



Civil Works, Crane and Road Requirements E-70



Please note that ENERCON GmbH reserves the right to technical modifications

1 Road requirements

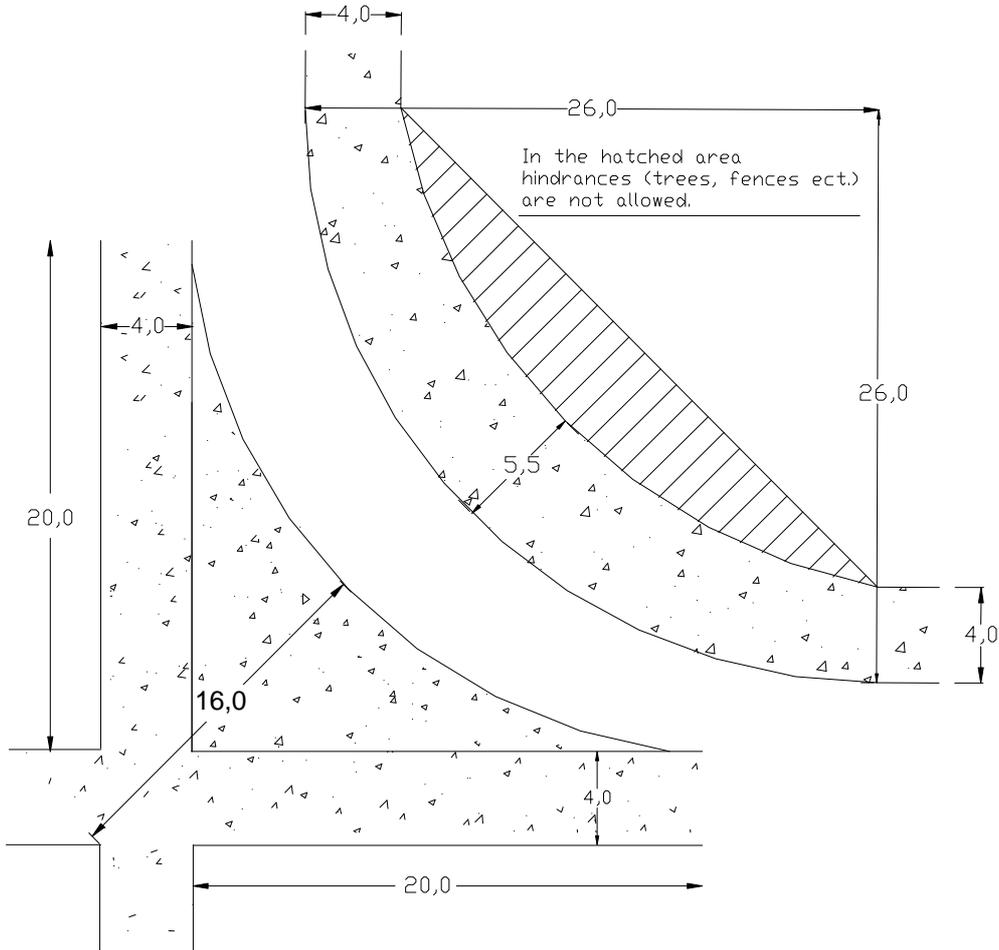
The access road has to be constructed before installation of the WEC. In case of repair or service it must be possible to reach the machine with service vehicles and a crane any time even after erection of the ENERCON-Wind Energy Converter. The roads have to be constructed in a way that they can carry heavy load trucks with an axle load of 12to and a maximum total weight of 120to and a crane with a maximum weight of 96to. It has to be sure that it is permitted to use all roads and bridges with the required vehicles.

At minimum, roads must have the following characteristics:

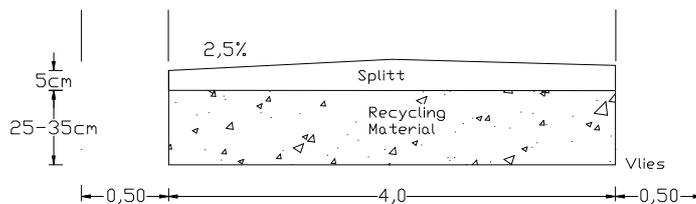
- Width: The width of the roads has to be at minimum 4,00m. The widest part that has to be transported is the generator. In a free horizontal space of 5,50m there are no hindrances allowed (e.g. fences, trees, walls etc.).
- Height: The highest part that has to be transported is the lower tower section. In a free vertical space of 4,65m are no hindrances allowed (e.g. overhead lines, telephone lines etc.).
- Maximum axle load: The crane has an axle load of 12to, the trucks app. 10to.
- Maximum Weight: Normally the tower section transports are the heaviest parts that have to pass the roads. The complete maximum weight will be given to you by the local transport company or by the ENERCON Project Management Department.
- Outer curve radius: The authoritative vehicles for the outer and inner radius are the tower trucks. Depending on the type and height of the tower the outer curve radius is between 25,0m and 28,0m (see sketches on page 4, 5 and 6).
- Inner curve radius: The inner curve radius is between 19,5m or 21,50m. The road width has to increase in the middle of the curve to 5,5m (63m steel tower and concrete towers) and 6,5m (84m and 98m steel towers) respectively (see sketches on page 4, 5 and 6).
- Maximum slope: The maximum slope of asphalt roads has to be lower than 12%. The slope of gravel roads has to be lower than 6%. A higher slope need to be checked by ENERCON. Please note that ENERCON will not pay any costs that might be arise due to the higher slope!



