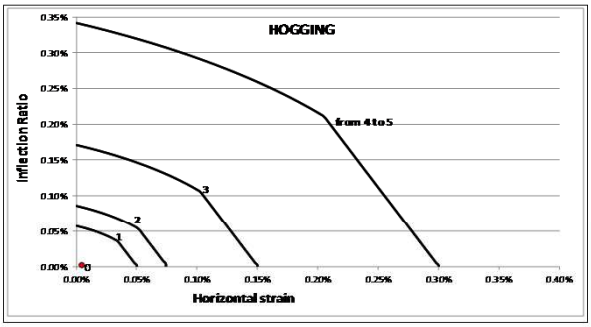
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.80
Max. Settlement of the building [mm]	$w_{building}$	6.80

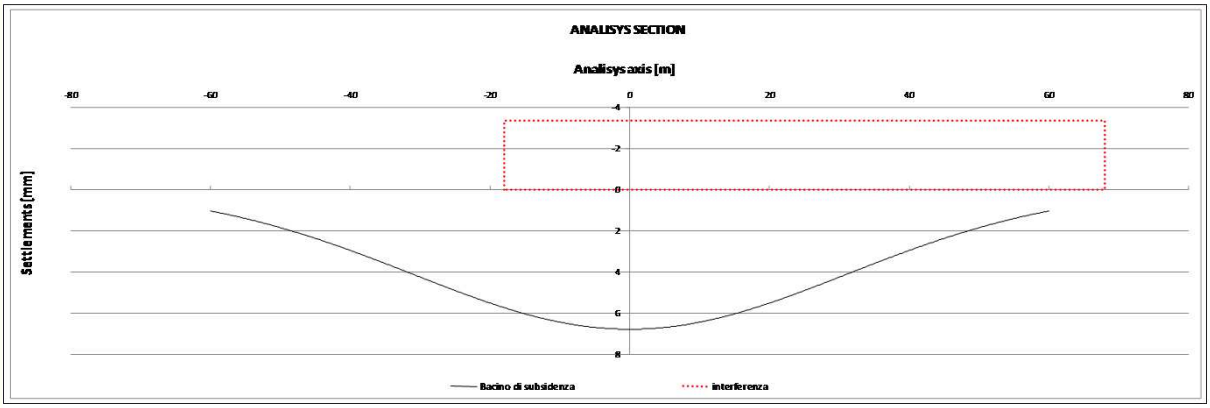
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.33E-04	1/7540
Maximum Angular Distortion	β	1.66E-04	1/6011

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.004%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.005%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

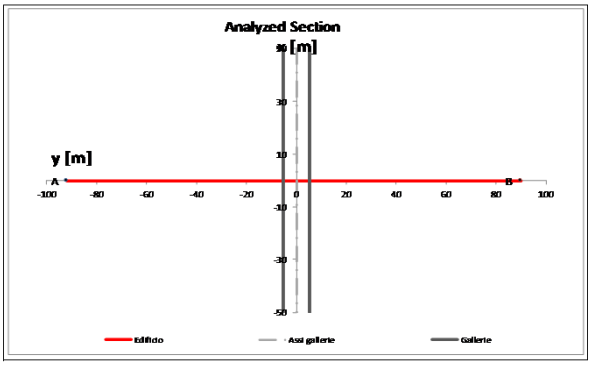
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	76

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	44.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	45.5	[m]
Length in the analyzed directio	L	182.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	64.5	64.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-92
B	0	90

Settlements	
Point	w [mm]
A	0.45
B	0.50

Direction analysys	A	B

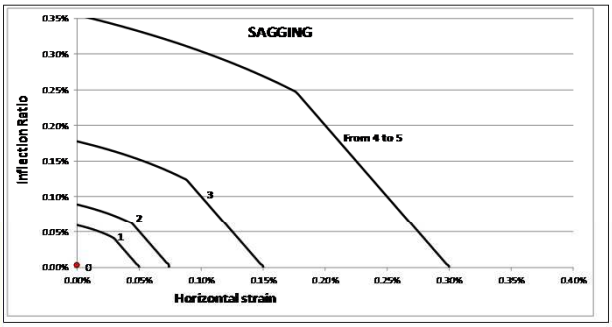
DAMAGE CLASS EVALUATION

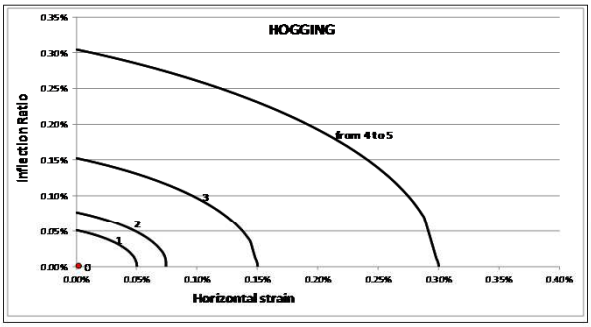
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	5.04
Max. Settlement of the building [mm]	$w_{building}$	5.04

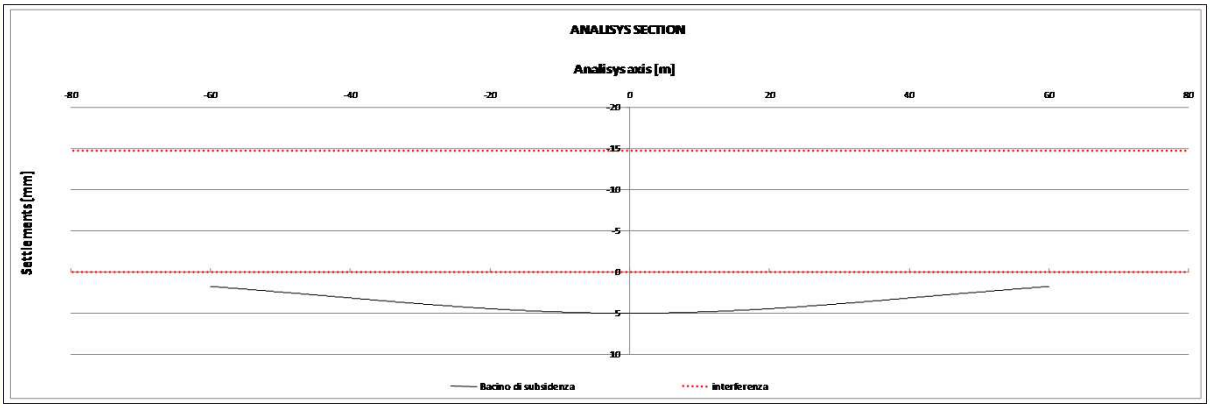
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	7.30E-05	1/13690
Maximum Angular Distortion	β	7.33E-05	1/13639

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.002%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

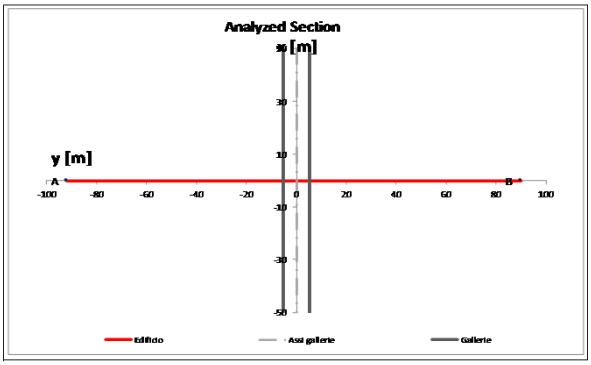
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	76_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	38.0	[m]
Max. Depth of foundation	z_f	7.5	[m]
Total Height	H	45.5	[m]
Length in the analyzed directio	L	182.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	58.5	58.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-92
B	0	90

Settlements	
Point	w [mm]
A	0.31
B	0.35

Direction analysys	A	B

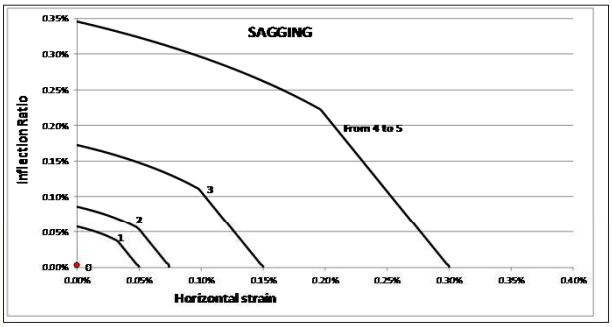
DAMAGE CLASS EVALUATION

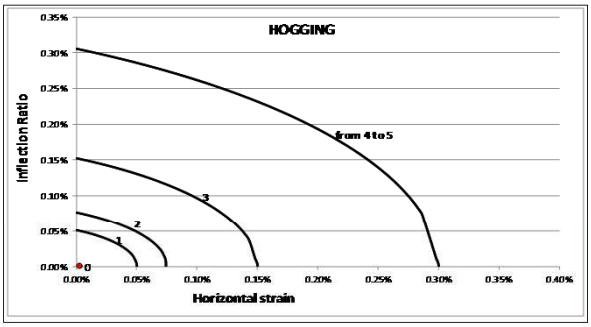
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	5.52
Max. Settlement of the building [mm]	$w_{building}$	5.52

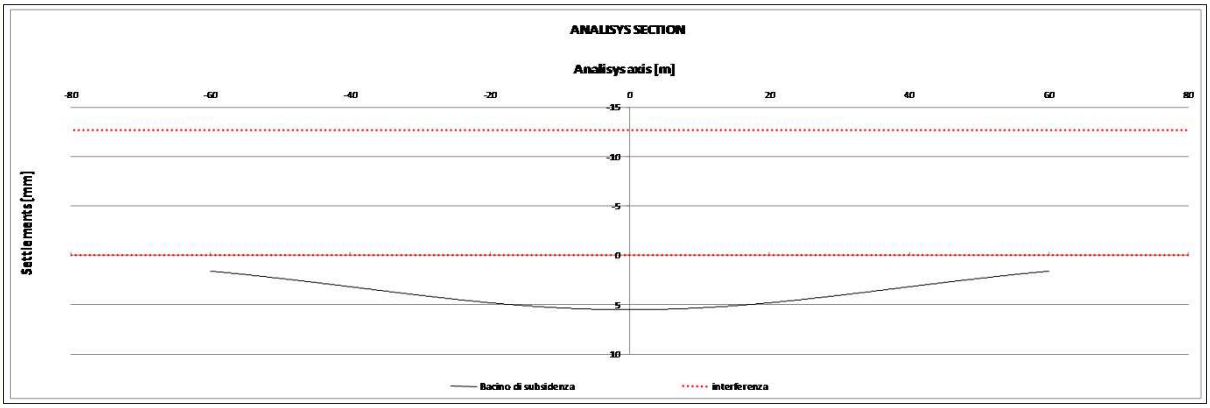
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	8.74E-05	1/11438
Maximum Angular Distortion	β	8.77E-05	1/11408

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.003%
Total strain	ε_{max}	0.003%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

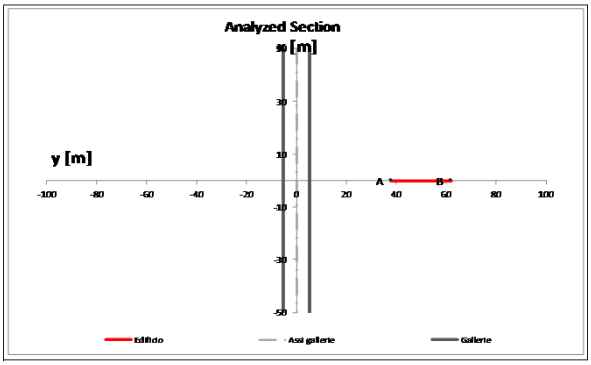
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	77

