

Road, Crane Pad and Hardstand Specifications for Vestas Turbines V100-1.8MW and V112-3.0MW

History of this Document

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1 Purpose

This document is intended as a guideline which describes the minimum requirements for Roads, Crane Pads and Hardstands for Vestas turbines V100-1.8MW and V112-3.0MW.

This document is also designed to be included in contractual agreements as a supplementary document to specify such minimum requirements and any deviation hereto. This document is not sufficient in and of itself to construct Roads, Crane Pads and Hardstands and must be supplemented for each project and site before construction work commences in order to ensure the specifications and the final choice of crane and transport equipment are aligned with the site requirements.

The exact design of Roads, Crane Pads and Hardstands must be agreed with Vestas in writing prior to start of construction.

RECIPIENT ACKNOWLEDGES THAT THIS DOCUMENT IS PROVIDED FOR RECIPIENT'S INFORMATION ONLY, AND THAT ANY AND ALL PROMISES, COMMITMENTS, OR OTHER REPRESENTATIONS BY VESTAS ARE CONTAINED EXCLUSIVELY IN SIGNED WRITTEN CONTRACTS BETWEEN RECIPIENT AND VESTAS, AND NOT WITHIN THIS DOCUMENT.

2 Abbreviations and Definitions

In this Road, Crane Pad and Hardstand Specifications for Vestas Turbines V100-1.8MW and V112-3.0MW. the following words, abbreviations and expressions shall have the meanings stated below:

Access Road(s)

Refers to a road, existing or purpose-built, which leads from any public road system to the Site Entrance.

Allowable Bearing Capacity

The ultimate bearing capacity of the materials below the supporting surface divided by the Bearing Capacitor Factor of Safety.

Assist Crane

Refers to the crane that will assist rigging the Main Crane and lifting various wind turbine components alongside the Main Crane.

ASTM

Refers to the American Society for Testing and Materials.

Bearing Capacity

Magnitude of uniformly distributed contact pressure of designated configuration on the supporting surface corresponding to the allowable bearing capacity of the materials below the supporting surface.

Bearing Capacity Factor of Safety

Ratio of ultimate bearing capacity to allowable bearing capacity to be determined by a qualified civil engineer, however Vestas requires a bearing capacity factor of safety value of not less than 1.5 (one point five).

BS

Refers to British Standards.

CBR

Refers to the California Bearing Ratio. This is a test to determine the ratio between the pressure required to penetrate the soil at the site and a standardized soil of known properties. This test is described in AASHTO test T193, and by ASTM D1883-05

Crane Pad

Refers to a hardstand area in connection with the erection or service of a wind turbine or metmast.

Crane Walks

Temporary carriageways used primarily by crawler cranes to travel the shortest distance between Crane Pads.

DCP

Dynamic Cone Penetrometer test to measure penetration rate (PR) in accordance with ASTM D 6951.

Degree of Compaction and Percent Compaction

Ratio of dry density of in-place soil or aggregate as measured by nuclear densometer in accordance with ASTM D 2922 to MDD, expressed as a percentage.

FTD

Field density test (including field water content). Test used to determine dry density of in-place soil or aggregate as measured by nuclear densometer in accordance with ASTM D 2922 with field water content of in-place soil or aggregate as measured by nuclear gauge in accordance with ASTM D 3017.

Hardstands

Refers to any area where wind turbine components and transport and installation equipment is stored, placed or parked and includes vehicle parking areas, lay-down and storage areas, compounds and other agreed working areas.

Lay-bys

Refers to a place parallel to the road where a vehicle can safely pull off to allow another vehicle to pass by in a safe manner.

Main Crane

Refers to the crane that will lift the wind turbine components into final position.

MDD

Maximum Dry Density as established by ASTM D 1557 Method C (modified Proctor).

OMC

Optimum Moisture Content corresponding to the maximum density as established by ASTM D 1557 Method C (modified Proctor).

PI

Refers to Plasticity Index. The difference between the water content at the liquid limit and the plastic limits. These values are determined through the Atterberg limits test, as defined by ASTM D 427 and D4318.

Public Road(s)

Refers to any national or rural road which is maintained by the local authorities and is in urban or rural areas in common use by the travelling public.

Roads

Refers to any Access and/or Site Roads.

Rut Depth

Maximum vertical distance between adjacent high and low points along a wheel path or track path.

