

Specification

Access Roads and Crane Platforms

E-48

49m & 59m Steel Tower

Legal notice

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1. Assembly of tower and wind energy converter

The tower and wind energy converter are installed in one stage (work step):

Bolting the tower flange joints to assemble the supplied tower sections.

The 49.00m steel tower consists of three steel tower parts plus the foundation basket cast in the foundation.

The 59.00m steel tower consists of three steel tower parts plus the foundation basket cast in the foundation.

The delivered wind turbine components are pre-assembled on the surface marked in Section 6.3 (incl. WEC assembly).

2. Crane technology

2.1. Crane technology details

The following crane technology is required for the work steps described above:

	Telescopic crane
Crane type	500t
Length / basic unit	20.00m
Width / basic unit	3.00m
Track gauge	3.00m
Supporting base	10.00m x 10.00m

2.2. Assembly of telescopic crane

The following work steps need to be performed:

- Delivery the basic unit incl. the auxiliary crane;
- Aligning the crane with the WEC centre;
- Providing approx. 5 trucks to transport the crane equipment to site;
- Supporting the crane on the crane platform and
- Assembly of jib.

3. Access roads

Any roadways, bridges or access roads have to be able to withstand the transportation of heavy loads up to a maximum axle load of 12t and a maximum total weight of 120t.

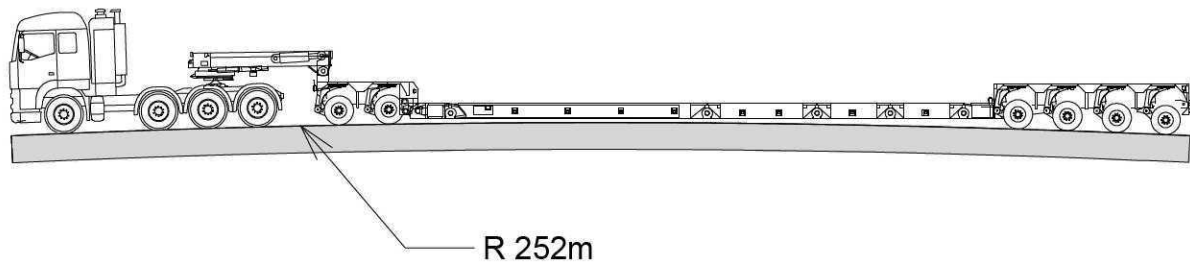
Access should be ensured **at all times; access roads should be frost-proof**. Even in case of heavy rainfall, access roads must be accessible and their bearing capacities maintained.

In the event of snowfall and icing, the contractor in charge of access road construction has to provide gritting and snow clearance services to ensure accessibility of the roads.

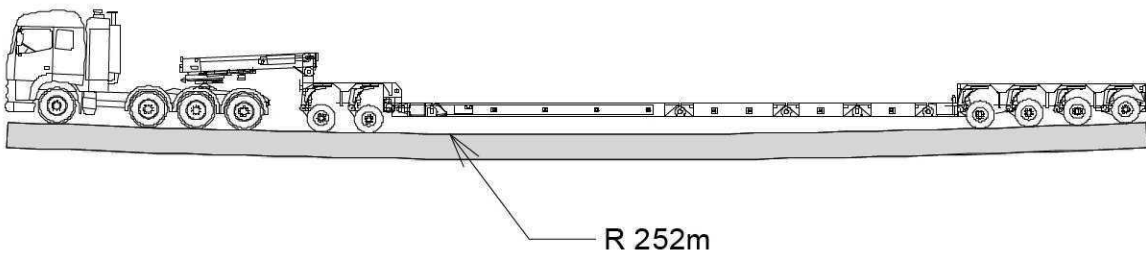
3.1. Minimum requirements on access roads

Usable roadway width	4.00m
Clearance width	5.50m
Clearance height	4.60m
Radius of curve, external	28.00m
Gradient, loose surface	≤ 7%
Gradient, paved surface	≤ 12%
Gradient in curves with lateral gradient	≤ 4%
Lateral gradient of access roads (only on straight roads without any gradient)	≤ 10%
Lateral gradient of access roads, particularly in curves and at gradients	≤ 1.5%
Ground clearance of transport vehicles	0.15m
Radius hilltop/ bottom of valley	252m
General requirements:	
Ability to withstand an axle load of up to 12t	
Ability to withstand an overall weight of up to 120t	
Roadway width in curves, see 4.1 & 4.2	
No obstacles on inside/outside of curves (see 4.1 & 4.2)	
Verification of carriageway bearing capacity (see 3.2)	
Verification of bridge bearing capacity	
Verification of bearing capacity of culverts and pipework	
Verification of distances from trenches, hollows and watercourses	
Verification of distances from high voltage/electrical/telephone cables	

Hilltop



Bottom of valley



3.2. Access road bearing capacity

The construction of the access roads should be coordinated with the responsible geotechnical engineer. The bearing capacity of the subsoil has to be tested and recorded by the geotechnical engineer.