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	24.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	38.5	38.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	38
B	0	62

Settlements	
Point	w [mm]
A	2.83
B	0.50

Direction analysys	A	B

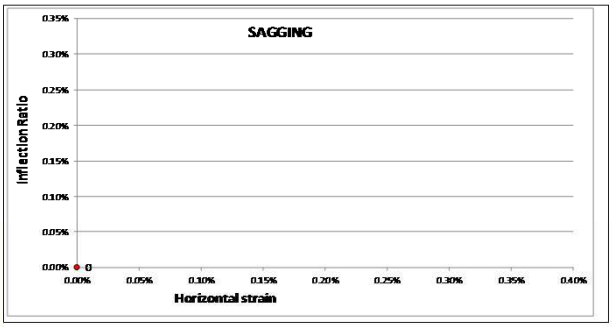
DAMAGE CLASS EVALUATION

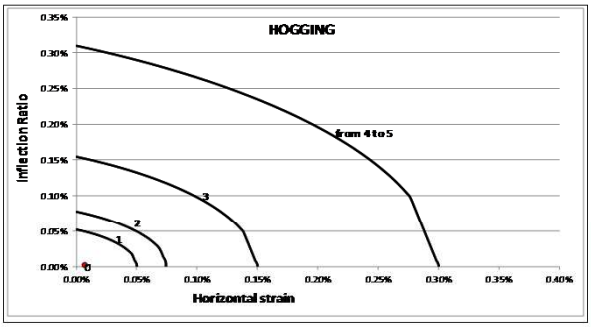
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.04
Max. Settlement of the building [mm]	$w_{building}$	2.83

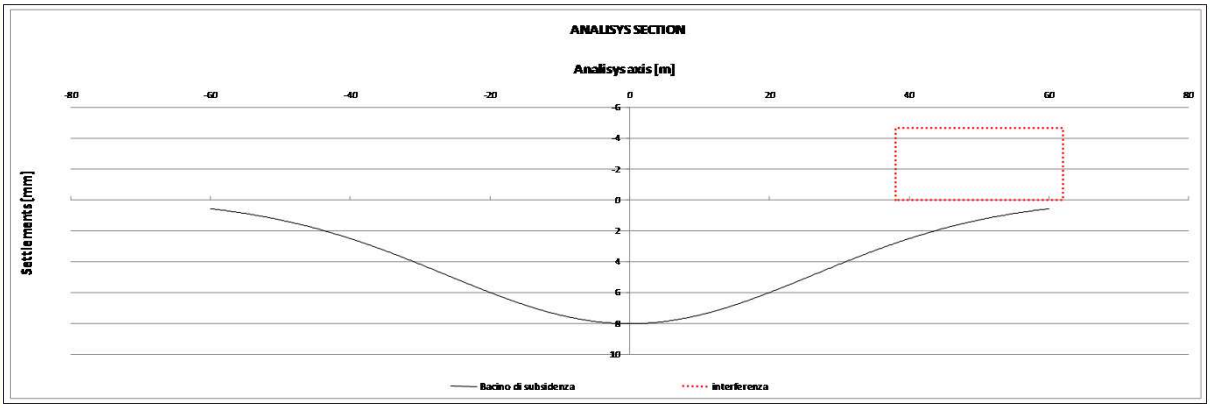
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.55E-04	1/6436
Maximum Angular Distortion	β	5.83E-05	1/17139

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.007%
Total strain	ε_{max}	0.008%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

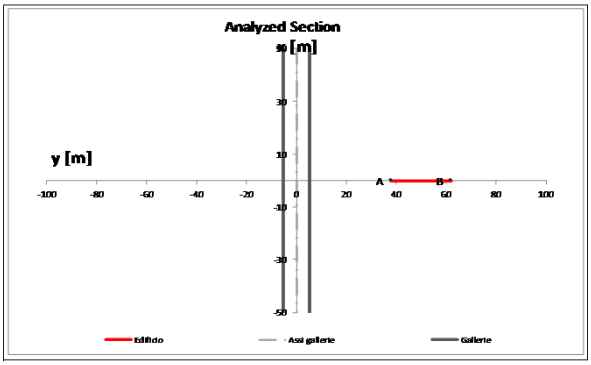
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	77_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	8.5	[m]
Max. Depth of foundation	z_f	7.0	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	24.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	33	33
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	38
B	0	62

Settlements	
Point	w [mm]
A	2.34
B	0.24

Direction analysys	A	B

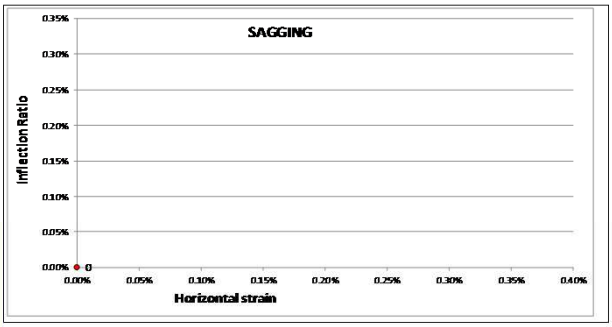
DAMAGE CLASS EVALUATION

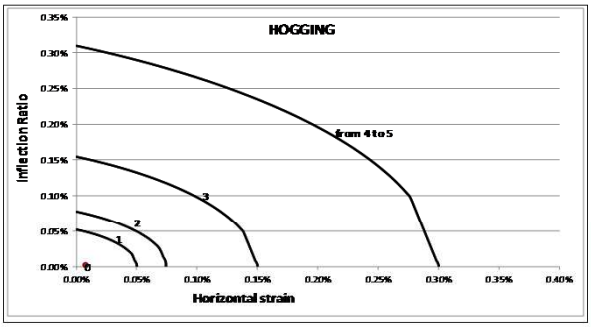
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	9.19
Max. Settlement of the building [mm]	$w_{building}$	2.34

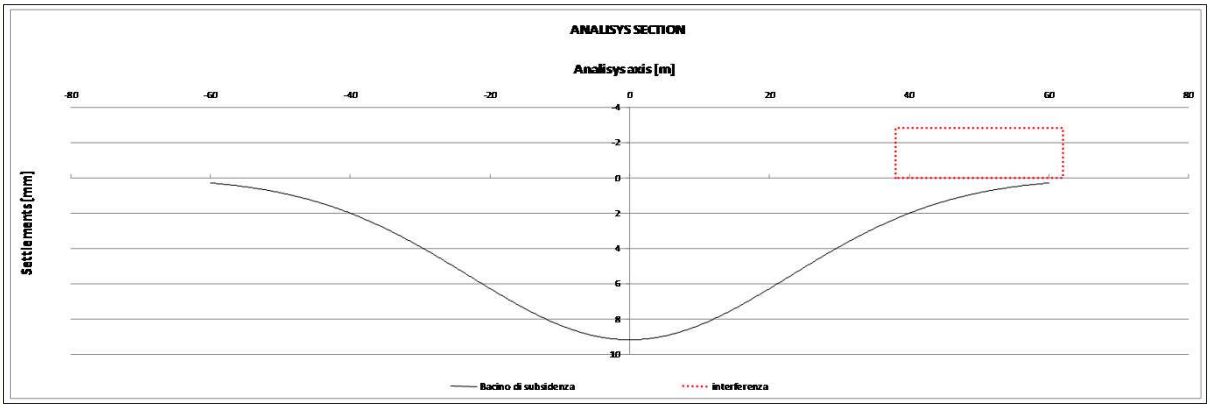
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.68E-04	1/5940
Maximum Angular Distortion	β	8.08E-05	1/12372

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.008%
Total strain	ε_{max}	0.008%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

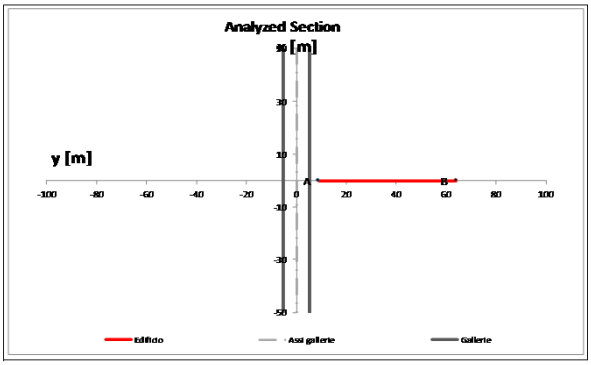
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	78

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	28.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	29.5	[m]
Length in the analyzed directio	L	55.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	9
B	0	64

Settlements	
Point	w [mm]
A	6.29
B	0.92

Direction analysys	A	B

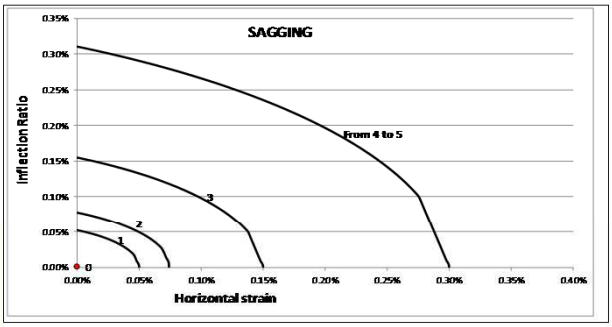
DAMAGE CLASS EVALUATION

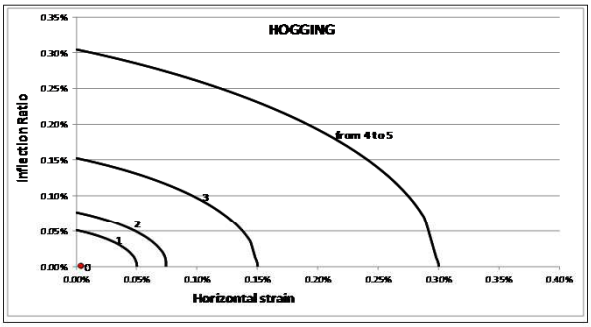
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.29

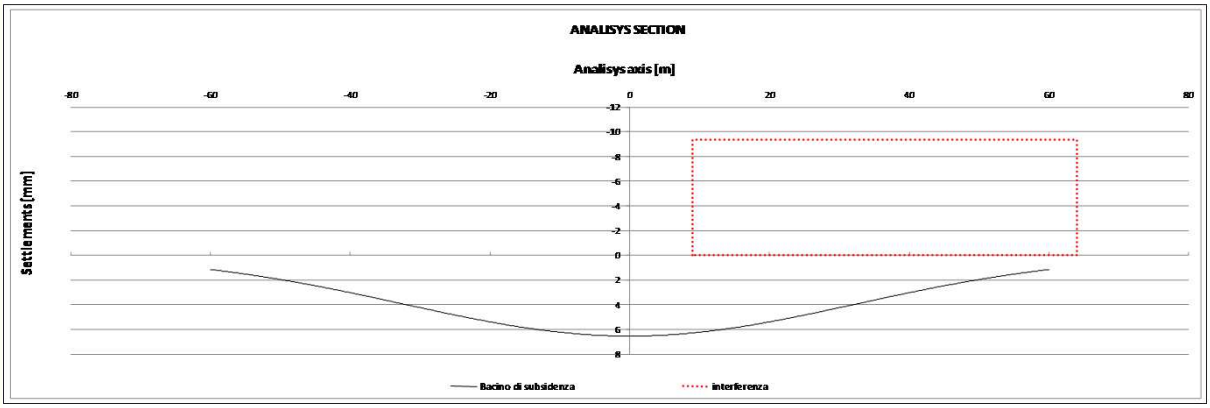
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8133
Maximum Angular Distortion	β	4.31E-05	1/23200

