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Provincia di Savona

COMUNE DI QUILIANO - COMUNE DI SAVONA



VALORIZZAZIONE DELLE FONTI ALTERNATIVE
PER SCOPI ENERGETICI

IMPIANTO PER LA PRODUZIONE DI ENERGIA ELETTRICA

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Technical specification

Access roads and construction site areas

ENERCON Wind energy converter
E-138 EP3 E2

81 m tubular steel tower

ENERCON
ENERGY FOR THE WORLD

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Further applicable documents

The titles of the documents listed are the titles of the original language versions, with translations of these titles in brackets where applicable. The titles of superordinate standards and guidelines are indicated in the original language or as an English translation. Document IDs always refer to the original language versions. If the document ID does not contain a revision, the most recent revision of the document applies. This list contains documents concerning optional components if necessary.

Document ID	Document
D02144945	Technische Mitteilung Fußgängerzugang zu WEAs (Technical Infomation Pedestrian access to WECs)
PLM-PM-DEP004	Baustellenordnung für den Bau von ENERCON Windenergieanlagen und Windparks (Construction site regulations for the construction of ENERCON wind energy converters and wind farms)

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List of abbreviations

Abbreviations

CM	Construction Manager
GPM	General Project Manager
WEC	Wind energy converter

Variables, units, formulas

$\mathbf{D_{Pr}}$	Degree of compaction after Proctor compaction test
$\mathbf{E_{V1}}$	Calculated deformation modulus of the first load cycle of a static plate load test
$\mathbf{E_{V2}}$	Calculated deformation modulus of the second load cycle of a static plate load test

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1 Introduction

Meticulous planning and design of construction site infrastructure is the basis for cost-effective construction work. Transport routes and construction site areas in the wind farm must ensure safe and cost-effective construction site traffic. Trouble-free function must be ensured throughout the entire period of use.

This specification applies to the transport and installation using a standard large crane of a WEC with the tower designation:

- E-138 EP3 E2-ST-81-FB-C-01
- E-138 EP3 E2-ST-81-FB-C-02

This specification describes the requirements for access roads and construction site areas for the wind farm infrastructure. In addition to this information, the following documents must also be included in the planning.

- Foundation data sheet for the applicable foundation version of the tower type
- Technical description of the tower type
- Data sheets on weights and dimensions of tower type, nacelle and rotor blades
- PLM-PM-ABT004 ‘Baustellenordnung für den Bau von ENERCON Windenergieanlagen und Windparks’ (Construction site regulations for the construction of ENERCON wind energy converters and wind farms)
- D02144945 ‘Technische Mitteilung Fußgängerzugang zu WEAs’ (Technical Infomation Pedestrian access to WECs)

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2 Installation of the wind energy converter

A WEC is installed in several stages. These stages are foundation construction; deep foundation, if necessary; installation and assembly of the tower and the nacelle. To enable cost-effective completion of the WEC in a short period of time, project-specific installation concepts are developed according to the size of the wind farm. As such, the work steps described in the following subsections can be performed in parallel in the wind farm.

2.1 Delivery of tower segments and WEC components

The tubular steel tower segments are delivered, depending on the installation concept, to the relevant construction site area or logistics area (see ch. 4.2, p. 10). The other WEC components for installing the WEC are transported directly to the designated hardstands (e.g. assembly area).

The tower system parts are delivered in advance. Storage at the site must be implemented according to a defined storage plan. The necessary construction site areas or logistics areas must be dimensioned and set up precisely in accordance with this specification.

2.2 Tower installation

The tubular steel tower sections are delivered to the designated construction site area and preassembled if necessary. The tubular steel tower sections are then lifted into position using the required crane technology and bolted together.



A project-specific installation and logistics concept can be compiled by the ENERCON GPM.

2.3 Nacelle installation

The nacelle components are delivered directly to the designated hardstands (e.g. assembly area). Once pre-assembly is complete, the pre-assembled nacelle is lifted using the crane equipment and mounted on the tower.

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3 Cranes

3.1 Cranes used

The relevant crane type is selected during the planning phase of the wind farm concept. The maximum soil bearing pressure underneath the crawlers or outriggers is limited with load distribution plates. The maximum permissible soil bearing pressure (see ch. 6.1.1.1, p. 26) must be verified using geotechnical calculations. The use of crawler cranes means it is possible, among other things, to move from site to site in a partially assembled state. Prior to this, the bearing capacity of the soil (see ch. 6.1.1.1, p. 26) and the loading gauge (see ch. 5.1.3, p. 17) must be tested on the crane routes.

3.2 Installing the crane with a lattice tower

A crane with a lattice tower is used to install the WECs. This crane technology places specific demands on the crane platform (see ch. 6.1.1.1, p. 26) and requires sufficient space to install the lattice tower (see ch. 6.1.1.1, p. 26 and ch. 6.2, p. 30). The basic unit and the individual crane parts (e.g. lattice tower parts, ballast, attachments) are delivered to the wind farm in the required quantities by truck. A lattice tower crane is assembled in the following individual stages:

- Delivery of the basic unit and auxiliary crane
- Alignment of the crane on the crane platform
- Arrival of approx. 35 trucks transporting the crane to the site
- Lattice tower installation at the site

To install the lattice tower, the existing access road to the crane platform is used. If the access road cannot be used, a temporary site road is needed.

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4 Transport and logistics

4.1 General

Installing a WEC involves a large number of abnormal load transports. These abnormal load transports are needed to deliver the tower components, WEC components and crane equipment, and for subsoil improvement measures and foundation construction. The maximum axle load of these abnormal load transports, some of which require a permit, must not exceed 12 t.

4.2 Construction and logistics concept

Specific installation and logistics concepts are necessary for large wind farms and for WECs erected at sites with special requirements (e.g. industrial sites, dikes, hills). In order to enable optimal project execution, the local conditions must be incorporated directly into the concept. Depending on the WEC type and the installation and logistics concept, there may be additional areas required, e.g. a logistics area and/or rotor blade storage area. The additional logistical costs must be borne by the customer.

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5 Access roads

Access roads in the wind farm are an integral part of the supply of material to the respective WEC sites. In addition, access roads ensure cranes can move around the wind farm. Access roads are used over the entire course of the project as the access for all transport types. In addition, the access roads are also needed to dismantle the WECs. The access road and construction site area concept and the construction work shall be designed in accordance with this specification.

Inadequate design or sizing of the access road can considerably increase logistics and installation costs over the course of the project. There is also an increased risk of delays to construction.

