Schedule G1
Site Specific Requirements – Kostolac Wind Farm

The Site Specific Requirements specified in this document shall be related to the Parties' obligations described within the Contract, Schedule B, Schedule J and Agreed Deviation List to ER where:

- The Employer is responsible for preparation of the Site Roads from Relevant Route Points (defined in Schedule G2 – Transport Survey) up to hardstands (defined in Schedule J). Road sections of the hardstands shall be a responsibility of the Employer.
- Hardstands (also named as crane pads) which are defined in Schedule J are responsibility of the Contractor.
- WTG foundations are responsibility of the Contractor.

In addition the Parties agreed that following agreements shall prevail over the Site Specific Requirements General Part from 4th of June 2020:

1. The Trial Run described in the Site Specific Requirements General Part shall have meaning of Trial Drive as defined in Conditions of Contract.
2. The Site Roads incl. road section of the hardstands shall be designed and constructed to be able to fulfil load of 20 tons per axle. The Contractor shall not operate vehicles exceeding load of 20 tons per axle.
3. The interfaces between Site Roads including road section of hardstands and hardstands shall be mutually agreed between the Parties during project execution as defined in Agreed Deviation List to ER
4. The Contractor shall maintain the hardstands until Take Over.
5. After the Take Over, the Employer shall be responsible for maintaining and restoration (if needed) of the Site Roads, hardstands and WTG foundations (preventive maintenance and corrective measures if needed) in accordance with Site Specific Requirements General Part from 4th of June 2020 to allow the Contractor to perform its obligations under the Service Agreement (LTSA).
6. As defined in Schedule B and Schedule D, the Contractor shall provide WTG type SG3.4-132 AM-1 3.3MW with the hub height of 114 m and total height (tip height) of 180 m.
7. The main traffic shall be managed by the Contractor and the Contractor shall manage its own transport trucks.
8. Number and position of passing and turning areas shall be defined during project execution.
9. As soon as the final design of roads and hardstands is ready, the Parties shall mutually agree on the driving direction to each of the hardstands to minimize the effort. In case that reverse drive is needed and it is not possible to achieve a 4% gradient, the Parties shall agree on the turning area.
10. The form of the Handover Checklist (Appendix 2 to Site Specific Requirements) shall be agreed during project execution between the Parties.
11. The Contractor shall be responsible for providing its own IT equipment as well as communication connection for its own use.
12. With regards, to 4.1.2 it is the Contractor's obligation to provide installation of a cleaning area for concrete trucks and other vehicles as defined also in Schedule B point 1.5.24.

Project information	
Project name:	**Kostolac**
Country:	**Serbia**
Employer:	**Jp Elektroprivreda Srbije**
Contractor:	**Siemens Gamesa Renewable Energy**

Revisions				
Rev.	**Date**	**Change**	**Responsible**	**Checked**
01				
02				

Table of Contents

1 GENERAL

1.1 Purpose

This document contains the minimum requirements for the Employer provided Site Infrastructure.

The document specifies the general requirements for the Access Roads, Site Roads, Assembly Areas, Construction Areas and Installation Areas to be used for the delivery of Contractor's scope of work. Furthermore, this document defines minimum requirements to be fulfilled by the Employer with respect to Compound and Storage Areas.

The document also specifies the necessary steps the Employer shall fulfill regarding the investigation, design, construction and documentation for the required infrastructure.

Limitations:

This document does not take into account the dynamic effects, acceleration and deceleration, sloping road- and slippery road surface, weather conditions, conditions of the transport equipment and road friction coefficient.

The requirements are based on idealized situations and applied safety factors to allow real life variations based on experience and judgements.

SGRE will consult with the Employer to adjust the requirements where possible to meet the site-specific conditions.

Safety shall always be the ruling factor in all situations.

1.2 Scope of Application and Validity

This instruction applies to all projects where the Contractor (or Turbine Supplier hereafter referred to as the Contractor) will perform the transportation, erection and installation work.

Non-conformances with these specifications can cause major problems, e.g. for transport, mounting and handling of the turbine components.

1.3 Abbreviations and Definitions

TSA: Turbine Supply Agreement - The Conditions of Contract

WTG: Wind Turbine Generator - As defined in the TSA

SG: SGRE Wind Turbine

Contractor: Siemens Gamesa Renewable Energy

Employer: **Jp Elektroprivreda Srbije**

Figure 1 below shows the placements and boundaries of the terms used in this document.

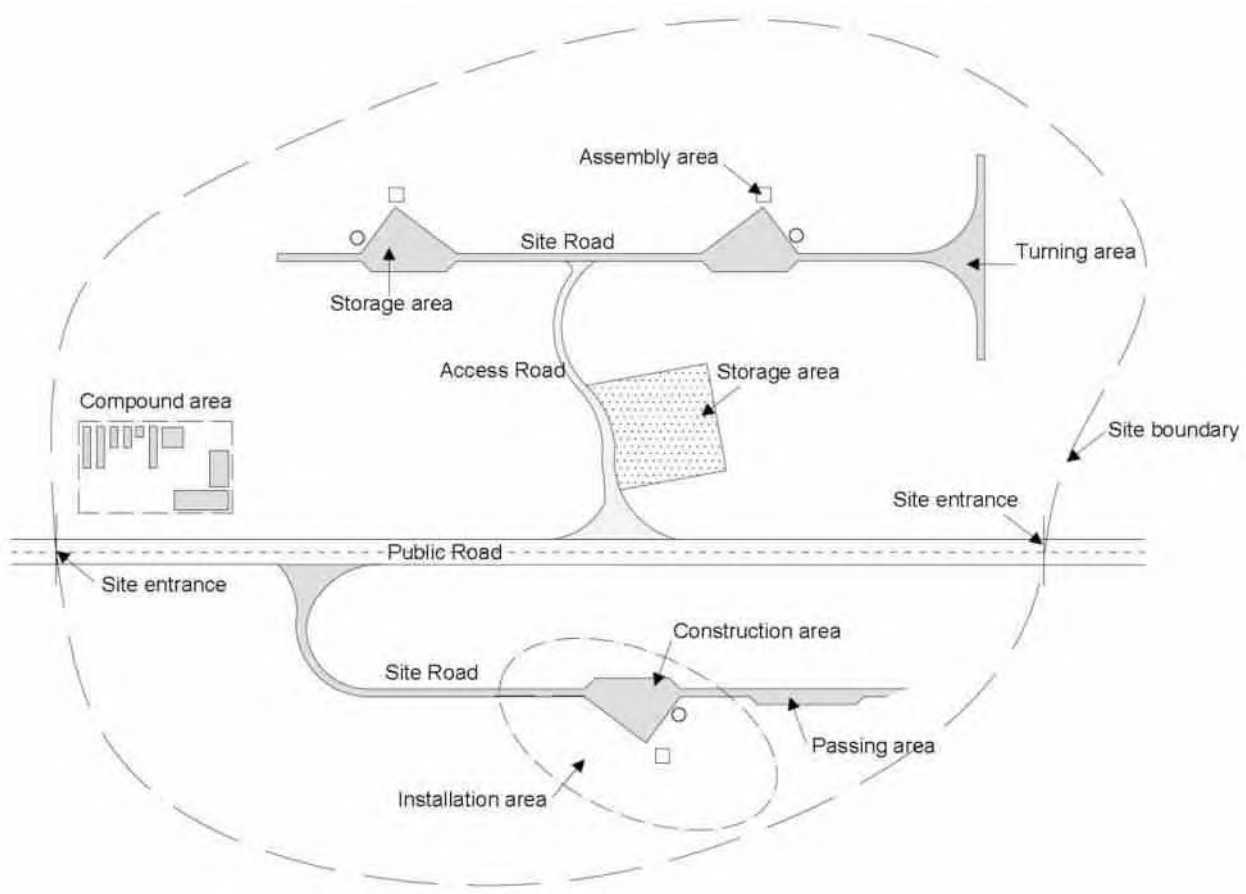


Figure 1: An Example of a Site.

Definitions:

Access Road Road connecting Public Road to the Site. This road can be Public Road or part of the Site Infrastructure.

Area(s) Means the Assembly Area, the Compound Areas, the Construction Area, the Installation Area and the Storage Area, or one of them, as the context requires.

Assembly Area Area on Site where the hub can be stored and where the rotor is assembled prior to the installation of the complete rotor. The area is only relevant for the Rotor Assembly Installation Method and Single Blade with the Kelly yoke.

Assist Crane A crane helping to rig/de-rig the Main Crane and supporting the Main Crane in the WTG erection.

Construction Area The part of the Installation Area located at each WTG foundation position which is required for assembling and operating the cranes, containers for lifting equipment, generator unit, Working Area with tools and containers etc.

Hardstand	An improved / stabilized area with a prepared surface where cranes can operate, vehicles can be parked, and material / components can be stored. Hardstand is also a general expression used for Construction Area. The bearing capacity of the hardstand is stated in **GP Table 7 and 8**.
Installation Area	The entire working area needed when erecting a WTG. The area consists of several areas, each with different requirements. The Installation Area may consist of an Assembly Area, Construction Areas for the cranes and, Storage areas and Trestle Areas.
Kv	The term Kv is used to represent the Vertical / Longitudinal radius (Also expressed as Rmin)
Main Crane	A crane capable of lifting the WTG components into the final position.
Passing Area	Area where Transport Vehicles safely can pass each other.
PU	Power Unit.
Public Road	Road that is open for public use and is maintained by a public authority.
Pre-Assembly	Assembly of certain WTG components that do not require the Main Crane for installation.
Rotor Assembly Installation Method	Method where the hub and the blades are assembled on ground prior to lifting of the entire rotor.
Safe Working Access	Areas that allow access/egress and work to be carried out safely without the risk of slips/trips/falls.
Service Period Requirements	Requirements given in this document for the Site Roads and Areas that the Employer must achieve in order for the Contractor to operate and maintain the WTGs in the agreed service and defects notification period.
Single Blade Installation Method	Method where the hub and the blades are installed individually.
Site	The place where the installation works are to be executed and to which all materials are to be delivered as defined in the Contract.
Site Boundary	The area where requirements given in this document must be achieved by the Employer in order for the Contractor and his sub-contractors to operate safely and efficiently during the construction phase and the service and defects notification period. The delimitated area is shown in **Figure 1**.
Site Entrance	The Site Entrance is the official entrance to the Site.
Site Infrastructure	General expression in this document for the Site Roads, Areas and Hardstands within the Site Boundary.
Site Facilities Compound Area	The base area for the Contractor's site management and technicians. The area consists of restroom facilities, parking and site offices. In some cases, the Site Facilities Compound Area may be combined with the Stores Compound Area.
Site Roads	Roads within the Site Boundary.
Storage Area	The lay down area for WTG components and tools. Depending on the Site Infrastructure, the Storage Area can be placed in connection with the Construction Area where it can be used as a Passing Area as well.

Stores Compound Area The base area for the Contractor's technical equipment including, but not limited to, plant, skips, waste disposal, tool containers, spares and fuel. In some cases, the Stores Compound Area may be combined with the Site Facilities Compound Area.

SU Switch gear unit.

Transport Vehicle General expression in this document for WTG and crane component transportation vehicles as well as cranes.

Trestle Area Area where the blades are stored on the Installation Area.

TU Transformer unit.

Turning Area Area where the Transport Vehicles can turn around to prevent long reverse driving.

Working Area Area free from trees, obstacles and trip hazards and prepared as to allow persons to move freely and safely while performing work. The Employer may be required to perform stabilising works if the ground is particularly soft/boggy.

2 RESPONSIBILITY AND AUTHORITY

The Employer shall design, construct and maintain the Site Infrastructure described within this schedule or exhibit in accordance with the Contract.

Site Infrastructure shall be functional at all times for heavy cranes, oversize trucks and the Contractor's personnel vehicles involved in the project execution, warranty period as well as the service and maintenance period. All Site and Access Roads shall be in good condition, maintained and repaired at all times (and under all weather conditions) by the Employer, including for example the clearance of water, snow, ice, hail, mud, debris, filling of pot holes etc. as required. The Employer shall also ensure that safe access is provided to the access point of the turbine at all times.

The detailed location of the roads and Areas are defined in Schedule / Exhibit J1/Employer's documentation.

The Employer and the Contractor shall each be responsible for their own traffic management and other traffic safety related activities within the Site Boundary. However, the Employer has the overall responsibility for the traffic management and other traffic safety related activities within the Site Boundary.

If the Employer becomes aware of road access restrictions, the Employer shall inform the Contractor of such restrictions as soon as reasonably possible thereafter.

The Employer remains at all times solely responsible for conducting investigations and designs according to this document. The Contractor's comments to the performed investigations and designs shall under no circumstances relieve the Employer of his responsibility, and the Contractor shall not be liable for any such comments.

3 INSTRUCTION AND ACTIONS

3.1 Basis of Design

3.1.1 General Design

Design of the Site Infrastructure including all Areas and Hardstands must be performed by the Employer in accordance with the laws and legislation applicable in the country where the wind farm is being developed, and with a consistent set of design codes, to yield a sufficient level of safety and suitability.

The present document generally refers to the Eurocode system with relevant National Annexes. Where appropriate, similar national standards yielding a level of safety comparable with the Eurocode system, may be used.

The Employer must pay due attention to the concentrated nature of loads. In particular, caution shall be applied with regards to assumed pressure distribution through the unbound base layers.

The design shall be performed taking into account the quality of the building materials that can be obtained for the works. The National Annexes of the Eurocodes and Gravel Roads Maintenance and Design Manual (by Ken Skorseth and Ali A. Selim, 2000) give guidelines for suitable material for the construction of the Site Infrastructure.

The design shall be performed based on the geometric requirements and applying loads as specified in **GP table 7 and 8**.

3.1.2 Geotechnical Investigations for Roads and Hardstands

Eurocode 7, EN 1997-2, Ground investigation and testing, is the ruling code to be applied by the Employer in collecting geotechnical data. The Employer shall plan geotechnical investigations in such a way as to ensure that relevant geotechnical information is adequate to manage identified and anticipated project risks. EN 1997-2, annex B, gives informative guidelines for the level and planning of geotechnical investigations.

3.1.3 Design Methodology

The Employer shall perform road design by using an empirical analytical method where actual stresses and strains in the pavement structure are calculated and compared with allowable stresses and strains. This method may be based on the simplified loads given in **GP section 7.1** (single wheel load, contact pressure and numbers of passes) and measured subgrade moduli.

The above described method will allow for variable thickness between the most frequently used parts of the Site Road network and the part of the road network that will have the lowest frequency of traffic.

The design has to be based on the local material properties (E-moduli/CBR) and the appropriate local criteria for these.

Alternatively, the road design can be based on national standard methods applying the detailed loads listed in **GP section 7.2**.

The Employer's design of Hardstands shall be based on an analytical determination of the geotechnical bearing capacity for the Hardstands applying loads as listed in **GP table 7 and 8** from the time of the plate bearing tests onwards.

3.1.4 Construction Supervision

To ensure that design conditions are fulfilled, construction supervision is crucial. The Employer shall ensure that construction supervision is carried out in accordance with EN 1997-1 using skilled personnel regarding:

- Ground conditions.
- Compaction control.
- Groundwater flow.
- Movements, yielding, stability of excavation walls and base;
- Safety of workmen with due consideration of geotechnical limit states.

3.1.5 Documentation

To facilitate a proactive dialogue about the layout and design of roads, Areas and Hardstands, the Employer shall submit the following documentation to the Contractor or their sub-contractors for review and possible commenting. Please note that the Contractor's possible comments to the design are in no way to relieve the Employer of its responsibilities under the Contract.

The Employer shall submit the following documentation to the Contractor for review:

- Prior to the construction of the infrastructure within the Site Boundary such as roads and Hardstands, the Employer shall present designs and documentation to the Contractor for review.
- No later than 4 months prior to commencing delivery of any WTG components, the Employer shall provide a detailed layout of the project site identifying the construction status of the roads and Hardstands.
- As built drawings of Hardstands shall be provided as specified in TSA Exhibit B [Contract Program].
- Results of each hardstand plate bearing tests shall be available upon request at least one month before Contractor's access to Site or as stated in TSA Exhibit B [Contract Program]. The Contractor shall be permitted to specify the locations of minimum four plate bearing tests at each hardstand.
- Type and quantity of verification testing (e.g. static plate load test)
- Acceptance criteria for testing (e.g. Ev1 and Ev2 for static plate load tests)
- Results from a minimum of four static plate load tests per Hardstand with at least two tests in the area of the Main Crane area
- Results from a minimum of one static plate load test for every 500m of road
- Verification of load bearing capacity and estimation of settlements for the Main Crane area
- Verification of load bearing capacity for remaining hardstands (auxiliary crane, assembly and storage areas) and roads

In addition to the above documentation the Contractor shall be entitled to ask for the below documentation.

