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Valutazione d'impatto ambientale D.Lgs. 152/2006 e ss.mm.ii.

BOREAS

Ampliamento del Parco Eolico di Ulassai e Perdasdefogu nel territorio del Comune di Jerzu (NU)

PROGETTO DEFINITIVO OPERE CIVILI

REPORT TRASPORTI SPECIALI

0	15/12/2020	Emissione per procedura di VIA	Sartec	Sartec	Sartec
Rev.	*Data*	*Descrizione*	*Red.*	*Contr.*	*Appr.*

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Valutazione d'impatto ambientale D.Lgs. 152/2006 e ss.mm.ii.

BOREAS

Ampliamento del Parco Eolico di Ulassai e Perdasdefogu nel territorio del Comune di Jerzu (NU)

PROGETTO DEFINITIVO DELLE OPERE CIVILI

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Class I

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Issued on 04/11/2020

Executor: Leanzio GAMBUTI

Approver: Francesco DRAGONE

Customer: Sardeolica

Transport Road Survey Report

Project: Abbila - Jerzu, Italy

History of this document

Doc. and Rev. no.:	Date:	Description of changes	Exec.	Appr.
MED TTT001	04/11/20	First issue	Leanzio GAMBUTI	FRADR

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Table of Contents

Summary

According to Customer requested it has been analyzed turbine type V162 5,6mw HH 125 m tower configuration transport feasibility for catching up to the Abbila – Jerzu Wind Park Site.

Road Survey date: **18/08/2020 – 12/10/2020**

Transport Supervisor: **Francesco DRAGONE (Vestas Italia)**

Attendants:

Transporter Representative: **Riccardo DI PALMA (La Molisana Trasporti)**

Specs Description

Project	**Abbila Jerzu**
Country	Italy
Location	Jerzu (NU) Sardegna region
Scope	Planning Stage – Transport Logistic – Feasibility Study
Turbine	V162 125m
Transport Mode	☐ Standard ☒ Transshipment ☒ Blade Lifter ☒ Tower ☒ Nacelle
Start From	port of Arbatax

Weight and Dimention

V162 4.2MW

Nacelle	length mm	width mm	height mm	Weight kgs
	18176	4200	4350	83670

Single blade	length mm	width mm	height mm	Weight kgs
	79350	4320	3294	21700

Hub	length mm	width mm	height mm	Weight kgs
	4980	4401	4040	64000

Drive train	length mm	width mm	height mm	Weight kgs
	7500	2700	3000	94040

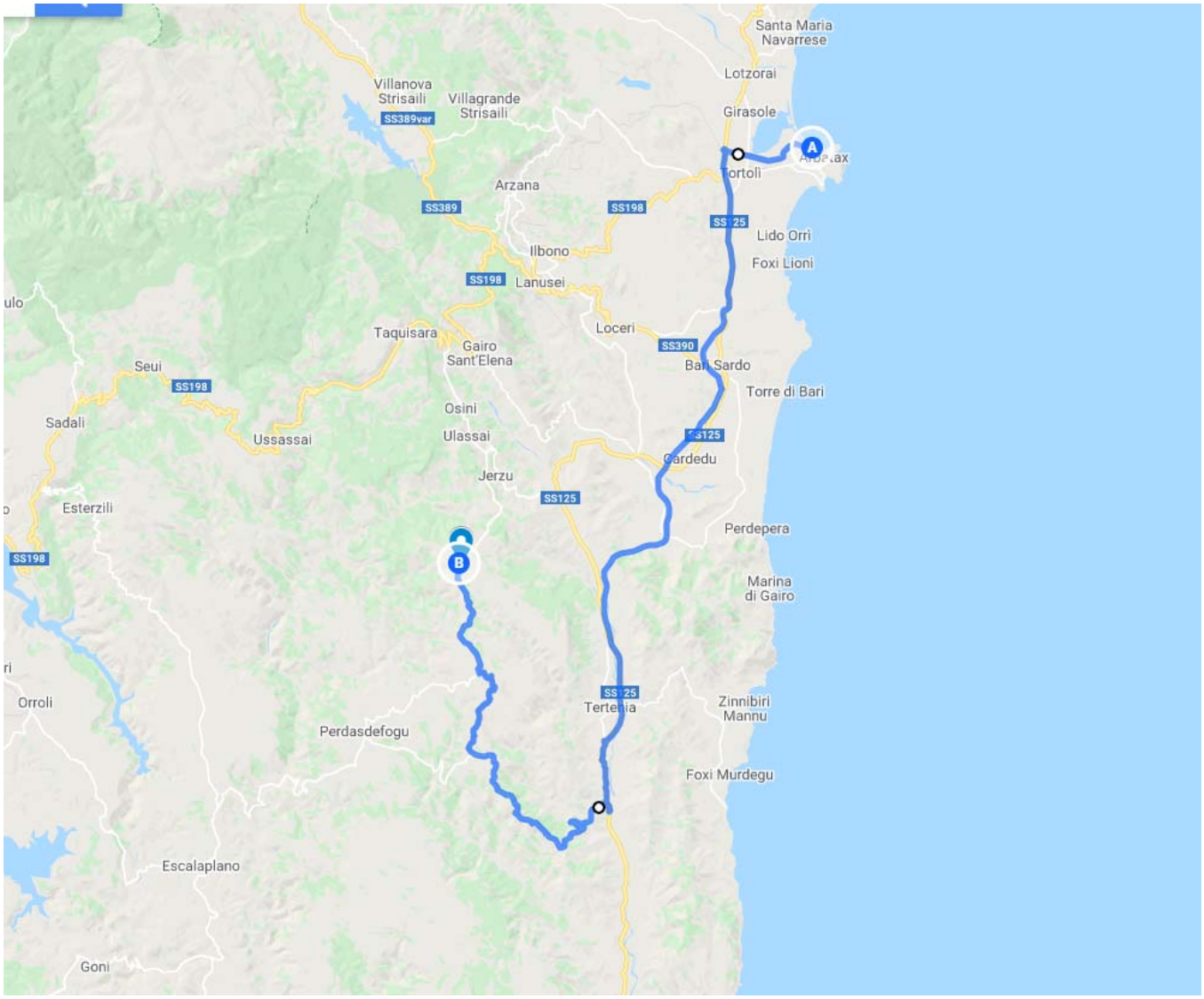
HH125m

Tower	Bottom end mm.	top end mm.	length mm.	weight kgs.
Section 1	4500	4150	12500	80000
Section 2	4150	4150	14280	77000
Section 3	4150	4150	16800	77000
Section 4	4150	4150	20720	75000
Section 5	4150	4150	28000	73000
Section 6	4150	4000	30000	53000

General Route Description

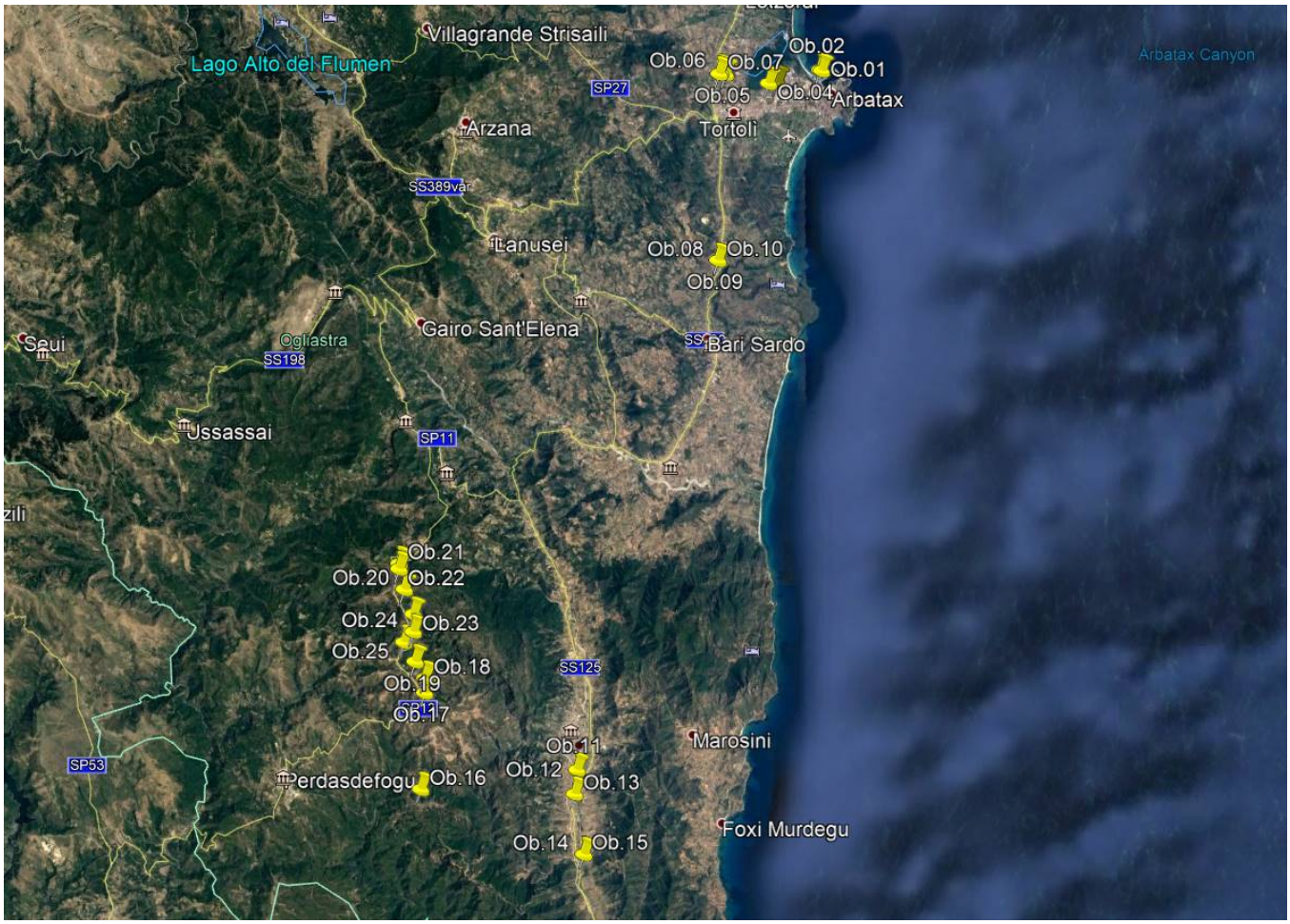
External Route

For the transport of the Wind Turbine, port of Arbatax has been considered as pick-up location.