E-70: Curve and Crossing for the 63m Steel Tower (example)



E66: Access Road Construction (Example)



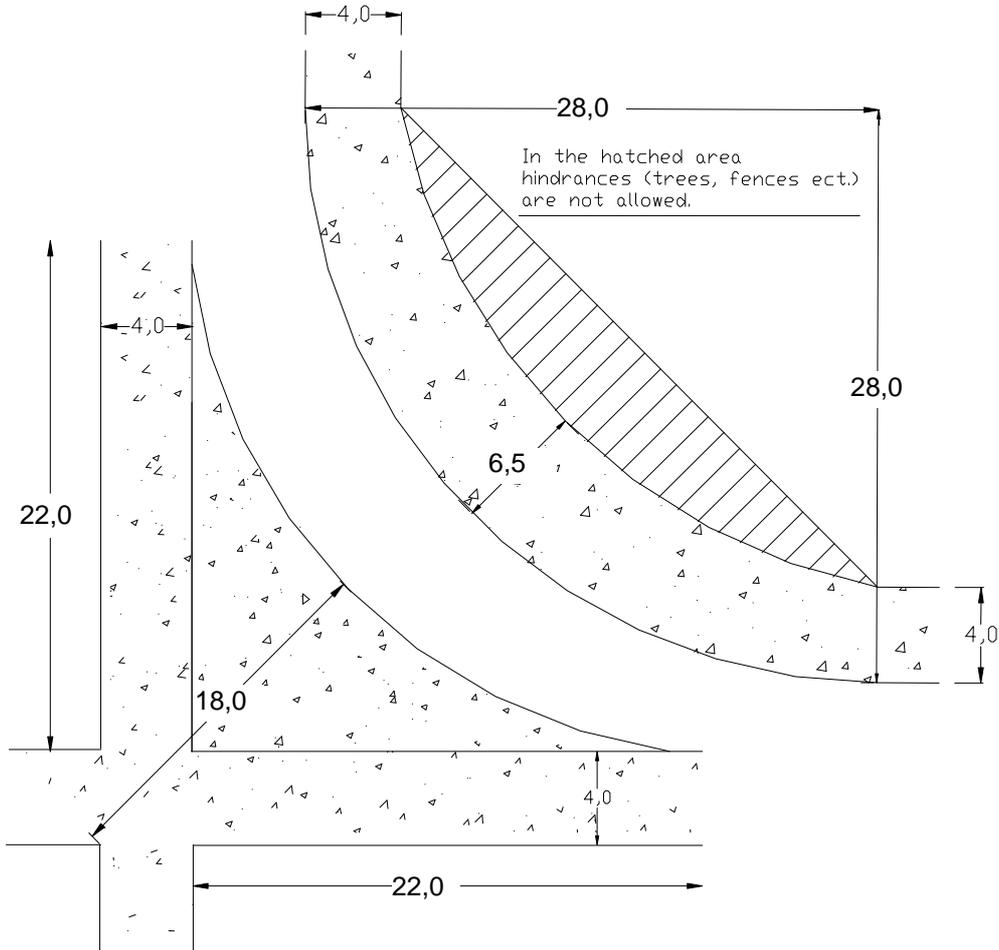
In a space of 0,5 m beside the road hindrances (trees, fences etc.) are not allowed. The road must be able to carry an axle load of 12to. The max. slope for asphalt is 12% and for gravel 6%.

Material	Explanation
Secutex Vlies	Mechanical bonded web filters the refined components out of the ascending water and prevents the silting - up of the road.
Recycling Material	Ballasted broken bricks respectively concrete take on the loads and develop a pressure cone.
Splitt 5/11	Broken gravel with a maximum corn of 11 mm prevent the natural cover of the road and create an optical clean surface.

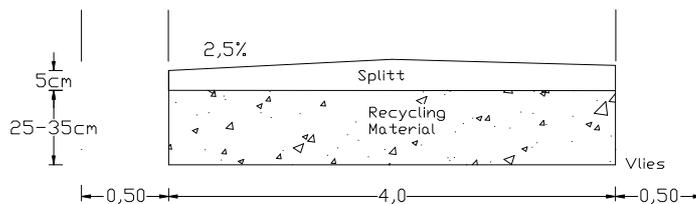
Attention
The above mentioned construction is an example for a ground with a mediocre load-bearing capacity. If the ground is soft (e.g. peat, buggy-soil ect.) a soil excavation, vlies and gravel can be required. In any case please come in contact with Enercon before starting the construction.