- Any additional results of geotechnical investigations
- Designs of the site layout including cross sections and material specifications
- Construction supervision reports
- Quality control documentation and test results
- Verification of site-specific / special geotechnical matters (e.g. slope stability, soil improvement)

- Verification tests of compaction of the subgrade and of each fill layer
- Type and quantity of suitability testing (e.g. particle size distribution, proctor test) of the construction materials

The test locations shall be selected considering the loading areas and in consultation with the geotechnical expert in order to ensure that the results reflect the representative subsoil conditions.

If the subsoil conditions are heterogeneous, the testing schedule needs to be adjusted by a geotechnical expert.

If the subsoil conditions differ substantially from the geotechnical investigation, additional geotechnical investigations shall be performed and the design shall be reviewed / adjusted.

A common in-situ test is the static plate load test as per DIN 18134 (or equivalent international standard). The testing shall be carried out with a suitable sized plate preferably at least 60cm. Dynamic load test can be considered if prior calibration has been made with static plate load test.
In general, plate load tests are only suitable for testing the compaction grade of superficial soil layers to a very limited depth. Since deeper soil layers may significantly influence the bearing capacity and settlement behavior of the soil structure under the applicable construction loading, it may be prudent to apply also suitable penetrative soil exploration methods.

The Employer shall provide in .dwg (cad) or similar format drawings of the Site Infrastructure:
- as-planned drawings: 20 weeks before contractual start of installation
- as-built drawings 5 weeks before contractual start of installation

As-built drawings of site roads and hardstands much include the following information:

- Dimensions
- Gradients
- Longitudinal radii
- Crossfalls
- Extents of bearing capacity
- Permissible ground bearing pressure
- Permissible axle loadings

3 weeks prior to start of turbine delivery, the Employer shall provide a Certificate that confirms the roads and the Hardstands are suitable for the purpose and comply with the requirements in this document.
The Statement or Certificate (provided in Appendix 3) shall be supplemented by the results of the performed verification tests (plate load tests).

The Hardstands and roads shall be subject to regular inspections, which shall be documented in field inspection logs, by a competent individual appointed by the Employer. Any inadequate areas identified must be reinstated to the designed standard.

Prior to the handover of Compound, Storage & Facilities and each WTG Hardstand, the Contractor and Employer shall complete the checklist (provided in Appendix 2).

3.1.6 **Trial Run**

A trial run shall be carried out as soon as possible after the completion of the Site Infrastructure. The trial run shall be completed at the latest 4 weeks prior to the WTG delivery commencement date as specified by the Contractor (excluding scheduled delivery of foundation parts).

Type and configuration of the vehicle used for the trial run shall be decided by the Contractor.

Site Infrastructure which does not comply with the requirements as set out in this document, shall be upgraded by and at the expense of the Employer, prior to the WTG delivery commencement date as specified by Contractor. Failure to accomplish such upgrades prior to the turbine delivery commencement date as specified in Schedule C / Contract Program will result in an extension of time for completion and compensation of additional cost to the Contractor in accordance with the TSA.

3.2 **Completion**

3.2.1 **General**

The Employer shall make an inspection after completion of Site Infrastructure in order to ensure that all requirements have been implemented correctly. Upon completion of this, the Employer shall contact the Contractor, who may perform his independent inspection. This shall however not relief the Employer from his obligations as set out in this document.

The Hardstand/Foundation handover checklist at Appendix 2 shall be used by the Contractor and Employer to document all areas not meeting the requirements specified herein. The Employer shall ensure all such comments are rectified prior to the date specified in Schedule C / Contract Program. The Contractor and Employer shall review this checklist on a regular basis thereafter (as mutually agreed but no less than every 2 weeks) to ensure all areas are appropriately maintained.

3.2.2 Example of site layout

The figures below show examples of road infrastructure for safe delivery of WTGs. Detailed discussions can be held between the Contractor and Employer to find the best and cost-effective solution.

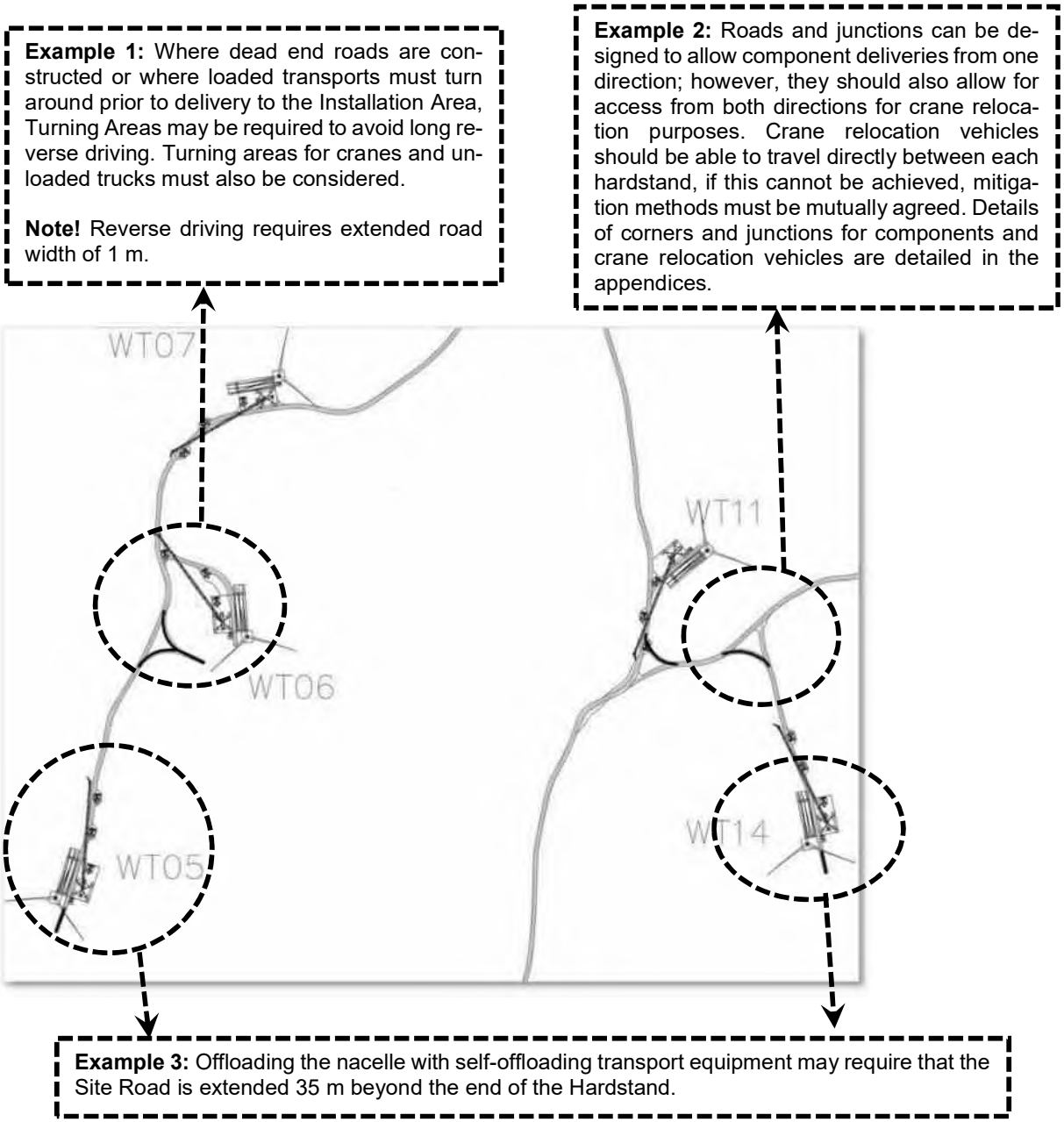


Figure 2: Example of site layout. The detailed project site infrastructure is provided in Schedule J1/ the Employer's documentation.

4 ROAD GEOMETRY AND GENERAL ROAD REQUIREMENTS.

4.1.1 Road Marking

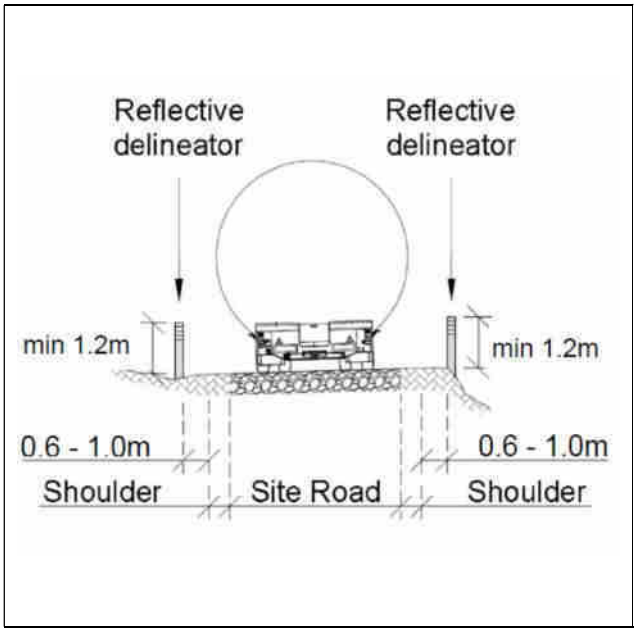


Figure 3: Placing of delineators by the road.

The Employer shall clearly mark the Site Roads with full bearing capacity (marked as **B** in **GP figure 4**).

Reflective delineators or similar device shall be mounted along dangerous and complicated road stretches.

Top of the reflector shall be min. 1.2m above the road surface. They shall be placed 0.6m to 1.0m outside the edge of the shoulder at a constant distance from the edge of the Site Road.

They shall be spaced a maximum of 60m apart on mainline sections and shall be spaced a maximum of 30m apart on ramp and curved sections. For curved sections, a pair of markers will be used to mark the start and finish of the curved section, as well as the apex of the bend.

Delineators may need to be removed for certain component deliveries (e.g. to allow for blade oversail). In such cases, the Employer shall arrange for their removal and reinstatement.

4.1.2 Road Surface

Roads and hardstands shall be constructed following the specifications of this document and **Appendix 1**, surfaced using Type 2 material, in accordance with the Specification for Highway Works, Clause 804 (i.e. from 63mm down and well graded), to ensure suitable surface for operations throughout performance of the works. For example:

- Site and Access Roads shall be regularly rolled to prevent large stones causing damage to cranes and other vehicles.
- Large potholes can cause damage to cranes and other vehicles and in extreme cases also present a hazard for vehicle operatives. Therefore, the roads shall be maintained as per the original design at all times to ensure there are no pot holes larger than that shown in **Figure 8**.
- The Employer shall be responsible for ensuring systems are in place to avoid excessive dirt / debris being deposited onto the Public Roads e.g. road sweeping or provision of wheel wash facilities as required. The Contractor shall cooperate with the Employer and other sub-contractors in relation to such systems of work.
- Preventative measures to reduce airborne dust particles, e.g. regular watering, should be undertaken in dry conditions to ensure visibility for drivers on site and reduce dust pollution in neighbouring areas.

The road surface should provide suitable traction to allow a single tractor unit on the component trailer to transport all components up to a gradient of 8% (or 15% with the addition of an 8x4 pulling unit, if included in our proposal). If suitable traction cannot be achieved due to surface quality or weather conditions prevalent at the time of transportation, then the time/cost of additional units will be at the expense of the Employer.

4.2 Road Width and Cross Fall

Due to the loads from transport vehicles, the Employer shall ensure a sufficient width of the road shoulders in order to obtain full bearing capacity for the road with the clearly marked width **B.**

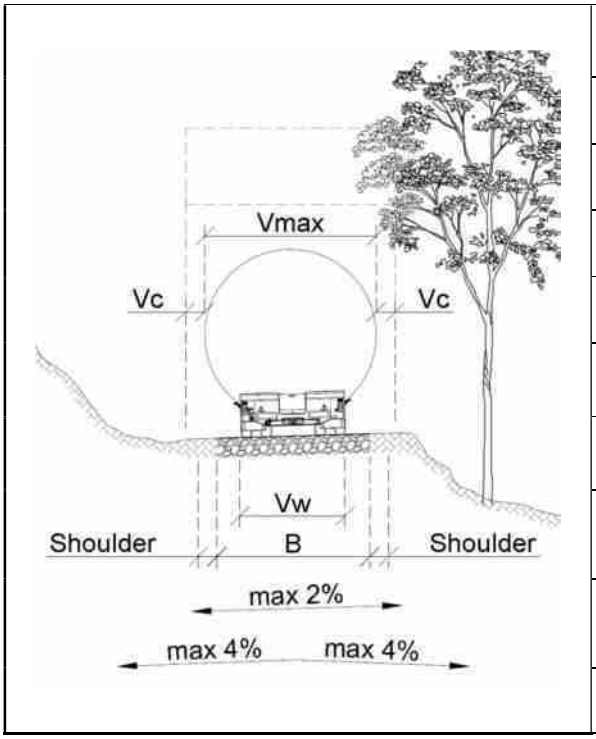


Figure 4: Road width and cross fall.

Min. width with **full bearing capacity** = B	4 m
Width of shoulders	X m*
Width of truck = Vw	3 m
Min. clearance on both sides = Vc	0.5 m
Width of component = Vmax	See appendix 1
Max. lateral slope – Ordinary road profile	See table 2
Max. lateral slope – Road roof profile (both sides)	See table 2
Min. height clearance (Access/Site Road to first WTG or crane fully de-rigged for all Site Roads)	6 m
Min. height clearance (Site Roads between WTGs, partially de-rigged with 20T axle road)	8m**
(Site Roads between WTGs, partially de-rigged with 24T axle road)	18m**

Table 1: Requirements for Site Roads.

**Width of shoulders to be defined by the Employer. It is, however, the Employer's responsibility to design the shoulders so that they provide adequate support for the 4m of driving surface.*
*** Axle load given for Site Roads on slopes less than 5%.*

NOTE: Reverse driving and any areas requiring pulling units as detailed **GP section 4.3** shall require the road width to be extended by a minimum of 1m. Reverse driving and push pull unit usage is possible on straight roads up to a maximum of approximately 500m. Locations requiring reverse driving and push pull units shall be pre-determined as part of the Site setup discussions.

Cross-fall requirements		
Straight Roads		**Corners**
Crossfall Single	**Crossfall Double**	**Crossfall Single *(Double crossfalls are not permitted on corners)***
2%	4%	2%

Table 2: Crossfall requirements

4.3 Gradient and Longitudinal Radius (Kv)

The maximum allowable gradient, longitudinal radius (Kv) and cross falls on roads are stated in **Table 3** and **Table 4.** The gradients shall be gradual and measured over an approximate distance of 12m.

Gradients and Push/Pull requirements	Max Gradient without push/pull unit*	Max Gradient with push/pull unit*
For WTG component transports	8%	15%
For reverse driving	4%	-
Crane (Main body) Partially De-rigged	8%	-
Crane Fully De-rigged	8%	15%
Crane componants	8%	15%

Table 3: Maximum gradients with and without push/Pull units.

The requirements above are based on a lattice boom crane as it is the assumed crane type to be utilised for this project. Should a different crane type be required or proposed, the Contractor shall discuss and agree the requirements with the Employer prior to Contract Effective date.