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

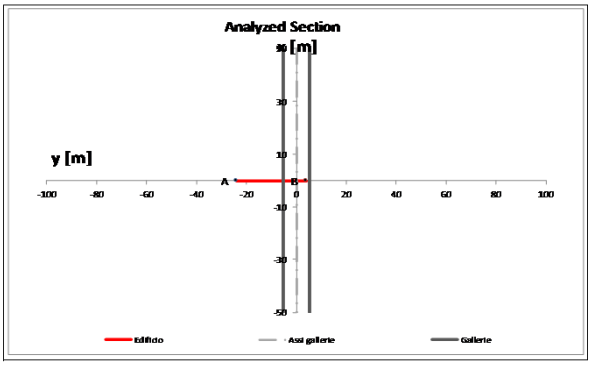
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	79

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	28.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-24
B	0	4

Settlements	
Point	w [mm]
A	4.96
B	6.49

Direction analysys	A	B

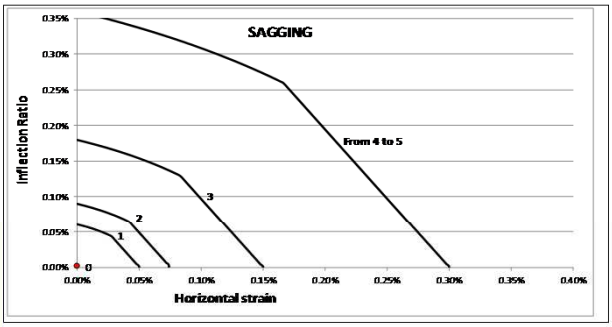
DAMAGE CLASS EVALUATION

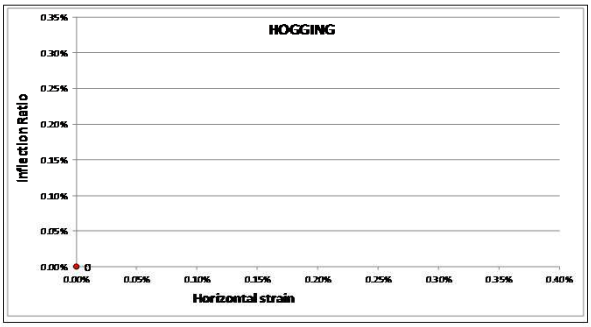
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.54

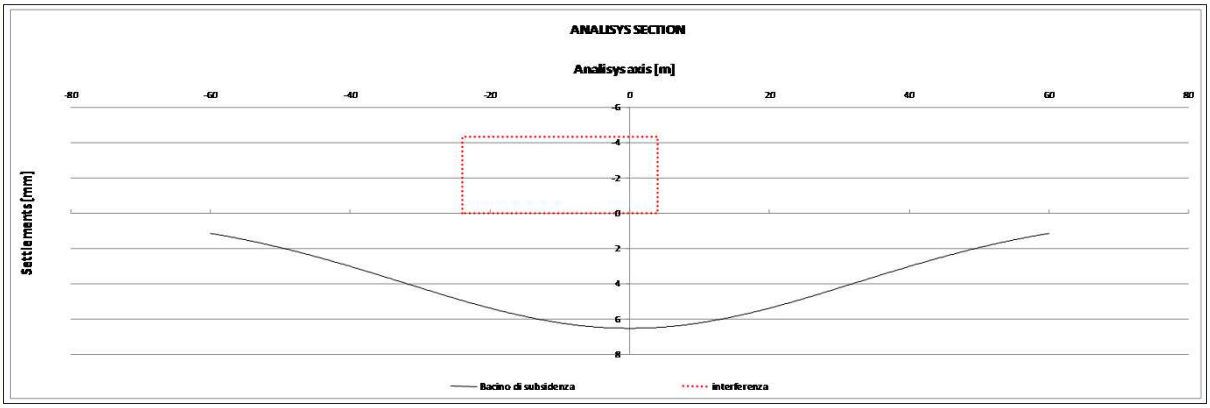
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.14E-04	1/8752
Maximum Angular Distortion	β	7.94E-05	1/12594

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

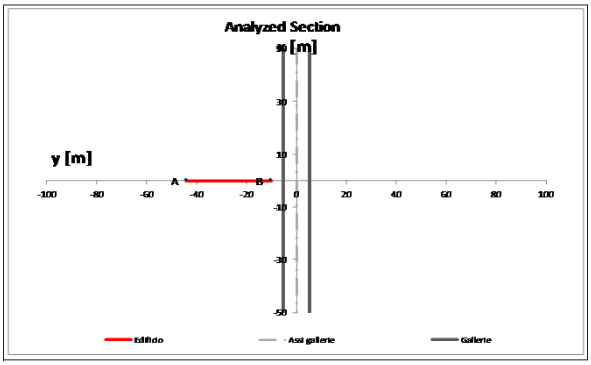
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	80

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	10.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	11.5	[m]
Length in the analyzed directio	L	34.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	48.5	48.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-44
B	0	-10

Settlements	
Point	w [mm]
A	2.58
B	6.24

Direction analysys	A	B

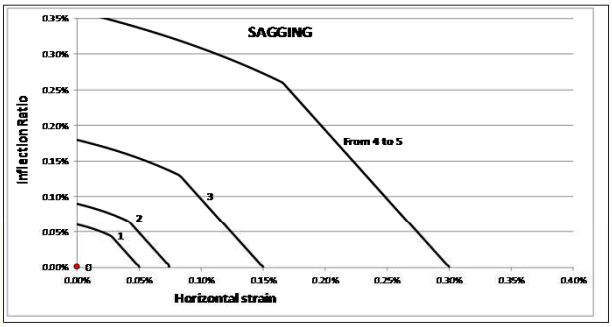
DAMAGE CLASS EVALUATION

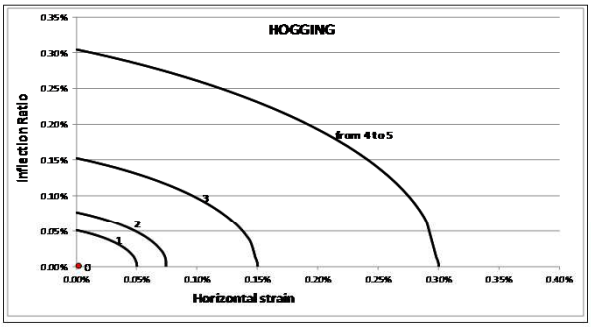
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.54
Max. Settlement of the building [mm]	$w_{building}$	6.24

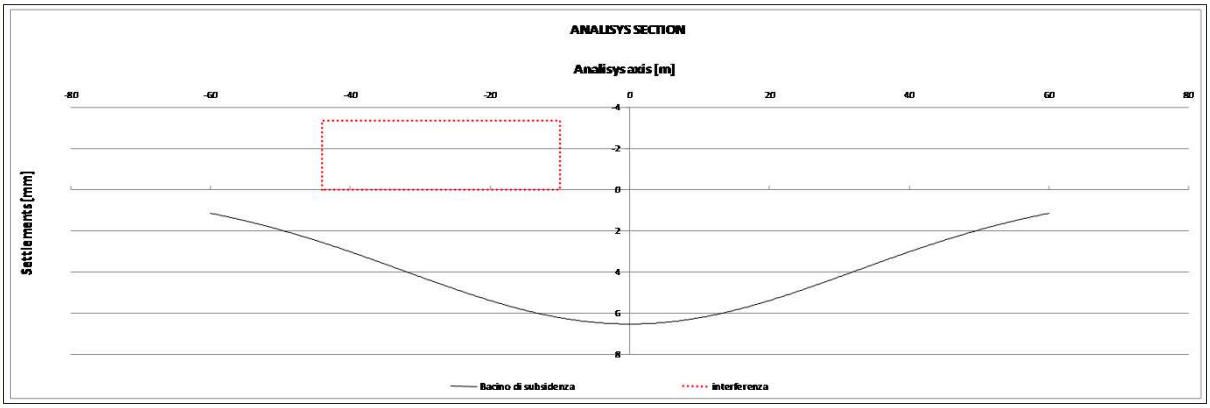
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.23E-04	1/8133
Maximum Angular Distortion	β	4.74E-05	1/21101

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.002%
Total strain	ε_{max}	0.002%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

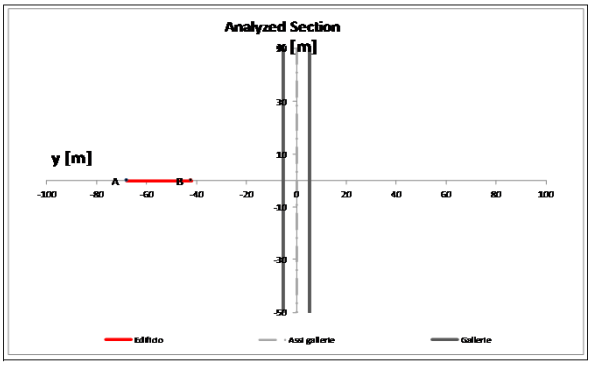
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	81

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	22.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	23.5	[m]
Length in the analyzed directio	L	26.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	38.5	38.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-68
B	0	-42

Settlements	
Point	w [mm]
A	0.28
B	2.24

Direction analysys	A	B

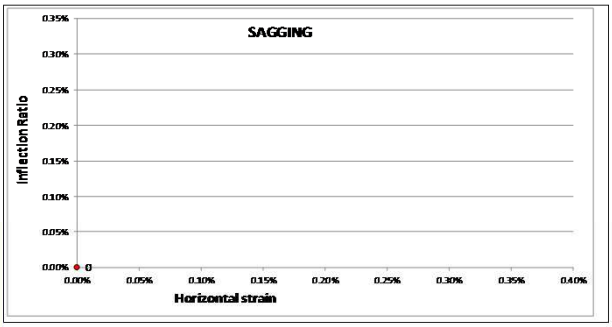
DAMAGE CLASS EVALUATION

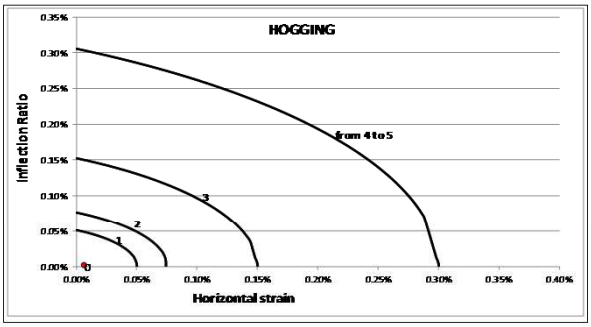
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	8.04
Max. Settlement of the building [mm]	$w_{building}$	2.24