E-70: Curve and Crossing for the 84m and the 98m Steel Tower (example)



E66: Access Road Construction (Example)



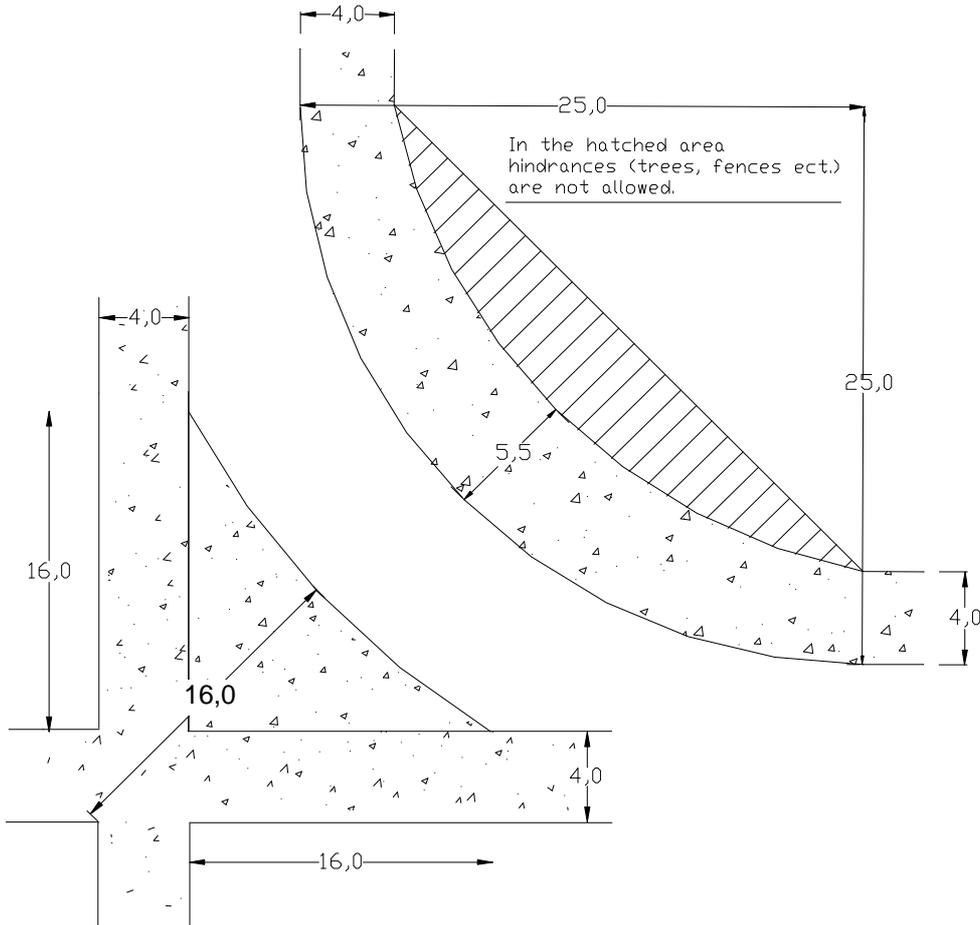
In a space of 0,5 m beside the road hindrances (trees, fences etc.) are not allowed. The road must be able to carry an axle load of 12to. The max. slope for asphalt is 12% and for gravel 6%.

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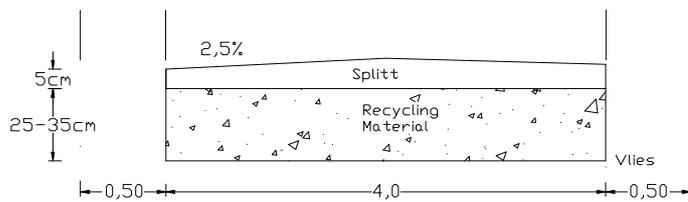
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E-70: Curve and Crossing for the 97m and 112m Concrete Tower (example)



E66: Access Road Construction (Example)



In a space of 0,5 m beside the road hindrances (trees, fences etc.) are not allowed. The road must be able to carry an axle load of 12to. The max. slope for asphalt is 12% and for gravel 6%.

Material	Explanation
Secutex Vlies	Mechanical bonded web filters the refined components out of the ascending water and prevents the silting - up of the road.
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Attention
The above mentioned construction is an example for a ground with a mediocre load-bearing capacity. If the ground is soft (e.g. peat, luggy-soil ect.) a soil excavation, vlies and gravel can be required. In any case please come in contact with Enercon before starting the construction.

2 Service Area

The service area must be dimensioned in a way that the cranes for lifting the wind energy converter can be placed on it as well as the trucks transporting the single machine parts. Furthermore, the pre-assembly of the machine house and hub has to be possible on it.

Examples for different tower types are given on pages 8, 9 and 10.

In general, the distance between the location of the tower and the service area should be 12,00m for the E-70. The area between foundation plinth and service area has to be enlarged by a width of 5,00m as an access to the tower (please see page 8, 9 and 10).

Before starting the construction of the service area, please get into contact with the ENERCON Project Management Department, the crane company and perhaps a soil-investigator to co-ordinate the structure of the crane area.