For gradients bigger than 8% and up to a maximum of 15%, a pulling unit (as shown in **Figure 7) is required. The use of pulling units is highly dependent on conditions such as length of gradient, straight/curved roads, road surface quality and weather conditions. Instances where gradients above 15% are required, these are to be assessed on a case by case basis. Special conditions are required to achieve this and can include, but are not limited to, the use of specialized pulling units and tarmac roads for the full duration of the gradient and length of the vehicle at the top and bottom of the gradient to ensure sufficient traction throughout. Unless explicitly stated, our proposal assumes movement of the crane in a partially de-rigged configuration for all WTG locations and that no pulling units are required for the project. If required, SGRE is able to work with the Employer to define those areas on Site which may require either a pulling unit or full crane de-rigging.*

***Actual achievable gradients depend on the quality of the road conditions and maintenance, and are therefore subject to Site conditions at the time of transportation. The Contractor shall identify any concerns to the Employer at the Trial Run for resolution by the Employer. Both parties shall then review the road condition on a regular basis during the transportation and installation phase to ensure the roads are maintained by the Employer in the condition agreed at the time of the Trial Run.*

****Permissible gradients for reverse driving are dependent on the type of vehicle, road width, quality of the road and whether the gradient is uphill or downhill. When reversing uphill, the permissible gradient is 4% under normal operating conditions. Normal operating conditions can be considered as all-weather road surface, road widths as per **GP section 4.2** and the transport equipment moving only under its own power. All instances of reversing with gradients higher than 4%, whether downhill or uphill, must be brought to the attention of SGRE and assessed on a case by case basis. When reversing uphill, gradients of 8% are potentially achievable on a short straight section (a maximum of 2 truck lengths) on a 6m wide road with sufficient traction and the aid of a pulling unit. When reversing downhill, gradients of 6% are potentially achievable on a short straight section (a maximum of 2 truck lengths) on a 6m road with sufficient traction. It is not possible to use a pulling unit with a blade truck whilst reversing.*

The Longitudinal radius defines how quickly a gradient can change over a section of road. It is important to allow safe transport of WTG components without bottoming out or causing excess stress to transport equipment. The baseline Kv is stated in the SSR **Appendix 1 Section 1.1**.

The Kv value is subject to change depending on the gradient of the road. On steeper sections of road WTG components must be transported lower to the ground in order to keep the centre of gravity at a safe level. The values for different gradients are detailed below.

Longitudinal Radius (Kv)	Kv (m)	x (mm)	Differential (x)
The Kv for this specific turbine is detailed in **Appendix 1 Section 1.1**. For gradients above 10%, the baseline Kv must be increased by 100m. For gradients above 15%, the baseline Kv must be increased by 200m.	350	320	The difference in height between any 2 points must not be greater than "x" over a distance of 30m.
	400	280	
	450	250	
	500	225	
	600	190	
	800	140	

Table 4: Kv Values for different gradients.

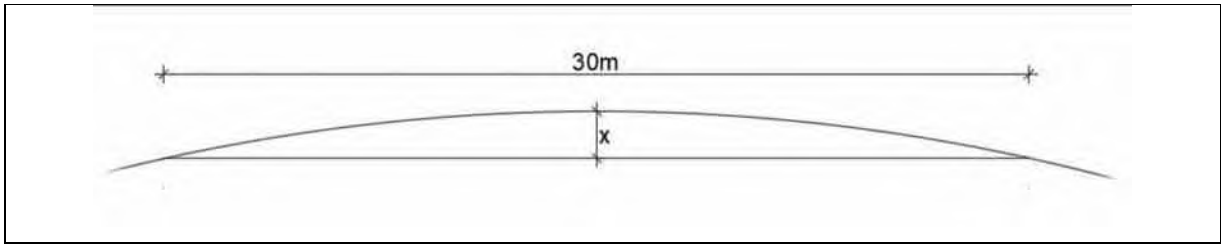
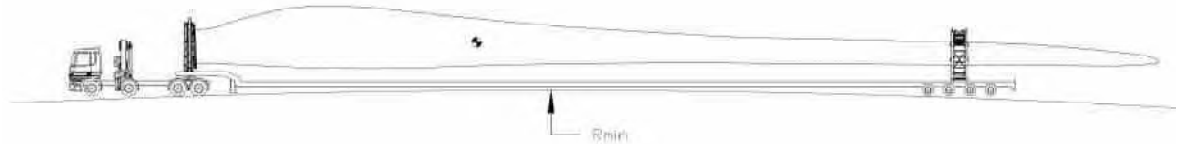
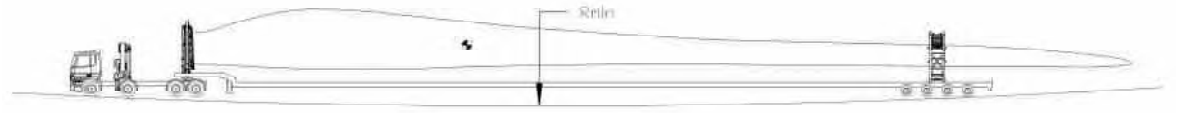


Figure 5: Example of x measurement to verify Kv.



Convex longitudinal radius



Concave longitudinal radius

Figure 6: Longitudinal radius.

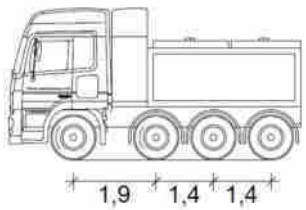


Figure 7: Example of a standard 8x4 pulling unit (4 of the 8 wheels are driven by the engine).

Figure 8: A well maintained Site Road shall not have pot-holes deeper than 30mm and/or a distribution/collection of pot holes that at the reasonable discretion of the Contractor cause unsuitable or unsafe driving conditions.

Figure 9: Example of a well-groomed gravel road with a slope for proper drainage.

4.4 Road Bends and Junctions

In order to ensure safe operation for the vehicles used during construction/installation, road bends and junctions shall be constructed by the Employer according to the requirements set out in **Appendix 4**. In addition:

- Road bends sharper than **90 degrees** may need to be custom designed and discussed in detail with reference to the actual transport equipment.
- Road bends with a vertical gradient bigger than 3% over the course of the bend need to be analysed for each individual situation.

4.5 Passing and Turning Areas

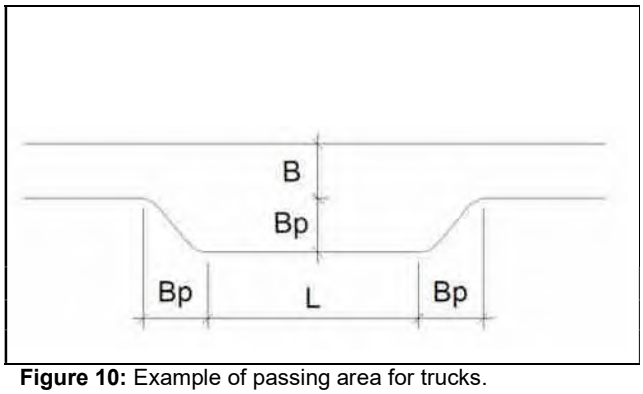


Figure 10: Example of passing area for trucks.

Depending on the road layout, logistics and choice of Hardstand arrangement, Passing and/or Turning Areas shall be incorporated into the Site Infrastructure design. Passing places shall be provided every 500m along the Site access track and on Site as required, depending on the final Site layout. Should this cause difficulties in the design, the Contractor will assist the Employer to identify other options to ensure a smooth traffic flow e.g. one-way system.

Requirement	Value
Length of passing (L)	25 m
Width of passing (Bp)	6 m

Table 5: Requirements for dimensioning Passing Areas.

Where dead end roads are constructed or where loaded transports must turn around prior to delivery to the Installation Area, Turning Areas are required to avoid long reverse driving. Please refer to **Figure 11 & Figure 12** for requirements relating to Turning Areas. Discussion is required between the Employer and Contractor in order to identify which Turning Areas should be constructed for loaded / unloaded trucks.

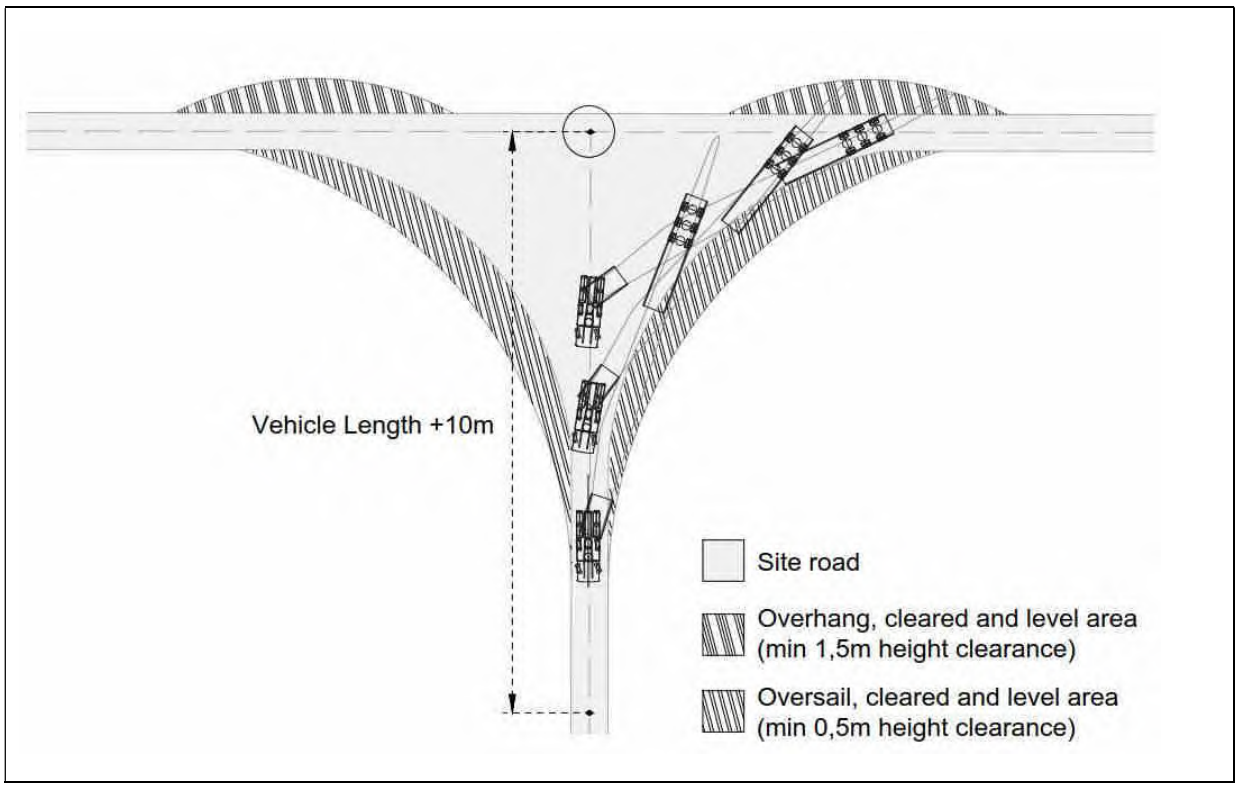
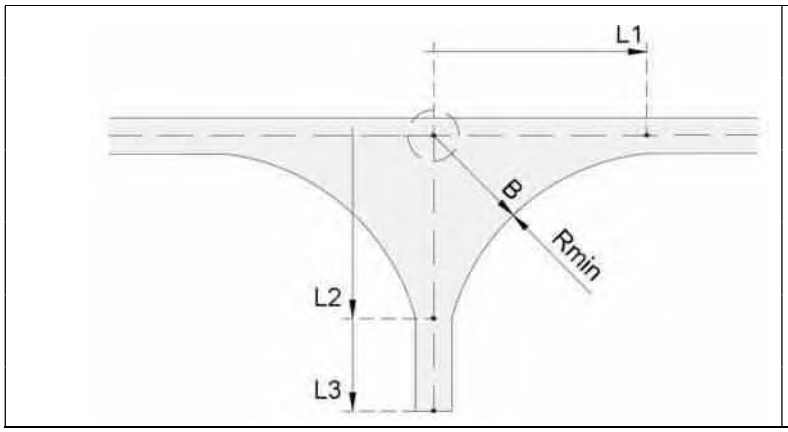


Figure 11: Turning Area for **loaded truck**. Hatched areas must be cleared of obstacles and levelled to allow oversail/ overhang during transportation. See **Appendix 4** for road bends and junctions to dimension the Turning Areas.



Angle X	90 °
R min	25 m
B	12 m
L1	22 m
L2	20 m
L3	35 m

Figure 12: Turning Area/Junction for empty trucks and crane relocation. Hatched areas must be with full bearing capacity and cleared of obstacles and levelled to allow oversail/overhang.

Table 6: Requirements for Turning Area for empty truck and or crane relocation.

Turning areas should be agreed with SGRE and the agreed locations detailed in Schedule J1.

4.5.1 Site Entrance – Access Plan

Transport Vehicles will normally arrive to Site during the hours of darkness, thus it may not be possible for them to safely continue driving inside the Site until daylight hours. This will be dependent on the complexity of the Site, e.g. tight corners, exposed road sections, gradients etc. Equally in some cases, the Transport Vehicles may not be able to access the Site due to adverse weather conditions.
In order to ensure the Site Roads are kept clear for site and emergency vehicles, a lay-by area that can allow a convoy of 3 blade delivery vehicles to safely park, while allowing other vehicles unhindered access to Site, may be required. The need for, location and size of this area must be agreed between the Employer and the Contractor.

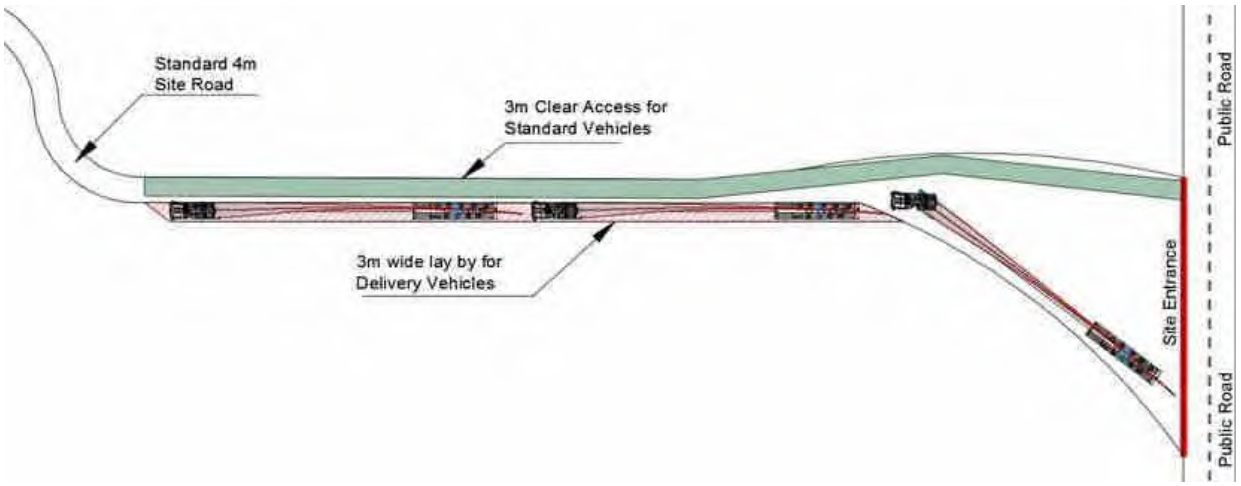


Figure 13: Example of a lay-by area for 3 blade delivery vehicles by the site entrance that allows for safe parking without blocking any Public or Access Roads.

4.5.2 Drainage

Along the Site Roads and Hardstands, sufficient drainage shall be included by the Employer to ensure that Site Roads and Hardstands are functional in all weather conditions.

4.5.3 Crossings

The Employer shall arrange for the fortification of earthworks and bridges on Site at points of crossing along pipelines and other underground services. Design of the necessary fortification shall be based on loads specified in **Table 9.**

4.5.4 Overhead Power Lines

Any LV/HV power or communication lines crossing Site Roads shall be clearly marked by the Employer and raised where required to provide the height clearance as per **Table 1**.

4.5.5 Indicative Transport drawings

The figures below show indicative types of Transport Vehicles used for transporting SGWT components. For more detailed information, please refer to the **Route Survey** document.

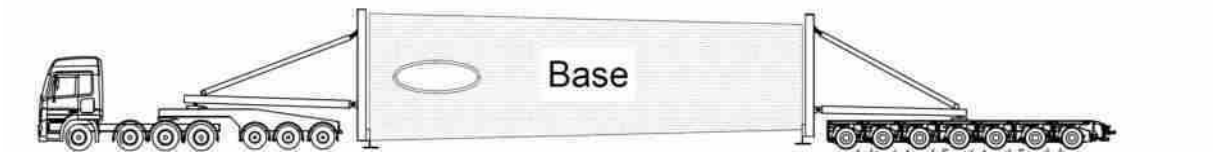


Figure 14: Self offloading tower transportation.