5.1 Routing

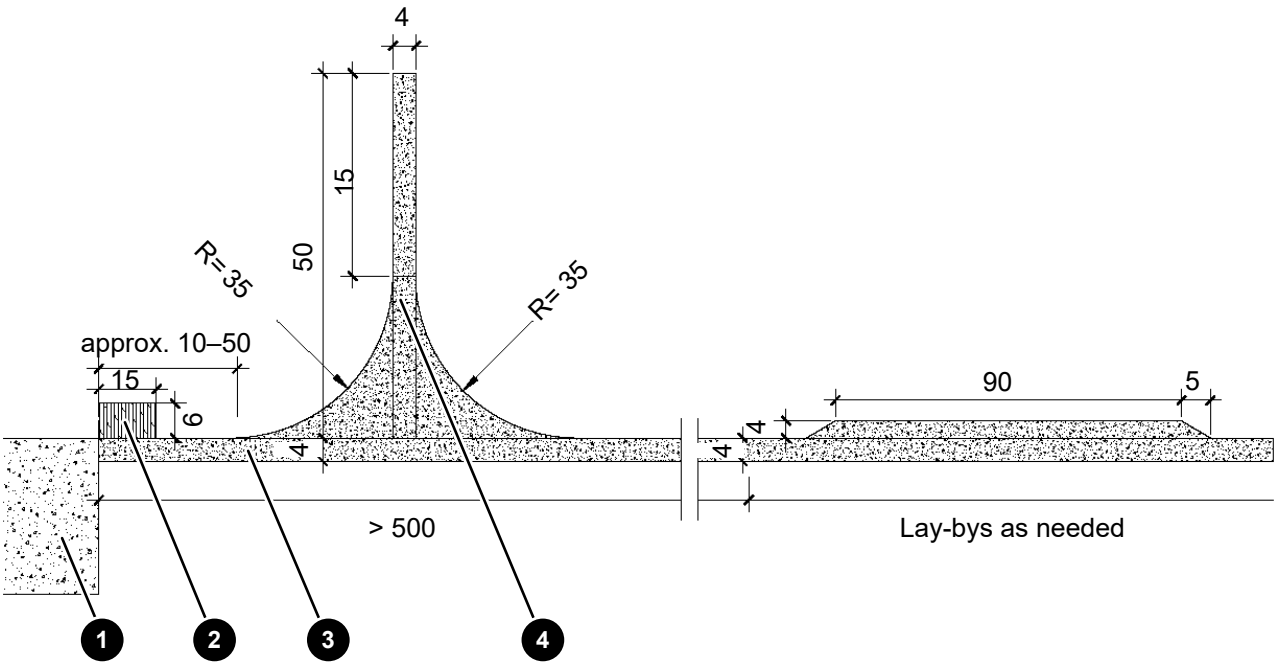


Fig. 1: Routing elements (all dimensions in metres)

1	Crane platform	2	Parking area
3	Access road	4	Turning area

The use of large and abnormal loads presents special challenges for the internal wind farm access roads, at intersections and curves, wind farm entrances and public roads.

Routing elements

In most cases, transport vehicles with a high total weight and wide loads are used to transport components to the construction site. Due to the major transport requirements and the transport costs, the routing of the access roads in the wind farm must be kept short and straight. The routes must be selected so that transport vehicles carrying abnormal loads are not forced to travel in reverse. If WEC sites

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are located in a dead-end position, which exceeds a length of 500 m, the access road to the site is provided with a turning area. The turning area must have a minimum length of 50 m. Depending on the location, turning areas may also be needed at shorter intervals (less than 500 m). This is decided by the ENERCON GPM. On long access roads, lay-bys and/or parking bays in sufficient number and length must be planned in consultation with the ENERCON GPM.

Lay-bys enable free-flowing oncoming traffic and are also required for ensuring obstacle-free rescue routes and lanes.

Wind farm entrance

If there are wind farm entrances from public roads, we recommend asphalting the first 50 m of the entrance. This enables vehicles exiting the site to clean their wheels before accessing the public road. This requirement shall be checked in consultation with the ENERCON GPM, according to local conditions.

When driving onto public roads, regulatory requirements may need to be considered.

Parking areas for long transports

In the wind farm or in the immediate vicinity, one or more areas must be identified, on which at least 3 long transports can be parked on an interim basis. This ensures that waiting transport vehicles do not impede the other construction site traffic. Long transports include the transport of rotor blades or steel sections of towers. For instance, lay-bys are suitable areas.

Obstacles on the route

Any particular obstacles to be crossed on the route must be clearly indicated with the appropriate markings, so that they can be detected by traffic. If lines must be crossed (e.g. pipelines, gas lines), a prior investigation must be carried out to make sure that it is possible to drive over them. The results of the investigation shall be submitted to the ENERCON GPM for inspection. In addition, approval to drive over them must be obtained from the pipeline operator. Lines must be secured by construction of special superstructures. To avoid contact with the construction traffic passing beneath, overhead lines must be clearly indicated by means of height limitation markings (e.g. wooden frames).

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5.1.1 Intersections and curves

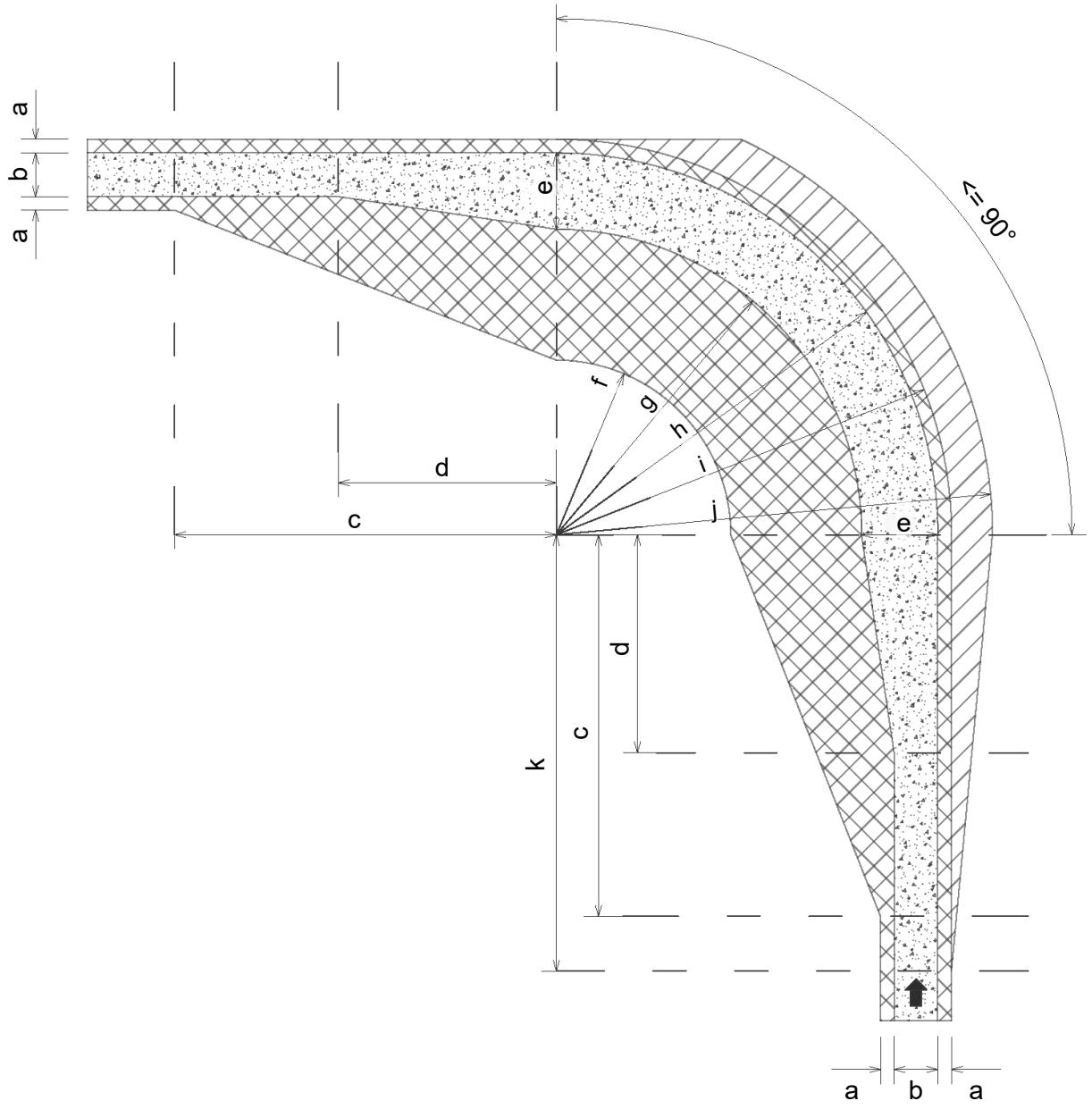


Fig. 2: 90-degree curve (construction diagram)

a	1 m	Lateral swept path (including safe distance)	b	4 m	Drivable width of road in straight line
c	40 m	Length of inner swept path at curve entry	d	35 m	Length of curve entry
e	7 m	Drivable width of road in curves	f	28 m	Inner radius of swept path
g	38 m	Inner radius of curve	h	45 m	Outer radius of curve
i	46.25 m	Inner radius of outer swept path	j	50 m	Outer radius of outer swept path
k	50 m	Length of outer swept path at curve entry			