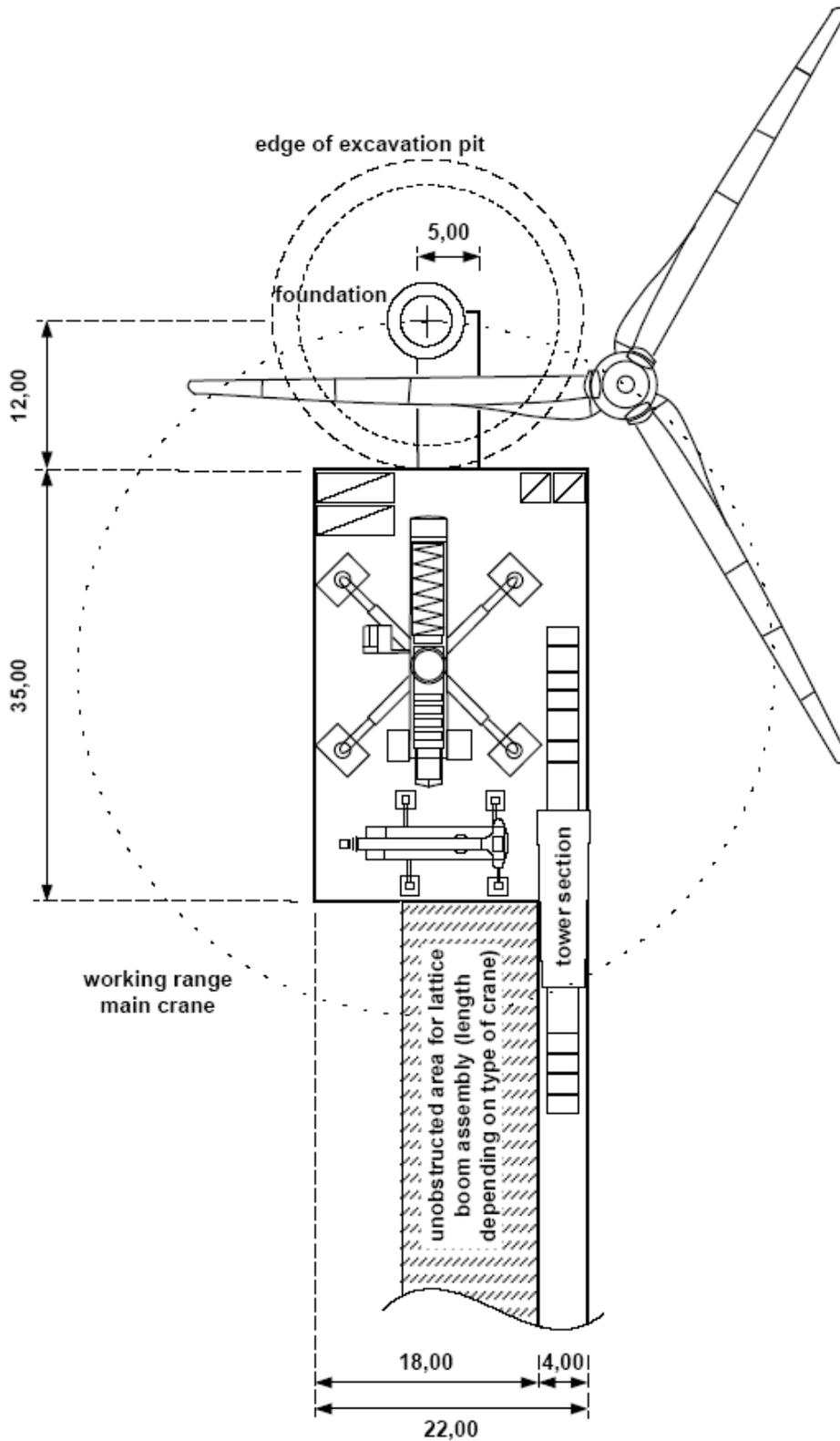
The service area must be constructed such as to led the vehicles' axle load (12to) and the crane's outrigger load (18,5to/m²) into the subsoil.

The construction of the service area must be able to carry vehicles with an axle load of 12to and the max. loads of the crane's outriggers (18,5 to/m²).