Site

Refers to all areas where the permanent works are to be executed and to which turbines and all associated equipment and materials are to be delivered, and any other areas that may be specified in the contract as forming part of the Site.

Site Entrance

The official entrance(s) to the site for all types of traffic.

Site Road(s)

Refers to any road built to carry traffic from the Site Entrance to the Crane Pads, sub-station or compound within the site boundaries.

Ultimate Bearing Capacity

The uniformly distributed surface contact pressure of designated configuration corresponding to local shear or punching shear bearing capacity failure as calculated from bearing capacity theory based on the thickness and properties of aggregate cover material, if any, above the subgrade surface and properties the soils below the subgrade surface.

2.1 Trafficking Trail

Report that provides proof that Roads and Crane Pads and Hardstands will not rut excessively when subjected to traffic.

Equivalent Single Axle Loads (ESAL) repetitions shall be calculated either by using the Load Equivalency Factors (LEF) from the tables in Appendix D of the 1993 AASHTO Guide for Design of Pavement Structures based on a Structural Number (SN) of 1 and terminal serviceability level (p_t) of 2.0 (two) or by using clause 802.14, Series 800 of Specification for Highway Works.

3 Required Documents

Transport Manual including all applicable underlying documents relevant to the turbine type(s) and mode(s) of transportation.

4 Public, Access and Site Road Specifications and Design



Risk of death and material damage due to overturning of truck, trailer and components.

Risk of death and severe material damage exists due to overturning of transport equipment and loads in situations where road construction or turning radius on Road is not adequate.

- Assessment/calculations must be prepared based on specific transport configuration for each site.

All Access and Site Roads must be completed before any wind turbine component delivery and must be maintained during the construction and installation period.

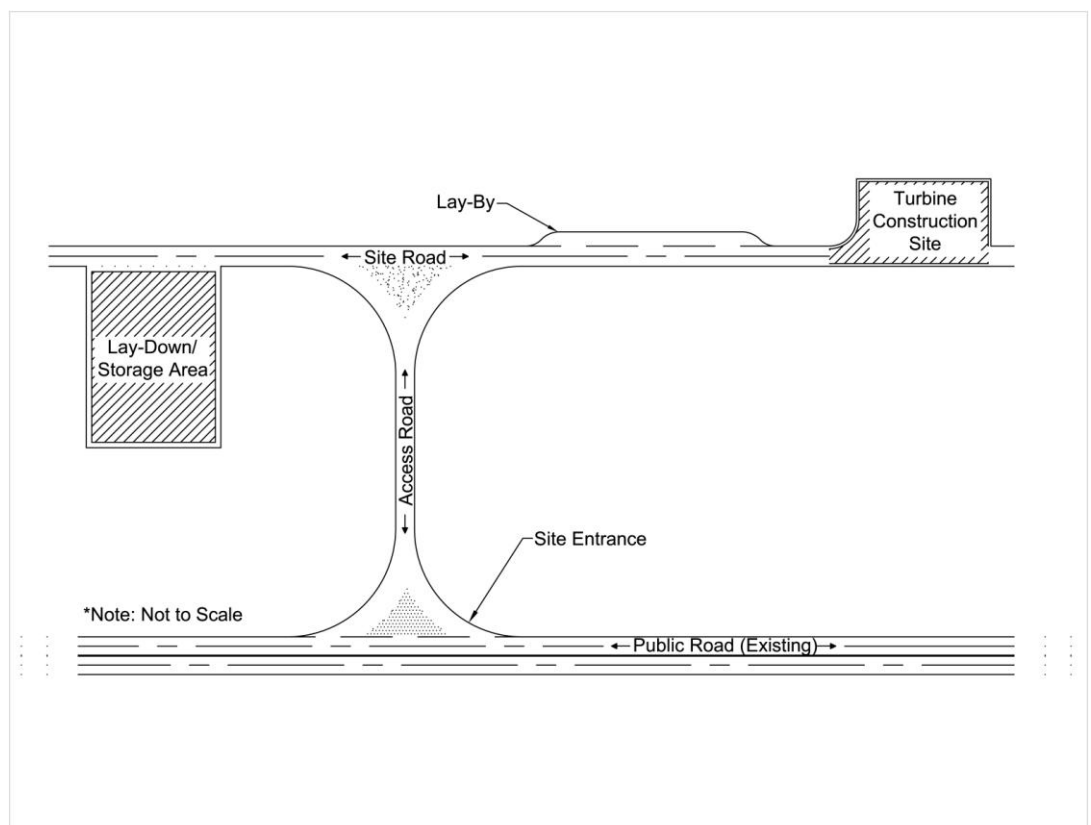


Figure 4-1: Road diagram

The following specifications shall apply:

- 4.1 The Road running lane width on straight roads must be a minimum of 5.5 (five-point-five) metres. A verge width of at least 1 (one) meter is recommended. See Figure 4-2, p. 7

- 4.2 The Road longitudinal slope must be a maximum of 8 (eight) degrees. **Any gradient in excess of 8 (eight) degrees must be discussed and agreed prior to signing of any contractual agreement.** See Figure 8-1, p. 16 Maximum gradients for transport (drawing number 0002-0294).
- 4.3 The horizontal clearance around the Access and Site Roads must be increased from 5.5 (five-point five) metres to 11 (eleven) metres when a crawler crane is used, as determined by Vestas.
- 4.4 The Road lateral gradient must be a maximum of 2 (two) degrees. See Figure 4-2, p. 7

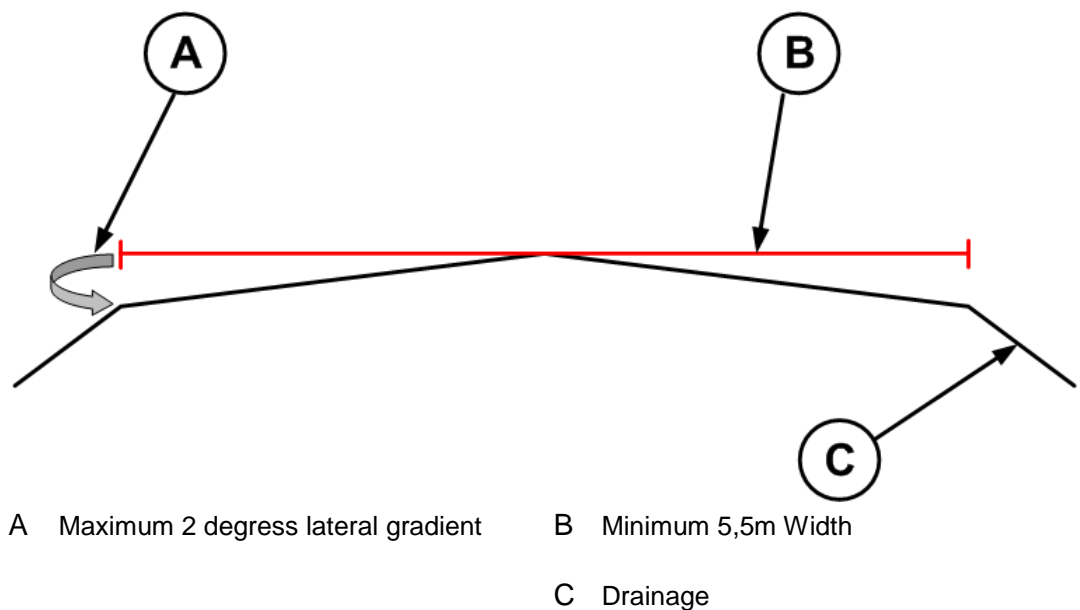


Figure 4-2: Width, gradient and drainage

- 4.5 The Road axle Allowable Bearing Capacity, in wet or dry conditions, must be a minimum of 17 (seventeen) metric tonnes.
- 4.6 The Road load Allowable Bearing Capacity must be a minimum of 180 (one hundred and eighty) nominal kN/m² in wet or dry conditions. All loads are exclusive of safety factors.
- 4.7 The Road horizontal bend radii must be designed, constructed or amended to accommodate the bending radii needed to transport all wind turbine components in accordance with the appropriate Vestas Transport Manual and the transportation equipment used by the transport supplier. See Figure 4-3, p. 8 **The bend radii must be agreed prior to signing of any contractual agreement(s).**