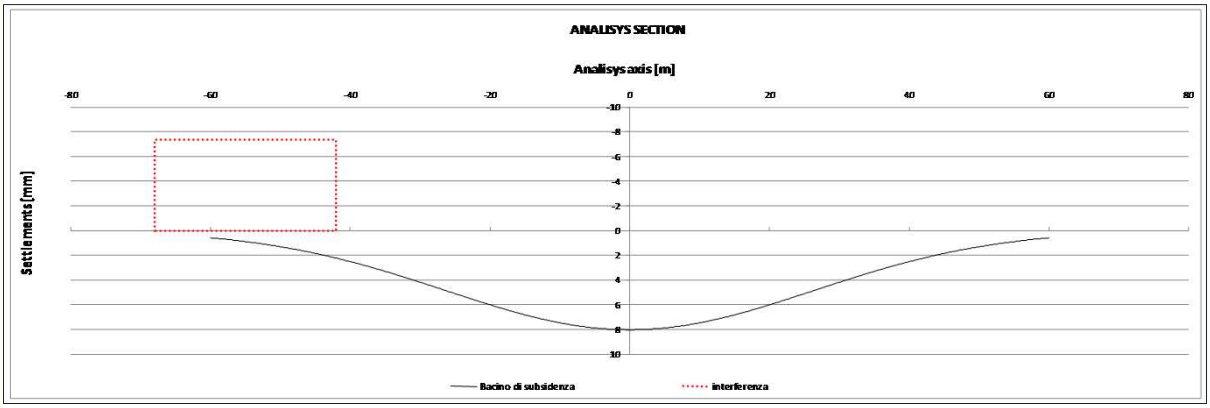
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.36E-04	1/7344
Maximum Angular Distortion	β	6.08E-05	1/16437

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.007%
Total strain	ε_{max}	0.007%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

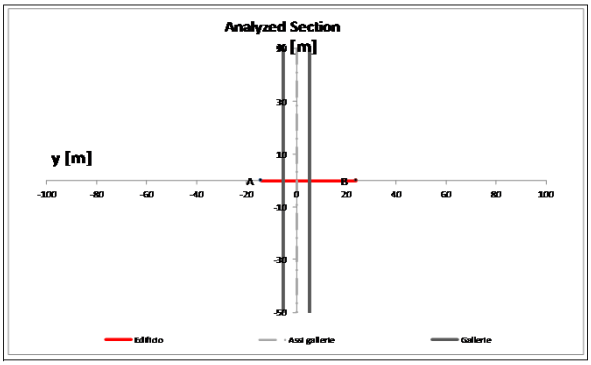
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	82

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	38.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	39.5	39.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-14
B	0	24

Settlements	
Point	w [mm]
A	6.86
B	5.28

Direction analysys	A	B

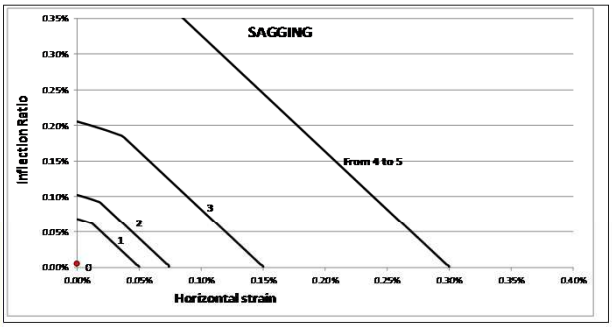
DAMAGE CLASS EVALUATION

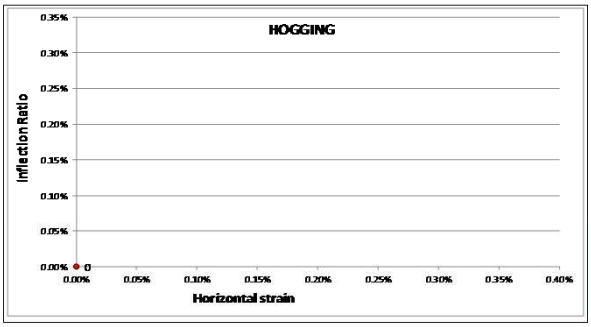
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.86
Max. Settlement of the building [mm]	$w_{building}$	7.86

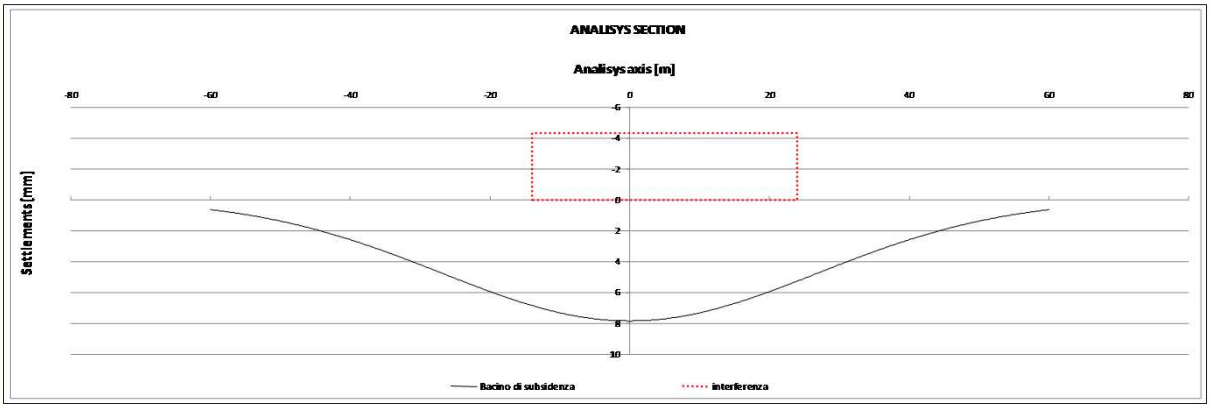
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.75E-04	1/5709
Maximum Angular Distortion	β	1.74E-04	1/5733

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.004%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.003%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

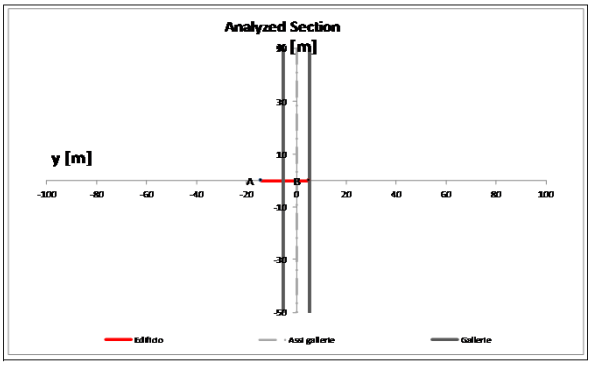
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	82_1-2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	19.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	39.5	39.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-14
B	0	5

Settlements	
Point	w [mm]
A	6.86
B	7.72

Direction analysys	A	B

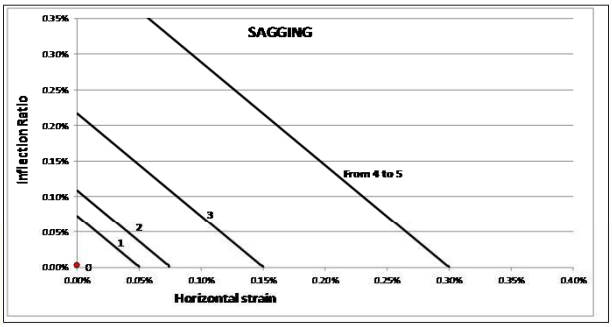
DAMAGE CLASS EVALUATION

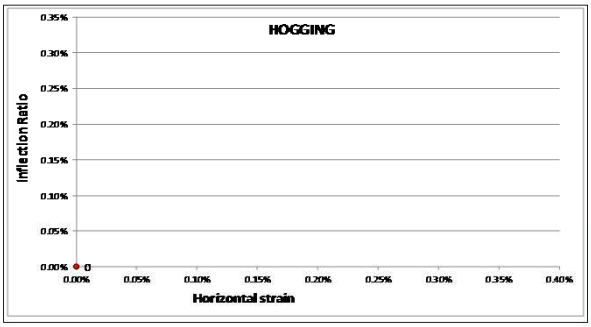
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.86
Max. Settlement of the building [mm]	$w_{building}$	7.86

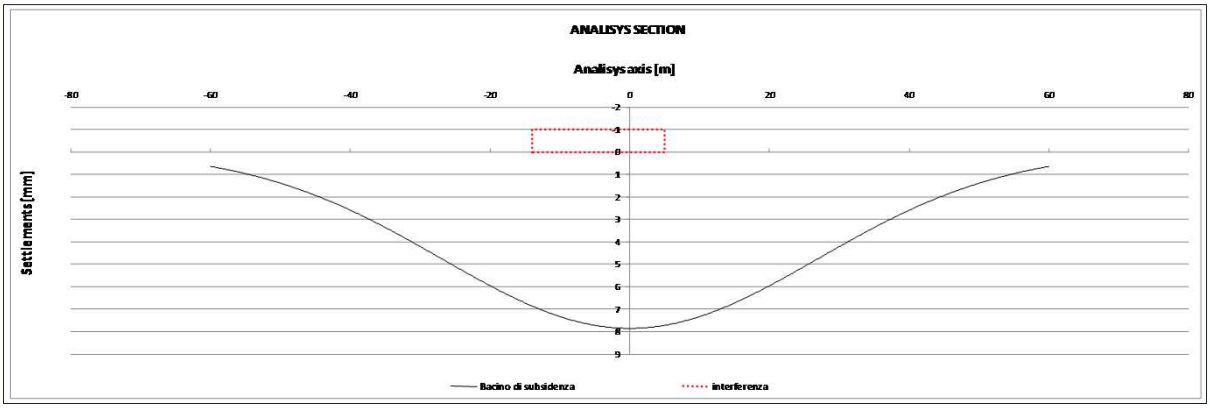
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.33E-04	1/7529
Maximum Angular Distortion	β	9.86E-05	1/10140

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

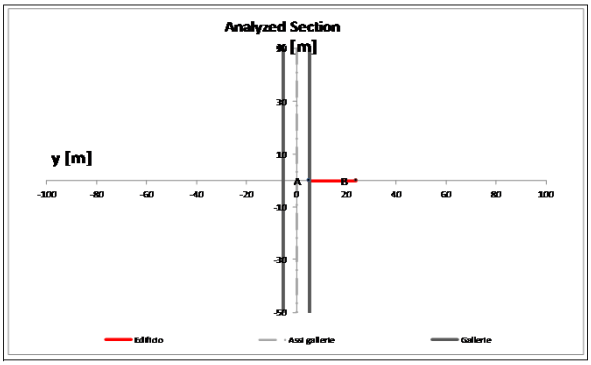
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	82_2-2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	19.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	39.5	39.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	5
B	0	24

Settlements	
Point	w [mm]
A	7.72
B	5.28

Direction analysys	A	B

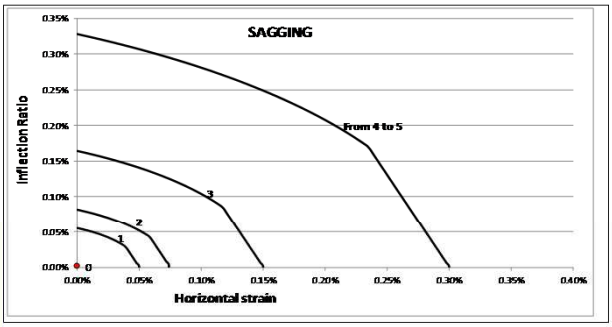
DAMAGE CLASS EVALUATION

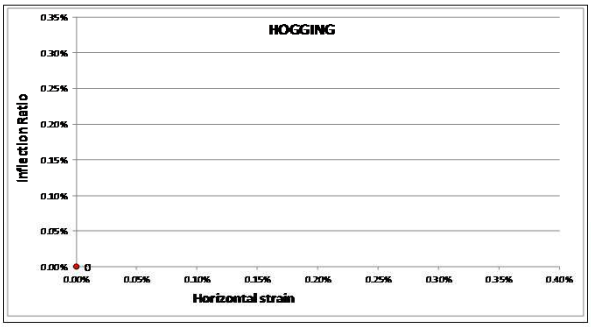
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	7.86
Max. Settlement of the building [mm]	$w_{building}$	7.72