Regular inspections have to be carried out at appropriate spacing's during the construction phase.

The test results and interpretations must be made available to the ENERCON Project Manager.

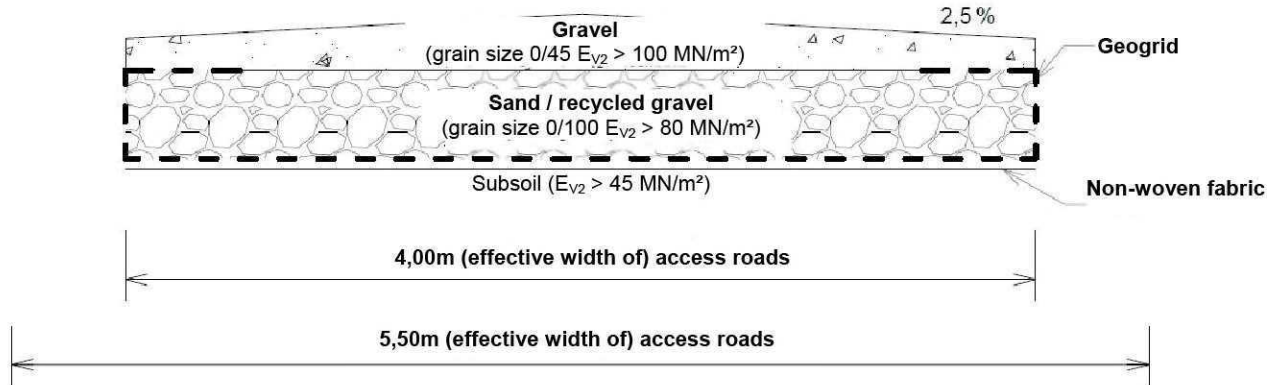
For cohesive soil it is recommended to use geotextiles or a geotextile/ geogrid combination to prevent fine grain particles from getting into the placed sub-base layer, and therefore destabilise the sub-base.

Data and required deformation moduli:

Natural ground	$E_{v2} \geq 45 \text{ MN/m}^2$
Substructure (e.g. sand)	$E_{v2} \geq 80 \text{ MN/m}^2 / D_{pr} \geq 100\%$
Bituminous base and wearing course	$E_{v2} \geq 100 \text{ MN/m}^2 / D_{pr} \geq 100\%$
Ratio E_{v2} / E_{v1}	≤ 2.2
Maximum axle load of transport vehicles	12t
Maximum axle load of crane	12t
Maximum vehicle weight	120t

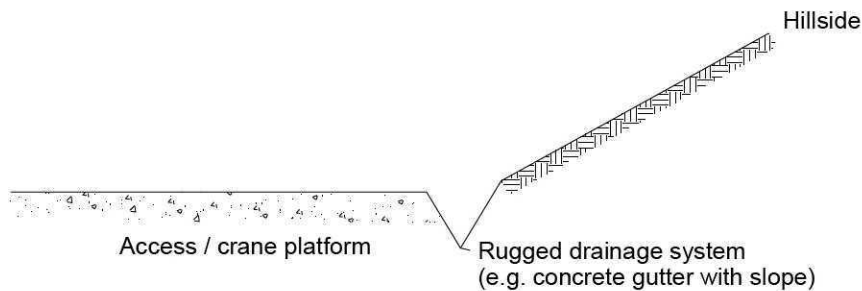
The specified values should be verified for each relevant layer by the responsible geotechnical engineer and subsequently approved in writing. If the specified values are not achieved, improvement measures should be proposed.