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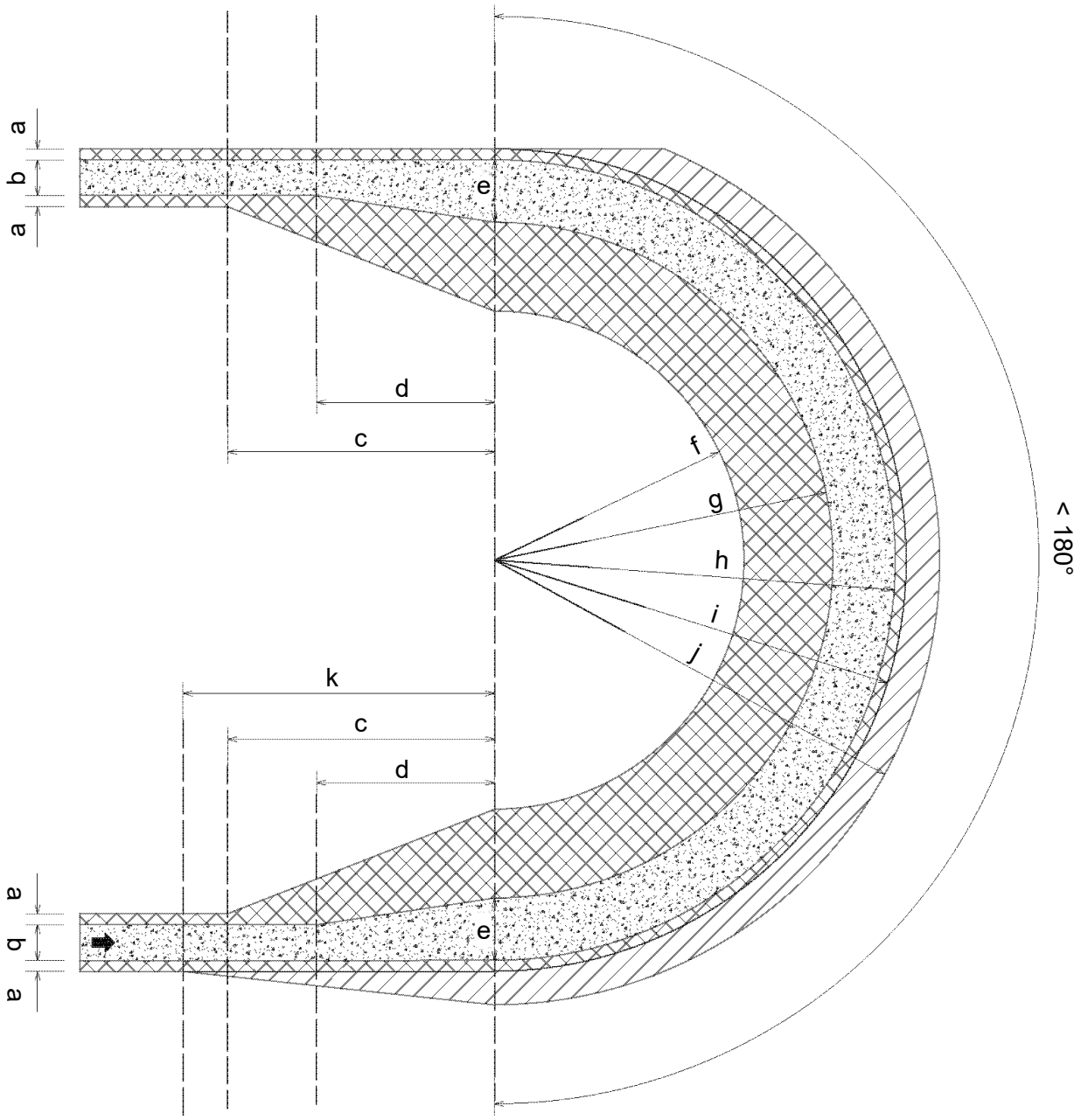


Fig. 3: 180-degree curve (construction diagram)

a	1 m	Lateral swept path (including safe distance)	b	4 m	Drivable width of road in straight line
c	40 m	Length of inner swept path at curve entry	d	35 m	Length of curve entry
e	7 m	Drivable width of road in curves	f	32 m	Inner radius of swept path
g	43 m	Inner radius of curve	h	50 m	Outer radius of curve
i	51.25 m	Inner radius of outer swept path	j	55 m	Outer radius of outer swept path
k	50 m	Length of outer swept path at curve entry			

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The longest transport combination is decisive for curve dimensioning. The curves and swept paths are implemented structurally in accordance with the dimensions indicated in the drawing. The inner radius for the drivable access road must not be less than 38 m. If this radius cannot be maintained due to local conditions, it is imperative that the ENERCON GPM is consulted to find an alternative solution.

Swept paths

Transport combinations with flatbed and/or swing-out load must be able to pass through curves without problem. Obstacles in the swept paths must be removed for this purpose if these obstacles exceed a certain height.

- Obstacles in the inner swept path must not protrude by more than 0.15 m max. above the level of the roadway.
- Obstacles in the outer swept path must not protrude by more than 1.25 m max. above the level of the roadway.

5.1.2 Crests, sags and gradients

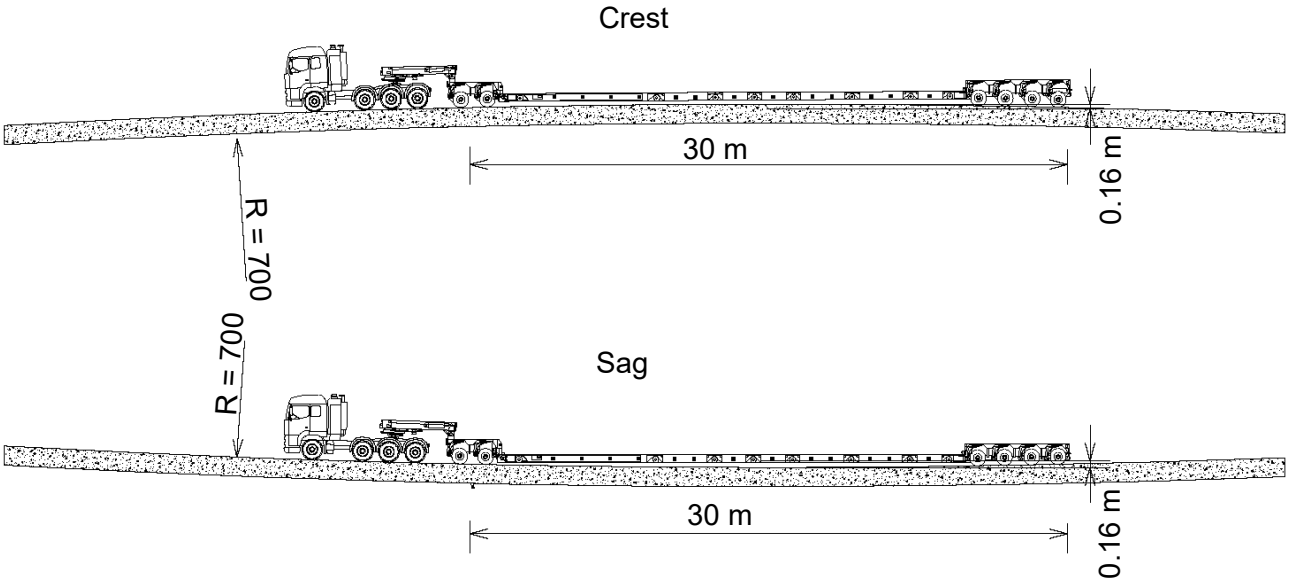


Fig. 4: Crest and sag (R = 700 m)

Abnormal loads with a maximum total length of 78 m are used to transport components to the construction site. For these transport vehicle combinations with excess length, the access roads must fulfil minimum crest and sag radii of 700 m. This prevents the transports from hitting the ground, e.g.in the case of flatbed transport vehicle combinations.