Port of Arbatax ► Via Baccasara ► Via Bargerbu► SS125 ► SS125 var ► SS125►
►Strada Militare►road inside the wind farm►SP13►
►Site Access A
►Site Access B
►Site Access C
►Reverse Area
►Site Access G
►Site Access D
►Site Access E
►Site Access F

Observation Map Overview



Road Modifications

Observation 1

Exit from port of Arbatax
The blades will be transhipped directly on the Blade Lifter Device.
The section tower and the nacelle will be transhipped directly on the special trailer.
You need a carriageway with a width of 4.5 meters in the straight part of the road and 6,0 meters in the curves All NOT INDICATED (cables, limbs, etc..) must be over 6,0 mt in height.
In addition, close to the bends before 100mt and beyond 100mt, in the middle of the carriageway, it will be necessary to leave an aerial clearance without any obstacles (limbs and cables) to allow the lifting of the blade.

39°56'11.85"N - 9°41'47.84"E

Observation 2

Exit to Arbatax port

39°56'12.91"N - 9°41'44.63"E

Observation 3

Driving into oncoming traffic

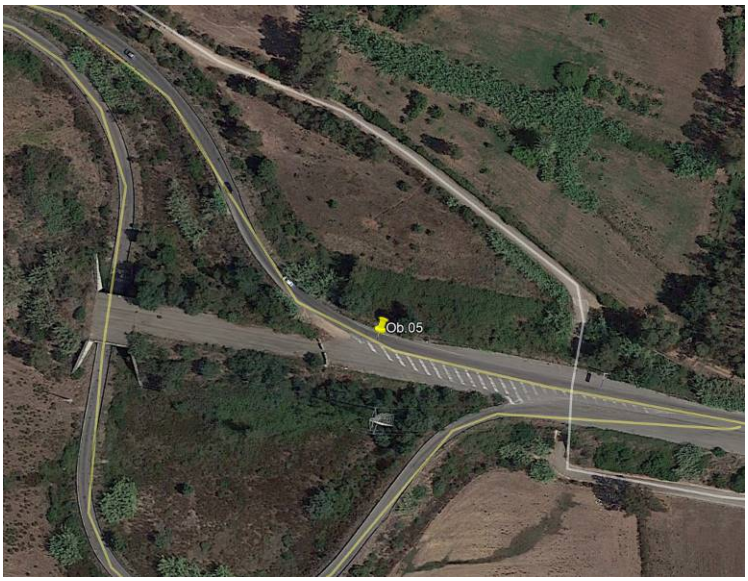
39°55'56.35"N - 9°40'30.63"E

Observation 4

Make enlargement as shown

39°55'55.25"N - 09°40'15.50"E

Observation 5
Make enlargement as per picture
Cut vegetation as shown
39°56'07.49"N - 09°39'00.17"E



Observation 6

Make enlargement 8mt

39°56'10.48"N - 9°38'51.48"E

Observation 7

Driving into oncoming traffic

39°56'07.78"N - 9°38'49.11"E

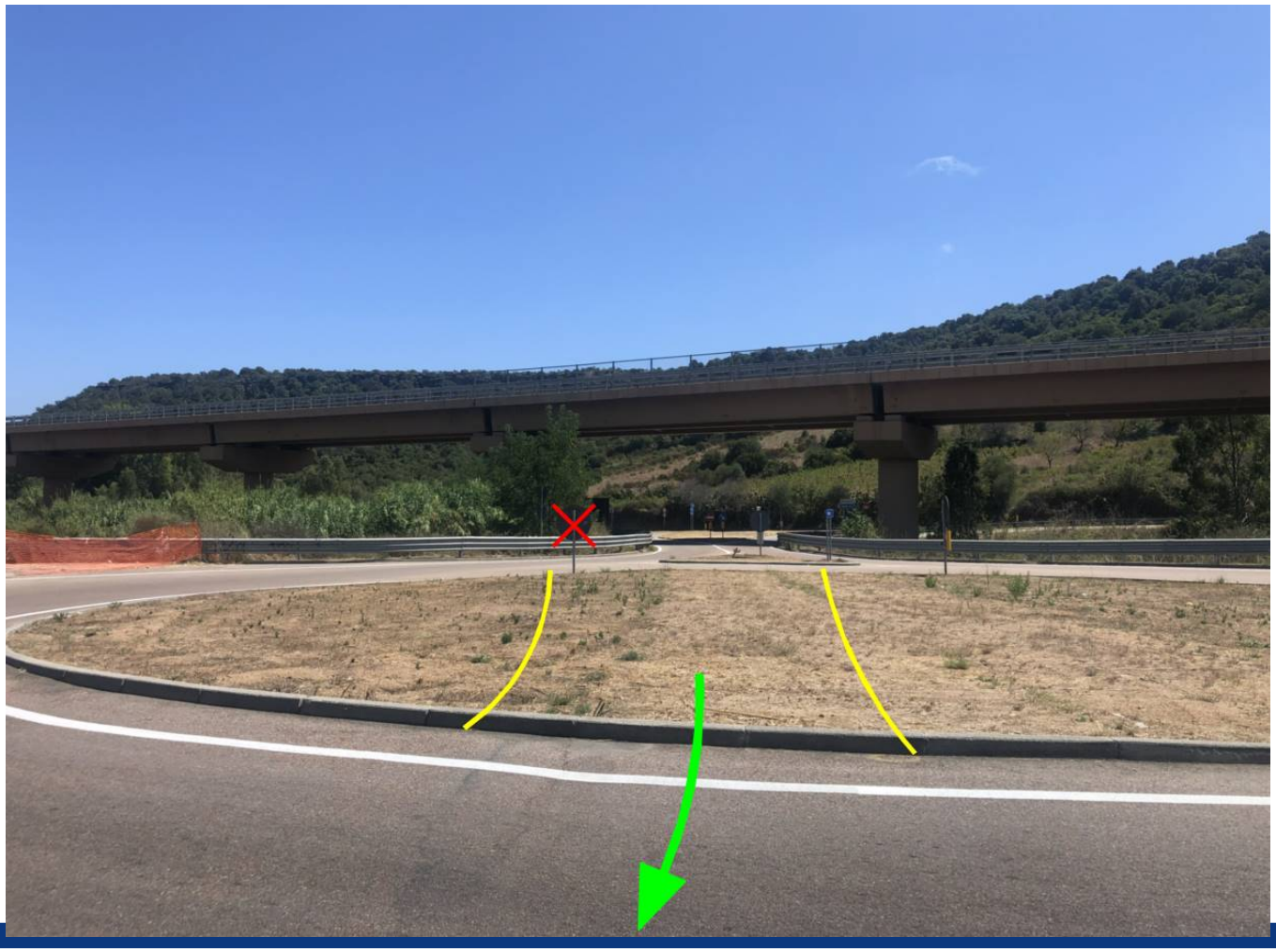
Observation 8
Make a passable area
Remove road signals as shown
39°51'57.71"N - 9°34'47.82"E

Observation 9

Remove road signal as shown

39°51'57.93"N - 9°38'46.61"E

Observation 10
Create by-pass as the “0054-6051- Wind farm Roads Requirements”
Remove road signal as shown
39°51'58.10"N - 9°38'46.73"E



Observation 11
Make a passable area as shown
Remove road signals as shown
39°40'38.15"N - 9°34'41.09"E

Observation 12

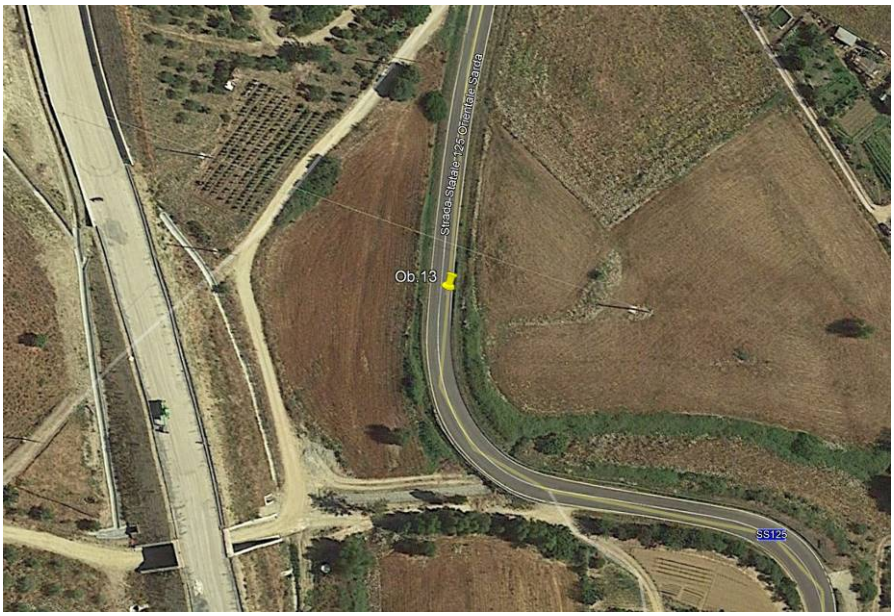
Remove cable as shown

39°40'36.84"N - 9°34'41.01"E

Observation 13

Remove cable as shown

39°40'06.05"N - 9°34'36.89"E



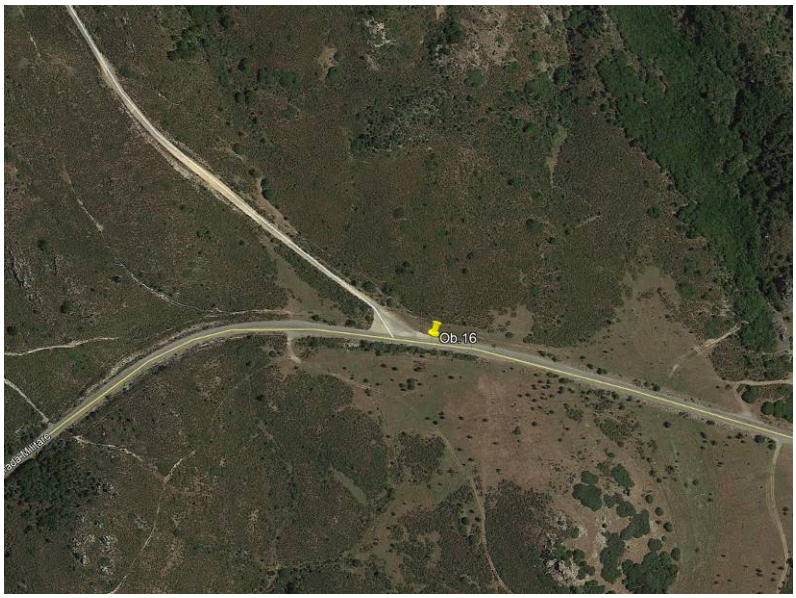
Observation 14
Make a passable area.
Remove the road signals as shown
39°38'45.17"N - 9°34'52.65"E