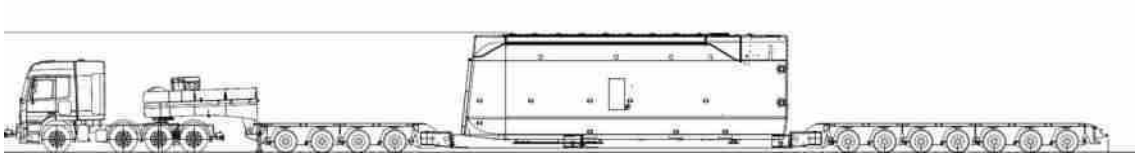


Figure 15: Geared nacelle transportation

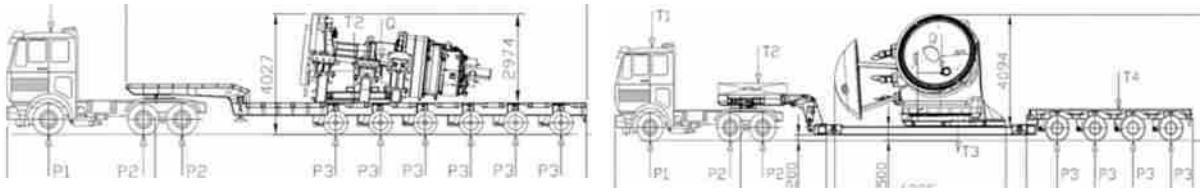


Figure 16: Geared drive train and hub transportation

Figure 17: Direct drive split nacelle transportation.

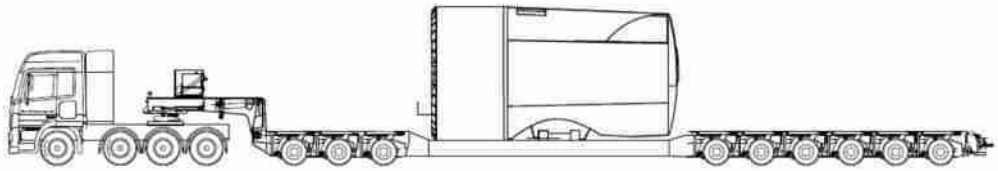


Figure 18: Direct drive full nacelle transportation.

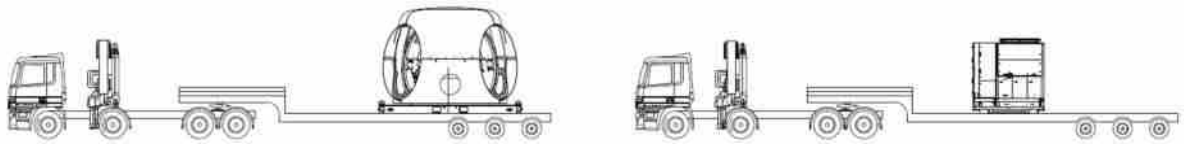


Figure 19: Direct drive hub and PU transportation.

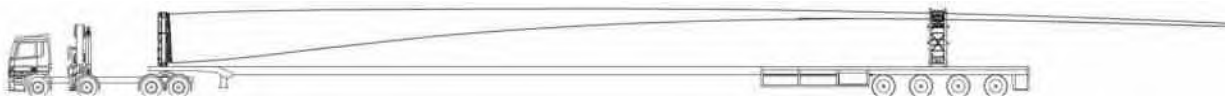
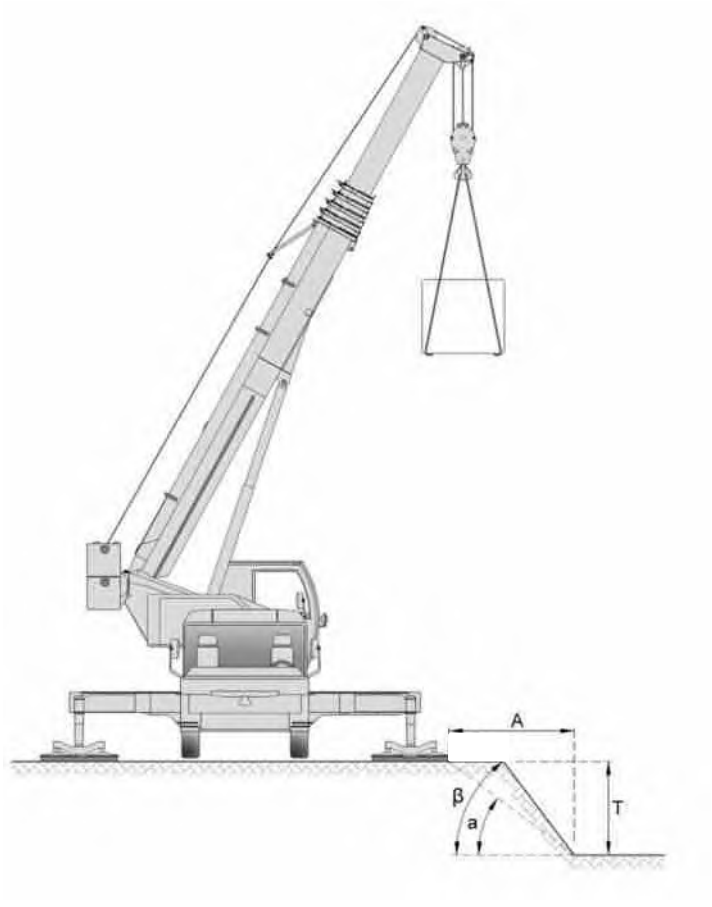


Figure 20: Blade transportation.

4.5.6 Slopes and trenches



Heavy loads must not be set up too close to slopes or trenches. Depending on the soil type, a safe distance must always be kept from the edges.

It is the Employer's responsibility to ensure that there is sufficient load bearing capacity within the Areas required in this document.

As ground conditions and building material can vary from place to place, safety margins are not included in this document.

Please refer to Appendix 1 for requirements regarding Hardstand geometry and level differences.

Figure 21: Requirements for setting up the crane near slope or trench.

5 INSTALLATION AREA

Construction Area in this document is based on an ideal circumstance of a flat piece of land. However, the Contractor acknowledges the fact that the terrain will have an impact on the final layout of the hardstand and storage area. **Therefore, it is recommended that a Site-specific layout is provided to the Contractor prior to Contract so that Siemens Gamesa can review and provide comments on how to optimize the Construction Area layout.**

The following requirements apply to all hardstand types. Whilst the price / programme have been based on these configurations, other options are available which can be discussed between the Employer and Contractor.

Please refer to **Appendix 1** for additional requirements regarding the Installation Area

5.1 Installation Area Requirements

5.1.1 General Information for WTG Installation Area

Installation Area includes the entire working area needed when erecting a WTG. It consists of several areas each with different requirements.

Configuration of the Installation Area depends on the following:

- Specific Site conditions
- Crane type
- Logistical possibilities
- Assembly method: Rotor Lift/ Single Blade Lift

In order to design the most effective Site layout that will work both for an optimal delivery and installation, it is crucial that the above-mentioned points have been investigated and analysed.

5.1.2 Example of Construction Area

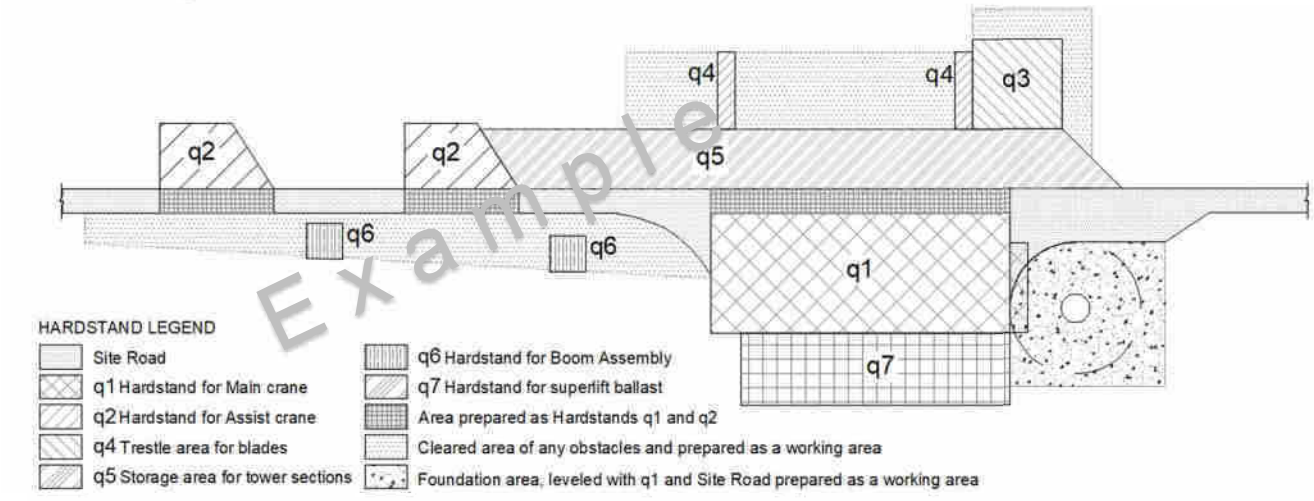


Figure 22: Example of Construction Area layout.

Upon written agreement between the Contractor and the Employer, it is allowed to modify the size or shape of the Construction Area when the installation has been executed. Every deviation should be documented and provided in drawings (preferably CAD format) under the responsibility of the Employer.

The modification must however **not** restrict the use of a crane during possible service and defects notification period. It shall be possible to re-establish this area in order to assemble the crane.

NOTE: Floating road principal must not be used for the Hardstand areas!

Employer shall prepare obstacle free areas in order to allow Safe Working Access for installation technicians. This includes removal of tree stumps and use of compacted stones if the area is particularly soft or boggy. Placing of deposits from excavation and clearing the Installation Area must be coordinated with Siemens Gamesa.

The Construction Area in **Appendix 1** is based on an ideal circumstance of a flat piece of land. However, the Contractor acknowledges the fact that the terrain will have an impact on the final layout of the hardstand and storage area. **Therefore, it is recommended that the employer provide a Site-specific layout to the Contractor prior to Contract so that Siemens Gamesa can review and provide comments on how to optimize the Construction Area layout**

5.1.3 Safe Working Access

The areas to be cleared of any obstacles are identified in **Appendix 1** These areas shall be prepared by the Employer to allow Safe Working Access for installation technicians.

For example:

- removal of tree stumps / large rocks
- use of compacted stones if the area comprises peat or is particularly soft/boggy
- leveled to ensure easy walking access to components
- edge protection/delineation if required due to terrain (at the reasonable discretion of the Contractor).

Other safety related requirements are identified throughout this document.

5.1.4 Hardstand for Main Crane q1

Hardstand for Assist Crane q2 (on slopes)Hardstand for Assist Crane q2 (on slopes)

The Employer shall clearly mark the area of Hardstand **q1** that has the full bearing capacity as stated in **Table 7.**

Figure 23: Example of rectangular Hardstand with Rotor Assembly.

5.1.5 Hardstand for Assist Crane q2

It is assumed that the Site Road and Hardstand for the Assist Crane **(q2)** are on the same level. Where necessary the Assist Crane can stand partly on the road and partly on **q2**. If the road has a gradient bigger than 1.5%, the road cannot be part of **q**2 and special solution is required, as detailed in **section 5.1.6.**

Figure 24: Example of Hardstand for Assist Crane **q2** on hilly terrain. Despite of the gradient of adjoining road, **q2** must always be levelled to within 1.5%.

5.1.6 **Hardstand for Assist Crane q2 (on slopes)**

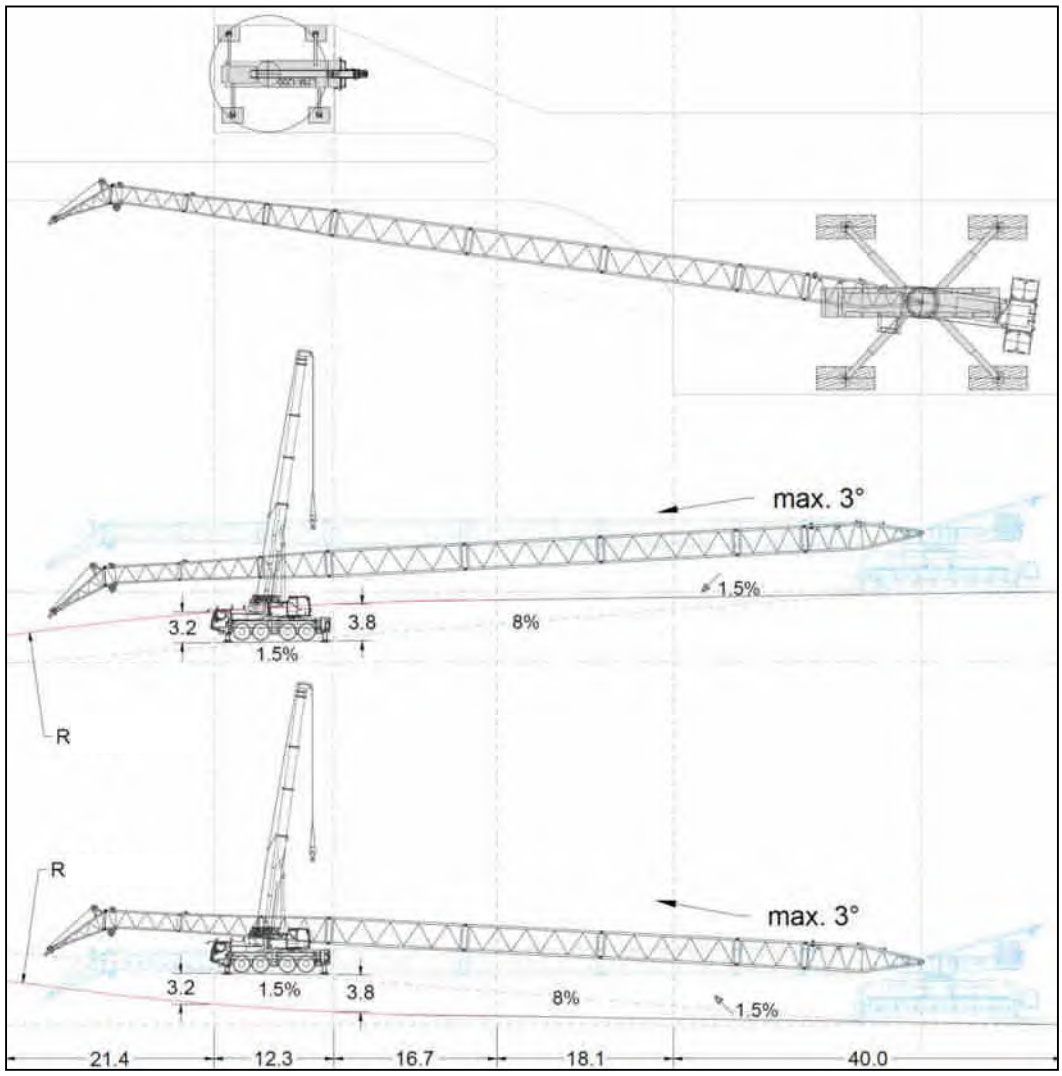


Figure 25: Example of Hardstand for Assist Crane q2 on hilly terrain.

If the slope of the ground dictates that the q2 area cannot be level with the road then a hardstand must be constructed offset to the road. The road must never breach the longitudinal radius stated in **Appendix 1 section 1.1** and **Table 4**. In these cases, a larger Assist Crane may be required due to the increased lifting radius during boom assembly. This must always be checked by the Contractor to explore any additional costs.

5.1.7 Hardstand for boom assembly q6

Boom assembly for the Main Crane may require additional hardstand (q6) when hub height of the WTG exceeds 80m. Location and size of the q6 depends on the soil conditions on the Site, boom configuration of the Main Crane as well as the type of Assist Cranes.

Boom assembly on a hilly terrain requires special solution which must be discussed with project manager for each WTG location.