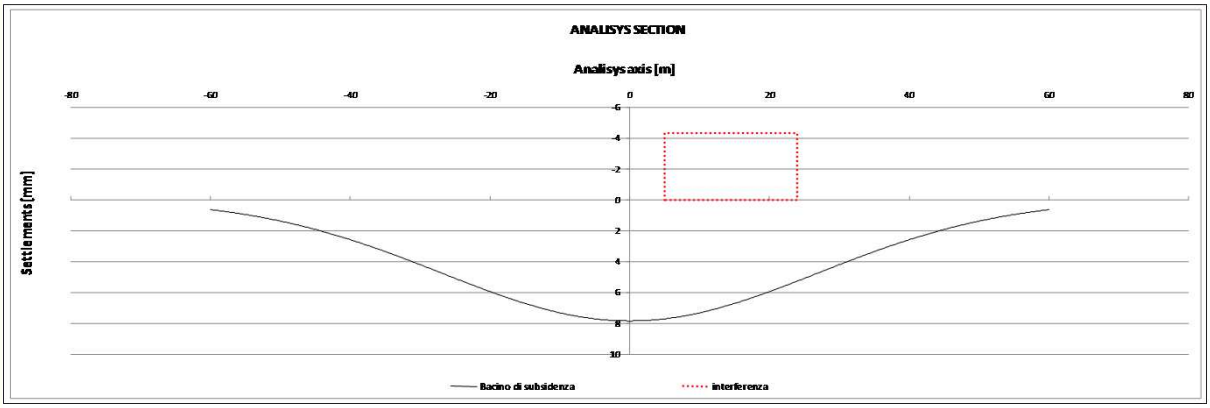
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.75E-04	1/5708
Maximum Angular Distortion	β	7.52E-05	1/13293

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

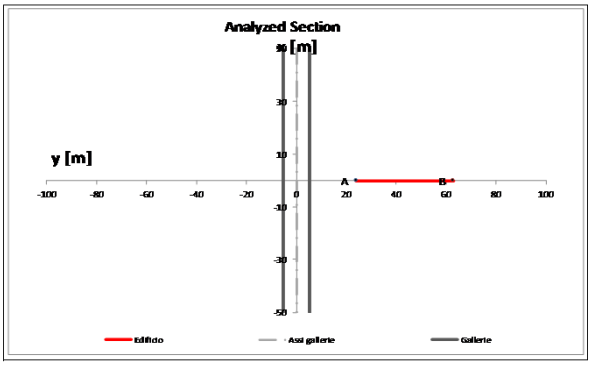
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	83

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	13.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	14.5	[m]
Length in the analyzed directio	L	39.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	46.5	46.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	24
B	0	63

Settlements	
Point	w [mm]
A	5.04
B	0.87

Direction analysys	A	B

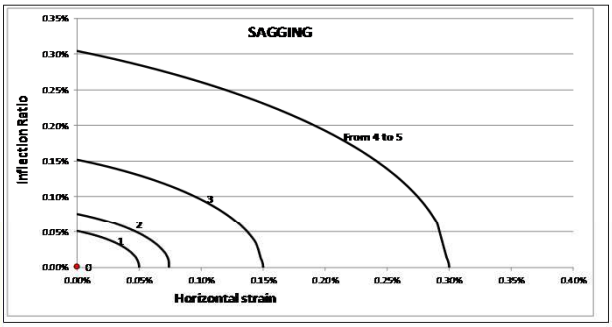
DAMAGE CLASS EVALUATION

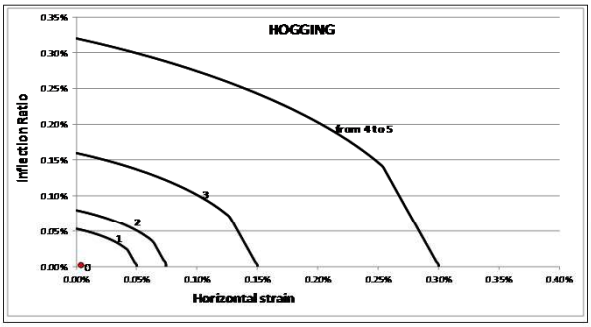
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.80
Max. Settlement of the building [mm]	$w_{building}$	5.04

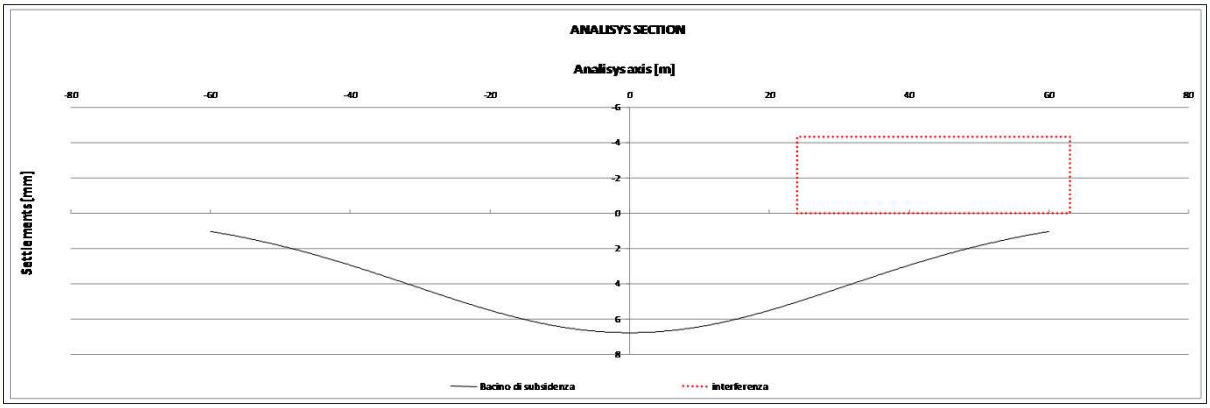
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.33E-04	1/7540
Maximum Angular Distortion	β	5.01E-05	1/19967

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.005%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

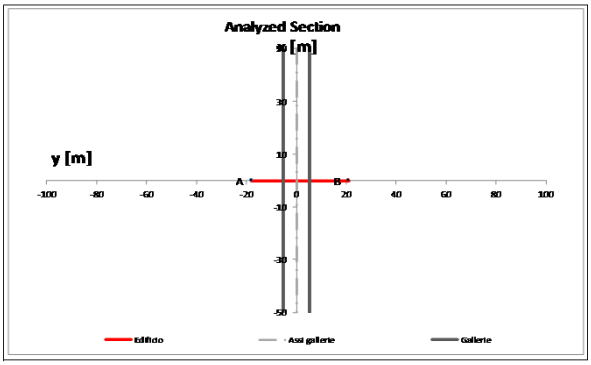
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	84

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	39.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	46.5	46.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-18
B	0	21

Settlements	
Point	w [mm]
A	5.75
B	5.41

Direction analysys	A	B

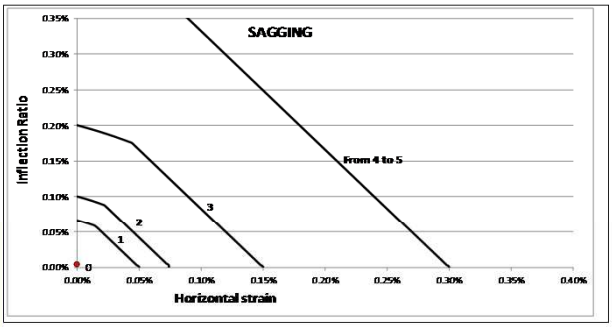
DAMAGE CLASS EVALUATION

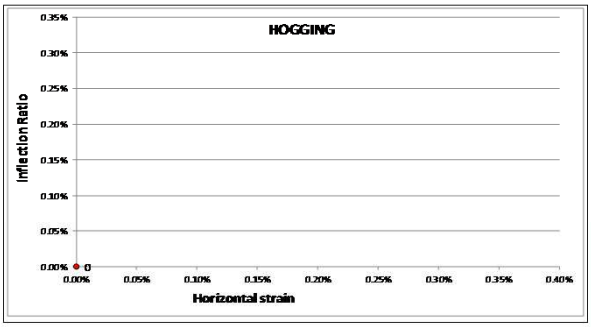
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.80
Max. Settlement of the building [mm]	$w_{building}$	6.80

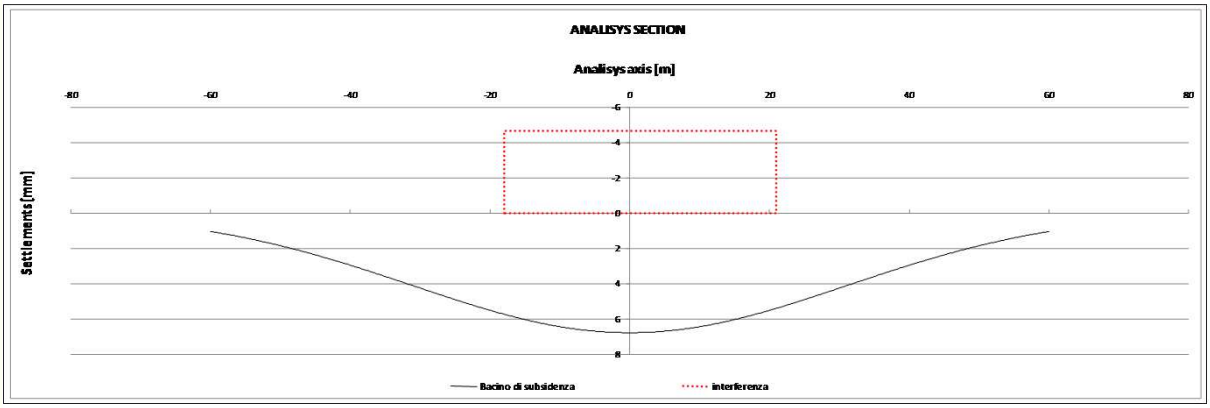
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.17E-04	1/8512
Maximum Angular Distortion	β	1.16E-04	1/8651

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.003%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

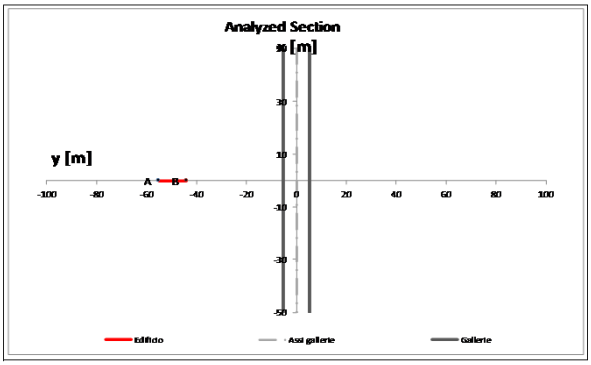
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	85