3.3. Example of access road construction



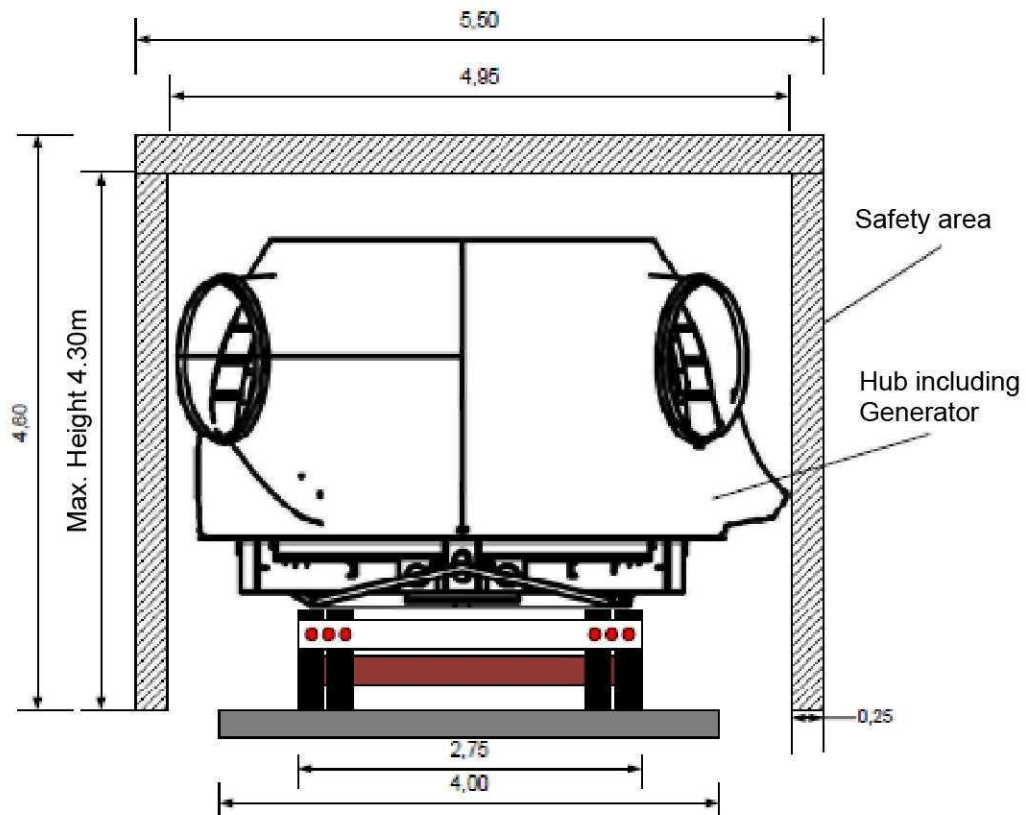
Note:

The structure illustrated above is merely an example of average load structure. When soft and/or organic subsoil's (peaty soil, etc.) are present, the geotechnical engineer should adjust layer thicknesses to the subsoil conditions or propose adequate ground improvement measures (excavation installation of geogrid, etc.). The responsible ENERCON Project Manager should always be consulted prior to any construction commencing.



If access roads or crane platforms are constructed directly adjacent to a hill or slope, a stable drainage system (e.g. concrete channel, drainage pipe) must be installed at the periphery of these areas. The drainage system must prevent surface water from the slope from flooding these surfaces during heavy rainfall events.