Observation 15
Make a passable area.
Remove the road signals as shown
39°38'45.71"N - 9°34'51.43"E

Observation 16

Road brecciated to do as per specifications

39°40'15.22"N - 9°30'15.00"E



Observation 17
End of the brecciated road
Create a widening to 5 mt
Remove the guard rail as indicated
39°42'23.91"N - 9°30'23.50"E

Observation 18

Create site access A as the “0054-6051- Wind farm Roads Requirements”

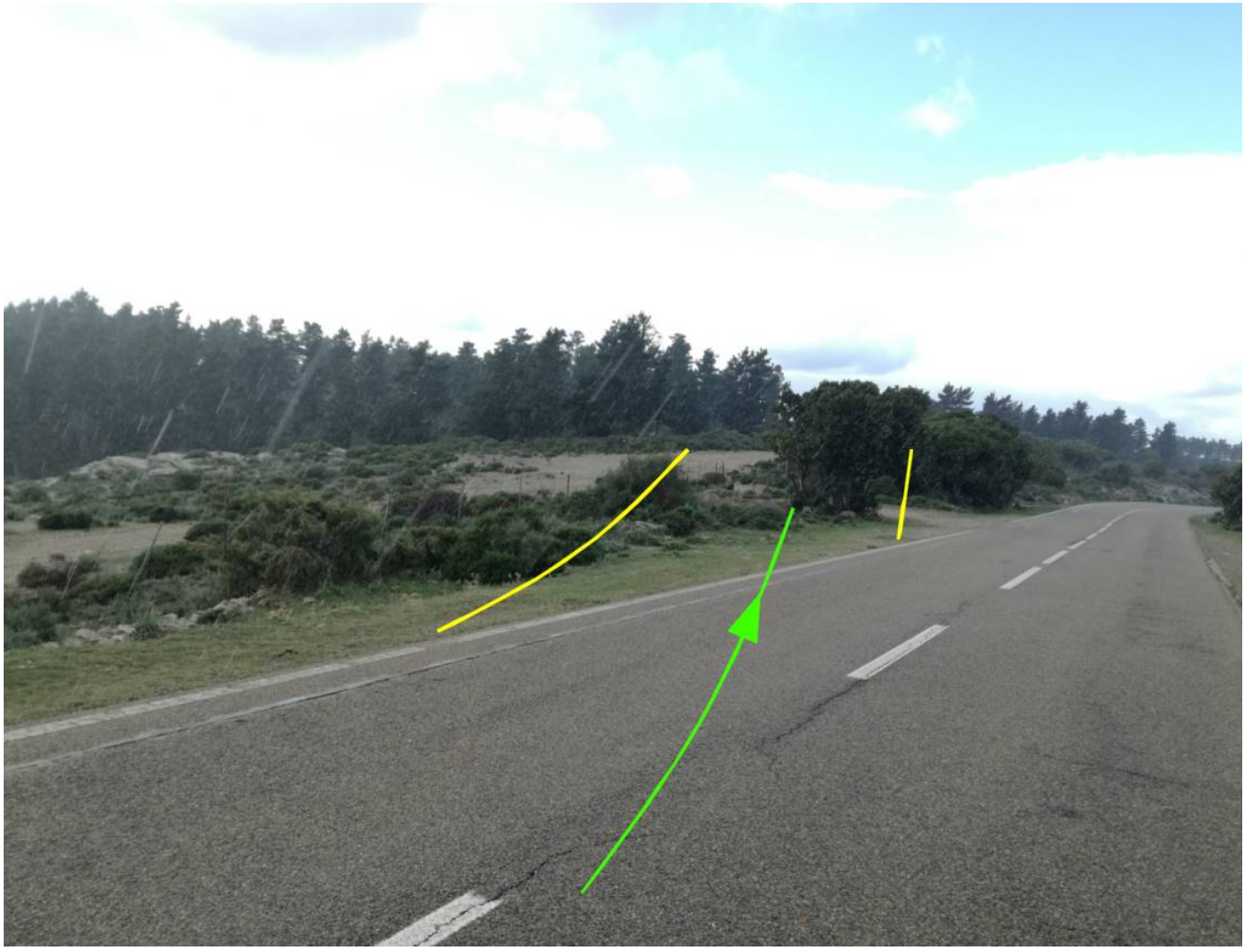
Coord. 39°42'42.96"N - 09°30'24.35"E

Observation 19
Create site access B as the “0054-6051- Wind farm Roads Requirements”
Coord. 39°43'05.20"N - 09°30'08.05"E

Observation 20

Create site access C as the “0054-6051- Wind farm Roads Requirements”

Coord. 39°44'40.52"N - 09°29'49.59"E



Observation 21
Reverse Area
Min 50mt
Coord. 39°45'14.51"N - 09°29'40.88"E

Observation 22
Create site access G as the “0054-6051- Wind farm Roads Requirements”
Coord. 39°45'07.55"N - 09°29'40.81"E

Observation 23

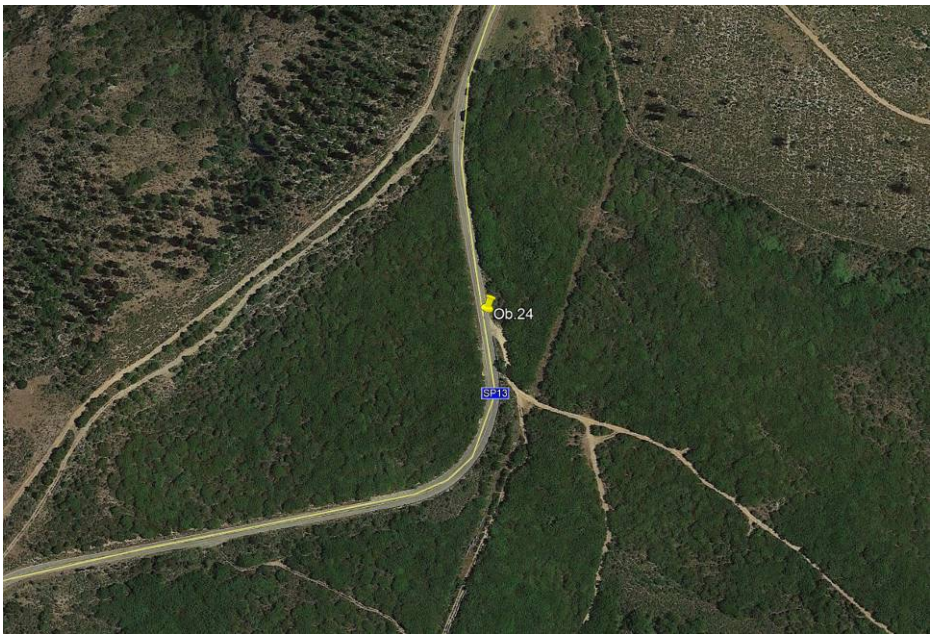
Create site access D as the “0054-6051- Wind farm Roads Requirements”

Coord. 39°44'07.77"N - 09°30'04.69"E

Observation 24

Create site access E as the “0054-6051- Wind farm Roads Requirements”

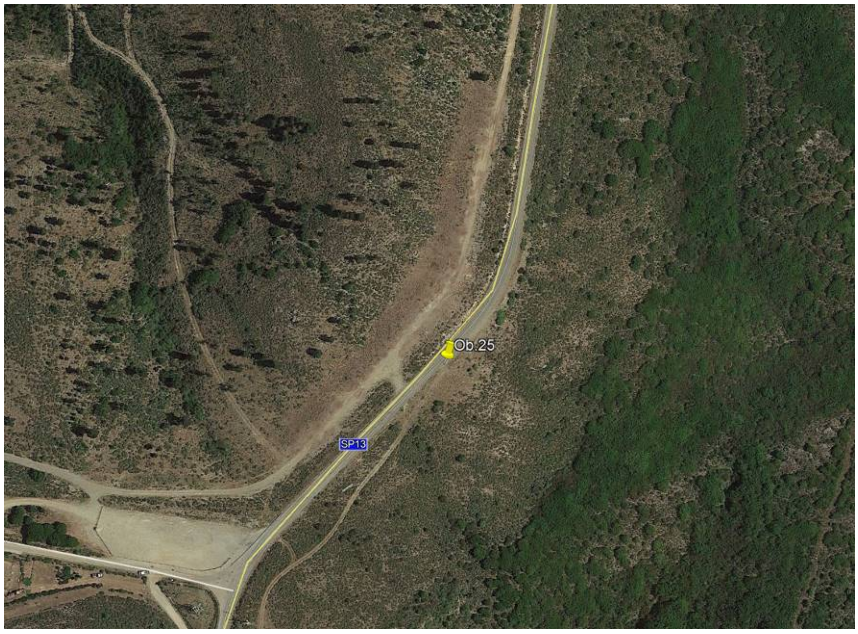
Coord. 39°43'44.62"N - 09°30'04.85"E



Observation 25

Create site access F as the “0054-6051- Wind farm Roads Requirements”

Coord. 39°43'30.89"N - 09°28'48.90"E



Conclusions and Highlighted

Every branches jutting out on routing roads will have to be cut (6,0 mt width and 6,0 mt high)

- Keep flat every height difference (along 45mt vertical bending radius has to be 250m) on the complete road surveyed.