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	14.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	15.5	[m]
Length in the analyzed directio	L	11.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	52.5	52.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-55
B	0	-44

Settlements	
Point	w [mm]
A	1.73
B	2.72

Direction analysys	A	B

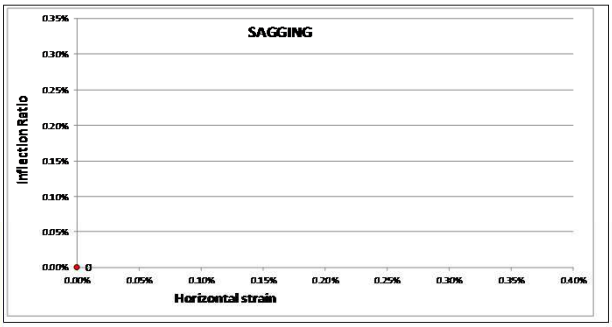
DAMAGE CLASS EVALUATION

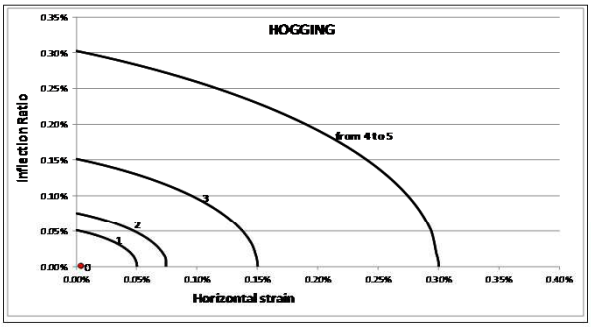
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.09
Max. Settlement of the building [mm]	$w_{building}$	2.72

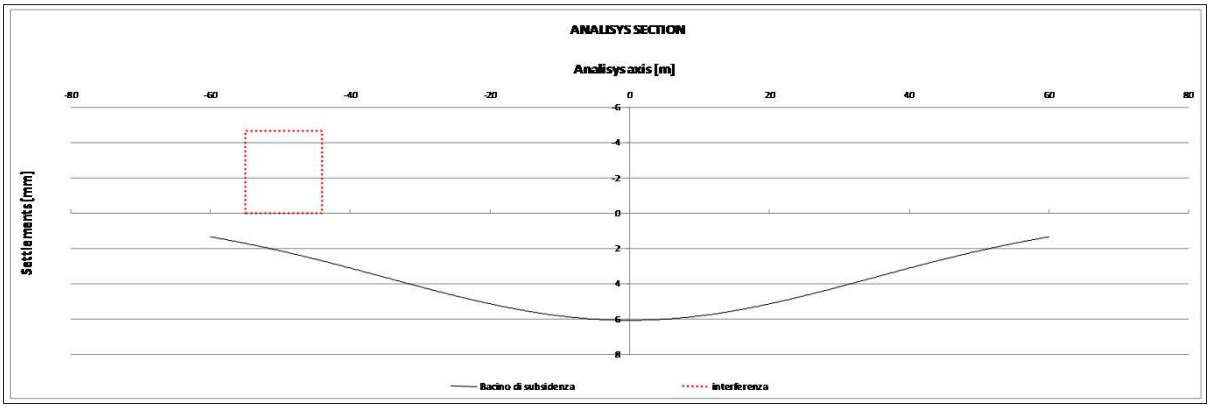
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	9.96E-05	1/10038
Maximum Angular Distortion	β	1.09E-05	1/91501

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.004%
Total strain	ε_{max}	0.004%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

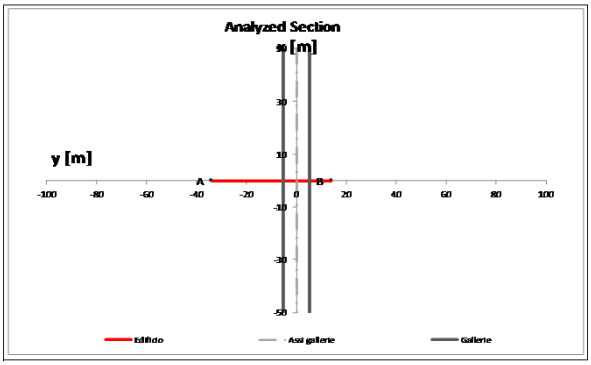
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	86

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	48.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	52.5	52.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-34
B	0	14

Settlements	
Point	w [mm]
A	3.77
B	5.61

Direction analysys	A	B

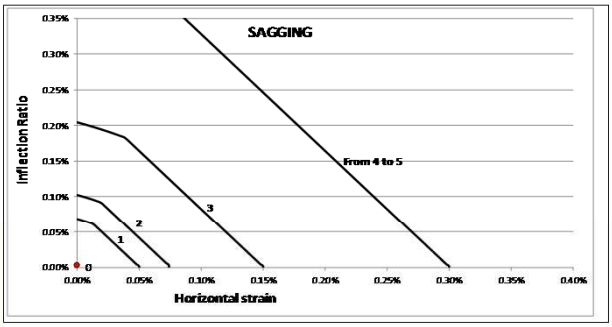
DAMAGE CLASS EVALUATION

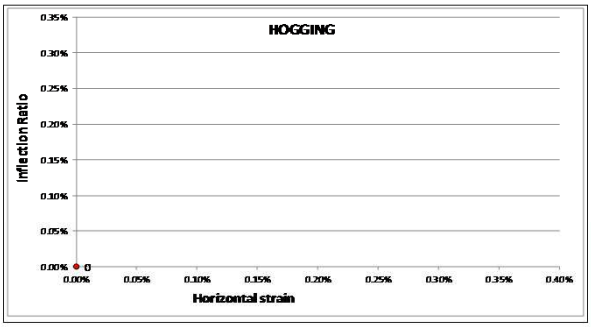
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.09
Max. Settlement of the building [mm]	$w_{building}$	6.09

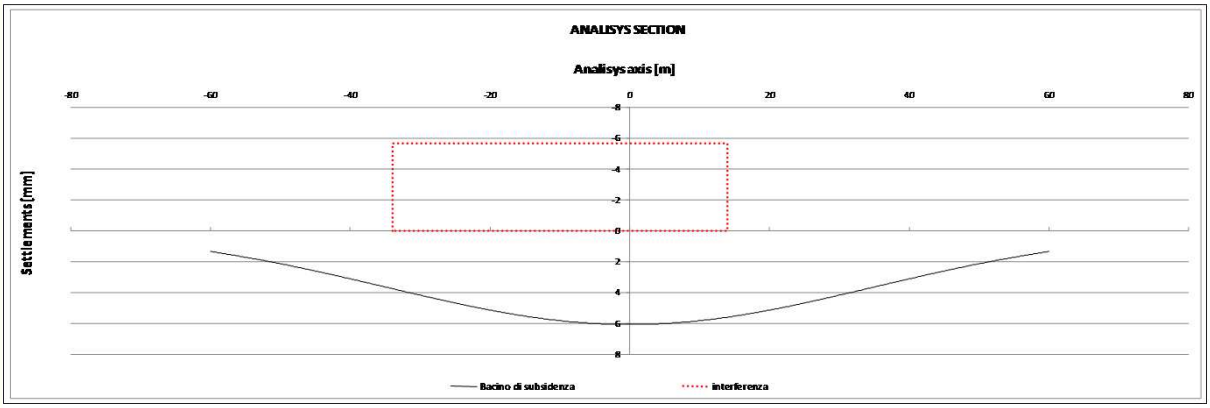
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.06E-04	1/9392
Maximum Angular Distortion	β	1.04E-04	1/9647

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.002%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.002%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

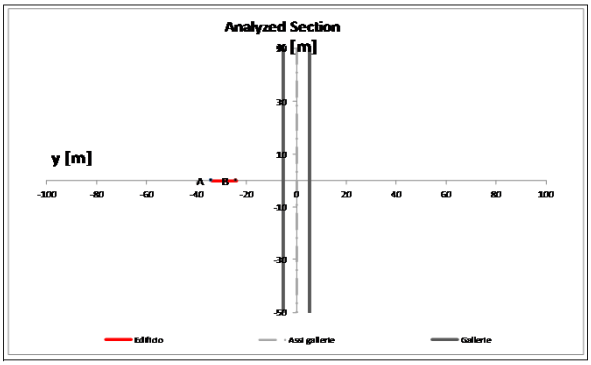
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	86_1-3

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	3.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	4.5	[m]
Length in the analyzed directio	L	10.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	52.5	52.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-34
B	0	-24

Settlements	
Point	w [mm]
A	3.77
B	4.79

Direction analysys	A	B

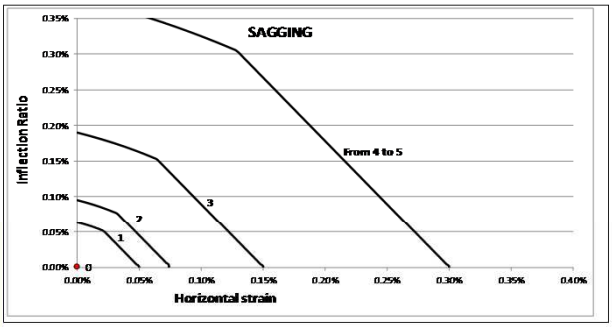
DAMAGE CLASS EVALUATION

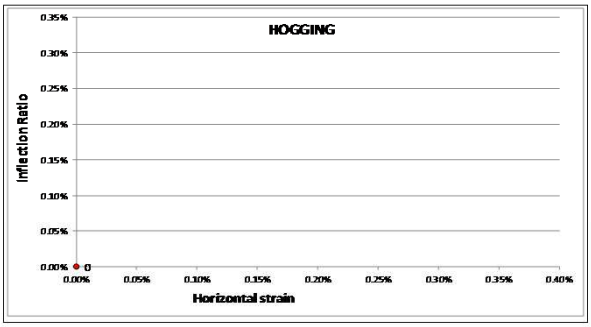
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.09
Max. Settlement of the building [mm]	$w_{building}$	4.79

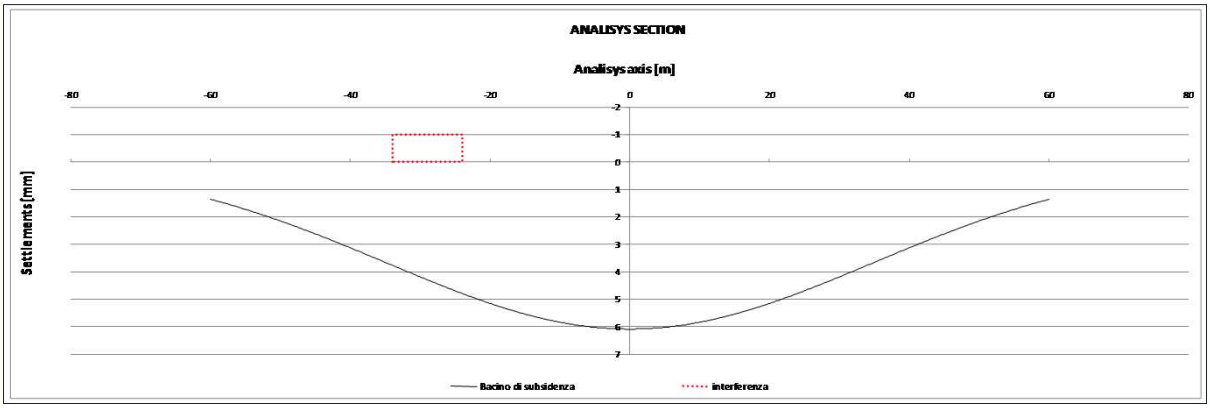
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.06E-04	1/9391
Maximum Angular Distortion	β	7.03E-06	1/142276