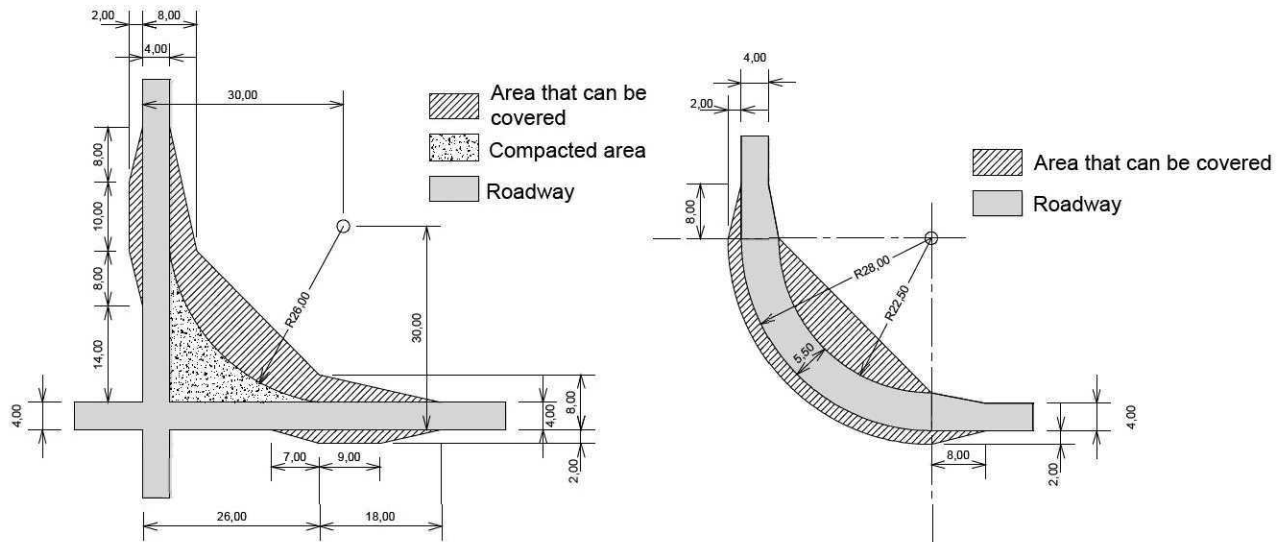
3.4. Transport loading gauge



4. Radii of curve

4.1. Minimum requirements on intersections and curves

In contrast to intersections, areas involving curves do not require the same degree of surfacing, as no squinch needs to be constructed.



Intersections

The construction method for intersection areas as illustrated above should be used for existing intersections. The dotted area should already be paved; if not, it has to be paved.

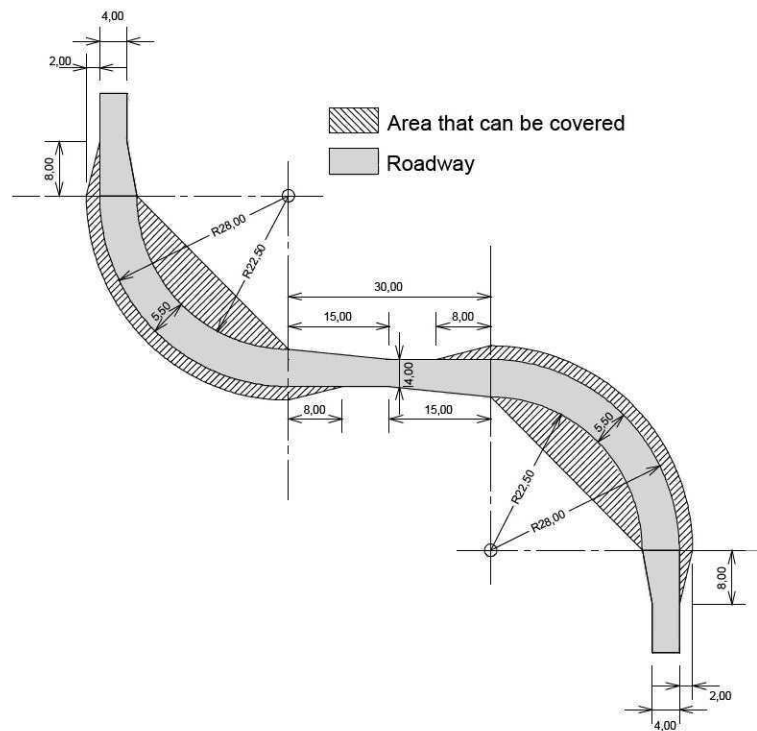
The hatched areas have to be free of obstacles, as the transported load protrudes into these areas.

Curves

The construction method for curve areas as illustrated above should be used for new access roads within the curves.