- Every air electric and phone cables have to be at least 6,0 mt high.

- From the transshipment area (port of Arbatax) you need a carriageway with a width of 4.5 meters in the straight part of the road and 6,0 meters in the curves All NOT INDICATED (cables, limbs, etc..) must be over 6,0 mt in height.
In addition, close to the bends before 100mt and beyond 100mt, in the middle of the carriageway, it will be necessary to leave an aerial clearance without any obstacles (limbs and cables) to allow the lifting of the blade.

- The survey road report has been written up considering authorities go head for exceptional transport along every route analyzed

- The feasibility studies and activities suppose owners availability for transiting and making civil works on their farmsteads.

- Site inland practicability, Wind Turbine Generators stocking area and its accesses roads have not taken into account.

- The survey road report has referred to the date 18/08/2020 and 12/10/2020 therefore variations and/or changes of practicability state will be evaluated subsequently

- For transport activities related to site and new roads, refer to Vestas guidelines as the “0054-6051- Wind farm Roads Requirements”

- This report do not take into account activities which could be eventually requested by the private or public authorities on the Access Roads as a condition for the obtainment by the Supplier of any Permit under this Agreement (including but not limited to verification of bridges and performance of all activities necessary in order to get the “ certificato di transitabilità”), therefore such activities, if any, shall be performed by the Buyer.”

Wind farm Roads

Requirements

DMS no: 0054-6051

Version No.	Date	Prepared by	Revised by	Approved by	Description of changes
7	06/09/18	RGOBA / LUSPR	LGB / ADMAD	TKJ / PIPRE	E2E requirements conformity
8	26/04/19	RGOBA / LUSPR / DDLCO	LGB / ADMAD	TKJ / PIPRE	V162 Requirements.
9	03/09/19	LUSPR / DDLCO	LGB / ADMAD	TKJ	Update wording.

CONTENTS

1. INTRODUCTION

The purpose of this specification is to establish the minimum road design and construction technical requirements for the roads to transport and install all Vestas wind turbine components . Each wind farm road design shall be defined by a dedicated road calculus report.

For the avoidance of doubt, the requirements set forth herein are necessary for a safe transport of the wind turbine components. However, such requirements alone are not sufficient to fully design and perform the wind farm roads. The design and construction of the roads and other wind farm related civil works shall require a specific calculus and design carried out by qualified experts considering all the calculus hypothesis to define all the applicable situations during the wind farm lifetime and construction period.

Very Important: Addendum to the present document

In the event that any of the standards set forth herein cannot be fulfilled because of technical or economic reasons, an alternative solution shall be found in order to allow a safe wind turbine installation.

Such alternative solutions shall be reviewed and agreed by Vestas prior to the execution of works. The agreed special solutions can be attached as an addendum to the present document in order to be applied in a specific project as valid alternative.

Furthermore, in some specific geographical areas it may be possible to customize and/or to optimize some of the requirements of the present specification. These complementary modifications can also be attached as an addendum to the present document for exclusive application on such areas.

2. WIND FARM ROADS SPECIFICATIONS AND DESIGN

2.1 USEFUL ROAD WIDTH

The minimum useful width to assure a safe transportation of the wind turbine components must be 4,5 m on straight sections of the wind farm roads.

On bends sections of the wind farm roads, it is recommended to perform a truck simulation with adequate software to determine the necessary widening. Otherwise, the recommendations from the Annex can be used as a first approach. Upon request, Vestas can perform a specific simulation to determine the optimum bend widening.

When crawler cranes are used during installation of wind turbines, the useful road width will be increased up to the width of the crawler crane plus a margin of, at least, 10 cm to allow its safe circulation (to be confirmed with crane company).

As a reference, in case of using a narrow track crawler crane, the most common useful road width on this case is 6 m. In case of using conventional crawler cranes, the above criterion is also valid and the most common useful road width is around 11 m. Final road width has to be confirmed with crane company based on final layout design.

Important note:

It is highly recommended to agree the road width with Vestas according to the site characteristics and cranes availability in order to optimize the total costs of the project and to have the safest and fastest way.

2.2 MAXIMUM LONGITUDINAL SLOPE

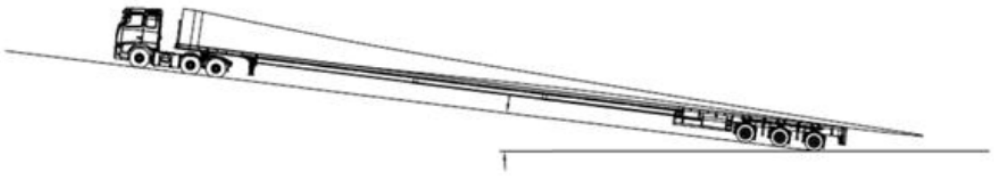


Figure 1: Longitudinal slope

The maximum longitudinal slope that the wind turbine component trucks can overcome is directly related to the quality of the pavement.

As a general design criterion, on dirt roads made of gravel or a graded aggregate where good pavement conditions cannot be assured due to often rain and/or possible poor construction and quality control or other circumstances, the wind farms maximum road longitudinal slope shall not exceed a value of 10% on straight stretches.
In mountain areas where it could not be possible to design roads with the above maximum slope due to environmental restrictions, the pavement shall be improved by using a suitable solution like concrete slabs or other one. On extreme cases where the slope may be higher than 14%, it shall be communicated to Vestas in all cases.

Once roads have been carried on site up to final pavement surface compacted and prior to wind turbine component transport, Vestas shall always validate and evaluate road condition to define the most suitable transport solution.

In case of relevant bends (low radius and high angle), the maximum longitudinal slope will be reduced on a proportional way to its complexity, and it is recommended not to exceed 7%.

If crawler cranes are going to circulate over the roads, it will be considered the maximum slope that these cranes can overcome. Allowable slopes for the crane total or partially assembled, and completely disassembled shall be evaluated in order to adapt the roads to those situations.

2.3 VERTICAL ALIGNMENT OF ROADS

The vertical alignment of roads, in relation to (parabolic) vertical curves, must be in accordance with the following criteria:

The minimum required values of the vertical alignment parameters (as described in Figure 2:) are established in Table 1 for each wind turbine model.

WTG	Kv min.
V80, V90	300
V100, V105	350
V110, V112, V116, V117	400
V120, V126	450
V136, V150, V162	500

Table 1. Minimum Kv

Vertical radius parameter (Kv) calculation:

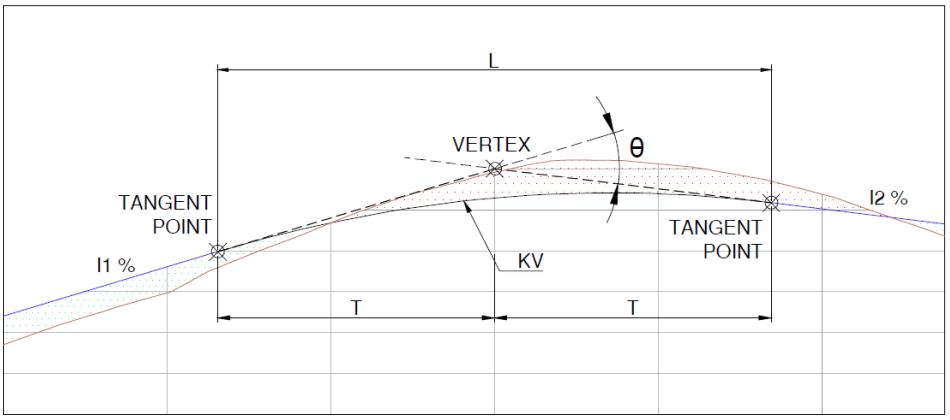
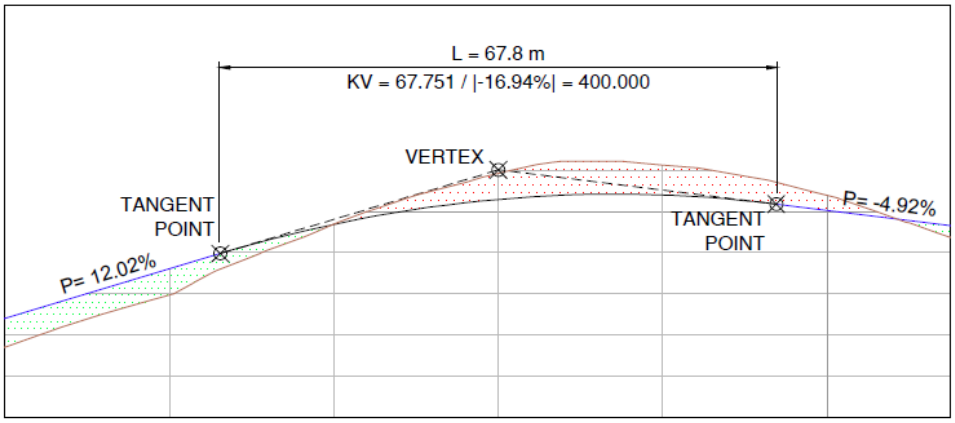


Figure 2: Representation of parameters for Vertical alignment

Convex radius example:

The following image shows an example of Kv calculation for a convex alignment:

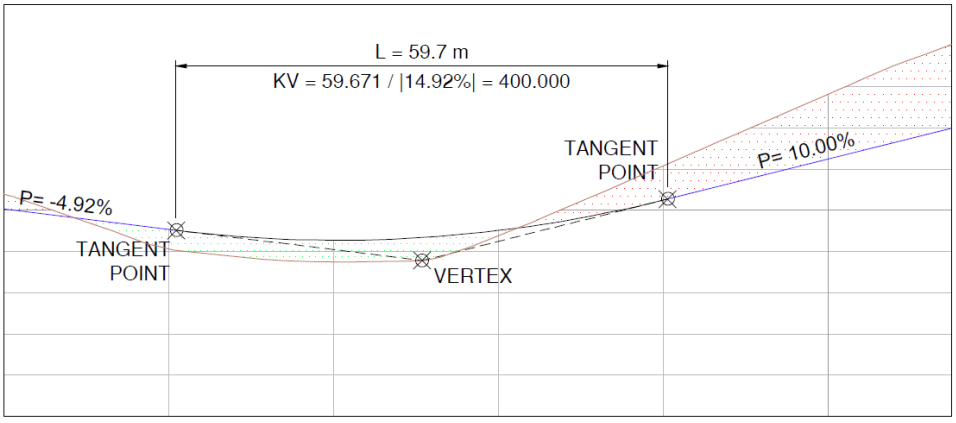


CONVEX RADIUS EXAMPLE :
KV= L / | I2 - I1 |
KV= 67.60 / | - 4.9% - 12.0% |
KV= 67.60 / | -16.9%|
KV= 400.00

Figure 3: Representation of Convex Radius Example

Concave Radius Example:

The following image shows an example of Kv calculation for a concave alignment:



CONCAVE RADIUS EXAMPLE :
KV= L / | I2 - I1 |
KV= 59.60 / | 10.0% - (-4.9%)|
KV= 59.60 / | 14.9%|
KV= 400.00

Figure 4: Representation of Concave Radius Example

2.4 LATERAL CROSS-FALL

In case that the designer decides to have a lateral cross-fall for rain water evacuation shall not exceed 2% from the centre of the road.

Figure 5: Longitudinal slope

2.5 ROAD OVERHEAD CLEARANCE

Road overhead clearance shall be at minimum 4,7 m from the pavement highest point. (This minimum value of 4,7 m depends upon the availability of special low bed hydraulic trailers for transport of tower sections, depends also on the final dimensions of the tower sections and depends on the blade tip overhang).

This value must be reviewed and approved by Vestas according to the specific project.

Any permanent obstacle or hazard situated overhead (e.g. power and telephone lines) shall be signalled with appropriate visual markers that will be kept in place throughout the duration of the construction and installation of the wind farm.

2.6 BEARING CAPACITY AND SUBGRADE

Roads Bearing Capacity

The wind farm roads load bearing capacity shall be at minimum 2 Kg/cm2. As an additional criterion the wind farm roads will be designed to bear a truck axle-load of 12 Tm.

Designer shall consider all hypothesis that would be applicable to the wind farm roads during its construction and lifetime. Dedicated road bearing capacity calculus has to be elaborated to ensure the transport of all machinery involved in the project.

The verification of the bearing capacity will be performed by static plate bearing test on site. The accredited laboratory that makes the static plate bearing test shall set up the acceptance criteria on it to confirm the required bearing capacity. To have an approximate reference, the results of the plate baring test should have the bulk modulus Ev2 greater than 50 MPa and the modulus ratio Ev2/Ev1 lower than 3. These figures shall be confirmed or modified by the accredited laboratory that makes the plate bearing test according to the final plate to be used.

In case of transport or crane mobilization will be done using sub-base layer, plate bearing tests will be done at sub-base layer following the same acceptable criteria mentioned above, therefore, road base design shall consider transport at road sub-base layer.

Subgrade

The soil survey shall characterize the soil on which the wind farm roads are to be constructed. To such purpose, soil samples (from beneath the topsoil) shall be taken in several representative points of the road network at intervals of 700 to 1000 meters. The collection of samples and performance of appropriate lab tests for soil characterization (California Bearing Ratio CBR, grading, plasticity, Proctor, etc.) shall be planned and carried out by a geotechnical expert.

The subgrade layer (below topsoil) upon which the roads are built shall have a minimum CBR value between 11 and 20.

In the event that such minimum CBR values are not achieved, the subgrade shall be accordingly improved by applying the most suitable method (lime or cement soil stabilization, addition of stone material, geotextile, etc.), depending on the kind of soil and following the instructions from an expert roads designer.

2.7 PAVEMENT

Roadbed Layer

The pavement of access and site roads (whether newly built or refurbished) shall be formed, as an initial recommendation, at minimum by a 15 cm thickness roadbed layer of graded aggregate, compacted to 98% Modified Proctor. Minimum thickness shall be defined by road calculus design report based on the AASHTO or applicable code.

Graded aggregate maximum grain size shall be lower than 20 mm and fines content shall be lower than 10% (<10% pass #200mm sleeve).

The graded aggregate used as pavement shall have low plasticity in order to prevent mud formation when it rains. Under no circumstances shall a graded aggregate with plasticity index (PI) value greater than 9 be accepted.

Graded aggregate grain size shall be between the following limits depending on its source: natural or crushed gravel:

Natural Graded Aggregate

	NATURAL GRADED AGGREGATE SIEVE SIZE: EN-933-2, ASTM C136 % CUMULATIVE PASSING									
Graded Aggregate	**EN**	40	25	20	8	4	2	0,5	0,25	0,063
	ASTM	1,5	1	3/4	3/8	Nº4	Nº10	Nº40	Nº60	Nº230
0/20	max	-	100	100	75	61	50	32	24	11
	min	-	100	80	45	32	25	10	5	0

Table 2. Roadbed layer Natural grain size limits.

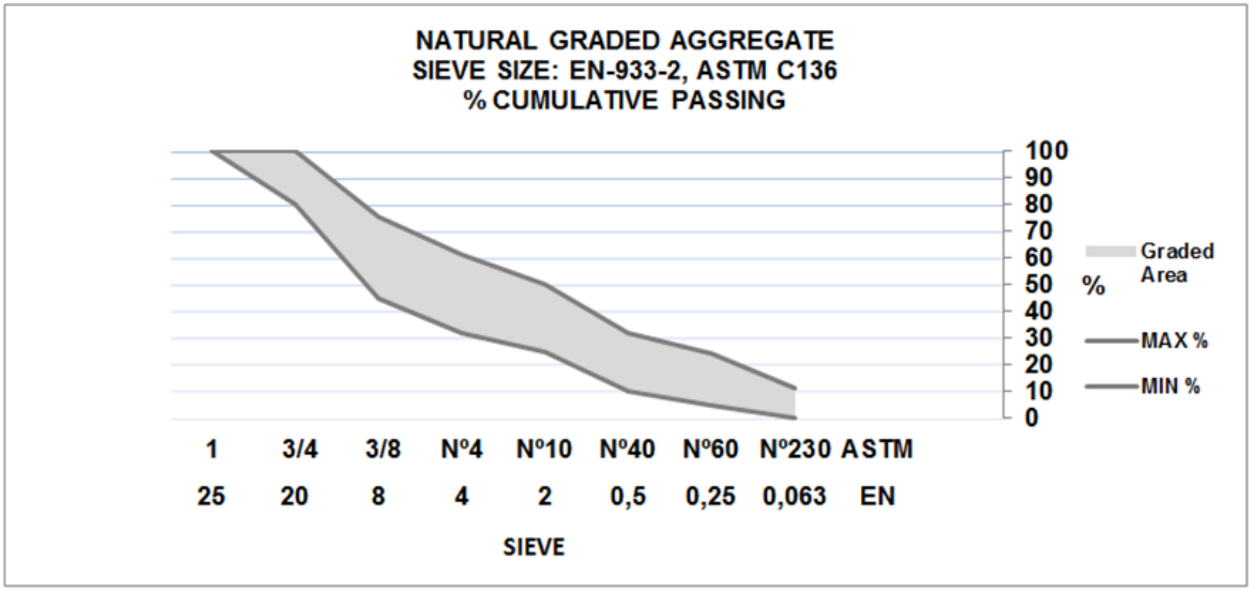


Figure 6: Roadbed layer Natural grain size limits.

rtificial Graded Aggregate

Table 3. Roadbed layer artificial grain size limits.

		ARTIFICIAL GRADED AGGREGATE SIEVE SIZE: EN-933-2, ASTM C136 % CUMULATIVE PASSING									
Graded Aggregate	EN	40	32	25	20	8	4	2	0,5	0,25	0,063
	ASTM	1,5	1,25	1	3/4	3/8	Nº4	Nº10	Nº40	Nº60	Nº230
0/20	% max	-	-	100	100	73	54	40	24	18	9
	% min	-	-	100	75	45	31	20	9	8	0

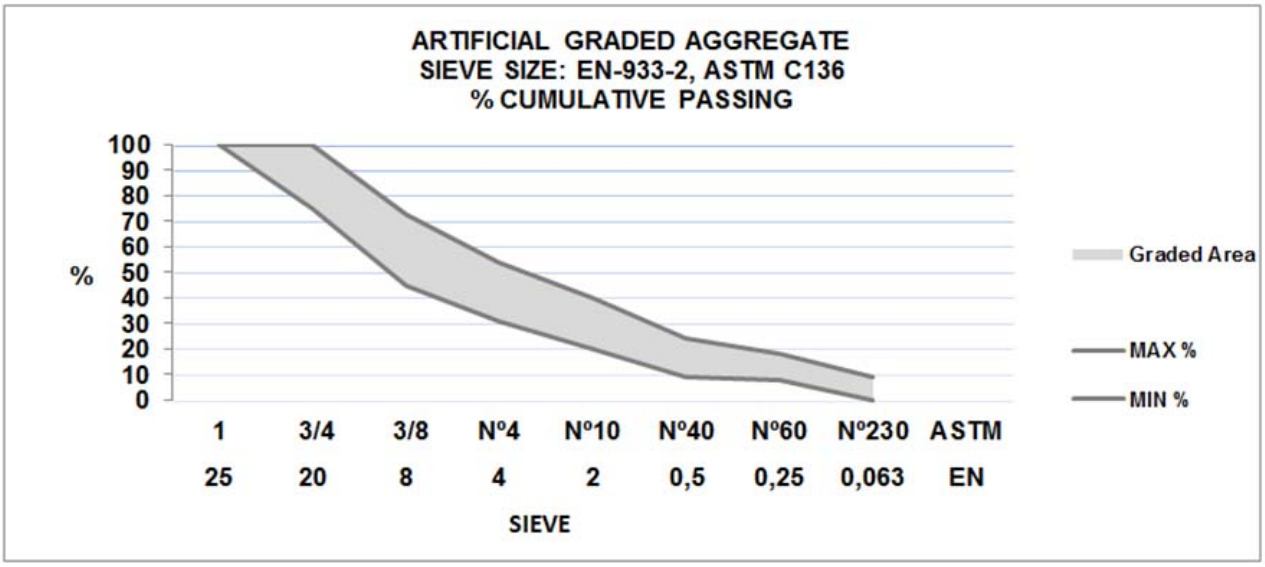


Figure 7: Roadbed layer artificial grain size limits.