Figure 4-3: Illustration of acceptable radii on Access / Site Road

4.8 The Road longitudinal radii (convex or concave) must not be less than 200 (two hundred) metres.

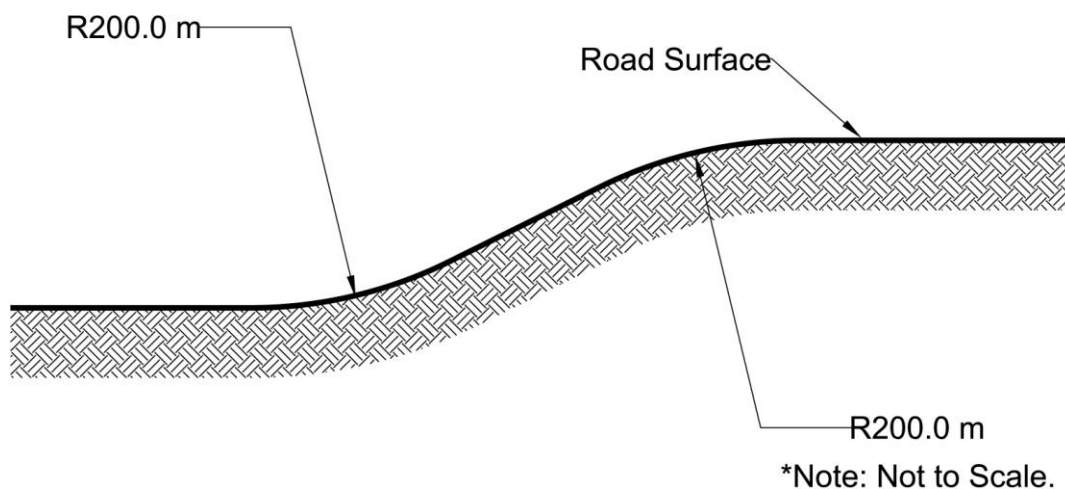


Figure 4-4: Vertical curve radius

4.9 Any irregularities in curvature shall have a maximum relative rise or fall of no more than 150 (one hundred and fifty) millimetres within any 30 (thirty) metre section.

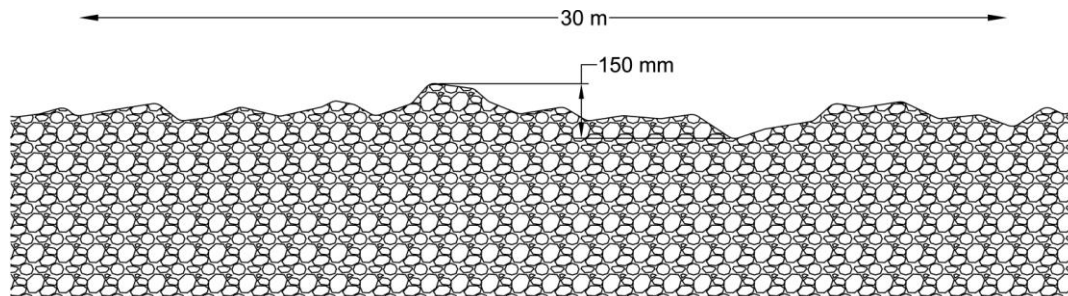


Figure 4-5: Maximum rise fall

- 4.10 Should temporary access be required from Public Roads to Access Roads, the intersections need to be modified to accommodate abnormal loads by constructing temporary carriageway with a minimum 48,5 (forty-eight point-five) meter outside turning radius and a minimum inside turning radius of 43 (forty-three) meters with suitable culverts and associated road widening as needed to complete turns. Temporary access areas must be constructed to the same specifications as Roads.