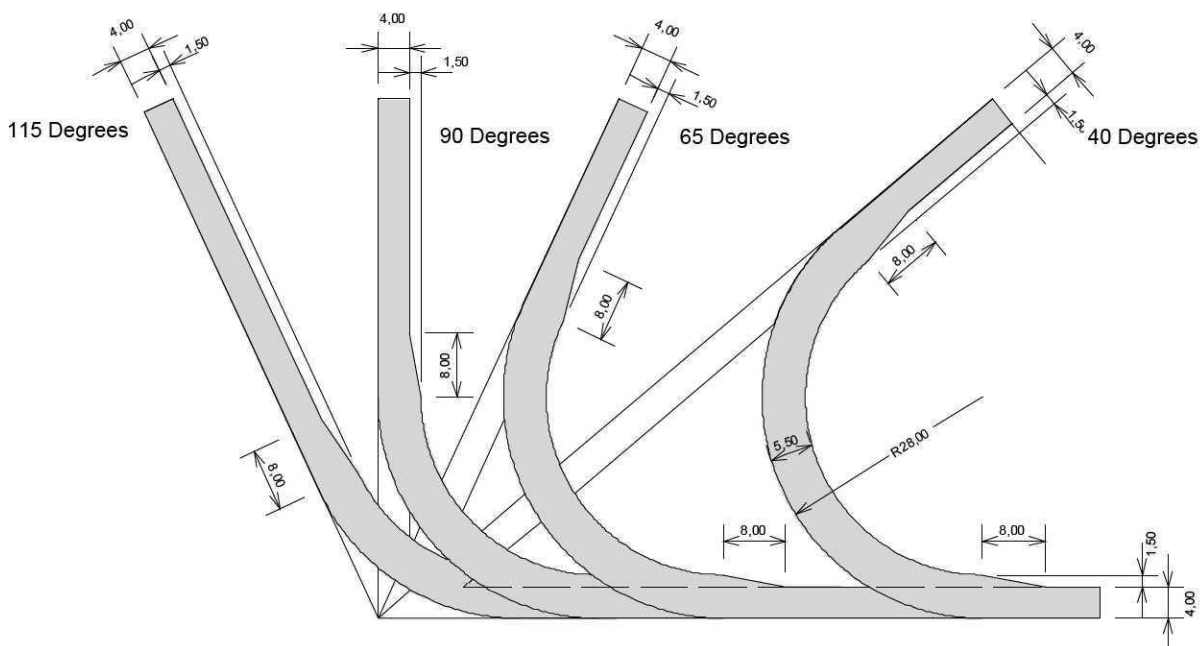
The hatched areas have to be free of obstacles, as the transported load protrudes into these areas.

For roads with many curves, it has to be ensured that there is always a minimum straight distance of 30.00m between two curves.



4.2. Radii of curves < 90 degrees and > 90 degrees

If the angle of the curve under construction is < 90 degrees, the curved part to be constructed moves outwards and the area associated with the 5.50m roadway width has to be extended accordingly (see hatched area). Again the load protrudes into the inside and outside areas of the curve (see 4.1).



5. Transport and logistics

5.1. Basic transport requirements

Basically, the transport vehicles must not exceed the maximum axle load of 12t (usually 10t). Thus, a transport vehicle with an actual overall weight of 100t has at least nine axles (plus towing vehicle).

About 8 transport cycles are required to deliver the entire wind energy converter (incl. tower) to the construction site. For the transport cycles of the crane, please see 2.2.

The following vehicles are used on ENERCON construction sites:

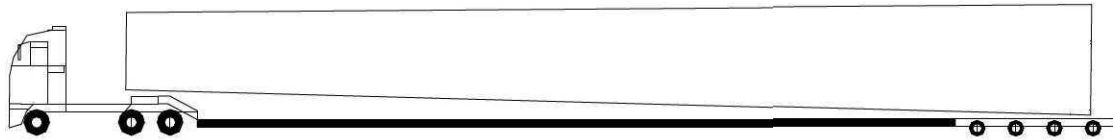
- Low-loader trailers;
- Flatbed trailers;
- Articulated trailers;
- Semi-trailers and
- Adapter vehicles.

The vehicles are telescopic to some extent in terms of length and width, and can be shortened to regular length once they have been unloaded.

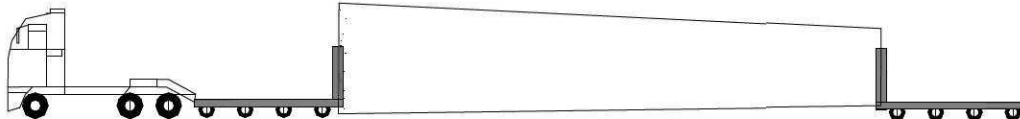
Maximum vehicle length is 35.00m (steel tower section).