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

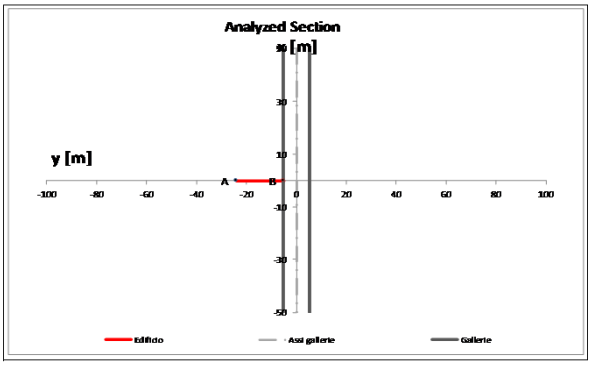
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	86_2-3

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	18.5	[m]
Length in the analyzed directio	L	19.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	52.5	52.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-24
B	0	-5

Settlements	
Point	w [mm]
A	4.79
B	6.03

Direction analysys	A	B

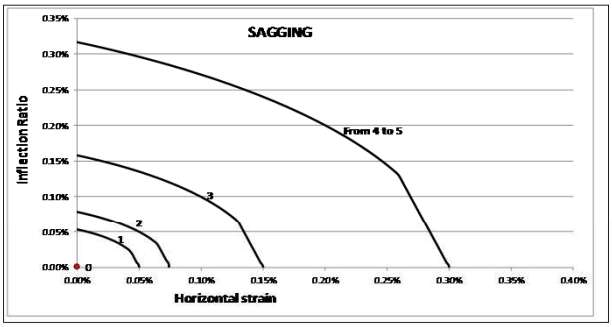
DAMAGE CLASS EVALUATION

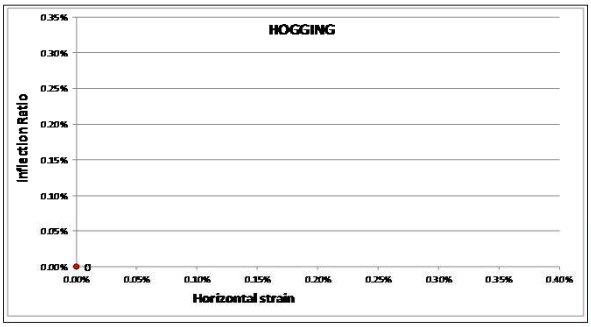
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.09
Max. Settlement of the building [mm]	$w_{building}$	6.03

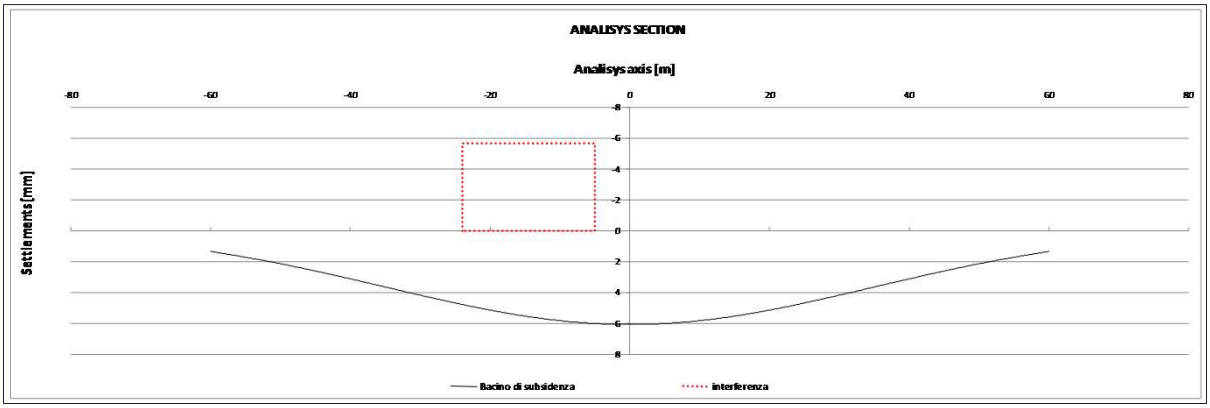
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	9.56E-05	1/10458
Maximum Angular Distortion	β	3.98E-05	1/25127

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A. CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

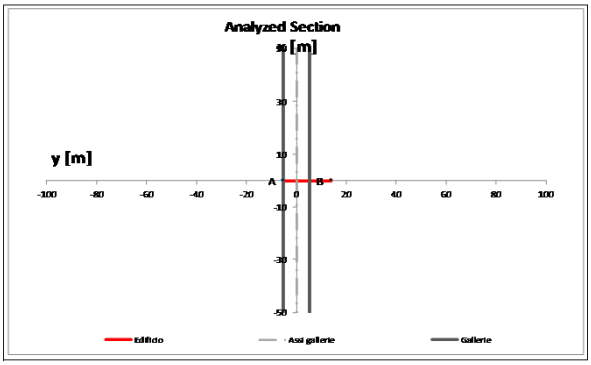
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	86_3-3

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	9.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	10.5	[m]
Length in the analyzed directio	L	19.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	52.5	52.5
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-5
B	0	14

Settlements	
Point	w [mm]
A	6.03
B	5.61

Direction analysys	A	B

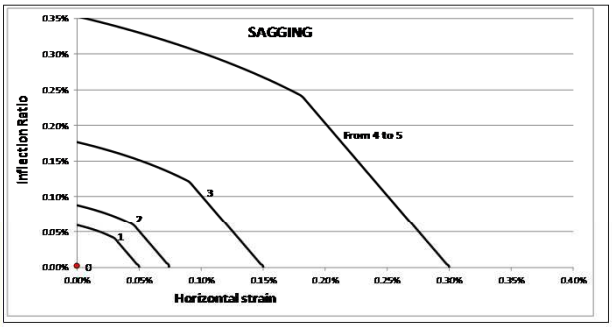
DAMAGE CLASS EVALUATION

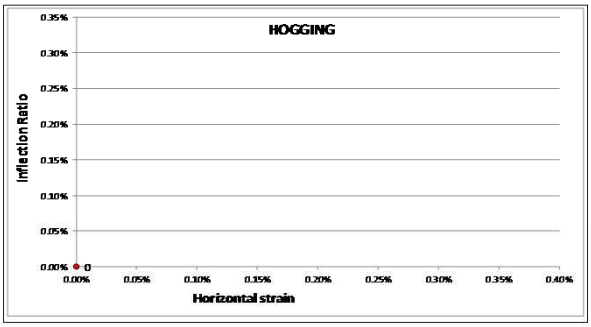
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	6.09
Max. Settlement of the building [mm]	$w_{building}$	6.09

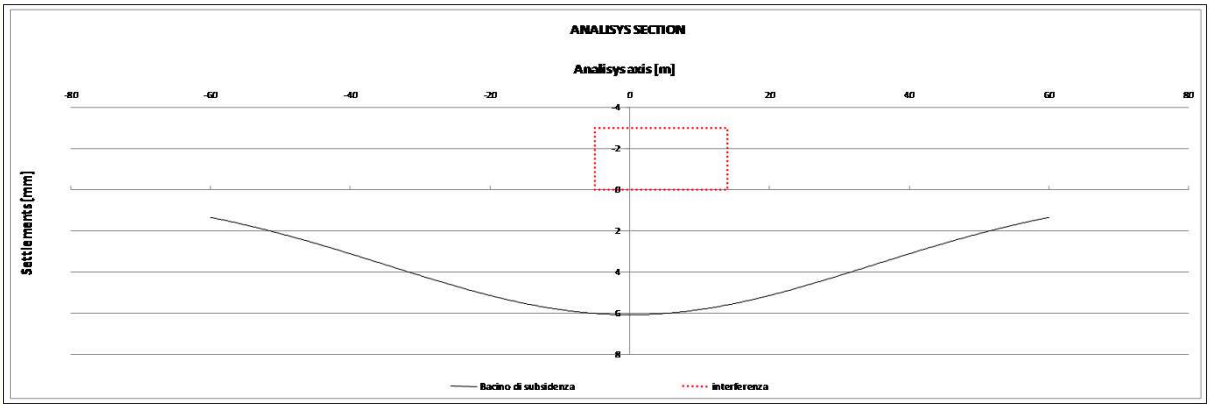
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.53E-05	1/15319
Maximum Angular Distortion	β	4.67E-05	1/21396

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	0.001%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.001%
Damage Class	0	

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

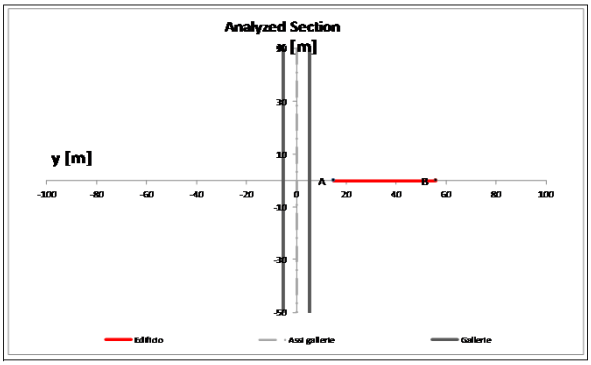
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	87

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	17.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	21.5	[m]
Length in the analyzed directio	L	41.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	18.9	18.9
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	15
B	0	56

Settlements	
Point	w [mm]
A	8.53
B	0.01

Direction analysys	A	B

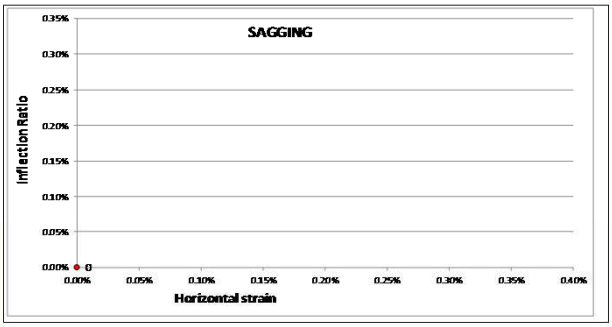
DAMAGE CLASS EVALUATION

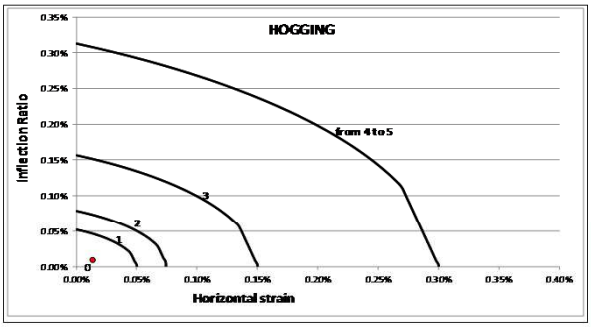
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	14.55
Max. Settlement of the building [mm]	$w_{building}$	8.53