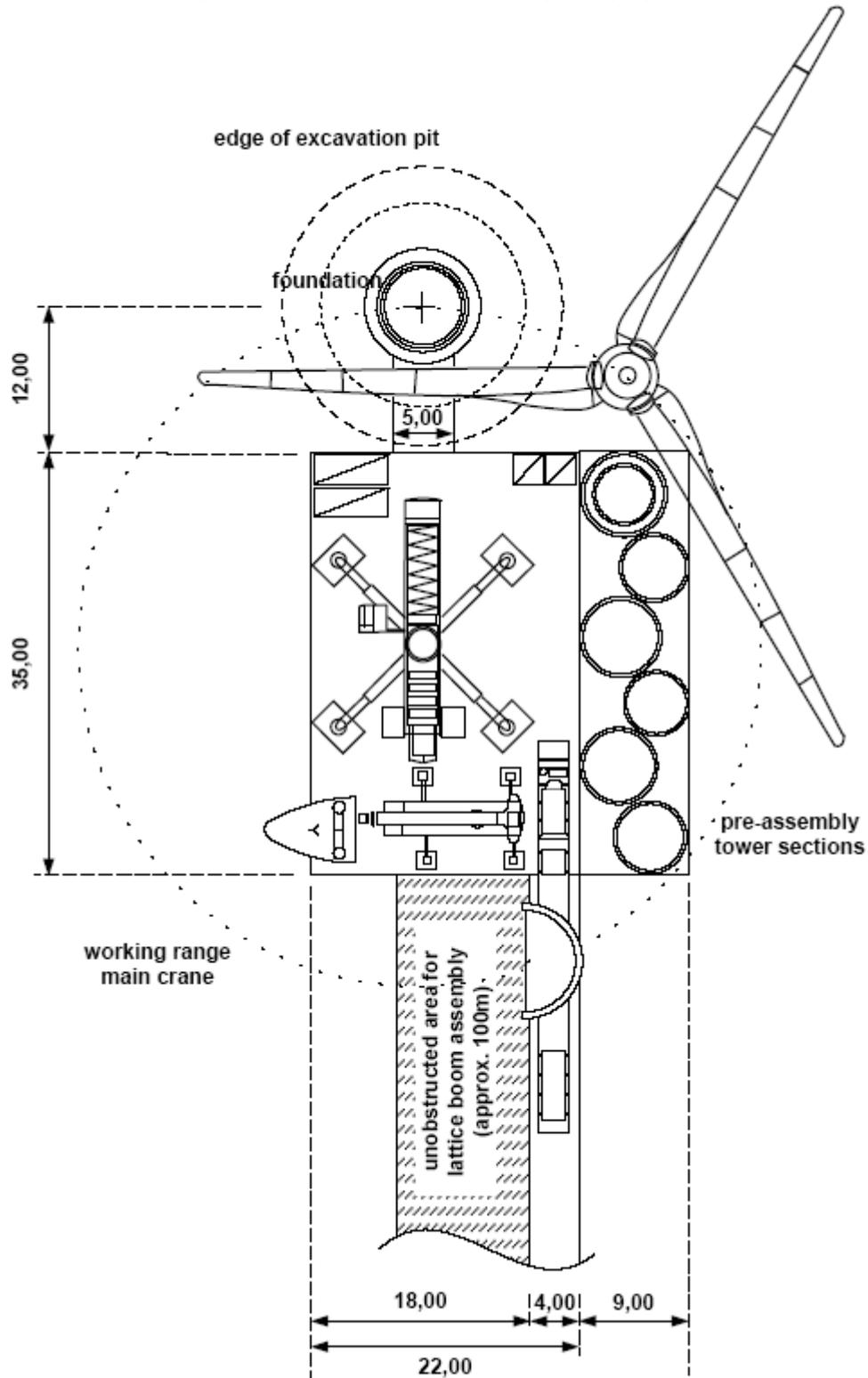


E-70: Service area of the 63m, 84m and 98m Steel Tower (example)