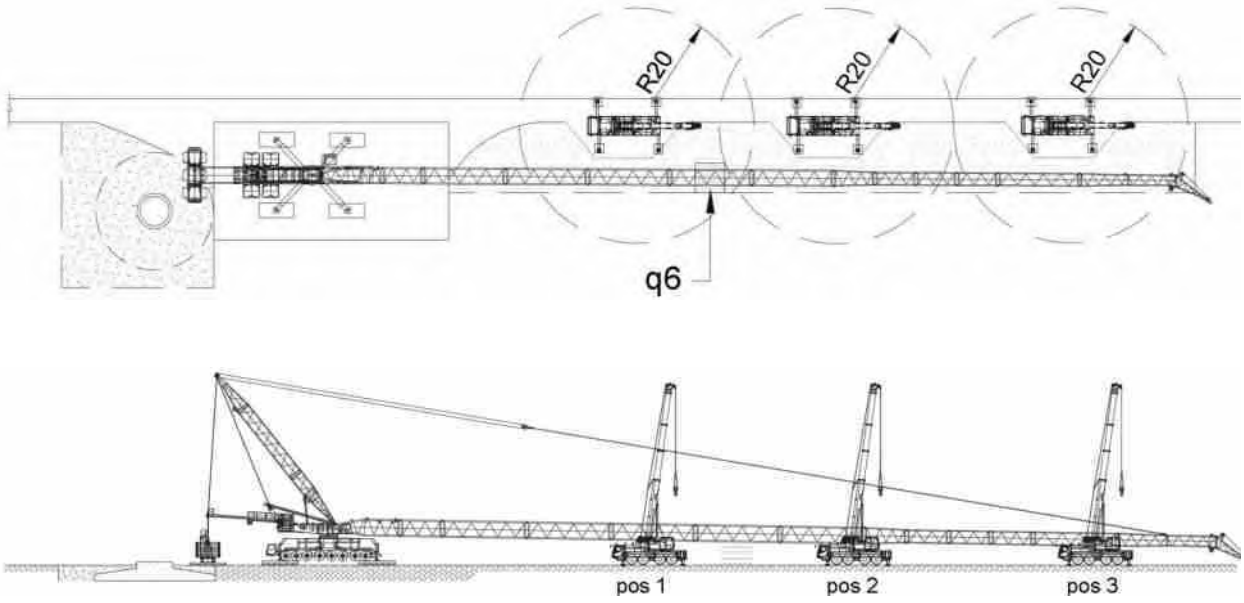


Figure 26: Example of boom assembly on flat terrain.

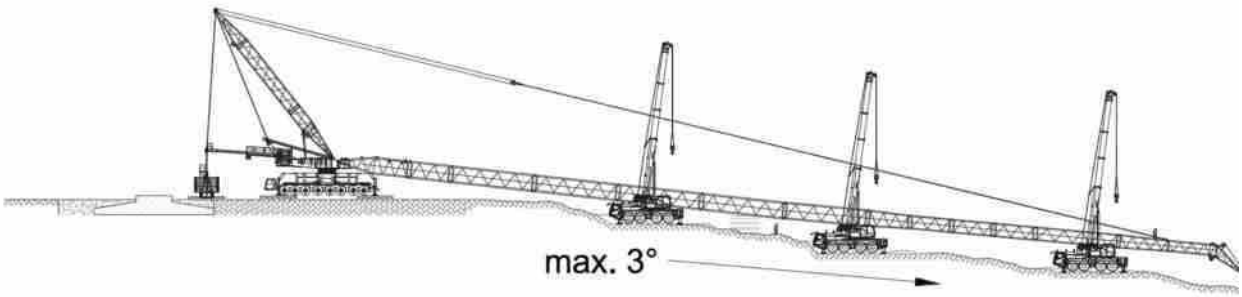


Figure 27: Example of boom assembly on hilly terrain.

5.1.8 Trestle area for blades q4

Figure 28: Example of trestle area q4.

Trestle area **q4** ("blade fingers") must be leveled and elevated min. 1.0m over the surrounding terrain to avoid blade touching the ground. Please refer to **Appendix 1 Section 4** for additional clearance requirements for the single blade installation.

There must be provided accessible Working Area between the fingers and tip end of the blades as per **Appendix 1 Section 4**. The Employer shall remove any high obstacles and trip hazards within this area to ensure safe operation.

Surface of **q4** must be leveled with adjoining road where the blades are offloaded from.

If **q4** is higher or lower than the adjoining road, this must be approved by Siemens Gamesa as it will have an impact on delivery of the blades.

Figure 29: Example of root end of a trestle area **q4**.
Note that wooden or steel plates under components may be required to distribute the load.

Figure 30: Example of a well prepared area between blade fingers.

Figure 31: Example of an unacceptable/unprepared area between blade fingers.

5.1.9 Transformers

For projects with internal transformers: an area of 4m x 4m is to be prepared in front of the WTG door to withstand 30 kN/m².

5.1.10 WTG Door Location

The Employer shall ensure that the foundations and power cable ducts are constructed in such a way that the WTG doors shall be directly facing the Hardstand area. Refer to foundation interface package for further details.

5.2 Level differences and access to WTG

Ideally, the top of foundation shall be level with the working platform. In case off a raised foundation, this must be brought to the attention of the Contractor prior to execution as this may affect crane selection and layout. Any embankment of the foundation must not encroach on the surrounding Installation Area or Site Roads. ***Please note, there may be extra time/cost associated with a level difference between hardstand and foundation.***

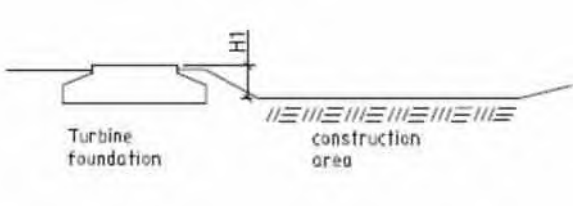


Figure 32: Example of foundation when Construction Area is below the top of foundation.

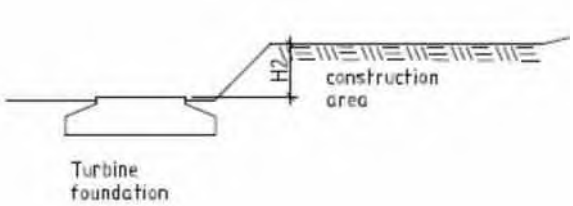


Figure 33: Example of foundation when Construction Area is above the top of foundation.

The Site Road along the construction area shall be level and at the same height as the construction area. This is necessary to ensure that trucks and cranes can maneuver smoothly from the road on to the construction area. A level site road is also important in order to ensure safe offloading of components. Any embankment of the foundation must not encroach on the surrounding installation areas or site roads.

Refer to **Appendix 1** for site and turbine specific foundation requirements.

5.2.1 Area for Tag Lines

Rotor Assembly and Single blade Installation Methods (see **Figure 34** and **Figure 35**) require special attention for ensuring cleared area for the safe use of tag lines.

The Employer shall ensure that the areas around the hardstand rotor assembly area and operating area for tag lines are prepared to allow rotor assembly and installation to be completed safely. An example of the area required is shown in **Figure 34** and **Figure 35**. This area shall be prepared as a Working Area (free from trees, obstacles and trip hazards and prepared as to allow persons to move freely and safely). Once the Employer's civil design is finalised, the Contractor shall work with the Employer to further define and optimize these areas, in order to minimise the felling and ground preparation works to be carried out by the Employer.

Prior to turbine erection, the Employer and Contractor shall together survey the area to be used for tag lines and identify any residual safety hazards (e.g. holes, level changes, marsh etc.). The Employer and Contractor will mutually agree appropriate mitigations measures to allow Safe Working Access, to be carried out by the Employer.

The drawings below are indicative only and can be furthered refined during the site visit. This is relevant for rotor assembly only.

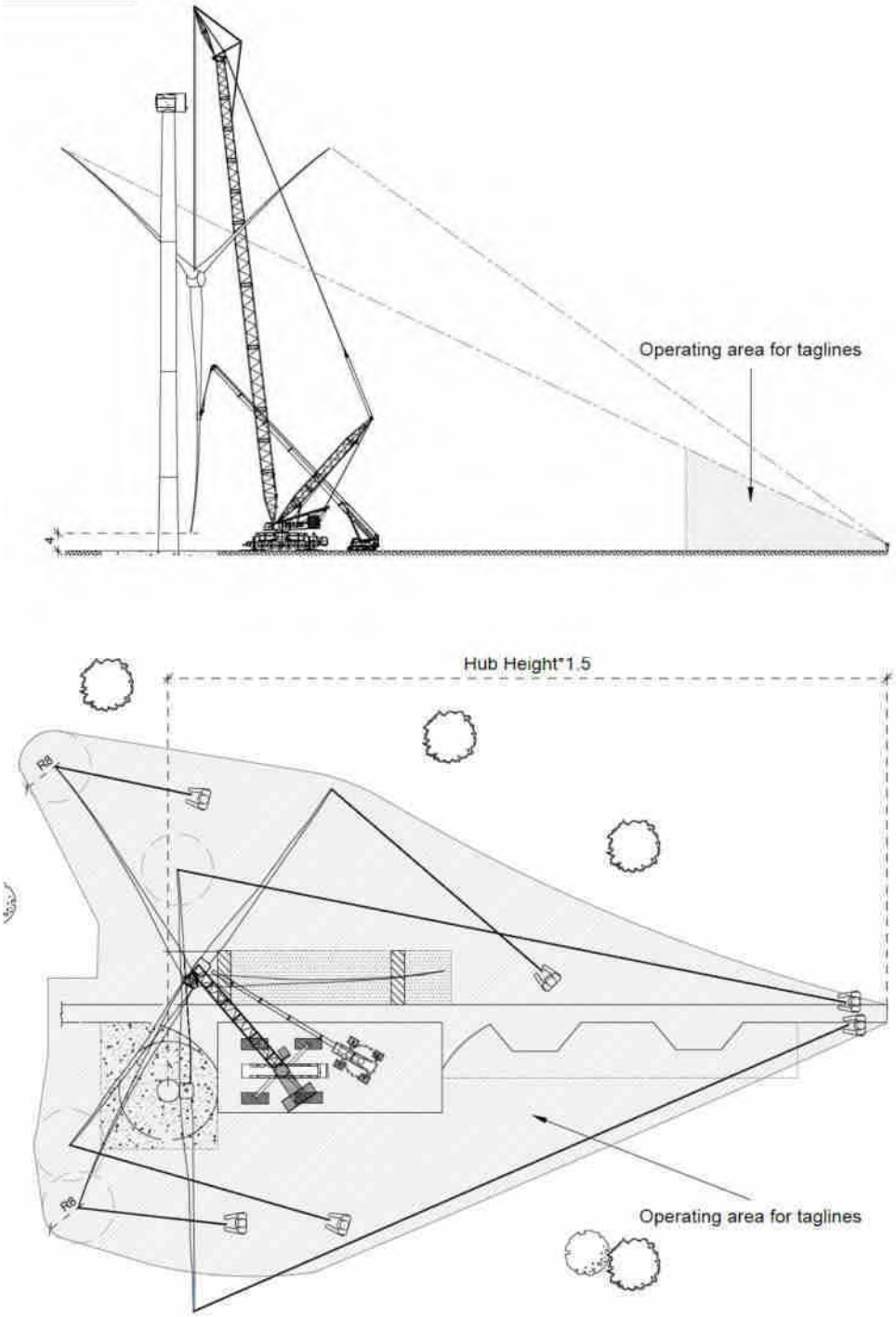


Figure 34: Indicative drawing of area requirements for the use of tag lines with rotor assembly installation method (Rotor assembled next to hardstand).

The drawings below are indicative only and can be furthered refined during the site visit. This is relevant for single blade installation only.

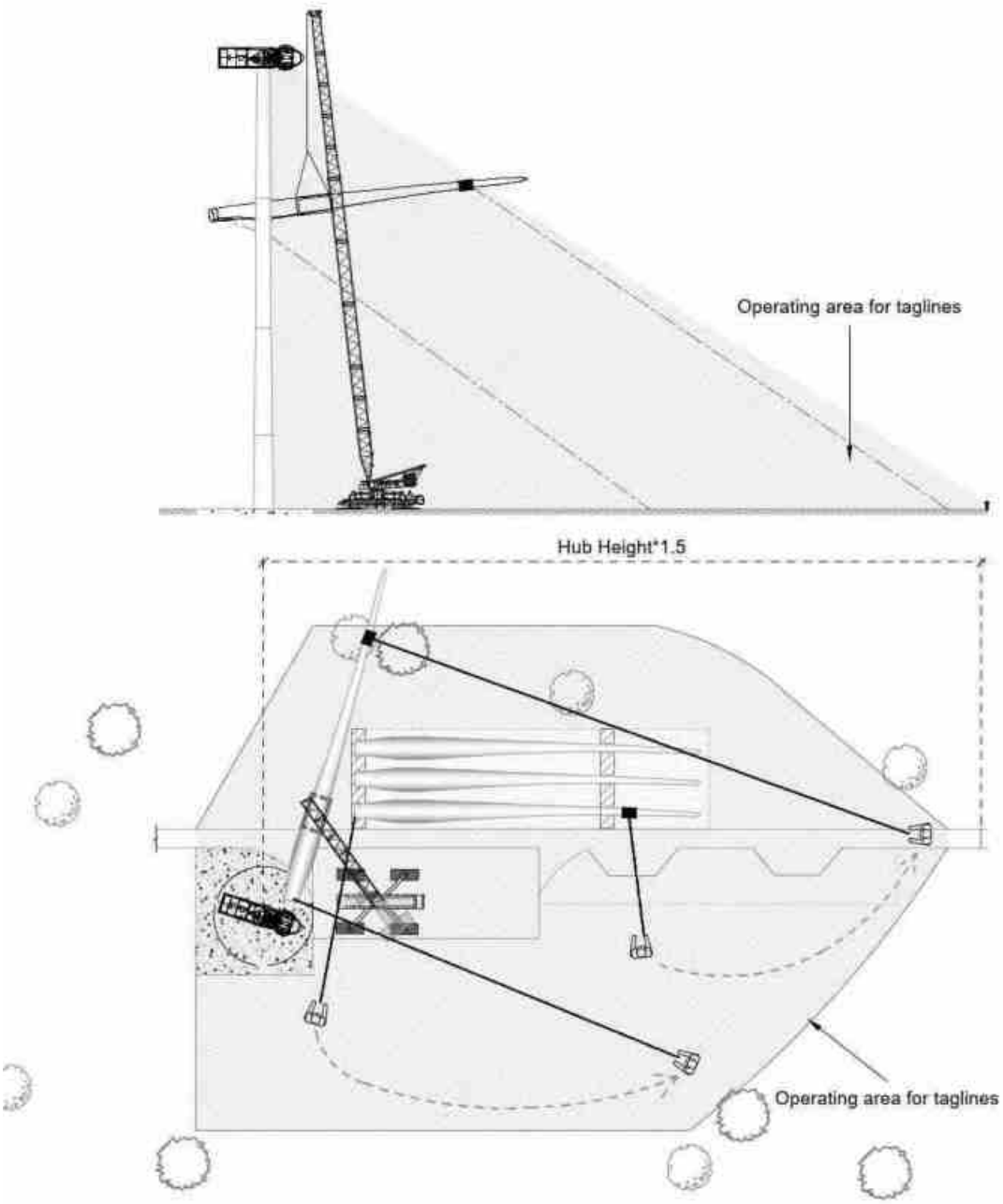


Figure 35: Indicative drawing of area requirements for the use of tag lines with single blade installation method.

6 LOADS

6.1 General

Compound and Storage Areas, Site Roads, Access Roads and Hardstands within the Site Boundary, plus any other geotechnical constructions, shall be designed, constructed and maintained by the Employer to withstand dynamic and static loads from heavy cranes, oversize trucks and the Contractor's personnel vehicles etc. involved in the execution.

All loads presented in the following are characteristic loads the Employer shall multiply with relevant safety factors in accordance with applied design codes.

6.2 Crane Load

Hardstand areas for the Main and Assist Crane **(q1, q2)** must be designed, constructed and maintained by the Employer so that crane outriggers can be placed randomly within the effective Hardstand areas. In case the soil conditions demand alternative solutions such as sand replacement or spread/pile foundations, the Contractor shall be informed about such actions. Areas must also be functional for future crane activities.

Table 7 describes the characteristic maximum loads that Hardstands for cranes shall be designed for:

Hardstand	Description	Load area [m x m]	Load kN/m^2
q1	Main Crane*	4 x (2.4 x 6.0)	250
q1	Pre-assembly Crane (500T)*	4 x (2.4 x 3.5)	250
q1	Pre-assembly Crane (750T)*	4 x (2.5 x 4.0)	250
q2	Assist Crane*	4 x (2.0 x 2.0)	200

Table 7: Characteristic maximum loads of cranes.