In specific instances, the radius can be reduced to R = 400 m. However, this requires specific transport vehicles that can lift the flatbed to a minimum height of 45 cm. R = 400 m corresponds to a camber (crest) or depression (sag) of 0.26 m over a length of 30 m.

Uphill and downhill gradients

Abnormal loads are only able to travel on access roads with maximum uphill and downhill gradients of ≤ 12 %. With gradients of 7 % or more, a bonded bituminous base and wearing course (e.g. asphalt, concrete) is installed. This ensures nonpositive traction for the trans-

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port vehicles. In individual instances, traction vehicles may be required (hilly or mountainous locations). This is clarified in advance in detail with the ENERCON GPM. The ENERCON GPM must evaluate the economic and scheduling effects.

Tab. 1: Requirements for the longitudinal profile of the access road

Parameter	Requirement
Gradient, loose surface course	≤ 7 %
Gradient, paved surface course	≤ 12 %
Gradient in curves with lateral incline	≤ 4 %
Ground clearance of transport vehicles	0.10 m
Radius of hilltop/bottom of valley	700 m

When using crests and sags with radii between R = 700 m and R = 400 m, consult with the ENERCON GPM.

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5.1.3 Loading gauge

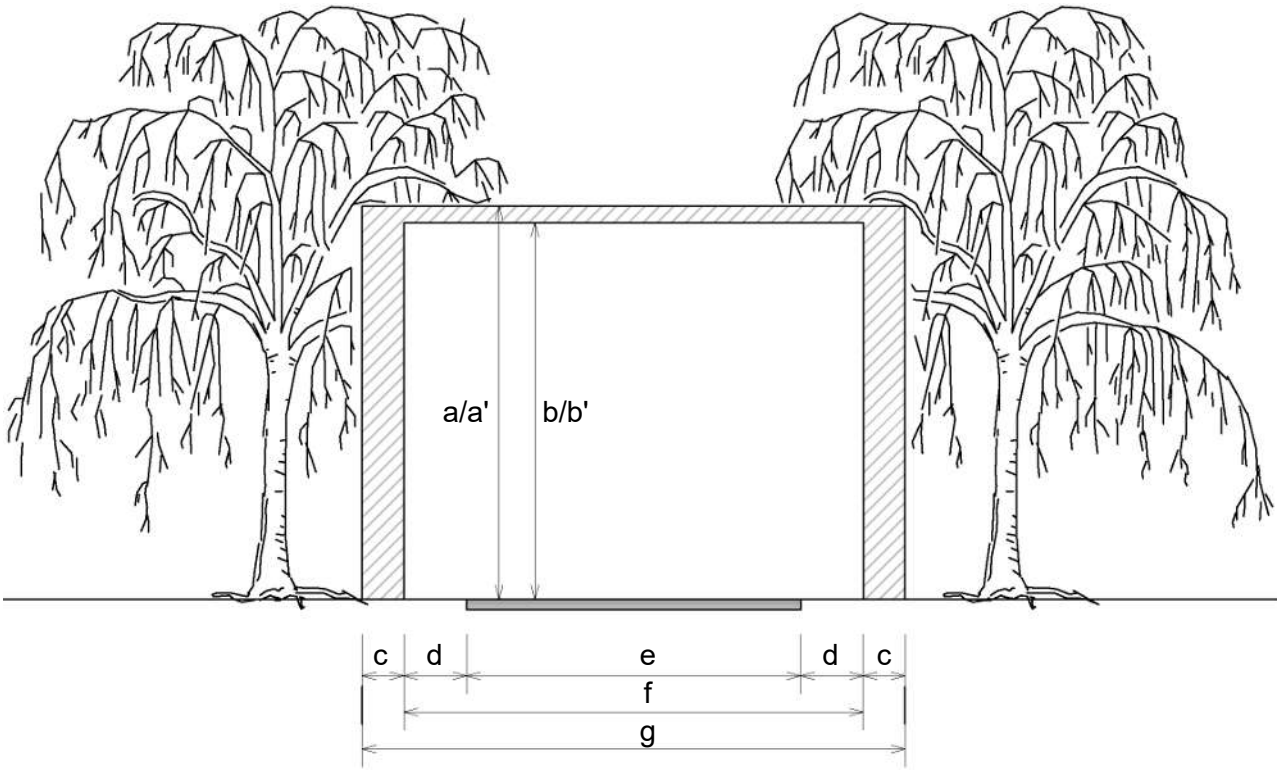


Fig. 5: Loading gauge

a	4.6 m	Clearance height	a'	5.4 m	Clearance height for 4.30–4.90 m diameter steel section
b	4.5 m	Load dimension: height	b'	5.3 m	Load dimension: height for 4.30–4.90 m diameter steel section
c	0.5 m	Lateral safety distance	d	0.5 m	Lateral swept path
e	4 m	Drivable width of road	f	5 m	Load dimension: width
g	6 m	Clearance width			

For abnormal loads, there must be a specific loading gauge above the access roads. Complying with this loading gauge ensures unhindered access by all vehicles on the access roads. The loading gauge defines the space that must be kept free from obstacles of any kind (e.g. structures, power lines, masts, trees, and branches) during construction.

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5.2 Structure of access roads

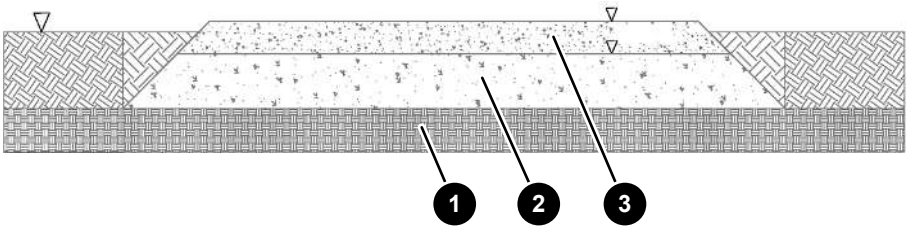


Fig. 6: Schematic structure of access roads

1	Load-bearing subsoil	2	Lower binder course
3	Upper binder course		

The upper binder course is contoured with a cross slope or a straight crossfall with an incline of 2–3 %. This ensures drainage to the sides. A drivable width of 4 m must be ensured. The side area (shoulder) must also be load-bearing in construction (note the load distribution angle of the binder course).

- For details of the longitudinal profile see ch. 5.1.2, p. 15

The actual design is sized and determined by the traffic engineer in accordance with the local soil conditions and coordinated with the ENERCON GPM before implementation.

5.2.1 Requirements

Investigation

The structural design of the access road varies, depending on the nature of the subsoil. The subsoil must be investigated adequately by subsoil exploration drill holes and probing. The number and depth of the explorations must be specified by the geotechnical expert in relation to the subsoil structure. The structural design of the access road is determined based on the results of the soil investigations.