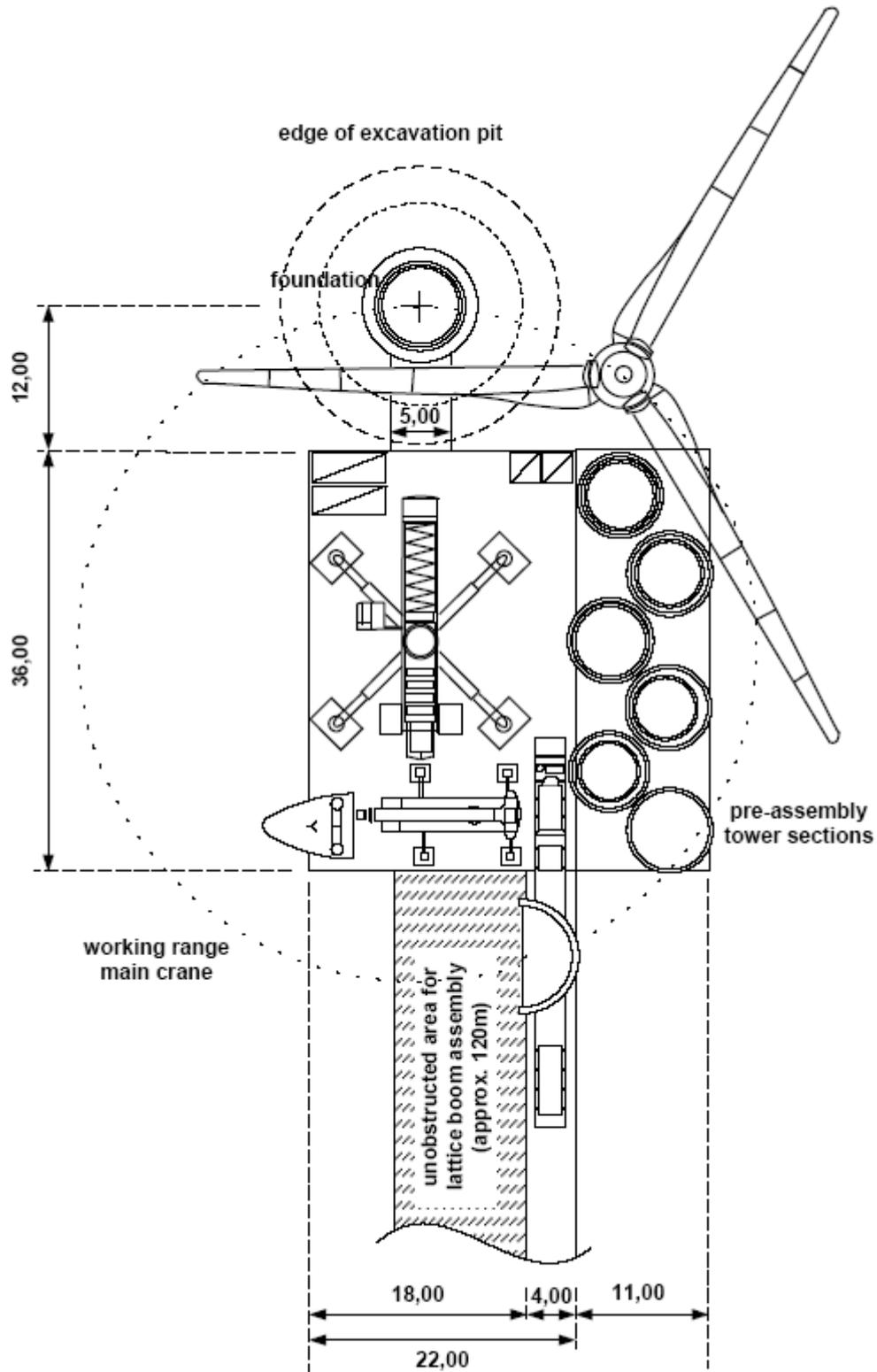


E-70: Service area of the 97m pre fabricated concrete tower (example)





E-70: Service area of the 112m pre fabricated concrete tower (example)



3 Transports

The single parts of the wind energy converter are transported to site on different trucks.

- | | |
|---|---|
| <i>Tower sections:</i> | - each tower section on one low-loader (see attachments) |
| <i>Hub:</i> | - Low-loader (total weight: approx. 52to) |
| <i>Stator/Rotor:</i> | - Low-loader (total weight: approx. 84to) |
| <i>GFK-parts:</i> | - 2 trucks |
| <i>Blades:</i> | - Truck (total weight : approx. 35to) |
| <i>Transformer house (if required):</i> | - Semi-low-loader (total weight: 30to + Transformer weight → please apply to ENERCON) |

The maximum height of the vehicles is 4,45m. It has to be ensured that the height of bridges, overhead lines etc. is not lower.

Time of delivery (night or day) mainly depends on the country and its driving permissions for trucks. It also depends on other circumstances: e.g. is there a wind farm or a single machine? Is there a stockyard next to site? To clear all these items please get into contact with the ENERCON Project Management-Department.

Normally the machine parts arrive on site first and are pre assembled. Directly after unloading is finished the trucks leave the site. On the second day all tower sections arrive on site and are installed. In parallel, the pre assembling of the machine parts continue. As soon as all tower sections are installed, the machine house, stator/rotor and the hub incl. the blades follow.

(Please see page 12 - 14 for a photo documentation of the whole transport procedure)



Section 1



Section 2



Section 3



Section 4



Nacelle



Generator



Rotorblade



Nacelle Side Casing



Hub
Hub Casing



Spinner

4 Crane requirements

E-70 with 63m steel tower

- 500to telescopic crane (mobile crane) with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 53to at a hook height of 73m or
- 500to lattice boom crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 53to at a hook height of 73m or
- 400to crawler crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 53to at a hook height of 73m.

E-70 with 84m steel tower

- 500to telescopic crane (mobile crane) with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 62to at a hook height of 100m or
- 500to lattice boom crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 62to at a hook height of 100m or
- 400to crawler crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 62to at a hook height of 100m.

E-70 with 98m steel tower

- 500to lattice boom crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 64to at a hook height of 118m or
- 400to crawler crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 64to at a hook height of 118m.

E-70 with 97m prefabricated concrete tower

- 500to lattice boom crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 51to at a hook height of 118m or
- 400to crawler crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 51to at a hook height of 118m and
- 500to telescopic crane for the assembly of the concrete tower required capacity 59 to, hook height 84m.

E-70 with 112 prefabricated concrete tower

- 500-600to lattice boom crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 51to at a hook height of 125m or
- 400-600to crawler crane with two independent hooks (two winches) in one lifting height plus one 120to mobile crane with one hook, required capacity 51to at a hook height of 125m and
- 500to lattice boom crane for the assembly of the concrete tower required capacity 92 to, hook height 96m

Using a lattice boom or crawler crane, it has to be ensured that the boom maybe laid down in its entire length and mounted by the small crane.