Maximum allowable total settlement shall not exceed 2cm for the specified maximum loads applied for the period of two weeks on crane hardstands.

Further details on Hardstand design are in the **SSR GP section 5 and **Appendix 1 Section 2***

The Employer shall construct the Hardstands, taking proper account of the static nature of the load from the Main Crane. The Employer shall pay specific attention to the risk of bearing capacity failure on soft deposits from the concentrated loads from the crane outriggers.

In the case that a crawler crane is to be used as the Main Crane, specifics of the civil works need to be further clarified due to the loads exerted on Site Roads when driving the crane between the Installation Areas with boom fully assembled.

Provided that soil conditions exclude heavy cranes to be installed directly on a constructed Hardstand, alternative solutions (sand replacement, spread / pile foundations etc.) must take into consideration that crane support feet in the future can be placed randomly within the effective Hardstand areas, unless otherwise agreed with the Contractor.

***NOTE:* No reverse driving allowed for Main Crane** (micro movement only on Hardstands). Turning head or similar must be provided where relevant.

6.3 Other Loads

Table 8 describes the ground bearing requirements that other hardstand areas shall be designed for:

Hardstand	Description	Load kN/m²
q3	Assembly Area/Container storage area	200
q4	Trestle area for blades	200
q5	Storage Area (WTG components)	200
	Compound Area excl. Storage Area	100
	Storage Area & Stores Compound Area	200

Table 8: Ground bearing requirements for other hardstand areas.

Figure 36: Example of component bracket. Arrows are showing the footprint area.

***NOTE*:** The distributed load from the component may be concentrated on a very small area due to the design of the brackets. Footprint from the bracket will generate substantially higher ground pressure than 200kN/m² and therefore steel plates under components may be required to distribute the load. Where necessary the Contractor will provide steel plates under components to distribute load.

7 TRANSPORT

The Employer can base the design of the Site Roads on one of the following two methods.

7.1 Method 1: The empirical analytical method

Method is based on the following assumptions:

- Number of passes shall be calculated based on the following equation:

Numbers of passes = 5,000 passes + (nos. of turbines serviced by road section) x 1,000 passes

(Maximum value for design: 15,000 passes).

(i.e. the minimum number of passes for a road section should be 5,000 with an addition of 1,000 passes for each turbine that has to be transported on the particular road section – up to a maximum value of 15,000 passes).

- Maximum **design** axle load (24 tons = 10 tons single wheel load). Not to be confused with characteristic loads!

Contact pressure for the design wheel should be 1.3 MPa.

7.2 Method 2: Maximum characteristic loads of transport vehicles.

For road design based on other methods, **Table 9** describes the maximum characteristic loads of transport vehicles. The listed loads may also be applied for design of junctions.

Vehicles	Axle load [T]	Total load [kN]
Nacelle transport	12	1447
Tower transport	12	1420
Hub transport	10	500
Blade transport	10	638
All cranes transported on public road	12	-
Assist Crane (100T wheel crane)	17 (incl. counterweight)	850
Assist Crane (100T wheel crane)	12 (fully de-rigged)	600
Main Crane	12 (fully de-rigged)	960
Main Crane on Site Road (of max5%)*	22* (partly de-rigged)	1820
Main Crane on Site Road (5%-13%)	24* (partly de-rigged)	1980
Main Crane on q1	26	2150

Table 9: Characteristic indicative loads of transport vehicles.

These requirements do NOT take into consideration the use of a crawler crane. If a crawler crane is shall be used in the project, this information will show up in the SSR.
Contact pressure for the design wheel should be 1.3 MPa.

The listed vehicle loads can be considered as informative maximum loads for different transport types. All relevant transport types may not be listed. For design purpose, detailed transport specifications should be collected.

*Please note that the crane can be transported in fully de-rigged configuration to reduce the Axle load requirement from 22T/24T to 12T per axle, but this has programme and hence cost implications, which Siemens Gamesa would be willing to discuss prior to Contract. The crane will be transported fully de-rigged on Public Roads and upon accessing the Site to the first WTG location. Therefore, a reduced bearing capacity of 12T is permissible on the main Site Access Road.

8 FACILITIES COMPOUND & STORAGE AREA REQUIREMENTS

This section specifies the requirements for the provision of the Compound and Storage Areas. SGRE will consult with the Employer to define the project specific requirements taking into consideration the size, location and planning restrictions of the wind farm. The Employer shall provide the prepared areas for the Compound and Storage Areas and the Contractor shall provide the facilities required. The location and size of the areas shall be discussed and agreed between the Employer and Contractor during the Site layout discussions.

The ground requirements for these areas are specified in **Table 8**, and their gradient shall not exceed 1.5%. The finished surface of the areas shall be easily maintained in all weather conditions. To ensure safe access and working conditions the areas shall be compacted and level, with suitable bearing capacity demonstrated by plate bearing test.

The below requirements are based on a one (1) crew and a one (1) crane setup. Should the project require more than one (1) crew and crane, the parties shall discuss the options and specify the appropriate requirements.

8.1 Site Facilities Compound Area

A Site Compound of a minimum 1,500m² (50m x 30m or similar) shall be provided by the Employer, providing room for the Contractor's temporary Site facilities (offices, messing and car parking).

The Contractor shall provide temporary Site office facilities for the Contractor's site management personnel. In addition, these facilities shall include messing facilities, changing room, and lavatory facilities for the Contractor's technical staff according to the minimum requirements of the applicable safety, health and welfare legislation.

The Employer shall ensure that connections to utilities such as running water, sewer system, power supply and telecommunication systems are available and ready to use at the time when the Contractor mobilizes on Site. The Contractor shall be responsible for the usage of the utilities during the project execution phase.

The Employer shall arrange telephone capacity for a minimum of six (6) phone lines and connections for six (6) work stations to be simultaneously connected to the internet by means of ADSL or equivalent, with a minimum maintained band width of 10 Mb (10mbs upload & download speed). The Employer shall be responsible for providing and connecting the telecommunication network to each workstation. The Contractor shall be responsible for providing its own IT equipment (computers, phones, fax, printers etc.) and shall be responsible for the cost of usage.

The Contractor shall arrange mobile toilet facilities next to the WTGs if required.

8.2 Stores Compound Area

A Stores Compound Area of a minimum 1,200m^2 (40m x 30m or similar) shall be provided by the Employer, providing room for the Contractor's plant (such as tele-handlers), skips, waste disposal, containers for tools and spares, technical equipment, fuel etc.

The Stores Compound Area should be located directly adjacent to the Site Facilities Compound Area. If required, the Contractor can assist in providing clear delineation between the two (such as fencing or similar).

In case the Stores Compound Area cannot be located directly adjacent to the Site Facilities Compound Area, an alternative location can be discussed and agreed between the Employer and Contractor.

8.3 Storage Area for WTG Components

A central Storage Area may be necessary if it's not possible to store all the WTG components on the Hardstands. The size of the central Storage Area will depend on the Hardstand configuration and the number of turbines, logistics and how the installation is to be carried out. It is therefore subject to discussion.

9 Abstract - Eurocode 7, EN 1997-1: Geotecnical design, Part 1: General Rules

EN 1997-1 is intended to be used as a general basis for the geotechnical aspects of the design of buildings and civil engineering works. The following subjects are dealt with in EN 1997-1:

Section 1: General
Section 2: Basis of geotechnical design
Section 3: Geotechnical data
Section 4: Supervision of construction, monitoring and maintenance
Section 5: Fill, dewatering, ground improvement and reinforcement
Section 6: Spread foundations
Section 7: Pile foundations
Section 8: Anchorages
Section 9: Retaining structures
Section 10: Hydraulic failure
Section 11: Overall stability
Section 12: Embankments

EN 1997-1 is accompanied by Annexes A to J, which includes:

Annex A: recommended partial safety factor values; different values of the partial factors may be set by the National annex.

Annexes B to J: supplementary information.

10 Abstract – Eurocode 7, EN 1997-2: Geotechnical design, Part 2: Ground investigation and testing

EN 1997-2 is intended to be used in conjunction with EN 1997-1 and provides rules supplementary to EN 1997-1 related to:

- Planning and reporting of ground investigations
- General requirements for a number of commonly used laboratory and field tests
- Interpretation and evaluation of test results
- Derivation of values of geotechnical parameters and coefficients

11 APPENDICES

Appendix No.	Title	Number of pages
1	Site Specific Requirements – SG 3.4–132; 114mHH	10
2	Handover Checklist	2
3	Handover Certificate	2
4	Road bends SG132	4

WTG information

Turbine type:	SG- 132
Hub Height:	114m
Amount of tower sections:	5
Amount of WTGs:	20
Installation method:	Single blade installation
Main Crane:	LG1750 or similar
Pre-assembly set-up:	Yes, with 750t crane
Assist Crane:	200t

Component Specifications

***NOTE:** Dimensions and weights are only indicative!*

Component		Length [m]	Width or diameter (large diameter) [m]	Height or diameter (small diameter) [m]	Weight [t]
SG132 (per blade)		64.950	4.480	2.850	22.210
Hub		5.900	4.270	4.090	38.100
Nacelle		12.530	4.160	4.160	70.800
Drive train (Shaft + LSS housing + Gearbox)		6.950	3.030	2.830	73.380
Drive train + Hub		12.080	5.920	5.400	102.220
SG132-T114 CII	**Section T1**	16.940	4.670	4.430	82.230
	Section T2	20.940	4.430	4.420	76.380
	Section T3	21.120	4.420	4.420	62.000
	Section T4	24.000	4.420	3.920	49.390
	Section T5	29.000	3.920	3.390	48.330

Revisions				
Rev.	**Date**	**Change**	**Responsible**	**Checked**
01				
02				

Table of Contents

1 Road and curve requirements

In order to ensure safe operation for the vehicles used during construction/installation, road bends and junctions shall be constructed by the Employer according to the requirements set out in **Appendix 4**. In addition:

- Road bends sharper than **90 degrees** must be custom built and discussed in detail with reference to the actual transport equipment.
- Road bends with a vertical gradient bigger than 3% over the course of the bend need to be analysed for each individual situation.
- Road bends in DWG format may be provided by the Contractor to the Employer upon request.

1.1 Longitudinal Radius

Assuming a reasonably straight road without narrow curves, the minimum allowable longitudinal radius on roads is stated in **Table 1**. Additional requirements for Longitudinal Radius (Kv) are stated in the **SSR General Part section 2.3**.

Road	Longitudinal Radius (Kv/R_{min})
For WTG component transports	500 m
For reverse driving	500 m

Table 1: Longitudinal radius.

2 Installation area

Construction Area in this document is based on an ideal circumstance of a flat piece of land. However, the Contractor acknowledges the fact that the terrain will have an impact on the final layout of the hardstand and storage area. **Therefore, it is recommended that a Site-specific layout is provided to the Contractor prior to Contract so that SGRE can review and provide comments on how to optimize the Construction Area layout.**

The following requirements apply to all hardstand types. Whilst the price / programme have been based on these configurations, other options are available which can be discussed between the Employer and Contractor.

Please refer to **Section 5 of the General Part** for additional requirements regarding the Installation Area.

2.1 **Rectangular hardstand with all components pre-delivered.**

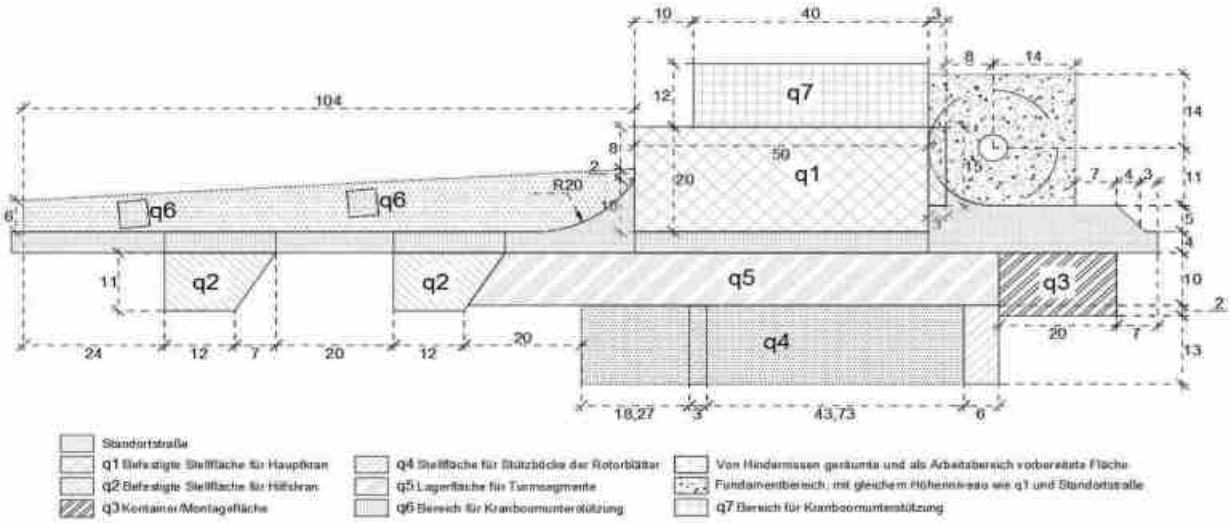


Figure 1: Example of Installation Area with modified rectangular Hardstand for the Main Crane (LG1750).

Note the options for hardstands q2-q5:

- Hardstands for the Assist Crane (**q2**) can be placed alternatively if terrain is complex.
- Hardstand for storage of containers (**q3**) can be placed alternatively if terrain is complex.
- Trestle area for blades (**q4)** and storage area for components **(q5)** may be moved in the layout if terrain is complex. It can also be left out if just in time delivery is required.
  Please note that there is a cost & time impact associated with the use of just in time delivery which must be discussed and agreed with SGRE.

Area	Description	Max. fall	Area (m^2)	Dimensions (m)	Maintenance	Relationship to other q areas
Road	Road section from q1 to q2	1.5%		4	Permanent	Level with q1, q2 and q5
q1	Hardstand for Main Crane*	1.5%	1000*	50 x 20	Permanent	See comments below
q2	Hardstand for Assist Crane*	1.5%	368.5*	(30 x 12) + 38.5	Temporary	Ideally the q2 will be level with the site road, if not, then access for the assist crane must be provided. Please see **GP Section 5.1.6**
q3	Storage area for containers*	0.5%	225*	20 x 12	Temporary	Level with q1 and q5
q4	Trestle area for blades*	1.5%	135*	(15 x 3) x 3	Temporary	No more than +/- 1m in level difference from q1
q5	Storage area for components*	1.5%	875*	87,5 x 10	Temporary	Level with q1, q2 and q3
q6	Hardstand for boom assembly**		xx	xx	Temporary	See **GP Section 5.1.7**
q7	Flying Ballast laydown Area	1,5%	480	40 x 12	Temporary	Level with q1

Table 2: Requirements for dimensioning the areas.

NOTE: *) Effective areas are with full bearing capacity.
**) Location and size of q6 is a subject to discussion with crane company.
***) Flying ballast laydown area can be made temporary for example with wooden mats.
(Load calculated as t/m^2, should be reserved up to 400t on approx. 22.5m^2).

Pre-assembly

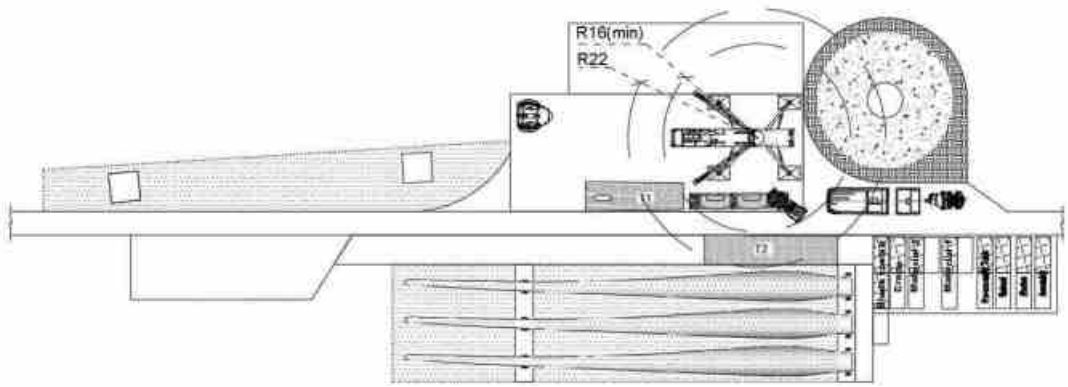


Figure 2: Example of pre-assembly and storage of components on the Installation Area.
T1 and T2 tower sections are pre-delivered and installed by the pre-assembly crane.
Blades, hub, drive train and Nacelle backend are pre-delivered and stored on the Installation Area before the Main Crane is on the hardstand. T3, T4 and T5 tower sections will be delivered after pre-assembly and before the main crane comes in. At least 1m free walking area must be ensured around the components for visual inspection. Steel plates under components may be required to minimize the ground pressure.
Dimensions are based on the LTM1750 pre-assembly crane.