Suitability for use

The access roads are created with sufficient bearing capacity, taking into account the expected traffic loads and in such a manner that they remain suitable for use over the entire period of use. They must remain suitable for use and their bearing capacities maintained even in the event of heavy rainfall. It must be ensured that the upper binder course remains permanently free of potholes. The maximum track groove depth must be limited to 7.5 cm. The design of the construction site areas must also provide a means of access road drainage. In the event of snowfall and icing, safe driving conditions must be ensured via the use of gritting and snow clearance services.

Gritting and snow clearance services are the responsibility of the wind farm operator.

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Execution planning as well as all specifications for testing, explorations, evaluations and verifications have to be submitted for review to ENERCON GPM without being specifically requested to do so.

5.2.2 Subsoil and pavement

To ensure safe, functional and cost-effective transport during construction, the following requirements must always be met:

Tab. 2: Minimum requirements for the access road

Parameter	Requirement
Drivable width of access road	4 m
Maximum permitted depth of ruts	7.5 cm
Lateral incline of the access road, particularly in curves and on gradients	2–3 %
Lateral incline of the access road (only on straight sections without uphill/downhill gradient)	≤ 5 %
Maximum axle load	12 t
Maximum total weight of transport combination	160 t
Deformation modulus of lower binder course	$D_{Pr} \geq 100\ \%/E_{V2}/E_{V1} \leq 2.3$
Deformation modulus of upper binder course	$D_{Pr} \geq 100\ \%/E_{V2}/E_{V1} \leq 2.3$

The construction company must check and document the specified deformation moduli for each installed layer. If the specified values are not achieved, improvement measures shall be taken. A static plate load bearing test on each installed layer is generally recommended.

Depending on the geotechnical report, a static plate load bearing test must be carried out on the access road every 200 to 500 m. Static plate load bearing tests must also be carried out at transitions from existing roads to site roads, at intersections, and at junctions.

The following items must be verified and the results recorded:

- Structure of access road (material and layer thickness)
- Adequate compaction of construction material
- Bearing capacity of access roads
- Bearing capacity of bridges
- Bearing capacity of culverts and pipework
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines
- Feasibility of crossing installed lines (e.g. pipelines)

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It may be advisable (long traffic routes, poor subsoil) to not dimension the access road based on the specified deformation modulus but instead based on the traffic load with consideration of the axle transitions.

To ensure a drivable width of the access road of 4.0 m, the access road width must be extended to at least 4.5 m because of the load transfer.

5.2.2.1 Subsoil and ground

Load-bearing subsoil is the basis for absorbing the high surface pressure caused by abnormal loads and the cranes used. This is why the topsoil and potential soft strata may be excavated until the first load-bearing stratum of natural ground has been reached. If cohesive and organic soils are not load-bearing, these are exchanged, or replaced with layers of compressed, suitable fill material (e.g. sand). Alternatively, other technical processes can be used (e.g. grouting, geogrid).

The bearing capacity of the subsoil must be verified. The required load distribution angle of the planned access roads is taken into account when excavating the width of the road.

5.2.2.2 Lower binder course

The lower binder course of the access roads inside the wind farm consists of loose materials such as sand, gravel or crushed stone. The live loads are transferred via this binder course to the subsoil. The binder course must withstand the climatic and mechanical loads. The material used must be certified for road construction. The grading curve of the material used must be in compliance with the national regulations as amended. Suitability of the material must be proven before placement by submitting valid test certificates. The necessary bearing capacity is ensured by graded grain size distribution and it is to be agreed with the geotechnical expert.

Brick fragments are not used as bulk material for the binder course. The material is pulverised by moisture and loses its strength,

Proper compaction of the binder course in layers has to be ensured.

5.2.2.3 Upper binder course

Material Certified crushed bulk material, e.g. gravel or crushed stone, is used as material for the upper binder course. An aggregate ranging from 0/32–0/45 mm is used. The percentage of fine aggregate must not exceed 5 % of the total. The grading curve of the materials installed must correspond to the applicable valid country-specific regulations. The suitability of the materials must be verified by up-to-date inspection certificates before installation. The upper binder course is installed as evenly as possible with a minimum camber of 10 cm with regard to the adjacent terrain. The minimum layer thickness is 25 cm.

In order to satisfy the stresses of high live loads, the upper binder course must be compressed properly in layers.

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Bonded upper binder course

If the access road has a pitch of 7 % to a maximum of 12 %, the upper binder course has a hydraulic or bituminous bond. The upper binder course provides a nonpositive bond that prevents the wheels of vehicles with abnormal loads from spinning.

Wind farm entrance

If there are wind farm entrances from public roads, we recommend asphalting the first 50 m of the entrance. This enables vehicles exiting the site to clean their wheels before accessing the public road. This requirement shall be checked in consultation with the ENERCON GPM, according to local conditions.

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6 Construction site areas

6.1 Work area at the WEC site

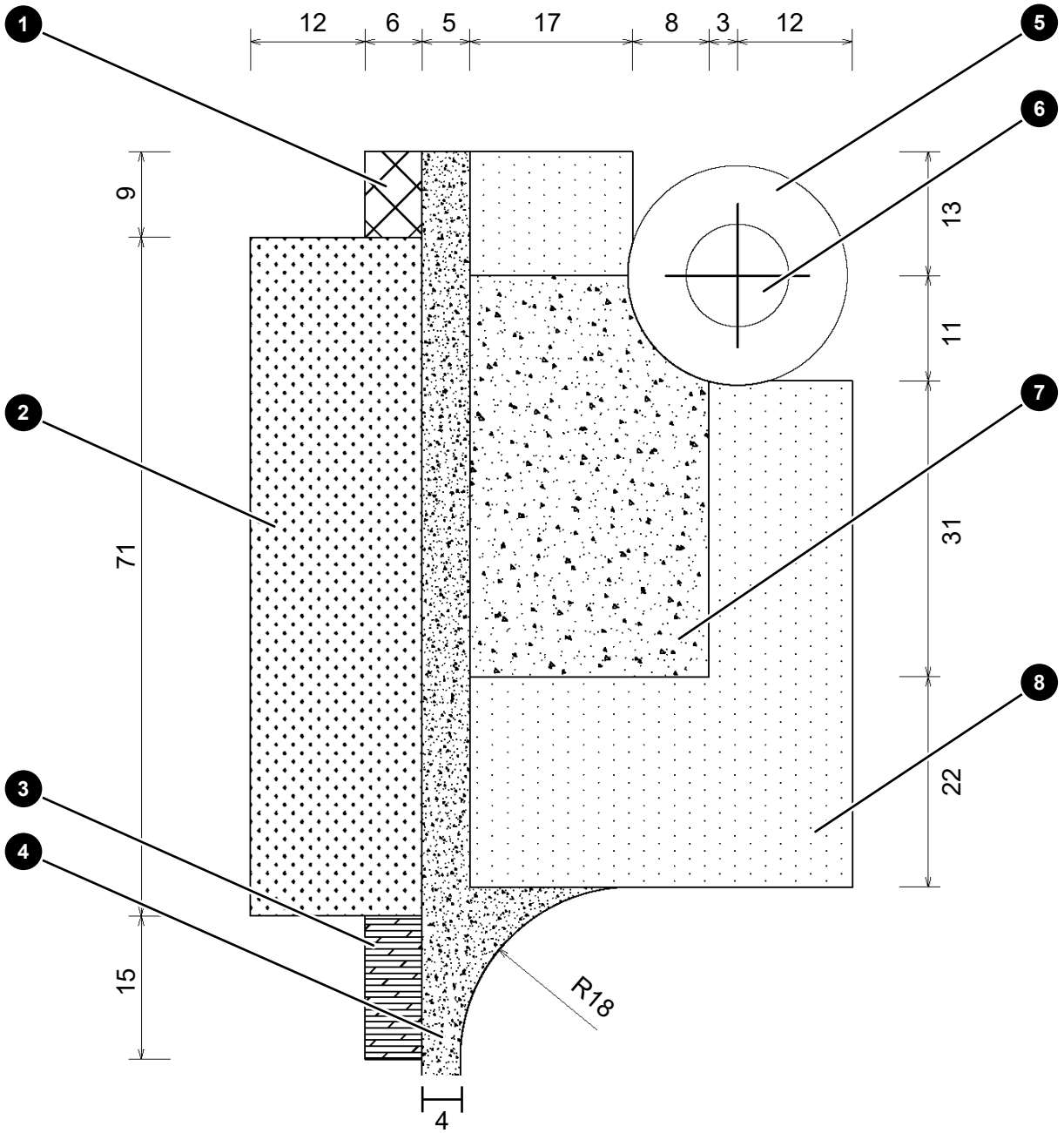


Fig. 7: Working area dimensions at the WEC site (all dimensions in metres)