5.2. Overview of transport vehicles

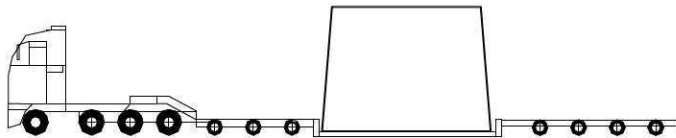
Semi transport truck - Steel tower sections



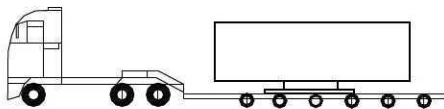
Adapter vehicle - Steel tower sections



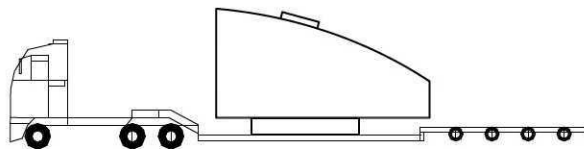
Flatbed transport truck - Precast concrete tower



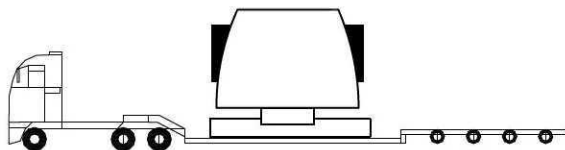
Semi transport truck - Generator



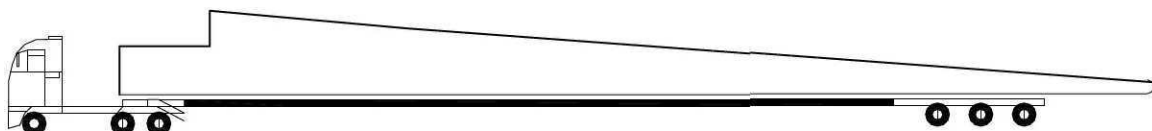
Flatbed transport truck - Machine house



Flatbed transport truck - Hub



Extendable semi transport truck - Rotor blade



6. Crane platform

6.1. Minimum requirements on crane platforms

The crane platform is the key to ensuring a trouble-free and safe working process during the installation phase. For this reason, it has to be constructed as a **permanent and frost-proof** structure.

The example given in section 6.4 depicts a standard crane platform. The ENERCON Project Manager should be consulted if deviations or adaptations to local conditions are required.

The construction of the crane platform should be coordinated with the responsible geotechnical engineer. The bearing capacity of the crane platform must be verified by the geotechnical engineer (e.g. by additional testing) and recorded accordingly. Difficult subsoil conditions (e.g. soft and/or organic layers) require additional verification (bearing capacity and settlement checks) to be performed **in consultation with ENERCON**.

During the construction phase, regular inspections have to be carried out at appropriate spacing's. The construction of the crane platform requires verification and written approval by the responsible geotechnical engineer.

In general, it should be a coarse-grained, **completely level surface (0° to max. $\pm 0.15^\circ$ [approx. 0.25 %])**, with a top surface constructed from aggregate (natural gravel / recycling concrete, no broken raddle) with a grain size of 0/32 mm.

The construction of the crane platform should ensure rapid drainage of any surface water. The upper edge of the crane platform has to be located max. 200mm below the foundation's upper edge.

It is **necessary to install a drainage system** in order to adequately divert rainwater away from the crane platform.

After the pre-assembly of the WEC components and prior to the crane installation for WEC assembly, the crane platform has to be re-worked in consultation with the responsible ENERCON Project Manager.

The entire platform (mind the auxiliary crane platform) must have a minimum bearing capacity of **185 kN/m²**.

Moduli of deformation required:

Natural ground	$E_{v2} \geq 45 \text{ MN/m}^2$
Substructure (e.g. sand)	$E_{v2} \geq 80 \text{ MN/m}^2 / D_{pr} \geq 100\%$
Bituminous base and wearing course	$E_{v2} \geq 100 \text{ MN/m}^2 / D_{pr} \geq 100\%$
Ratio E_{v2} / E_{v1}	≤ 2.3

If these values are not achieved, please contact the geotechnical engineer.

During foundation construction, the crane platform will also serve as a storage area for materials (e.g. reinforcing steel) and machinery.

If crane platforms need to be constructed near slopes, please contact the responsible ENERCON Project Manager. Special (construction) measures may be required in order to erect the jib and further actions (Superlift equipment / suspended ballast).