Main Assembly

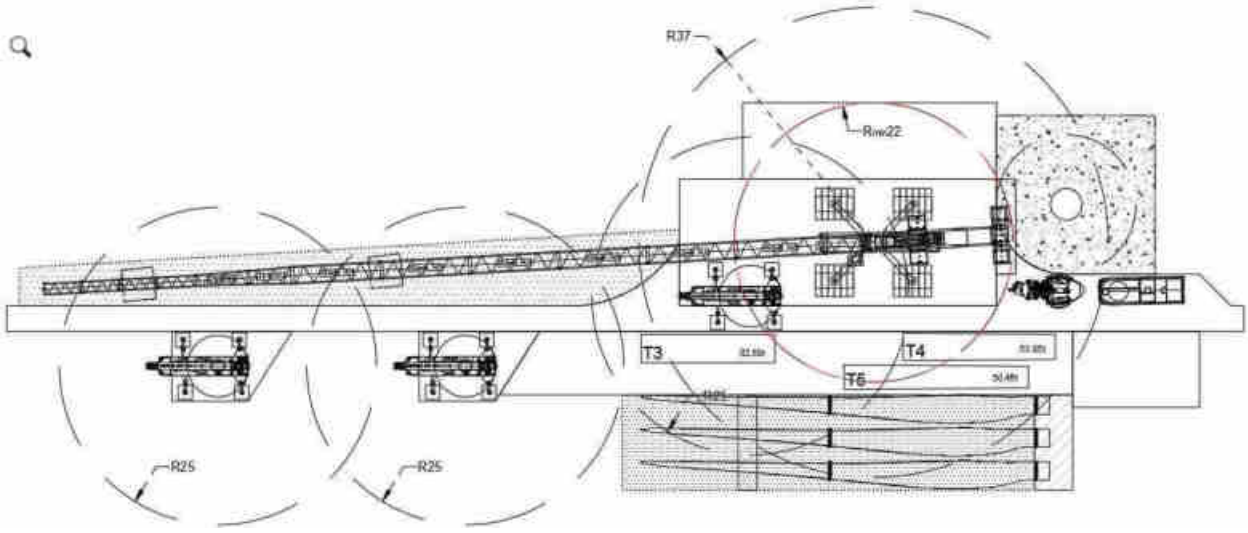


Figure 3: Example of assembly of the boom and storage of components on the Installation Area.
T3, T4and T5 tower sections, Blades, Drive train, Hub and Nacelle will be installed by the Main Crane. At least 1m free walking area must be ensured around the components for visual inspection. Steel plates under components may be required to minimize the ground pressure.
Dimensions are based on an LG1750 with boom configuration **SL8DHS (119+6m)**

3 Foundation and Access

3.1 Towers with T flange

The hub height of XXX.Xm takes into account a foundation height of **X**m. The employer shall ensure that the level difference between the Construction Area and top of foundation must not be more than **X**m. In the case that the height difference exceeds **X**m, the hardstand area and crane type is subject to change and must be assessed on a platform specific basis.

An external T-Flange at the T1 – T2 interface requires a working area of 10m surrounding the base of the tower as shown in **Figure 4**.

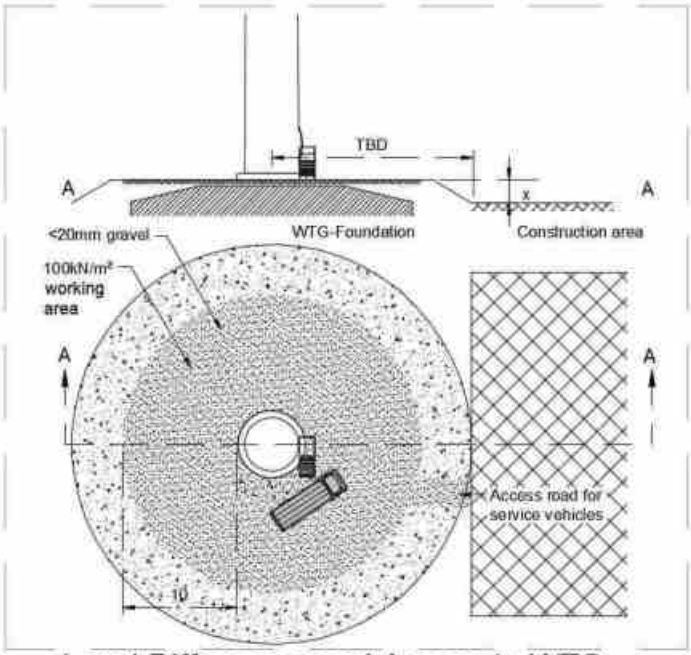


Figure 4: In the case that the foundation is not level with the hardstand, the service vehicle ramp can be **added after installation is complete.**

3.2 **Towers with Standard Flange**

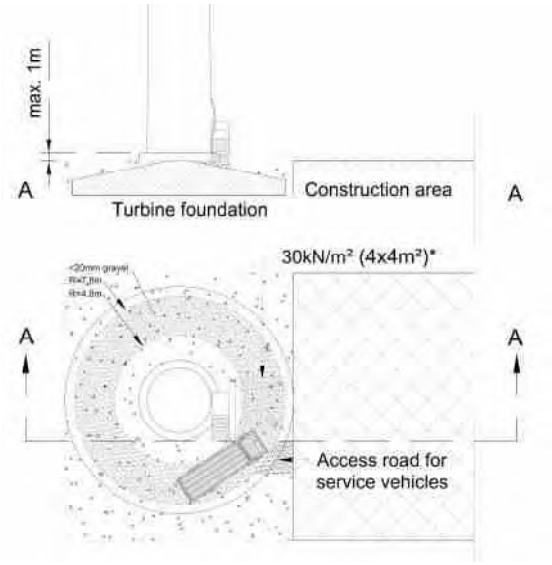


Figure 5: If the foundation is not level with the hardstand then a ramp for service vehicles must be **added after installation is complete.**

Figure 5: Example of not well-maintained service access to WTG.

Employer shall provide free and level access to the entrance of the WTG during the installation and after completion of the project. As soon as there is a risk of a fall from height, edge protection should be in place.

It is important to ensure a proper access road for service vehicles (see **Figure 5**) as heavy components must be within the reach of the nacelle's service crane.

Schedule G4 (FII Pack) "Foundation interface" will give guidelines for positioning of the staircase.

4 Blade storage requirements

A minimum clearance of 1.0m underneath the blades and 1.2m between each blade, component or other obstacle is needed within the working area. An example of the cleared area needed within the trestle area is shown in **Figure 6**. This working area extends approximately 6m to the left and right of the blade's center of gravity (CoG). A 3m wide working area is required in front of the root end to remove transport frames. This area should be suitable to drive on with light machinery such as a forklift or manitou, etc.

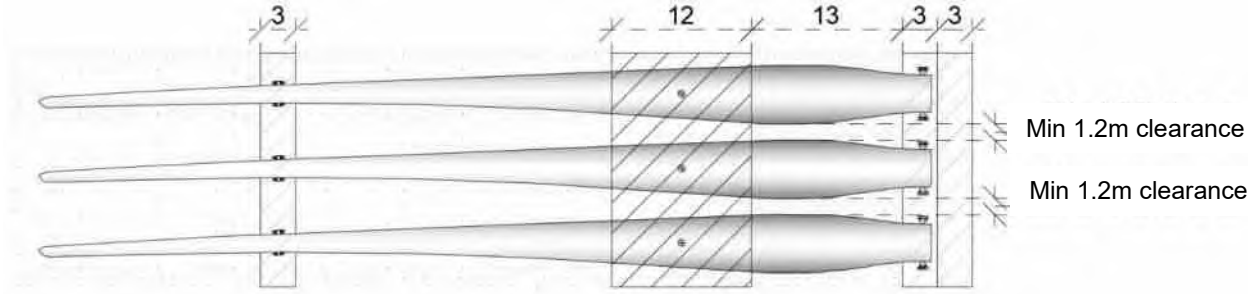


Figure 6: Working area for blade storage and installation for **SG132**

5 Proposed delivery methodology

The proposed method of delivery for each WTG is described below. This is provided for planning information purposes only and may change depending on circumstances at the time of installation at the discretion of the Contractor.

To be populated during pre-contracting solution development with Employer. Where required, different Hardstand configurations can also be developed to suit the Site topography.

WTG No	Method of Delivery / Reverse Driving required?	Hardstand Type
T1	[Describe method of delivery and if reverse driving is required]	[To be used where more than 1 hardstand configuration is required]
T2	[Describe method of delivery and if reverse driving is required]	[To be used where more than 1 hardstand configuration is required]
T3	[Describe method of delivery and if reverse driving is required]	[To be used where more than 1 hardstand configuration is required]
T4	[Describe method of delivery and if reverse driving is required]	[To be used where more than 1 hardstand configuration is required]
Etc.		

Appendix 2: Site Specific Requirements Handover Checklist

Name of Wind Farm: Kostolac	Date :

Compound Storage & Facilities: ☐ WTG Nr: ____	Drawing Nr: ____

Condition of	Yes	No	Remarks:
Access Roads to WTG			
➢ Road width and cross falls to specification	☐	☐	
➢ Surface quality to specification	☐	☐	
➢ Findings from trial run incorporated	☐	☐	
➢ Delineators provided as advised in the SSR	☐	☐	
➢ Gradients as per the requirements	☐	☐	
➢ Loaded / unloaded Turning Areas as per specification	☐	☐	
➢ Lay-by or Passing Areas as per the specification	☐	☐	
➢ Barriers for the over-head lines in place	☐	☐	
➢ Appropriate signage present on Site Roads & access	☐	☐	
➢ Appropriate barriers or other control measures in place to restrict access of farm animals to construction areas (if applicable)	☐	☐	
Turbine Foundation			
➢ Base backfilled & compacted	☐	☐	
➢ Safe personnel access to/from base	☐	☐	
➢ Top of base tidy	☐	☐	
➢ Base finish acceptable	☐	☐	
➢ Ducts acceptable	☐	☐	
➢ Protrusion of bolts within specified tolerances	☐	☐	
➢ Bolt condition acceptable	☐	☐	
➢ HV/LV/SCADA cables installed	☐	☐	
➢ Earthing cables installed	☐	☐	
Crane Hardstand			
➢ Acceptable surface	☐	☐	
➢ Acceptable dimensions	☐	☐	
➢ Acceptable levels / falls	☐	☐	
➢ Safe vehicular access on Hardstand	☐	☐	
➢ Restrictions present	☐	☐	
➢ Load bearing test results available	☐	☐	
➢ Areas for crane boom assembly free from obstructions and as per the specification	☐	☐	
➢ Sufficient space to manoeuvre delivery trucks after dropping off main components	☐	☐	

Condition of	Yes	No	Remarks:
Blade Storage Area			
➢ Acceptable surface	☐	☐	
➢ Acceptable dimensions	☐	☐	
➢ Acceptable levels / falls	☐	☐	
➢ Areas between the blade fingers and around the tip area have safe and free from obstructions access for technicians	☐	☐	
➢ Acceptable access for control of taglines during lift	☐	☐	
➢ Restrictions present	☐	☐	
Compound and storage area			
➢ Area size and dimension is to specification	☐	☐	
➢ Safe and appropriate access to the areas	☐	☐	
➢ Telephone, broadband, water, sewer and electricity connections are available and as per the specification	☐	☐	
➢ Acceptable surface, ground conditions and bearing capacity	☐	☐	
➢ Car parking space for SGRE plant and equipment are as per the specification	☐	☐	
➢ Appropriate lighting available around the Compound and Contractor facilities	☐	☐	
➢ Security fence around the Compound Area	☐	☐	
Outstanding Items	☐	☐	
Safety Inspection Report	☐	☐	

Appendix 3: SSR Handover Certificate

Name of Wind Farm: Kostolac	Date :

WTG Nr: ____ Site Road Section._____	Drawing Nr: ____

The following is to be filled out by the Employer's civil contractor who has undertaken the design and construction of crane hardstands and access tracks. All design and construction is as per SGRE SSR specifications. Testing and inspections will be performed to ensure the construction will continue to satisfy the SSR requirements for the duration required.

To be filled out by Employer's civil contractor:

Design and Condition of	**Initials**	**Remarks:**
Access Roads & Crane Hardstands ➢ Design of roads & hardstand has been carried out by a competent Geotechnical Engineer in accordance with relevant design standards. ➢ Correct supervision has been performed throughout the construction process to ensure all works have been completed in accordance with the design. E.g. extent of compaction, layer thickness, geo-grid overlaps, formation level testing etc. ➢ An adequate surface and ground water drainage plan has been designed and implemented that will ensure the site will stay in good condition throughout the duration of the works. ➢ All dimensions and gradients are within the specifications of the SGRE SSR. A level survey has been completed to ensure this and is available for inspection on request. ➢ All bearing capacities and settlement levels are in accordance within the limits defined in the SGRE SSR. ➢ Load bearing test results available. ➢ Asbuilt drawing provided to Contractor showing dimensions, gradients, crossfalls and permissible ground bearing pressure/axle loadings.All records of design and construction work have been documented and available for inspection on request.		
	Yes No	
Outstanding Items	☐ ☐	
Safety Inspection Report	☐ ☐	

We hereby certify that the design and construction work completed at (**Turbine number/Road section**) has been carried to meet the SGRE SSR requirements and will remain within these requirements throughout the duration of the works.

Signature of Employer's civil contractor: _____

Date: _____

1.0 Road Bends and Junctions

In order to ensure safe operation for the vehicles used during construction/installation, road bends and junctions shall be constructed by the Employer according to the requirements set out in **Figure 1** and the tables in part **3.**

Road bends with a vertical gradient of more than 3% over the course of the bend need to be analysed for each individual situation.