Turbine	Weight (to)	Min. Lifting heights = Tower height + (m)	Dimensions (m)
E-70			
Nacelle	18	10	7,5 x 5,5 x 6,1
Stator / Rotor	51	10	Ø 5 x 2,2
Hub	25	10	Ø 5,5 x 5,2
Hub with blades	42,5	10	Ø 70 x 5,2
Rotor blade 33,30 m	5,8	10	33,3 x 1,9 x 4,2
Towers	Weight (to)	Min. Lifting heights (from foundation surface)	Dimension (m) length / top diameter / bottom diameter
63m steel tower (WTGS class I)			
Section I	39*	73	25,95 / Ø 2,00 / Ø 2,79
Section II	49*	47	21,20 / Ø 2,79 / Ø 3,56
Section III	53*	26	14,95 / Ø 3,56 / Ø 4,20
foundation section	12*	10	2,00 / Ø 4,20 / Ø 4,64
84m steel tower (WTGS class II)			
Section I	39*	94	25,48 / Ø 2,00 / Ø 2,71
Section II	53*	69	23,07 / Ø 2,71 / Ø 3,35
Section III	61*	45	20,20 / Ø 3,35 / Ø 3,91
Section IV	61*	25	14,35 / Ø 3,91 / Ø 4,30
foundation section	16*	10	2,00 / Ø 4,30 / Ø 4,86
98m steel tower (WTGS class II)			
Section I	45*	108	28,50 / Ø 2,00 / Ø 2,73
Section II	62*	80	25,84 / Ø 2,73 / Ø 3,33
Section III	64*	54	19,54 / Ø 3,33 / Ø 3,85
Section IV	57*	34	14,41 / Ø 3,85 / Ø 4,30
Section V	26*	20	3,80 / Ø 4,30 / Ø 4,55
Section VI	36*	16	3,80 / Ø 4,55 / Ø 4,98
foundation section	29*	10	3,36 / Ø 4,98 / Ø 5,66
97m concrete tower (WTGS class II)			
Steel section I	37*	108	25,05 / Ø 2,00 / Ø 2,92
Steel section II	10*	84	3,08 / Ø 2,92 / Ø 3,02
18 Concrete sections	19 - 59	84	3,83 / Ø 3,02 / Ø 7,50
112m concrete tower (WTGS class II)			
Steel section I	37*	124	25,05 / Ø 2,00 / Ø 2,92
Steel section II	10*	96	3,08 / Ø 2,92 / Ø 3,02
22 Concrete sections	19 - 92	96	3,83 / Ø 3,02 / Ø 7,50

Depending on the crane, the working radius for assembly the E-70, varies between 22 – 32m.

*Due to manufacturing tolerances the tower weight may vary +/- 5 %

Revision : 10		Prepared : 18.12.1998
Date : 29.09.2004		Improved : M. Richter

5 Installation

Attention: Maximum wind speed for erection is 10m/s.

5.1 Installation Procedure Tower

For installing the tower, it is necessary to have two cranes. The small crane lifts up the bottom of the tower section, the big crane the top of it. This procedure is carried out simultaneously until the tower section has been lifted up about two to three meters.

Afterwards, the small crane stops and the big crane lifts the section up. Having reached its vertical position, the tower section is disconnected from the small crane. The big crane lifts the tower section to its final position where it is flanged to the other tower section already installed.

After the tower installation has been completed, the tower is levelled into the vertical position.

5.2 Installation Procedure WEC

The big crane lifts the nacelle which is flanged to the top section of the tower.

In order to move the generator and the rotor into the vertical position whilst pulling it up, two independent hooks are necessary.

Please refer to page 21 for a photo documentation of the whole installation procedure.

6 Personnel and Time Requirements

6.1 Installation

Installation team: 8 persons, from whom 3 could be locally trained

Number of turbines: 1 WEC within one week

6.2 Electric Works

Team: 6 persons, from whom 2 could be locally trained

Time: approx. three days per WEC

6.3 Commissioning

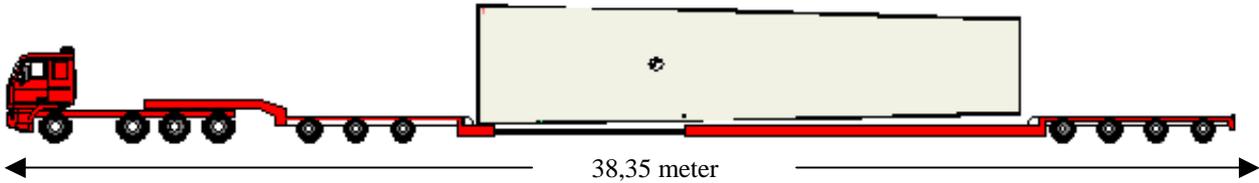
Team: 2 persons

Time: approx. two days per WEC



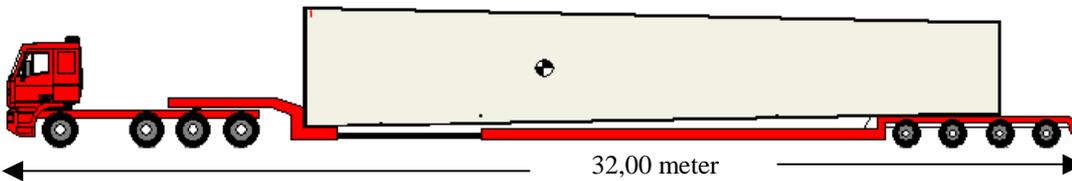
7 Attachments

E-70 / 63 m Steel Section 3



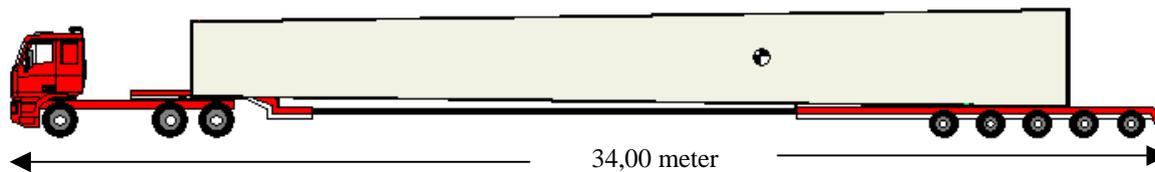
<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> Æ	<i>Small</i> Æ
Section 3	14,95 m	53,0 t	4,20 m	3,56 m