Sub-base Layer

In case more than 20 cm thickness layer is required, a sub-base layer will be placed underneath the roadbed. The maximum grain size in the sub-base layer may be incremented up to 40 mm.

Graded aggregate grain size shall be between the following limits depending on its source: natural or crushed gravel:

Natural Graded Aggregate

		NATURAL GRADED AGGREGATE SIEVE SIZE: EN-933-2, ASTM C136 % CUMULATIVE PASSING								
Graded Aggregate	EN	40	25	20	8	4	2	0,5	0,25	0,063
	ASTM	1,5	1	3/4	3/8	Nº4	Nº10	Nº40	Nº60	Nº230
0/40	max	95	90	84	63	46	35	23	18	9
	min	80	65	54	35	22	15	7	4	0

Table 4. Natural Subgrade layer grain size limits

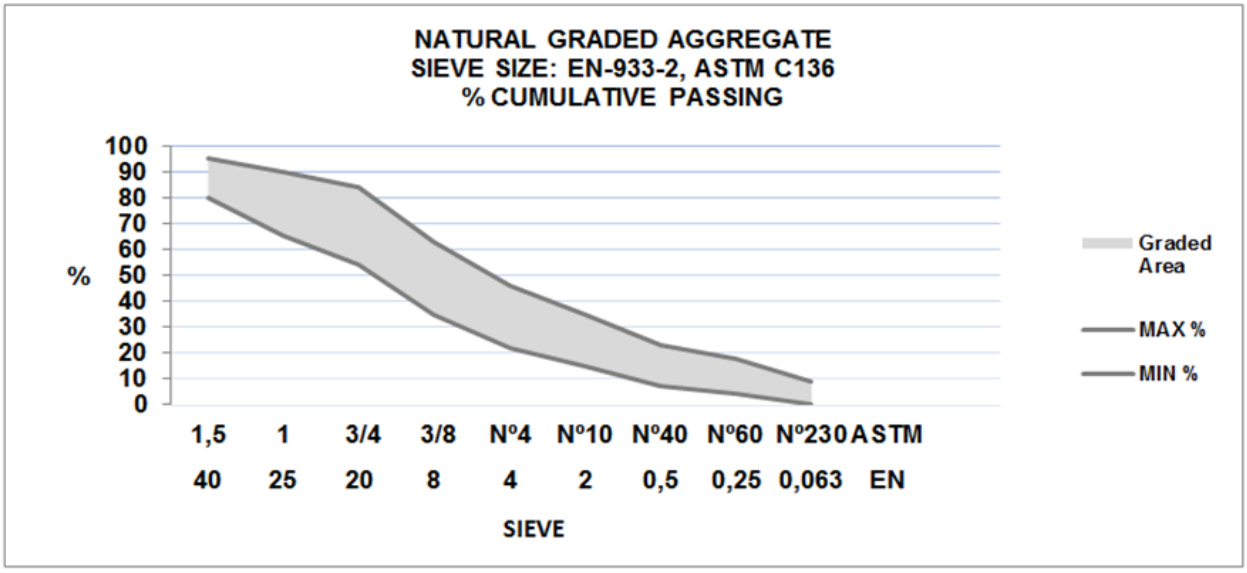


Figure 8: Natural Subgrade layer grain size limits.

Artificial Graded Aggregate

		ARTIFICIAL GRADED AGGREGATE SIEVE SIZE: EN-933-2, ASTM C136 % CUMULATIVE PASSING									
Graded Aggregate	EN	40	32	25	20	8	4	2	0,5	0,25	0,063
	ASTM	1,5	1,25	1	3/4	3/8	Nº4	Nº10	Nº40	Nº60	Nº230
0/32	max	100	100	90	76	63	45	32	21	16	9
	min	100	88	65	52	40	26	15	7	4	0

Table 5. Artificial Subgrade layer grain size limits

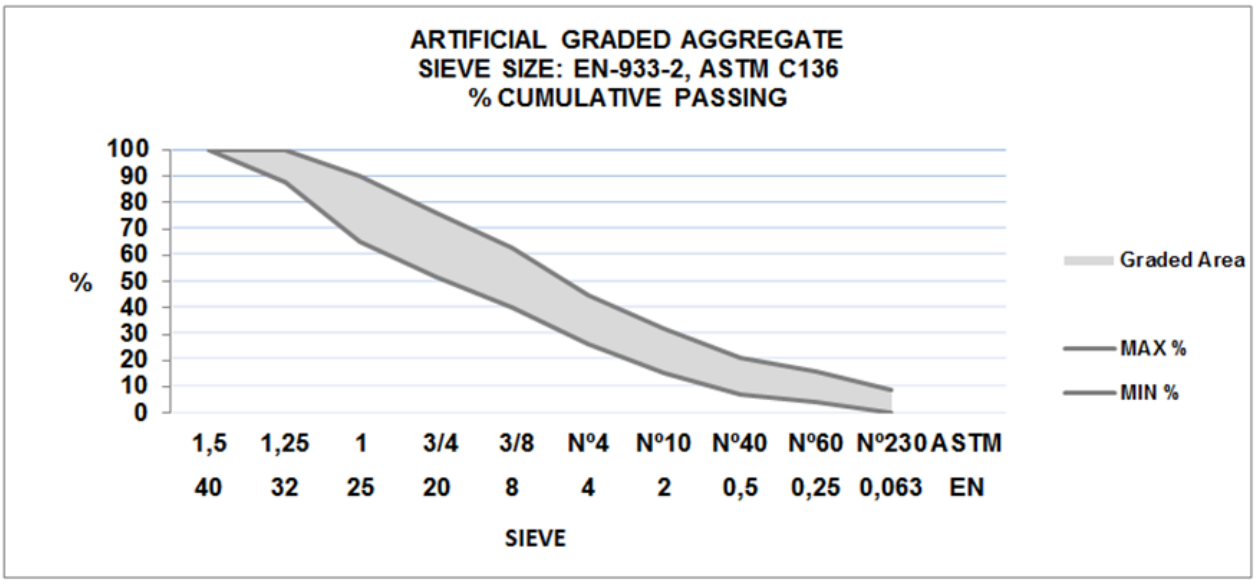


Figure 9: Artificial Subgrade layer grain size limits.

In the event that an improvement of the subgrade is required, and the proposed solution entails the use of geotextile or geogrid, recommendations from the supplier regarding the graded aggregate material may apply.

Additionally, if necessary, an special study of the sub-base layer shall be performed to ensure its suitable behaviour against compression, tensile and shear stresses.

In any case, the final design shall comply with the quality conditions demanded by Vestas herein and shall allow the transport of the components in safety conditions.

2.8 BRIDGES AND CROSSINGS

Special attention must be paid to bridges and other types of crossings to make sure their maximum bearing capacity is sufficient to allow the passage of loaded vehicles. In case of insufficient bearing capacity, an alternative itinerary shall be sought, or adequate technical solutions shall be put in place to allow trucks to transit safely. In any case, the load bearing capacity of bridges or crossings shall be communicated to Vestas that will review and approve it prior to the commencement of works.

2.9 EXISTING ROADS

Exceptionally, secondary roads with lower load bearing capacity and/or poor asphalted pavement may be used; however the passage of trucks may cause severe damage thereto. The improvement of these roads previous to the wind turbine components transportation and/or the repair after transport shall be evaluated and foreseen. The responsibility and costs for in-course or subsequent repairing and re-establishment of such roads will be not sustained by Vestas.

2.10 DRAINAGE SYSTEM

Road drainage shall be designed to control the flow of rain water alongside the roads and allow the road to self-drain. Whenever judged necessary by an expert technician, and following a hydrological basin and terrain gradient survey, the drainage system shall include paved or unpaved side ditches and masonry drains.

Cross drainage culvert shall be laid over, at least, 10 cm blinding concrete layer and covered by, at least, 5 cm of blinding concrete layer. Backfilling shall be covered with excavated material and graded aggregated layer as applied in the cross section.

In areas where the road needs to be provided with a lateral slope in order to ease drainage, the maximum gradient shall not exceed 2%. In any case, symmetry of the road section in relation to its centreline shall be maintained.

2.11 TURNING AREAS

In correspondence of the last WTG location at the end of dead-end site roads it is usually problematic for trucks to perform a 180º manoeuvre and exit from the same way they entered. In these locations an adequate turning area must be provided for the 180º manoeuvre of trucks. In some cases, part of the existing hardstand can be used for the manoeuvre. Whenever this is not possible for practical or safety reasons, a dedicated turn-around levelled and compacted area similar to Figure 10:. In any case, the proposed solution shall be communicated to Vestas that will review and approve it prior to the commencement of works.