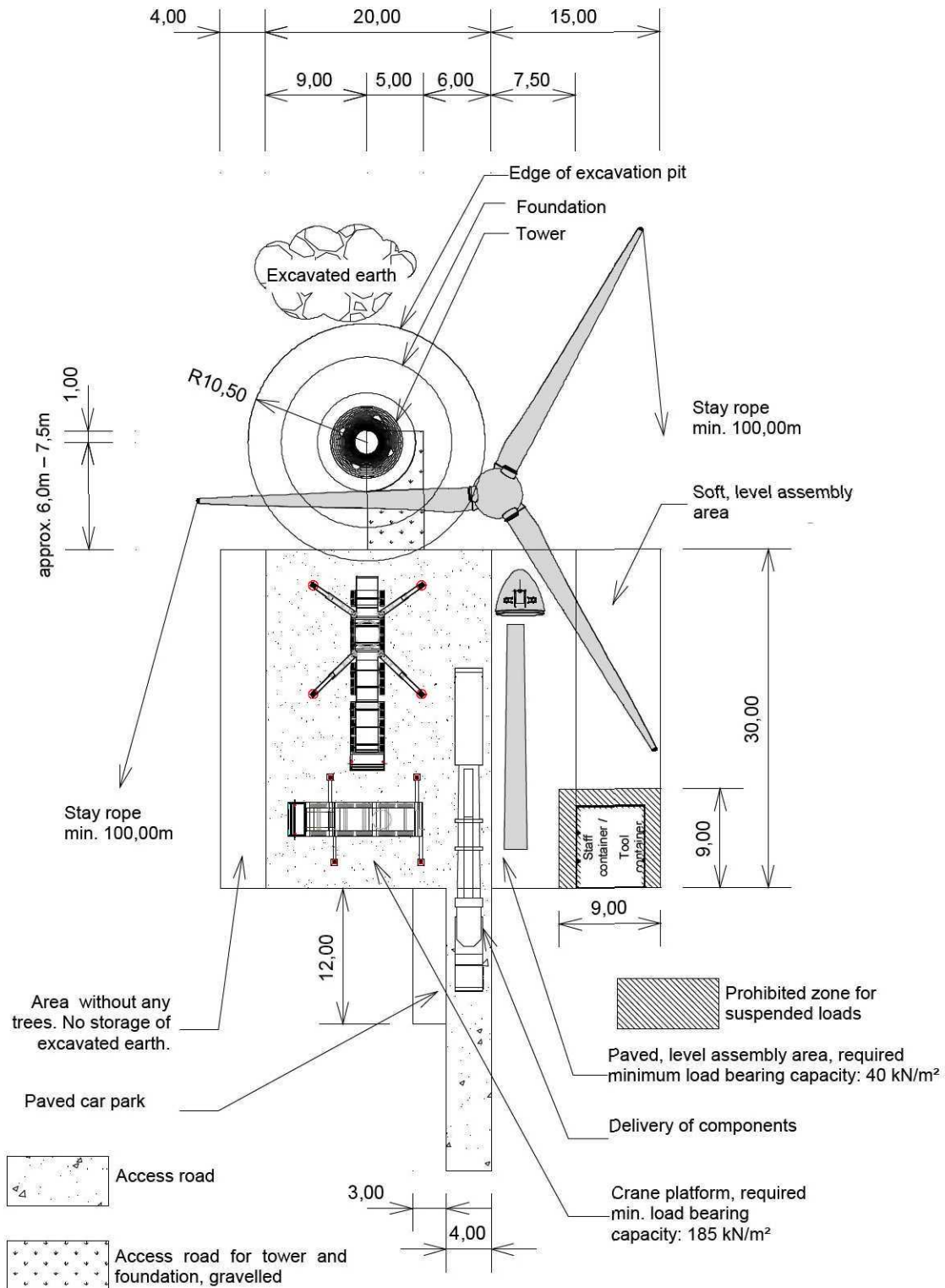
Any excess **soil excavated** during the construction phase that is not needed for foundation backfilling must not be stored laterally from the foundation. Storage is allowed **only at the back of the foundation**, otherwise excess excavated soil has to be removed completely (see 6.3).

The assembly area is a temporary area with a good bearing capacity that is used for storage and installation of WEC components.

The assembly area has to meet the following requirements:

- coarse-grained, levelled surface
- maximum gradient of 1% over the entire surface
- The entire area has to have a surface pressure/bearing capacity of **40kN/m²**.
- The additional storage area has to be level and without any roots. At a later time, ENERCON will place excavator mats on this surface to store further components.

6.2. Standard crane platform



6.3. Crane platform in forested areas