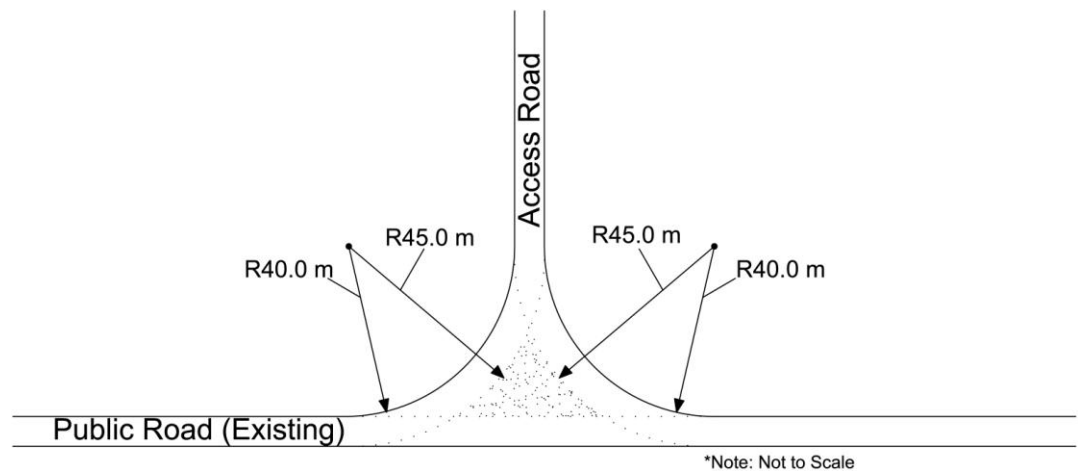


Figure 4-6: Road intersection

- 4.11 The Road overhead clearance must be a minimum of 6.6 (six point six) metres from the surface of the road.
- 4.12 For Access and Site Roads any permanent obstructions or hazards, including those situated overhead, must have “goal posts” with bunting strung between them. The “goal posts” must be maintained for the duration of the construction and installation period.
- 4.13 The Access and the Site Road must be well graded Type 1 stone (according to BS specification for highway works or local equivalent) and the maximum particle size after compaction must be 32 (thirty-two) millimetres.
- 4.14 The Access and the Site Road CBR, according to ASTM standard at OMC and MDD, must be > 60% (sixty percent).
- 4.15 The Access and Site Road PI must be <10% (ten percent).

- 4.16 The Access Roads, Site Roads, Crane Pads, and Hardstand drainage system must be designed to control and dissipate the flow of surface water along and under the Roads so as to self-drain. See Figure 4-7, p. 11



Figure 4-7: Illustration of suitable road surface and drainage

- 4.17 Provision must be made for a hammerhead, or other suitable and safe turning facility at the end of each Site Road or spur which allows abnormal load vehicles to turn around and egress the site.