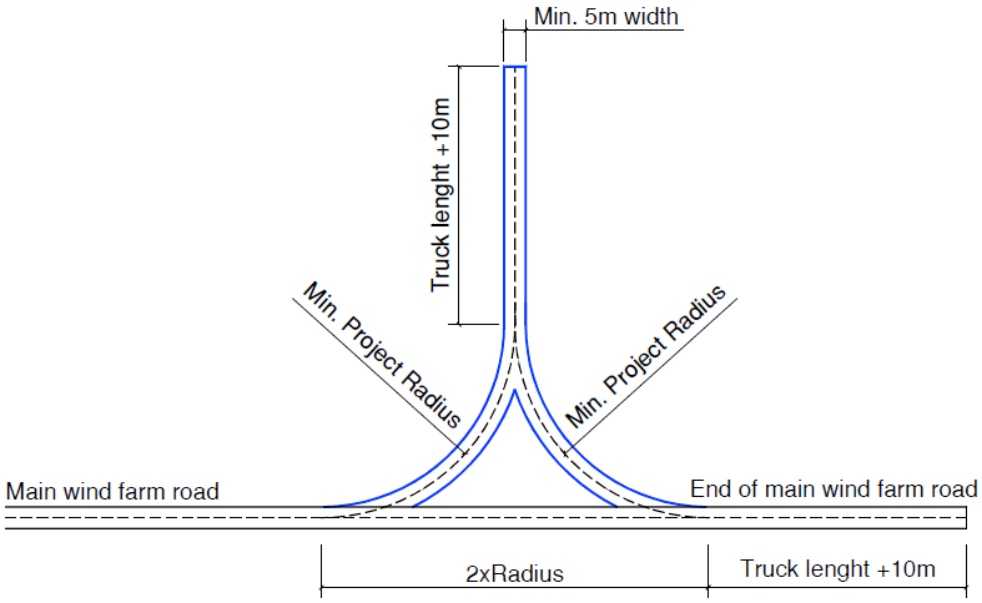


Figure 10: Turning Area Minimum Dimensions

2.12 TRUCK LAY-BAY AREAS

All site and access roads only 5m wide and more than 5 Km long shall be provided with truck lay-by areas designed to have an extra width of 5 m and 50 m long. Such lay-by areas shall be established at intervals of 4 to 5 km, as well as in correspondence of any critical road point if so requested by Vestas. The critical points shall be agreed upon separately prior to executing any contractual agreement. Lay-by areas shall be clear of any debris, levelled, compacted and free of any drainage system.

2.13 TRAFFIC SIGNALS

The needed traffic signals will be placed along the road to assure a safety driving according to the Safety Plan of the project.

In particular, proper signalling for high slopes and vehicles top speed will be installed.

3. ROADS MAINTENANCE

Access and site roads shall be adequately maintained throughout the duration of the wind farm construction and installation period, including:

a. Periodically watering the roads when dust is created by the transit of vehicles. This is done to minimize segregation of the pavement's fine aggregates and prevent health and safety problems.

b. Periodically cleaning all side ditches and masonry drains to ensure no obstructions prevent rain water from flowing through thus, deteriorating the efficiency of the drainage system.

c. In case of more than 2 weeks from plate bearing test performing and transports trucks and/or crane mobilization, additional watering, compaction and base layer thickness increased could be requested by Vestas to ensure safety transport. After these updates, additional plate bearing tests would be requested to check road bearing capacity.

d. In case of using crawler crane assembly mobilization between the turbine locations it is necessary to perform a base layer finished regularization by adding and compaction, at least, 10cm graded aggregated thickness to ensure road quality and regularization.

4. INSPECTION AND CONTROL

4.1 GRADDED AGGREGATE

Graded aggregate grain size shall be as mention in paragraph 2.7.

For any provided production volume, at least four (4) samples have to be tested, adding one (1) more every ten thousand cubic meters (10.000 m3), or excess fraction every fifty thousand cubic meters.

The following test will be performed on each sample. These tests shall be done according to the international regulation that applies in the project region:

- Modified Proctor, according to ASTM D1557-09, AASHTO T180-01 (or its national equivalent standard).
- Liquid limit and plasticity index*, according to ASTM D-4318, AASHTO T90-00 (2004) or ISO/TS 17892-12 (or its national equivalent standard).
- Grain Size by sieving**, according to EN 933-1:2012 or ASTM C-136 (or its national equivalent standard).

4.2 COMPACTION AND SOIL BEARING CAPACITY

As mention in paragraph 2.6., static plate-bearing test is recommended to assure the well compaction of the roads and its bearing capacity.

Static plate bearing test shall be done in a staggered pattern where the truck wheel is expected to be in contact with road surface. In case transversal section has cutting and embankment, the plate bearing test shall be done in the embankment part as shown in the following figure:

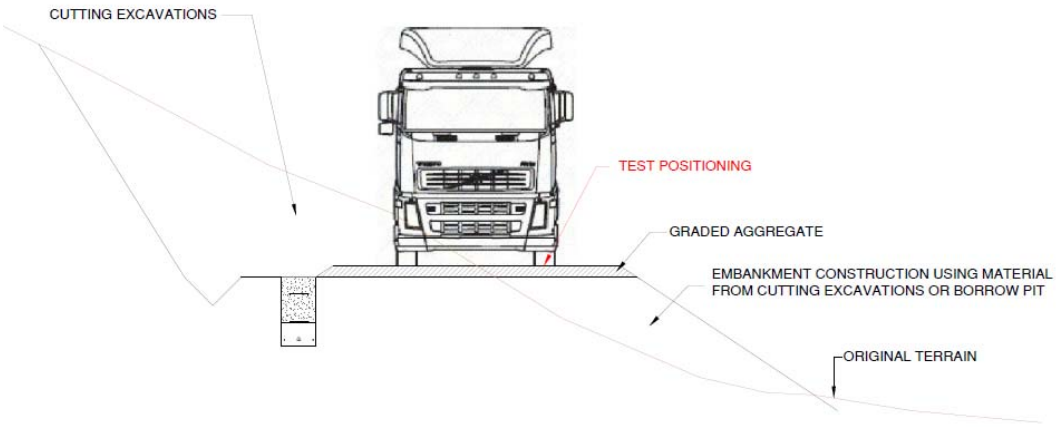


Figure 11: Plate Bearing Test Positioning

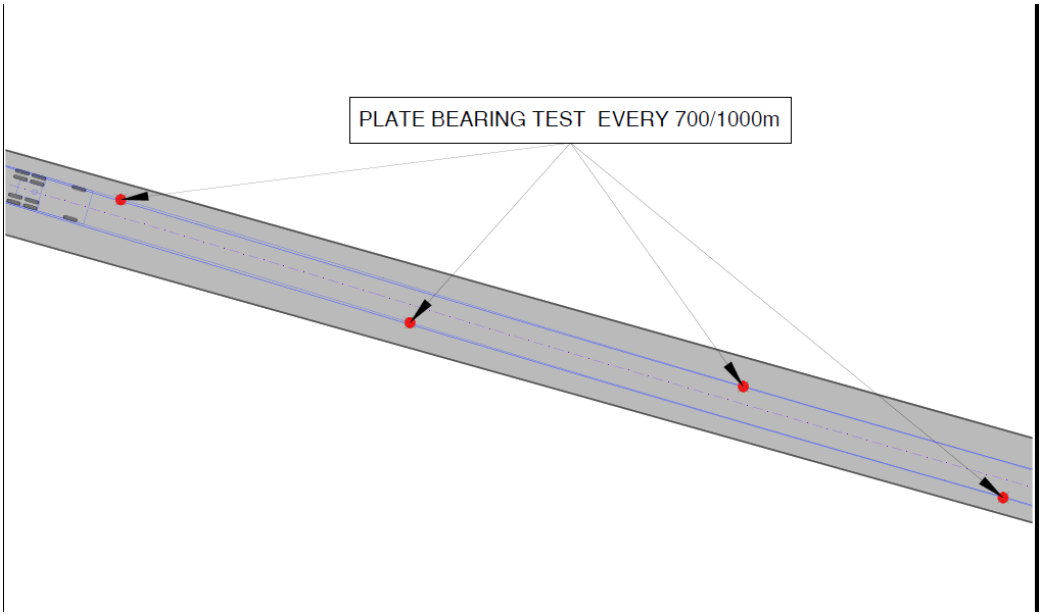


Figure 12: Plate Bearing Test Positioning

Nuclear density test is recommended to assure the well compaction of the roads and the required bearing capacity. If these tests were not available, another equivalent one can be proposed. The nature of such tests shall be established by an expert based on the geotechnical characteristics of the wind farm and the materials which are used for the roads.

4.3 TRANSPORT TRIAL

If deemed necessary, an unloaded transport trial using the longest vehicle may be conducted to verify the geometrical suitability of site and access roads.

ANNEX: BEND WIDENING

The following charts are provided as an orientation to determine the necessary widening on low radius bends. It is important to note that the following sketch is not considering the affection area caused by the blade overhang. So that, for a higher accuracy, it is recommended to use adequate truck simulation software. Upon request, Vestas can perform a specific simulation to determine the optimum bend widening and the clear and free of obstacles necessary area to avoid interferences between the blade and the site conditions (natural soil, trees, existing buildings etc), not only outside the bend but also inside.

The following sketch is the key to understand the different bend widening according to the wind turbine model and the bending radius:

Key:
*1 : Angle formed by the turning of the road
*2 : Bending radius.
*3 : External side of the extra widening, with respect to the center of the bending radius.
*4 : Internal side of the extra widening, with respect to the center of the bending radius.
*5 : External side of the blade swept area, with respect to the center of the bending radius.
*6 : Internal side of the blade swept area, with respect to the center of the bending radius.
*7 : Parameter to locate the extra widening.
Note: Parameters every 10 meters before & after the turning, and every 15 degrees along the turning
*8 : All units provided are in meters.