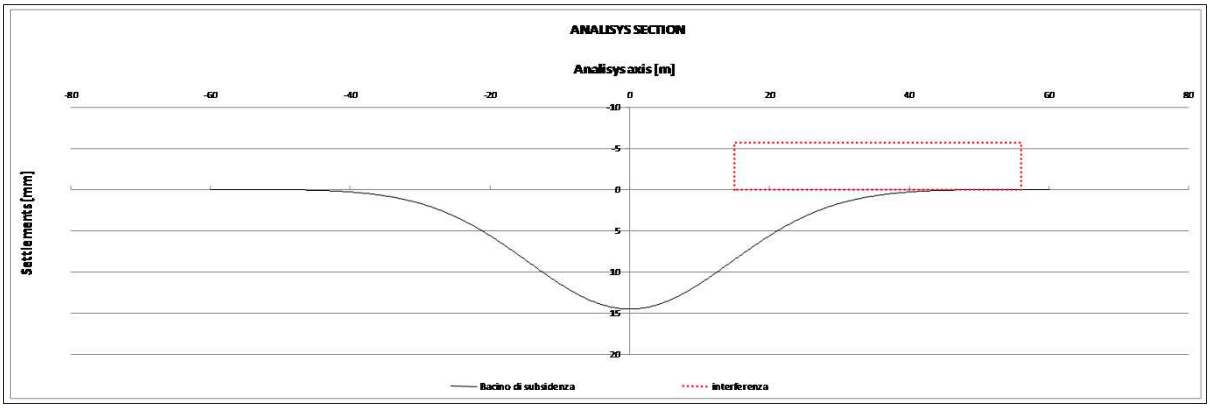
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	6.07E-04	1/1648
Maximum Angular Distortion	β	3.99E-04	1/2506

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.009%
Horizontal strain	ε_h	0.014%
Total strain	ε_{max}	0.017%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

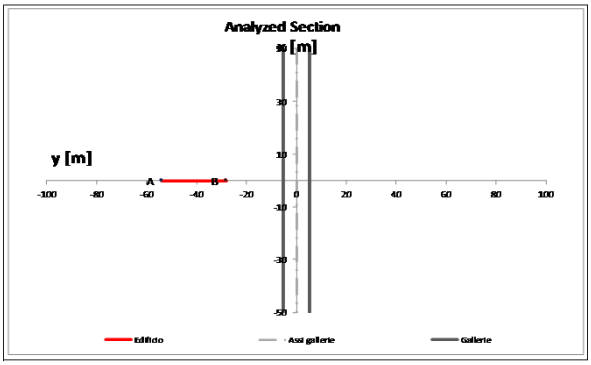
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	88

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	15.0	[m]
Max. Depth of foundation	z_f	1.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	26.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	5.2	5.2
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-54
B	0	-28

Settlements	
Point	w [mm]
A	0.00
B	0.00

Direction analysys	A	B

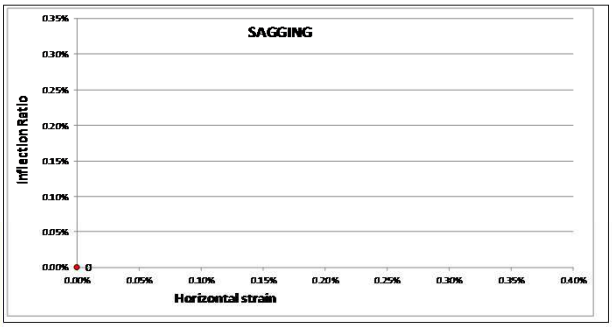
DAMAGE CLASS EVALUATION

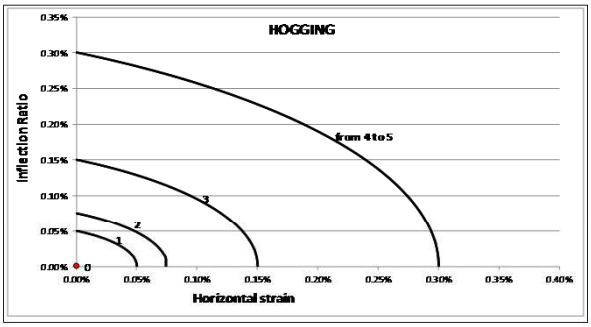
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	33.53
Max. Settlement of the building [mm]	$w_{building}$	0.00

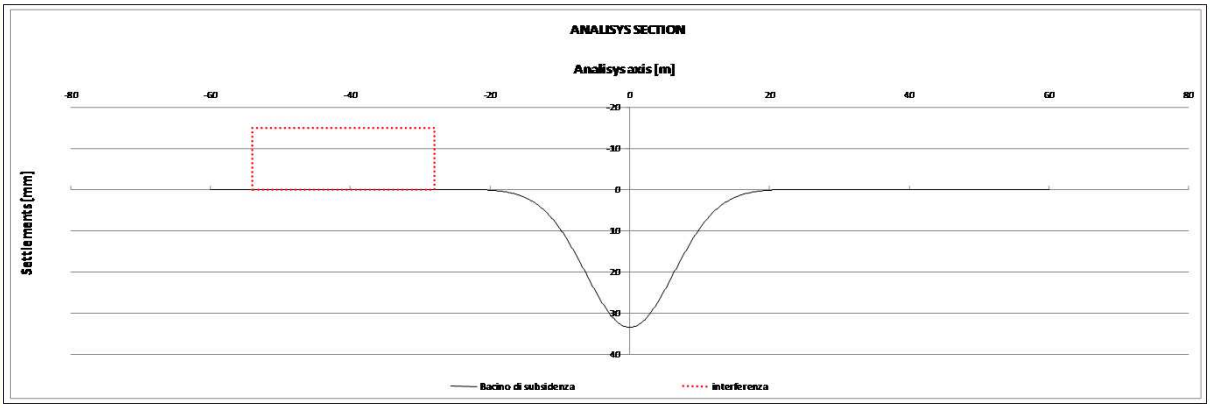
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	1.19E-06	1/837481
Maximum Angular Distortion	β	1.13E-06	1/886668

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0

ROCKSOIL S.p.A.
CONSULENZA E ASSISTENZA TECNICA nel campo della GEOINGEGNERIA

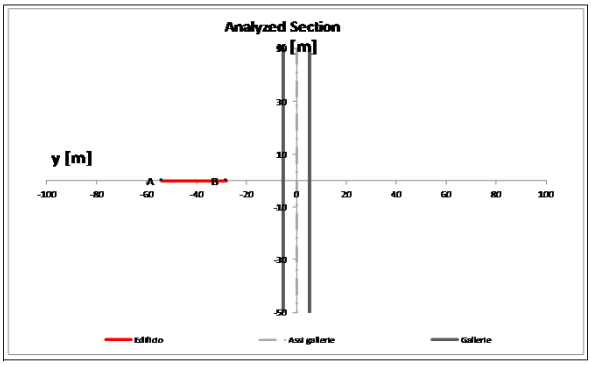
PROJECT: GALLERIA SCOLMATORE BISAGNO

Segment:

Building N°	88_hip2

Building Features			
Function	civile		
Construction year	-		
Number of stories	-		
Basements	-		
Structural type	C.A.		
Foundation Type	-		
Conservation state	-		
Height from ground	h	12.0	[m]
Max. Depth of foundation	z_f	4.5	[m]
Total Height	H	16.5	[m]
Length in the analyzed directio	L	26.0	[m]

Tunnel Features		Left Tunnel	Right tunnel
F [m]	D	10.6	10.6
Overbunden [m]	C	2.2	2.2
Longitudinal position [m]	Tunnel Face Position	1000	1000
V_L (Volume loss)	V_p	0.3%	0.3%
K parameter	k	0.6	0.6



Building coordinates - Cartesian axes		
Point	X [m]	Y [m]
A	0	-54
B	0	-28

Settlements	
Point	w [mm]
A	0.00
B	0.00

Direction analysys	A	B

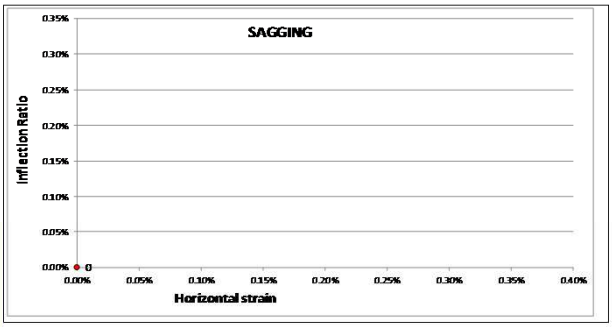
DAMAGE CLASS EVALUATION

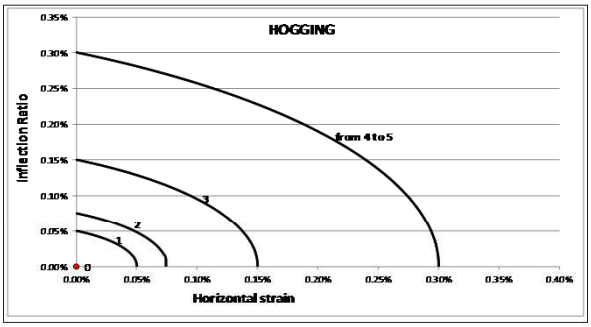
RESULTS - Settlements		
Max. Settlement at ground level [mm]	w_{ground}	46.93
Max. Settlement of the building [mm]	$w_{building}$	0.00

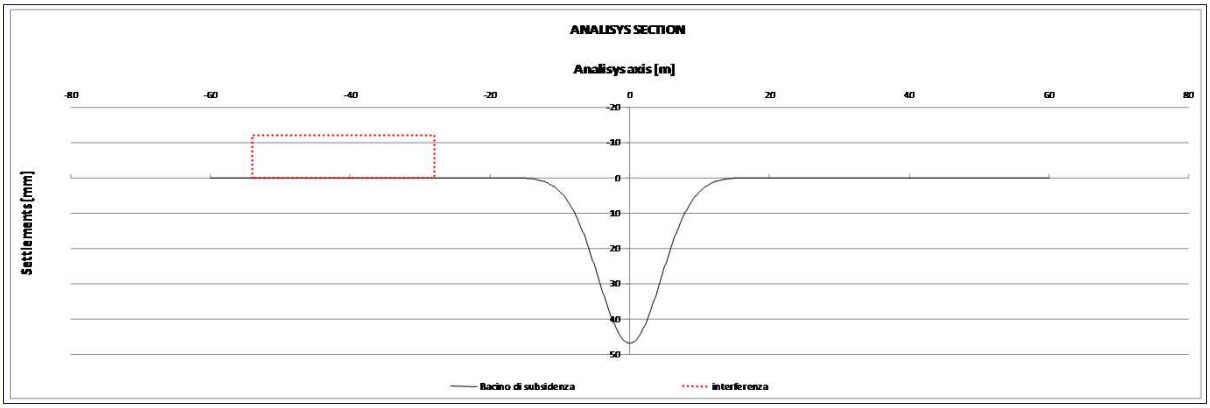
RESULTS - Rotation and angular distortion			
Maximum Rotation	θ	2.46E-10	/4073153077
Maximum Angular Distortion	β	2.38E-10	/4193947672

SAGGING's zone (compression zone)		
Inflection Ratio	Δ/L	
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	
Damage Class		

HOGGING's zone (tension zone)		
Inflection Ratio	Δ/L	0.000%
Horizontal strain	ε_h	0.000%
Total strain	ε_{max}	0.000%
Damage Class	0	







Damage Class (BOSCARDIN & CORDING, 1989)	0