The following tables show the dimensions required for various corner types, where;

- A: is the width of the road necessary for transport
- A1: represents the road width (at least 4 m), which may be increased depending on the width necessary for manoeuvring the vehicle
- A2: Is the occupation of the vehicle when manoeuvring cannot adjust to the A1 road width
- Is/SAi: Is the maximum interior sweep of the vehicle or its cargo
- Es/SAe: Is the maximum exterior sweep of the vehicle or its cargo
- R30: Represents the radius curve at the centre of the road
- 90º: Represents the angle formed by two straight sections of road joined by a curve of a given radius

2.0 Example of how to use measurements

RADIUS - ANGLES			
	90°		
R30	A	SAe	SAi
R35	9	9.01	5.51
R40			

Table 1: Example turning radius

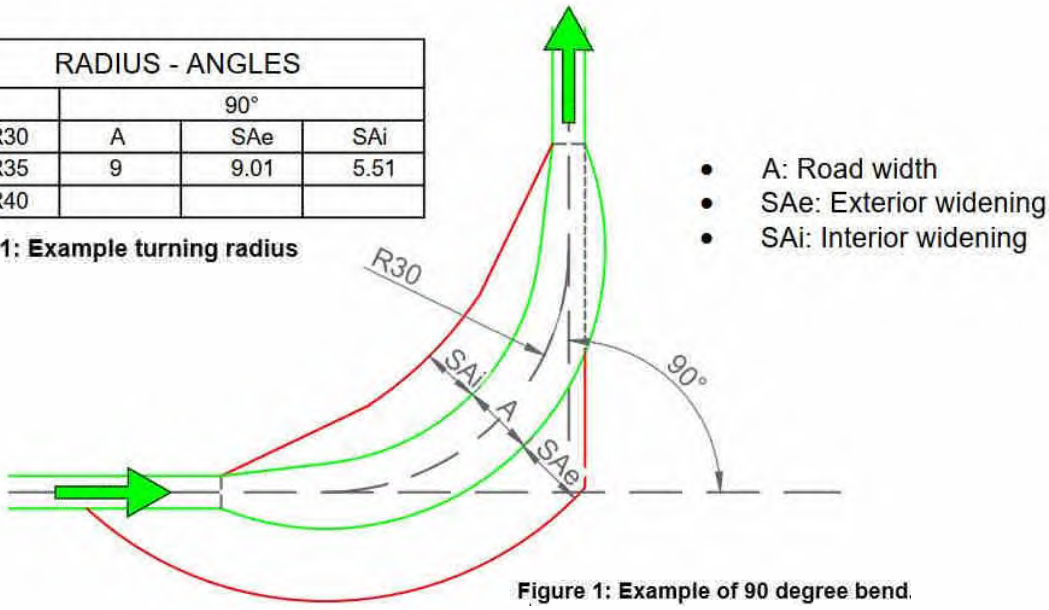


Figure 1: Example of 90 degree bend

A – Road width
Es/SAe – Exterior shoulder (sweep of the blade free of obstacles)
Is/SAi - Interior shoulder (sweep of the blade free of obstacles)
The curve radius will be the radius of the alignment curve on the Centre of the road

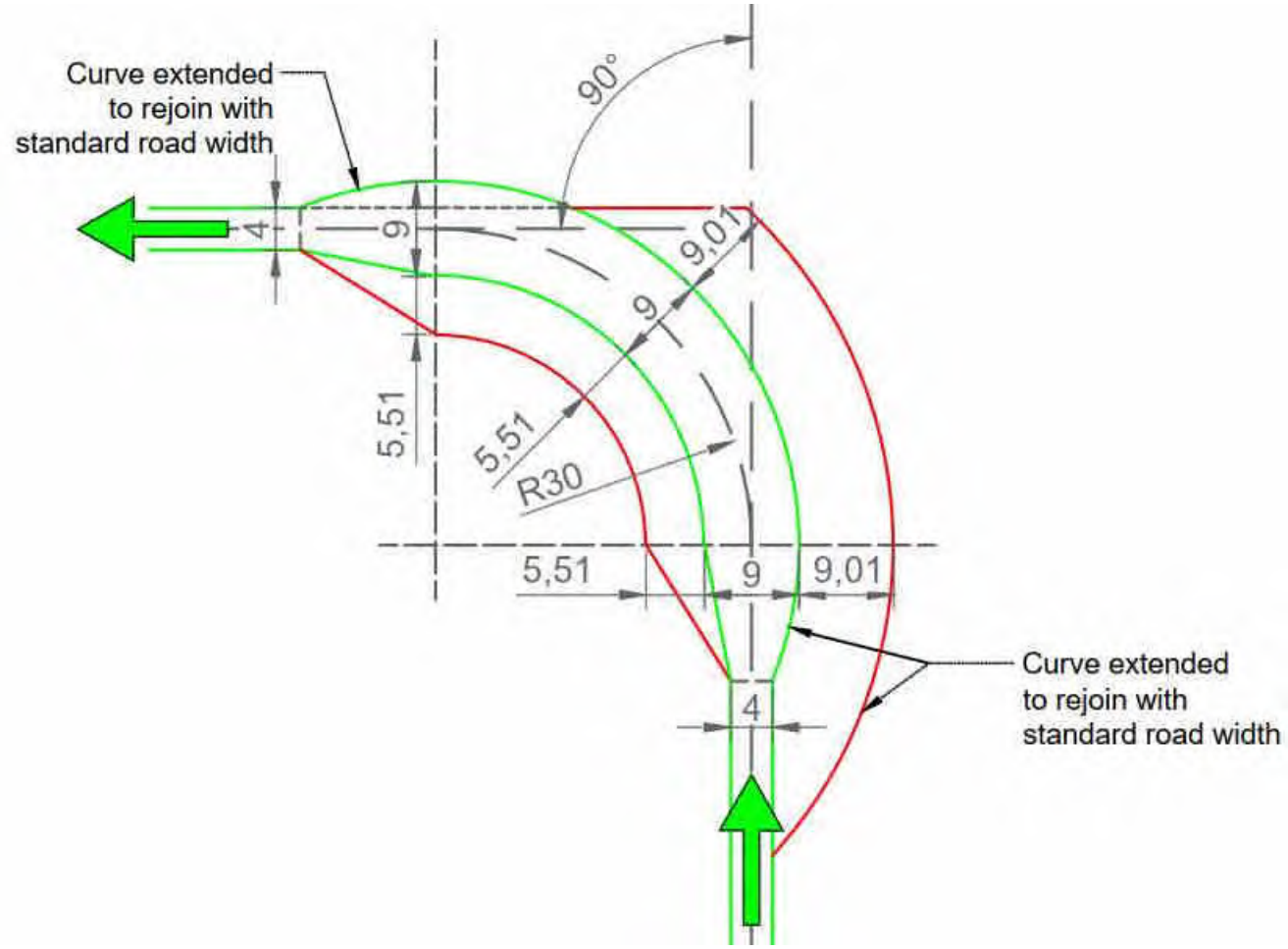


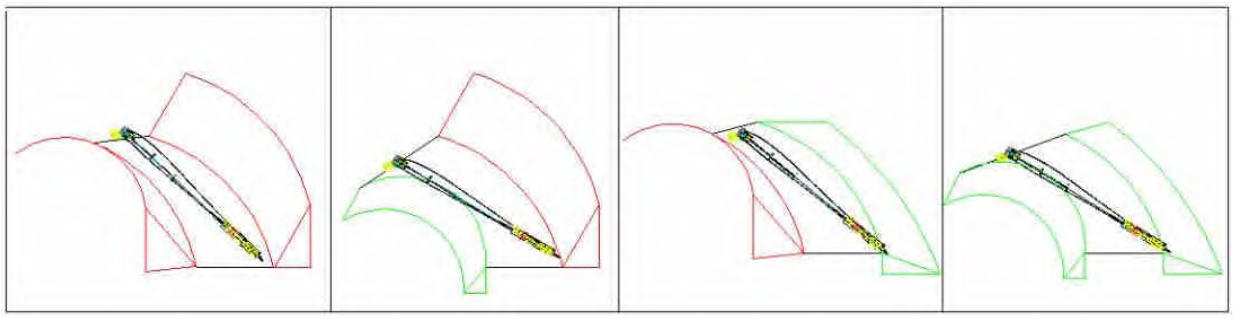
Figure 2: Detailed example of turn using figures in Table 1 **(*example only, figures are not specific to the blade type in this SSR!)***

3. Table of Results for SG132

CURVE RADIUS	G132 ANGLE OF CURVE DEVELOPMENT																				
	0°			10°			20°			30°			40°			50°			60°		
	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is
5	5.0	-	-	5.0	0.50	0.5	5.0	0.5	3.6	6.0	1.0	5.5	6.0	2.3	8.1	6.3	3.2	10.5	8.3	3.2	11.2
10	5.0	-	-	5.0	0.50	0.5	5.0	0.5	3.6	6.0	0.7	5.2	6.0	2.1	8.0	6.0	3.0	9.8	7.7	3.1	10.7
15	5.0	-	-	5.0	0.50	0.5	5.0	0.5	3.4	6.0	0.7	5.2	6.0	2.1	7.7	6.0	2.8	9.6	7.2	3.0	10.2
20	5.0	-	-	5.0	0.50	0.5	5.0	0.5	3.0	6.0	0.5	5.2	6.0	1.6	7.5	6.0	2.5	9.0	6.7	3.0	9.5
25	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.7	6.0	0.5	4.5	6.0	1.6	7.0	6.0	2.5	8.6	6.5	3.0	9.0
30	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.7	6.0	0.5	4.5	6.0	1.5	6.9	6.0	2.3	8.4	6.0	3.0	9.0
35	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.7	6.0	0.5	4.4	6.0	1.4	6.4	6.0	2.3	7.7	6.0	3.0	9.0
40	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.5	6.0	0.5	4.0	6.0	1.1	6.3	6.0	2.0	7.3	6.0	2.6	8.2
45	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.4	6.0	0.5	4.0	6.0	1.0	5.7	6.0	1.8	6.7	6.0	2.2	7.4
50	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.4	6.0	0.0	3.9	6.0	1.0	5.6	6.0	1.5	6.3	6.0	1.8	6.8
55	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.4	6.0	0.0	3.9	6.0	0.6	5.0	6.0	1.4	5.9	6.0	1.5	6.0
60	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.3	6.0	0.0	3.9	6.0	0.4	4.8	6.0	0.9	5.3	6.0	1.1	5.4
65	5.0	-	-	5.0	0.50	0.5	5.0	0.5	2.2	6.0	0.0	3.3	6.0	0.2	4.3	6.0	0.4	4.6	6.0	0.5	4.6
70	5.0	-	-	5.0	0.50	0.5	5.0	0.3	2.2	6.0	0.0	3.1	6.0	0.1	4.0	6.0	0.3	4.2	6.0	0.3	4.3
75	5.0	-	-	5.0	0.50	0.5	5.0	0.3	2.2	6.0	0.0	3.1	6.0	0.0	3.8	6.0	0.2	4.1	6.0	0.2	4.1
80	5.0	-	-	5.0	0.50	0.5	5.0	0.0	2.2	5.0	0.0	3.1	6.0	0.0	3.5	6.0	0.0	3.6	6.0	0.0	3.6
85	5.0	-	-	5.0	0.50	0.5	5.0	0.0	2.2	5.0	0.0	3.1	5.0	0.0	3.6	6.0	0.0	3.4	6.0	0.0	3.4
90	5.0	-	-	5.0	0.50	0.5	5.0	0.0	2.0	5.0	0.0	3.0	5.0	0.0	3.5	6.0	0.0	3.1	6.0	0.0	3.2

CURVE RADIUS	G132 ANGLE OF CURVE DEVELOPMENT																				
	70°			80°			90°			105°			120°			130°			140°		
	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is
5	11.0	3.2	11.6	15.0	3.2	11.7	19.8	3.2	12.6	28.8	3.2	13.5	-	-	-	-	-	-	-	-	-
10	10.0	3.1	11.4	14.0	3.1	11.7	18.0	3.0	12.3	26.0	3.2	12.5	-	-	-	-	-	-	-	-	-
15	9.0	3.1	10.7	12.5	3.1	11.5	16.0	3.1	11.6	20.5	3.2	12.0	32.5	3.5	12.5	-	-	-	-	-	-
20	8.5	3.0	10.2	11.0	3.0	10.6	14.0	3.0	11.0	19.0	3.2	11.6	26.0	3.5	12.0	31.5	3.7	12.7	-	-	-
25	7.5	3.0	9.7	9.5	3.0	10.6	12.0	3.0	11.0	15.0	3.2	11.4	20.5	3.5	12.0	24.5	3.5	12.3	28.8	4.0	12.4
30	7.0	3.0	9.5	8.3	3.0	10.0	10.0	3.0	10.0	12.7	3.2	10.0	15.7	3.4	10.7	18.2	3.4	11.0	20.2	3.4	11.8
35	6.5	3.0	9.2	7.0	3.0	9.4	8.9	3.0	9.4	9.6	3.1	9.6	11.5	3.2	10.7	12.4	3.3	10.7	13.8	3.3	11.0
40	6.0	3.0	8.9	6.0	3.0	9.1	6.5	3.0	9.2	6.8	3.0	9.3	7.3	3.1	10.0	7.5	3.1	10.3	7.8	3.2	10.7
45	6.0	2.5	7.7	6.0	2.7	8.0	6.0	2.8	8.2	6.0	2.8	8.2	6.0	2.8	8.2	6.0	2.8	8.2	6.0	2.8	8.2
50	6.0	2.2	6.9	6.0	2.2	6.9	6.0	2.2	7.0	6.0	2.2	7.0	6.0	2.2	7.0	6.0	2.2	7.0	6.0	2.2	7.0
55	6.0	1.6	6.0	6.0	1.6	6.0	6.0	1.6	6.2	6.0	1.6	6.2	6.0	1.6	6.2	6.0	1.6	6.2	6.0	1.6	6.2
60	6.0	1.2	5.5	6.0	1.2	5.5	6.0	1.2	5.5	6.0	1.2	5.5	6.0	1.2	5.5	6.0	1.2	5.5	6.0	1.3	5.6
65	6.0	0.7	4.8	6.0	0.7	4.9	6.0	0.8	4.9	6.0	0.8	4.9	6.0	0.8	4.9	6.0	0.8	4.9	6.0	0.8	5.1
70	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5
75	6.0	0.2	4.1	6.0	0.2	4.1	6.0	0.2	4.1	6.0	0.2	4.1	6.0	0.2	4.1	6.0	0.2	4.1	6.0	0.2	4.2
80	6.0	0.0	3.6	6.0	0.0	3.7	6.0	0.0	3.7	6.0	0.0	3.8	6.0	0.0	3.8	6.0	0.0	3.8	6.0	0.0	3.8
85	6.0	0.0	3.4	6.0	0.0	3.5	6.0	0.0	3.5	6.0	0.0	3.5	6.0	0.0	3.5	6.0	0.0	3.5	6.0	0.0	3.5
90	6.0	0.0	3.2	6.0	0.0	3.2	6.0	0.0	3.2	6.0	0.0	3.2	6.0	0.0	3.2	6.0	0.0	3.3	6.0	0.0	3.3

CURVE RADIUS	G132 ANGLE OF CURVE DEVELOPMENT											
	150°			160°			170°			180°		
	A	Es	Is	A	Es	Is	A	Es	Is	A	Es	Is
5	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-
25	34.0	4.5	12.5	-	-	-	-	-	-	-	-	-
30	23.2	3.5	12.3	26.0	3.6	12.4	29.0	3.6	12.4	32.2	3.6	12.4
35	15.0	3.3	11.4	16.0	3.4	12.2	17.5	3.2	12.3	18.5	3.5	12.3
40	8.5	3.2	11.0	8.6	3.2	11.0	9.0	3.2	11.0	9.0	3.4	11.0
45	6.0	2.8	8.2	6.0	2.8	8.2	6.0	2.8	8.3	6.0	2.9	8.3
50	6.0	2.2	7.0	6.0	2.2	7.0	6.0	2.2	7.1	6.0	2.2	7.1
55	6.0	1.6	6.2	6.0	1.6	6.2	6.0	1.6	6.2	6.0	1.6	6.2
60	6.0	1.3	5.6	6.0	1.3	5.6	6.0	1.3	5.6	6.0	1.3	5.7
65	6.0	0.8	5.1	6.0	0.8	5.2	6.0	0.8	5.3	6.0	0.8	5.3
70	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.5	6.0	0.6	4.6
75	6.0	0.2	4.2	6.0	0.2	4.2	6.0	0.2	4.2	6.0	0.2	4.2
80	6.0	0.0	3.9	6.0	0.0	3.9	6.0	0.0	4.0	6.0	0.0	4.0
85	6.0	0.0	3.5	6.0	0.0	3.6	6.0	0.0	3.7	6.0	0.0	3.7
90	6.0	0.0	3.3	6.0	0.0	3.3	6.0	0.0	3.3	6.0	0.0	3.4



Considering the different cases that may arise, the way to use the values of the previous table is indicated.

Case 1.
Cleared slope on both sides with no possibility of overhang.
Total necessary road width = A + Es/SAe + Is/Sai.

Case 2.
Mixed profile of a cleared slope on the inside of the curve (without the possibility of inner overhang) and embankment slope on the exterior (allowing carriers to pass over the overhang).
Total necessary road width = A + Is/SAi
Necessary exterior widening = Es/SAe.

Case 3.
Mixed profile of an embankment slope on the inside of the curve (with the possibility of inner overhang) and cleared slope on the exterior (with no possibility of outer overhang).
Total necessary road width = A + Es/SAe.
Necessary interior widening = Is/SAi.

Case 4.
Embankment slope on both sides with the possibility of overhang on both sides of the curve.
Total necessary road width = A.
Necessary exterior widening = Es/SAe.
Necessary interior widening = Is/SAi.

If the terrain itself does not prevent overhang on both sides, rather it is some sort of obstacle (plants, walls, signs, etc.), the formulas in Case 1 will apply.