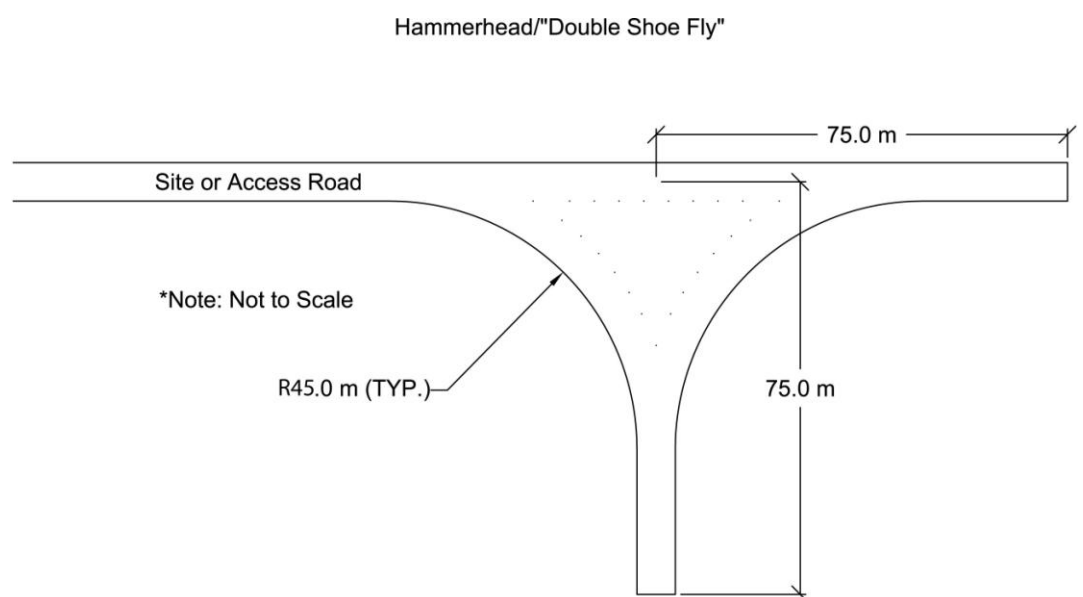


Figure 4-8: Hammerhead

- 4.18 Lay-bys at least 55 (fifty-five) metres long and 5,5 (five-point-five) metres wide must be provided to accommodate all road transport on the Access and the Site Roads. Lay-bys must be established a minimum of every 1 (one) kilometre of the Site Roads and the Access Roads and at critical points on the Site Roads and the Access Roads. **The critical points must be agreed prior to signing of any contractual agreement.**
- 4.19 All Lay-bys must be clear of all debris and the area must be level and self-drained.
- 4.20 Access Roads, Site Roads, and Lay-bys must be maintained, graded, watered, swept etc. throughout the duration of the construction and installation period to prevent surface deterioration or obstruction and ensure safe passage. This shall include snow and ice removal and dust prevention.
- 4.21 Access Roads, Site Roads, and Lay-bys must be marked with snow poles where applicable.
- 4.22 Where crawler cranes are to be used fully rigged, the following parameters apply:
- a) The horizontal clearance around the Access and Site Roads must be increased to 11 (eleven) metres.
 - b) Crane pad allowable bearing capacity must be greater than 200 (two hundred) kN/m² in wet or dry conditions.
 - c) The Access and Site Road allowable bearing capacity must be increased to greater than 250 (two hundred and fifty) kN/m² in wet or dry conditions.
 - d) For Access and Site Road gradients greater than 6% (six percent) the ground bearing capacity must be at least 270 (two hundred and seventy) kN/m² in wet or dry conditions.
 - e) Access and Site Road width of 6.5 (six point five) metres minimum.
 - f) No overhead obstructions on the Access and Site roads between the turbines.

5 Crane Pad and Hardstand Specification and Design



Risk of death and material damage due to overturning of Crane.

The possible risk of death and severe material damage exists due to any overturning of the crane or loads in situations where applied loading is not resisted by properly strengthened ground.

- ▶ Assessment/calculations must be prepared based on specific lift plans.

All Crane Pads and Hardstands must be completed before any wind turbine component delivery to site and maintained during construction and installation according to Figure 8-2, p. 17. Crane Pad Final area (drawing number 0008-5053).

- 5.1 The Crane Pad working surface dimensions to be constructed at each wind turbine location must be a minimum of 25 (twenty-five) metres by 50 (fifty) metres. For turbines with hub height higher than 80 (eighty) metres a minimum 25 (twenty-five) metre by 50 (fifty) metre area is required to accommodate the larger crane needed.
- 5.2 The Crane Pad maximum lateral slope must be 2 (two) degrees.
- 5.3 The Crane Pad maximum longitudinal slope must be 2 (two) degrees.
- 5.4 The Crane Pad must provide a ground bearing capacity of minimum 200 (two hundred) KN/m² to be tested at each corner of the pad and also in the centre of the pad. The compaction must be to 98% (ninety-eight percent) Modified Proctor. **“Floating” crane pads over poor ground are not recommended and use of such crane pads require agreement and possibly further engineering measures prior to signing of any contractual agreement.** All loads are exclusive of safety factors.
- 5.5 The Crane Pad shoulder slopes must be maximum 45 (forty-five) degrees.
- 5.6 The Crane Pad drainage must be designed to control the flow of surface water on, alongside and around the Crane Pads so as to self- drain.
- 5.7 Maximum level difference between top of foundation insert and Crane Pad must not exceed 0.5 (zero point five) metres measured from the centre of the Main Crane to the foundation insert.
- 5.8 Provision must be made for the safe and proper lay-down and storage of wind turbine components at, or adjacent to the Crane Pad, within the operating radius of the Main Crane and within the operating radius of the Assist Crane.
- 5.9 If the Main Crane has a lattice jib, then a trestle area and hardstand will be required to build up the jib. The Assist Crane will require a hardstand to same specification as Main Crane but with dimensions of 20 (twenty) metres by 9 (nine) metres. See Figure 5-1, p. 12

- 5.10 Provision of suitable storage and lay-down areas for other wind turbine components and associated equipment. See Figure 5-1, p. 12. Where space is at a premium and lay-down areas cannot be constructed, consideration should be given to the alternative triangular crane pad layout as shown in Figure 8-3, p. 18
- 5.11 When lattice jib is used, the rigging area for the Main Crane must have a minimum length equal to wind turbine hub height plus 20 (twenty) percent of the hub height added to this length parallel to the Site Road. The usable width must be minimum 7 (seven) metres.