1	Waste collection point	2	Storage area
3	Parking area	4	Access road
5	Foundation	6	Tower
7	Crane platform	8	Assembly area

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Different jobs are performed in the working area at the site of the WEC to be erected. The work ranges from foundation construction to installing the nacelle on the tower. The work area consists of various construction site areas for assembly and storage of WEC components, for which different requirements apply. The construction site areas must therefore be sufficiently dimensioned and have sufficient bearing capacity to ensure safe and cost-effective progress of the project.

Sequence of construction

The sequence of construction activities in the work area of the WEC differs depending on the type of WEC foundation.

Sequence of construction for **foundations below ground level** where the excavation pit is completely backfilled:

1. Creating the entire substructure of the crane platform and assembly area. The upper binder course is laid up to a distance of approx. 16.5–18 m to the centre of the foundation. If necessary, establishing a working level.
2. Creating the foundation.
3. Backfilling the excavation pit Completing the upper binder course of the crane platform and assembly area as far as the foundation plinth. Reworking and profiling the entire crane platform as per minimum requirements.
4. Installing the tower and WEC. The area around the foundation must be level and usable during this time.

Sequence of construction for **foundations below ground level with foundation plinth above ground level**:

1. Creating the entire substructure of the crane platform and assembly area. The upper binder course is laid up to a distance of approx. 16.5–18 m to the centre of the foundation. If necessary, establishing a working level.
2. Creating the foundation.
3. Backfilling the excavation pit to ground level. Completing the upper binder course of the crane platform and assembly area to about half the foundation heel. Reworking and profiling the entire crane platform as per minimum requirements.
4. Installing the tower and WEC. The area around the foundation must be level and usable during this time.
5. Applying the soil load as far up to foundation plinth after completion of the WEC.

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Sequence of construction for **foundations on ground level**:

1. Creating the entire substructure of the crane platform and assembly area. The upper binder course is laid up to a distance of approx. 16.5–18 m to the centre of the foundation. If necessary, establishing a working level.
2. Creating the foundation.
3. Completing the upper binder course of the crane platform and assembly area as far as the foundation edge. Reworking and profiling the entire crane platform as per minimum requirements.
4. Installing the tower and WEC. The area around the foundation must be level and usable during this time.
5. Sloping the foundation or applying the soil load after completion of the WEC.



The soil load is applied to the foundation after completion of the WEC so that the area remains available for cherry pickers, for instance. If the area is not available, extra costs for repair measures will result.

Differences in level

In order to ensure a smooth sequence of construction, the following differences in level must be observed:

- Between construction site areas and surrounding terrain: If the height difference between the construction site areas and the surrounding area is > 0.30 m, the side areas need to be sloped with a gradient of 45°. Depending on the height of the slope, there is a circumferential strip around the perimeter on which loads must not be placed. If necessary, the area must be increased in size in order to create the required useful area.
- Between crane platform and assembly area: Both areas are located at the same height level.
- Between crane platform and foundation top edge: The permissible height difference can be found in the foundation data sheet.

If larger height differences are necessary owing to the local circumstances, this will be discussed and agreed with the ENERCON GPM.

Storing excavated earth

Any excess earth excavated during the construction phase that is not needed for foundation backfilling is stored outside the work area only. When creating heaps of earth, take into account the planned cable route and cable bushing from and to the WEC. The minimum distance from the heaps of earth to the work area is 4 m. So as not to impede delivery of the tower and WEC components, excavated earth must not be stored in the swept path of the transport vehicles. The same applies long the crane jib assembly area. If not used, the excess excavated earth is removed in full.

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Locations for winches

In order to guide the WEC components during lifting, they are held in position with ropes and winches. The position of the winches depends, among other factors, on the component to be lifted and the wind situation and is coordinated shortly beforehand with the ENERCON CM or installation team. The winches are positioned at a minimum spacing to the tower base, which corresponds to 1–1.5 times the tower height.

The winch location must be accessible with a telescopic handler. Depending on the local forest density, additional areas may have to be cleared.

Deviations from the standards described here may affect the installation and logistics concept. This will result in extra costs, longer construction times and possibly delays in the course of the project. Adaptations on account of local circumstances must be coordinated with the ENERCON GPM.

6.1.1 Requirements

Investigation

The structural design of the crane platform and assembly area may differ, depending on the nature of the subsoil. The subsoil must be investigated adequately by subsoil exploration drill holes and probing. All strata relevant to settlement and soil failure must be recorded during this process. The number and depth of the explorations must be specified by the geotechnical expert in relation to the subsoil structure. The structural design of the crane platform and assembly area is then determined based on the results of the soil investigations.

Suitability for use

The construction site areas are created with sufficient bearing capacity, taking into account the expected loads and in such a manner that they remain suitable for use over the entire period of use. They must remain suitable for use and their bearing capacities maintained even in the event of heavy rainfall. The maximum track groove depth must be limited to 7.5 cm. The design of the areas must also provide a means of drainage. In the event of snowfall and icing, safe driving conditions must be ensured via the use of gritting and snow clearance services.

Gritting and snow clearance services are the responsibility of the wind farm operator.

Execution planning as well as all specifications for testing, explorations, evaluations and verifications have to be submitted for review to ENERCON GPM without being specifically requested to do so.

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6.1.1.1 Crane platform

The crane equipment is placed on the crane platform. This is the place where the main construction activities are performed. The highest stresses from live loads and distributed loads act on this area. An insufficiently designed or dimensioned crane platform may result in unforeseen movements or toppling of the crane.

Material

Certified crushed bulk materials, such as gravel, crushed stone or similar material, is used as material for the upper binder course that fulfils the requirements. The minimum layer thickness is 25 cm. An aggregate ranging from 0/32–0/45 mm is used. The percentage of fine aggregate must not exceed 5 % of the total. The grading curve of the materials installed must correspond to the applicable valid country-specific regulations. The suitability of the materials must be verified by up-to-date inspection certificates before installation.

Tab. 3: Crane platform minimum requirements

Parameter	Requirement
Surface evenness	≤ 0.25 %
Minimum bearing capacity	185 kN/m²
Deformation modulus of lower binder course	$D_{Pr} \geq 100\ \%/E_{V2}/E_{V1} \leq 2.3$
Deformation modulus of upper binder course	$D_{Pr} \geq 103\ \%/E_{V2}/E_{V1} \leq 2.3$

Load bearing capacity of the crane platform has to be verified by shear failure calculations, or for sloping sides by slope failure calculations. Settlement calculations are required to avoid that the maximum permissible inclination of the crane is not exceeded. The crane loads are reduced to the specified permissible ground pressure by load distribution plates below the chains or claws.