E-70 / 63 m Steel Sec. 2



<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> Æ	<i>Small</i> Æ
Section 2	21,20 m	49,0 t	3,56 m	2,79 m

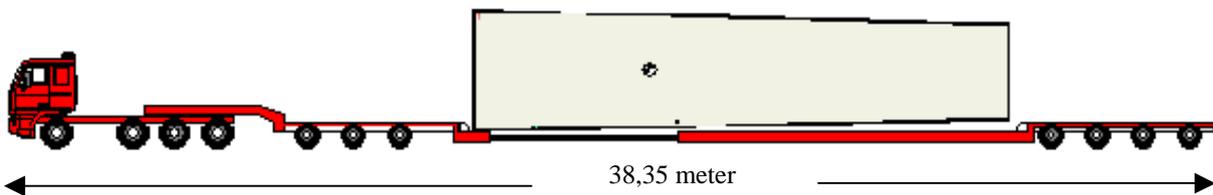
E-70 / 63 m Steel Sec. 1



<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> Æ	<i>Small</i> Æ
Section 1	25,95 m	39,0 t	2,79 m	2,00 m

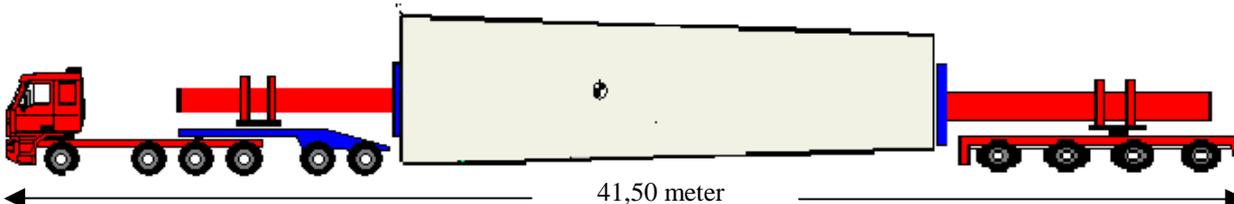


E-70 / 84 m Steel Section 4 - Open bottom low loader



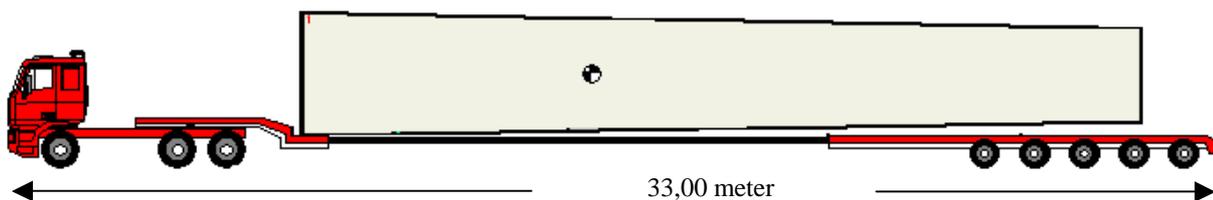
<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> <i>Æ</i>	<i>Small</i> <i>Æ</i>
Section 4	14,35 m	62,0 t	4,30 m	3,90 m

E-70 / 84 m Steel Sec. 3 – adapter loader



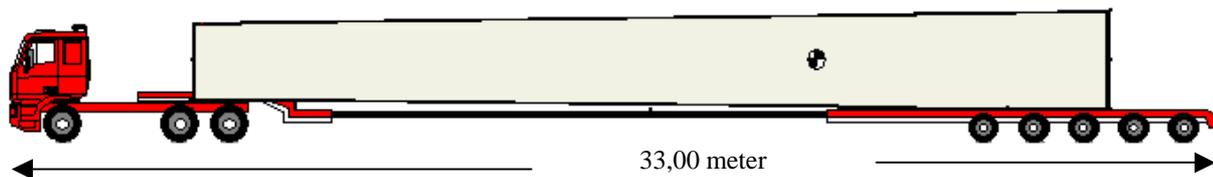
<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> <i>Æ</i>	<i>Small</i> <i>Æ</i>
Section 3	20,20 m	62,0 t	3,90 m	3,35 m

E-70 / 84 m Steel Sec. 2



<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> <i>Æ</i>	<i>Small</i> <i>Æ</i>
Section 2	23,07 m	53,0 t	3,35 m	2,71 m

E-70 / 84 m Steel Sec. 1



<i>Designation</i>	<i>Length</i>	<i>Weight</i>	<i>Great</i> <i>Æ</i>	<i>Small</i> <i>Æ</i>
Section 1	25,48 m	39,0 t	2,71 m	2,00 m