Figure 5-1: Illustration of relative lay-down area

- 5.12 Off-loading area for nacelle must be minimum 7 (seven) metres by 50 (fifty) metres and within the working radius of the Main Crane.
- 5.13 Off-loading area for blades must be minimum 15 (fifteen) metres by 58 (fifty-eight) metres and within the working radius of the Main Crane.
- 5.14 Provision must be made for the safe and proper lay-down and storage of parts in a suitable secure location. Parts include and are not limited to: lifting tools, service platforms (lifts), uninterruptible power supply, tower cables, nose cone parts, stairs, steps, ladders, boxes of bolts and 40 feet (13.8 metres) parts containers.
- 5.15 Provision of suitably located and sized compound area, relative to the amount of MW being installed.
- 5.16 Compounds, storage and lay-down areas must be clear of all debris, and the area must be level and free draining and have the same bearing capacity and proof testing as the Crane Pad.

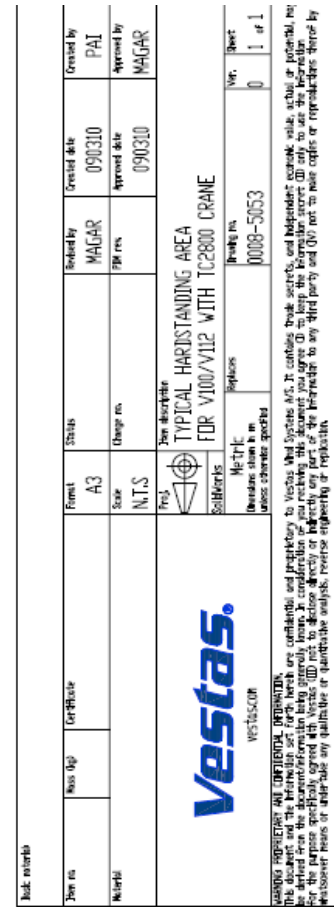
6 Testing and Inspection

Any Roads, Crane Pads or Hardstands must not be taken into use until:

- 6.1 Measurements and results of agreed tests proving the ground bearing capacity of the Access Roads, Site Roads, Crane Pads, and Hardstands have been provided. The tests must as a minimum include:
 - ✎ Proof roll record for any area subjected to loading showing that the ground has been rolled and compacted sufficiently to resist deformation and rutting due to the applied loads.
 - ✎ Trafficking Trial as per the requirements of Clause 12, Series 800, Volume 1, Specification for Highway Works to conform with BS EN 13285. In particular, the mean vertical deformation after 1000 equivalent standard axles shall be less than 30 (thirty) millimetres.
 - ✎ Plate bearing test (to BS 1377 or local equivalent) results showing that minimum bearing capacity is achieved. DCP and FDT tests can be used to corroborate the plate bearing test, where deemed necessary.
- 6.2 An inspection of the work has been completed.
- 6.3 A test-run has been successfully performed on the Roads by using a vehicle of equivalent longest length which would be employed on transportation during construction and installation.

7 Other Requirements

- 6.1 Provision must be made for:
 - a. Sufficient area for safe parking of vehicles.
 - b. Any required gates at the point of access to site.
 - c. Any required signage at or on the approaches to the point of access to the site.
 - d. The clearance of all overhead obstructions to ensure safe and unhindered travel for all cranes.
 - e. All excess overburden or topsoil etc. to be stored on the lower slope side of the Site Road and Hardstand areas.
- 6.2 The provision of a level, compacted area with radius of 5 (five) metres wide around the turbine tower is recommended to assist future maintenance.



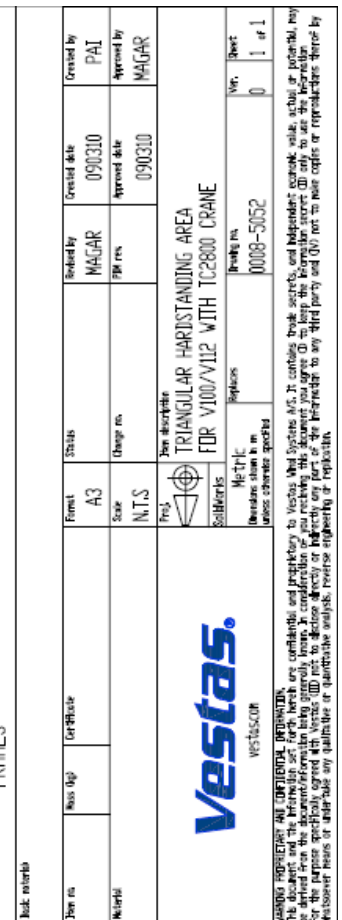


Figure 8-3: Triangular Hardstand Area with Crane