The geotechnical verification of load distribution has to be submitted for areas each with the following dimensions:

- 2 m x 10 m
- 5 m x 10 m

The following items must be verified and the results recorded:

- Structure of the construction site area (material and layer thickness)
- Adequate compaction of construction material
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines

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6.1.1.2 Assembly area

The assembly area mainly serves to store the tubular steel tower sections and as a working area for assembling the WEC components. This area is only required during construction and can be restored to its original state after work in the wind farm has been completed.

Material

Certified crushed bulk materials, such as gravel, crushed stone or similar material, is used as material for the upper binder course that fulfils the requirements. The minimum layer thickness is 25 cm. An aggregate ranging from 0/32–0/45 mm is used. The percentage of fine aggregate must not exceed 5 % of the total. The grading curve of the materials installed must correspond to the applicable valid country-specific regulations. The suitability of the materials must be verified by up-to-date inspection certificates before installation.

Tab. 4: Minimum requirements for the assembly area

Parameter	Requirement
Surface evenness	≤ 1 %
Minimum bearing capacity	135 kN/m²
Deformation modulus of lower binder course	$D_{Pr} \geq 100\ \%/E_{V2}/E_{V1} \leq 2.3$
Deformation modulus of upper binder course	$D_{Pr} \geq 103\ \%/E_{V2}/E_{V1} \leq 2.3$

Load bearing capacity of the assembly area has to be verified by shear failure calculations, or for sloping sides by slope failure calculations. Settlement calculations are required to avoid that the maximum permissible inclination of the crane is not exceeded. The crane loads are reduced to the specified permissible soil pressure by load distribution plates below the chains or claws.

The geotechnical verification of load distribution has to be submitted for areas each with the following dimensions:

- 1 m x 8 m
- 3 m x 8 m

The following items must be verified and the results recorded:

- Structure of the construction site area (material and layer thickness)
- Adequate compaction of construction material
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines

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6.1.1.3 Storage area

The storage area is used, among other things, to store rotor blades and sometimes also for construction site equipment such as material containers, transport frames, etc. The surface is set up on the side of the crane platform. It does not have to be surfaced but it must be level, smooth, dry and free of roots, trees and shrubs. Practicability for telescopic handlers must be ensured.



In the event of failure to meet the above requirements ENERCON reserves the right to claim additional costs for reinforcement measures from the operator/owner.

6.1.1.4 Working level (if required)

The carrier device used for constructing pile foundations or for ground improvement measures through vibro replacement/vibro compaction is located on the working level.

Tab. 5: Minimum requirements for the work area

Parameter	Requirement
Form: Circle	Coordination with ENERCON GPM
Surface evenness	≤ 1 %
Minimum bearing capacity	Coordination with ENERCON GPM
Deformation modulus of lower binder course	D_{Pr} ≥100 %/E_{V2}/E_{V1} ≤ 2.3/

The following tests must be carried out and recorded:

- Compaction (static plate load bearing tests, dynamic probing)
- Distances to ditches, pits and bodies of water
- Distances to cable routes and overhead lines
- Surface gradients for drainage

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6.1.2 WEC sites in wooded areas

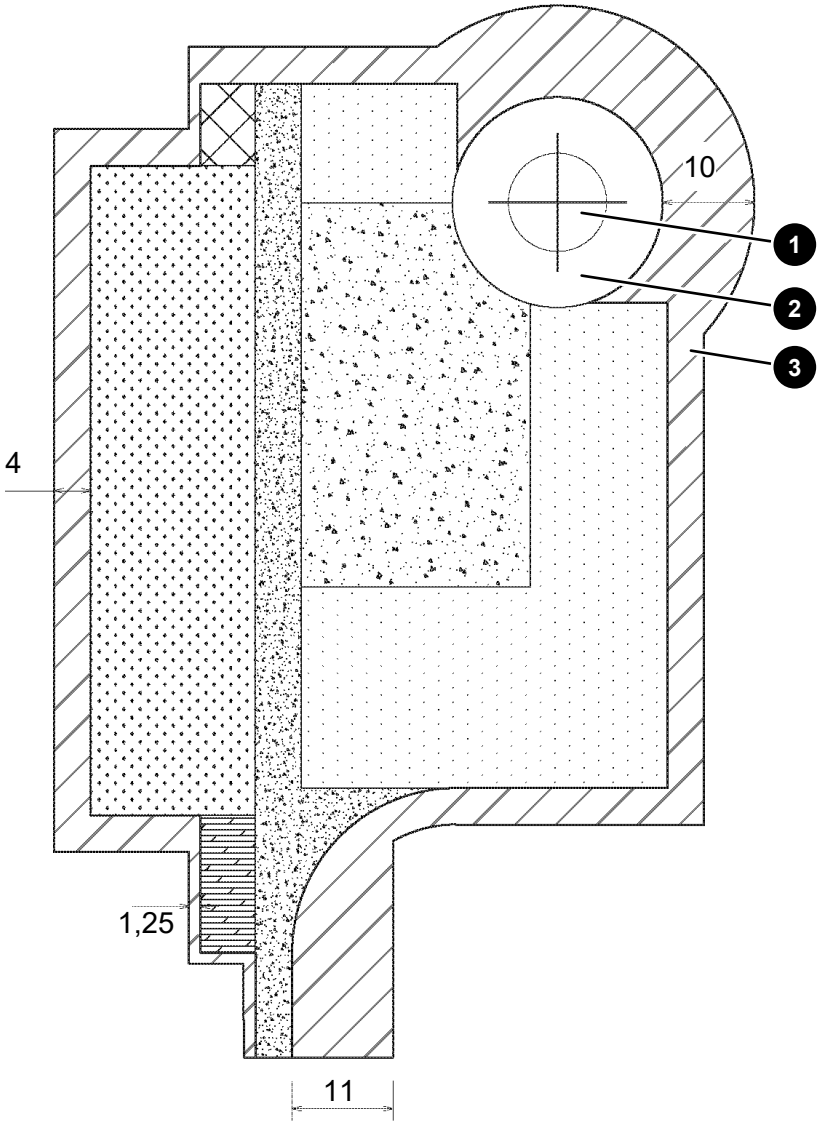


Fig. 8: Work area at the WEC site in woodland areas, dimensions (all dimensions in metres)

1	Tower	2	Foundation
3	Clearing zone		

When erecting WECs in wooded areas, an area is kept free or cleared around the work area at the WEC site and around the foundation. Excavated earth must not be stored in the clearing zone during construction work. The clearing zone can be partly reforested after the WEC has been installed.

Ropes and winches are used to guy and position the rotor blades for guiding during the hoisting process. The winches are fixed to the ground at a minimum distance of 1× tower height in metres to the blade tip. Depending on the local forest density, additional areas may have to be cleared for guying set-up (refer to *Locations for winches*, p. 24). This is coordinated with the ENERCON GPM.

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6.2 Crane jib assembly area

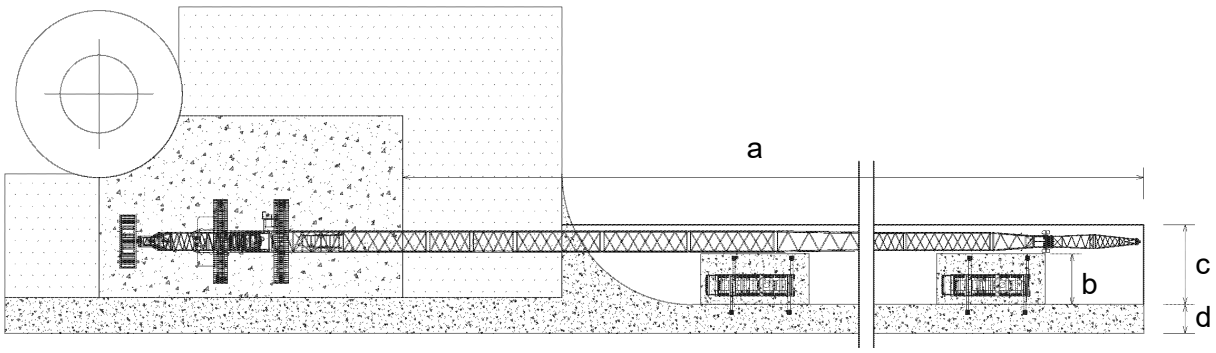


Fig. 9: Crane jib assembly area

a	102 m	Length of crane jib assembly area, starting from crane platform	b	10 m	Width of auxiliary crane platform
c	15 m	Total width of crane jib assembly area	d	4 m	Drivable width of road

The individual jib components of the lattice tower main crane are assembled, spanning a length of up to 102 m. It must be ensured that the lattice tower for the large crane can be set down in the event of rising wind speeds during assembly as well. This requires a clearing along the length of the lattice tower jib. Lattice tower jibs can be installed only up to a certain gradient. If there are height differences in the crane jib assembly area, consult with the ENERCON GPM. This particularly applies to gradients between the basic unit and the lattice tower jib.

Auxiliary crane areas

The lattice tower jib of the large crane is assembled and erected with the support of an auxiliary crane. The auxiliary crane is positioned to the side of the lattice tower tip. In order to facilitate consecutive assembly of the individual jib components, a paved roadway is required for the auxiliary crane. If the access road to the crane platform is straight, long enough and if local conditions make lattice tower assembly possible, it is used for that purpose. If not, a temporary auxiliary road will be built. In order to support the auxiliary crane and distribute its loads, auxiliary crane platforms measuring 10 m in width must be established at certain intervals, immediately adjacent to the access road or auxiliary road. The number and location of auxiliary crane areas is coordinated with the ENERCON GPM and crane service provider.

Tab. 6: Requirements for the crane jib assembly area

Parameter	Requirement
Bearing capacity of the access road or auxiliary road	12 t axle load
Surface pressure of the auxiliary crane platforms	Min. 135 kN/m²

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Approval by an authority may be required for the construction of the temporary road for lattice tower assembly. The **operator/owner** should check if this approval is necessary.

6.3 Rotor blade storage area

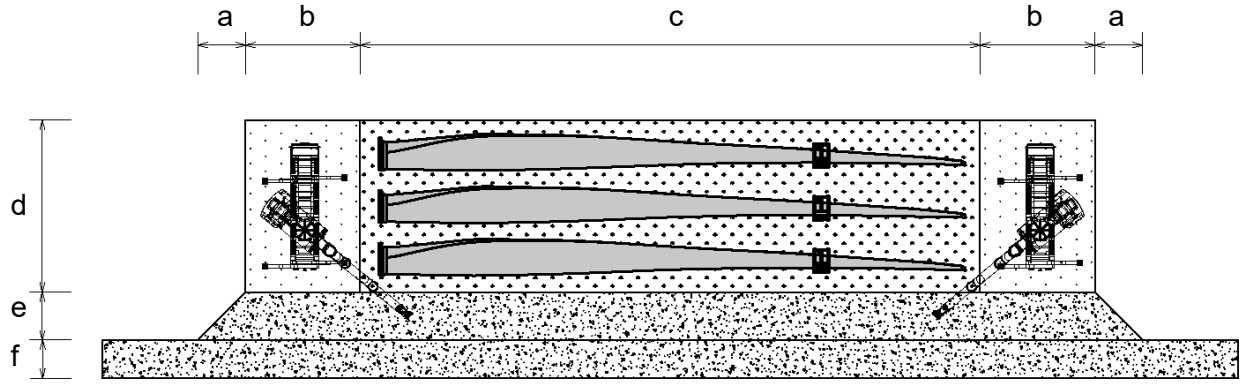


Fig. 10: Rotor blade storage area (construction diagram)

a	5 m	Length of funnel lay-by	b	12 m	Width of auxiliary crane platform
c	71 m	Length of rotor blade storage area	d	18 m	Width of rotor blade storage area/ length of auxiliary crane platform
e	5 m	Width of lay-by	f	4 m	Drivable width of road

The rotor blade storage area serves as temporary storage for rotor blades. The area can also be used for transferring rotor blades. The rotor blade storage area is located in a lay-by along the access road. The storage area is free of stumps and roots. An auxiliary crane is located on each of the two front sides of the storage area for moving the rotor blades.

The rotor blade storage area is included in the plans if no storage area can be constructed at the WEC location or if no just-in-time delivery of the rotor blades is possible due to the installation and logistics concept. The size of the rotor blade storage area and its position within the wind farm are derived from the installation and logistics concept and are agreed upon with the ENERCON GPM. The additional logistical costs must be borne by the customer.

Tab. 7: Requirements for the rotor blade storage area

Parameter	Requirement
Bearing capacity of the lay-by	12 t axle load
Minimum load-bearing capacity of the auxiliary crane platforms	min. 135 kN/m²

The rotor blade storage area does not replace the parking spaces for excess length transport vehicles required to be specially indicated (see *Parking areas for long transports*, p. 12).

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6.4 Central contact point

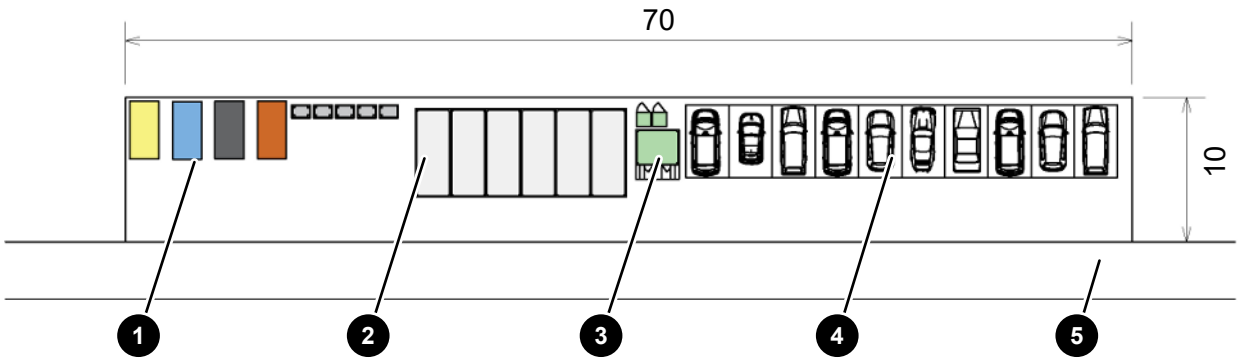


Fig. 11: Central contact point (all dimensions in metres)

1	Waste containers	2	Construction site containers
3	Sanitary facilities	4	Car parking spaces
5	Access road		

Central infrastructure is required in every wind farm. The central infrastructure includes the office container of the ENERCON CM, car parking spaces, waste containers and sanitary facilities. To this end, a specific area can be created as a central contact point or existing areas can be used or extended, e.g. the logistics area. The office containers and waste containers do not have to be located in the same area. The waste containers must be accessible for loading and unloading by truck.

The area of the central contact point is gravelled or covered with steel or composite panels. The bearing capacity of the area is dimensioned for vehicles with an axle load ≤ 12 t.

The construction site equipment, the location within the wind farm as well as dimensions and distances on the area are coordinated on a project-specific basis with the ENERCON GPM. If necessary, the local situation and conditions as well as country-specific regulations must be observed.

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