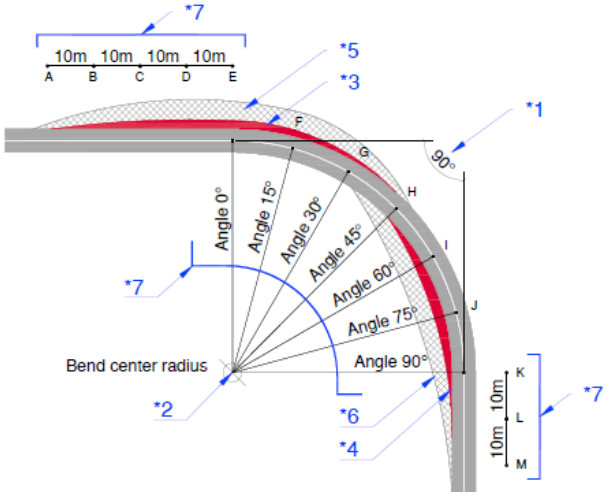


Figure 13: Bend widening dimensions location of values.

90º*1 BEND WIDENING - 5 METERS WIDE ROAD														
Radius *2	External *3								Internal *4					*7
	A	B	C	D	E	F	G	H	I	J	K	L	M	
45m	-	-	-	0.5	0.7	0.9	0.6	-	-	-	0.3	-	-	
50m	-	-	-	0,1	0,2	0,5	0,4	-	-	-	-	-	-	*8
55m	-	-	-	-	-	0,2	0,2	-	-	-	-	-	-	

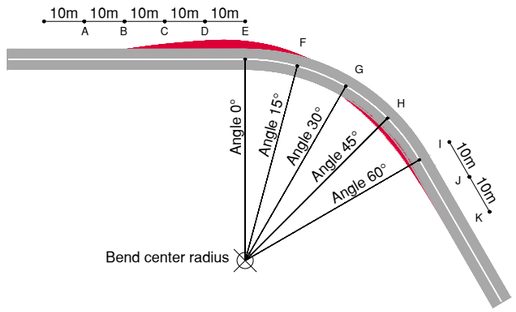
Table 6. Bend Widening values.

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
35m	-	-	-	0,1	0,2	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
35m	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
35m	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

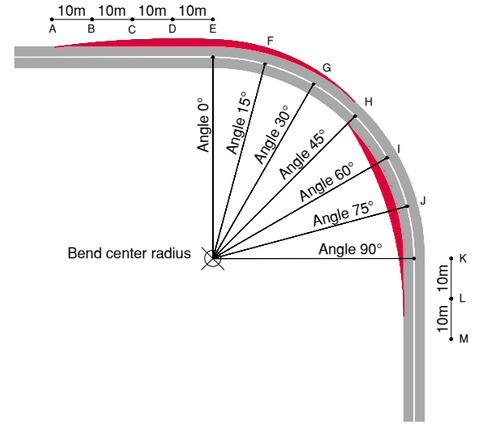


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
35m	-	-	-	0.1	0.2	0.2	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
35m	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
35m	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

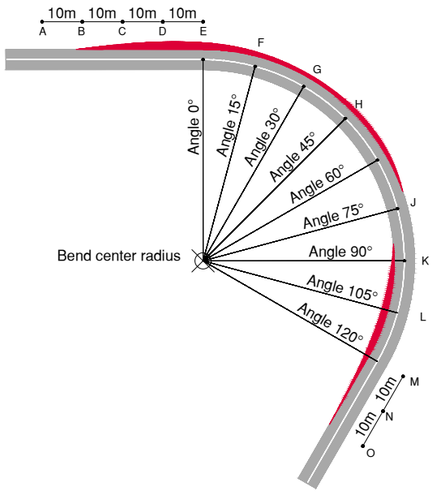


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
35m	-	-	-	0.1	0.2	0.2	0.2	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
35m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
35m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

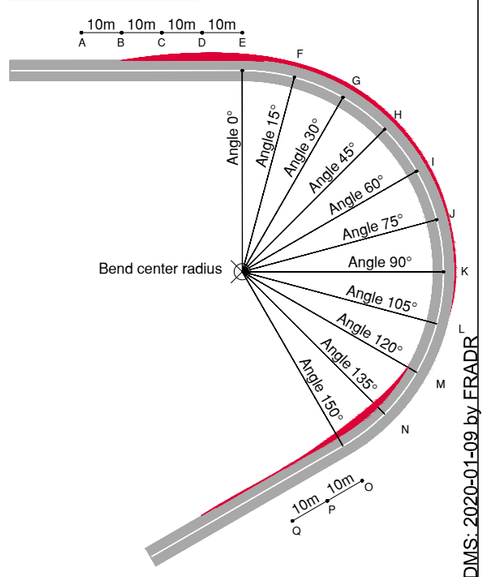


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
35m	-	-	-	0.2	0.4	0.3	0.2	0.1	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

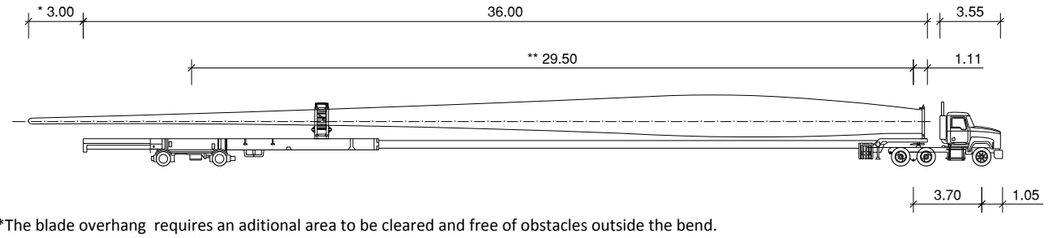
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
35m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
35m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 300$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	35m
Min. straight length before/after the bend *	75m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

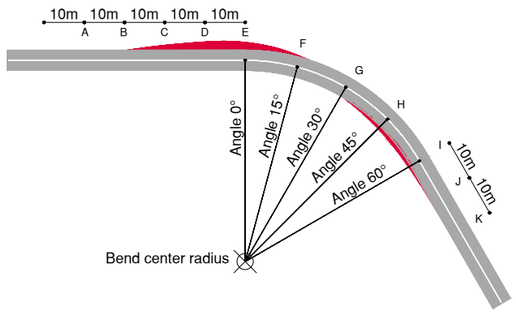
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V80 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD												
Radius	External						Internal					
	A	B	C	D	E	F	G	H	I	J	K	
40m	-	-	-	0,6	0,6	-	-	-	-	-	-	
45m	-	-	-	0,3	0,4	-	-	-	-	-	-	
50m	-	-	-	-	-	-	-	-	-	-	-	

60º BEND WIDENING - 6 METERS WIDE ROAD												
Radius	External						Internal					
	A	B	C	D	E	F	G	H	I	J	K	
40m	-	-	-	-	-	-	-	-	-	-	-	
45m	-	-	-	-	-	-	-	-	-	-	-	
50m	-	-	-	-	-	-	-	-	-	-	-	

60º BEND WIDENING - 6.5 METERS WIDE ROAD												
Radius	External						Internal					
	A	B	C	D	E	F	G	H	I	J	K	
40m	-	-	-	-	-	-	-	-	-	-	-	
45m	-	-	-	-	-	-	-	-	-	-	-	
50m	-	-	-	-	-	-	-	-	-	-	-	

60º Bend widening diagram:

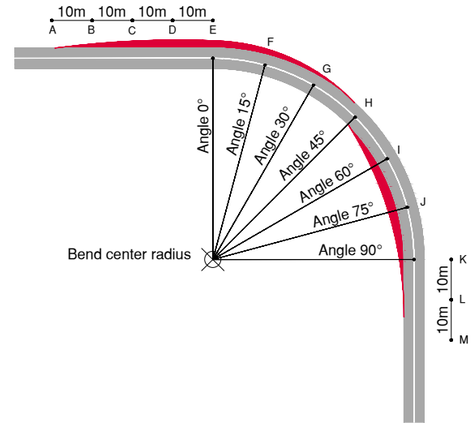


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
40m	-	-	-	0.7	0.6	0.4	0.3	0.2	-	-	0.3	-	-
45m	-	-	-	0,4	0,4	0,2	0,1	0.1	-	-	-	-	-
50m	-	-	-	-	-	-	0,1	0.1	-	-	-	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
40m	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
40m	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

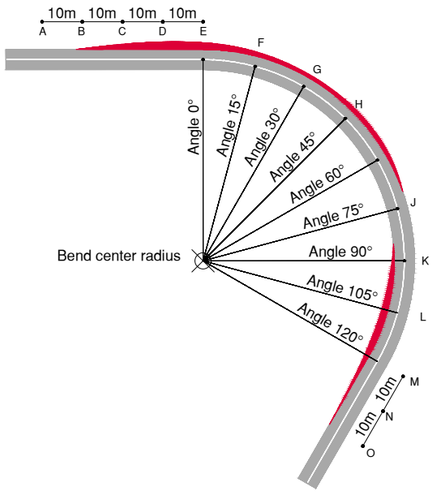


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External										External				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
40m	-	-	-	0.8	0.7	-	-	0.3	0.3	0.2	-	-	-	-	-
45m	-	-	-	0.2	0.2	-	-	0.3	0.3	0.2	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

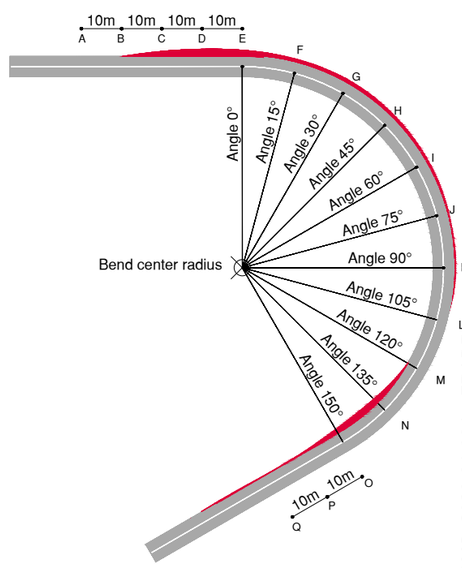


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
40m	-	-	-	0.8	1.0	-	-	0.2	0.4	0.5	0.4	-	-	-	-	-	-
45m	-	-	-	0.4	0.3	-	-	-	-	0.3	0.2	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

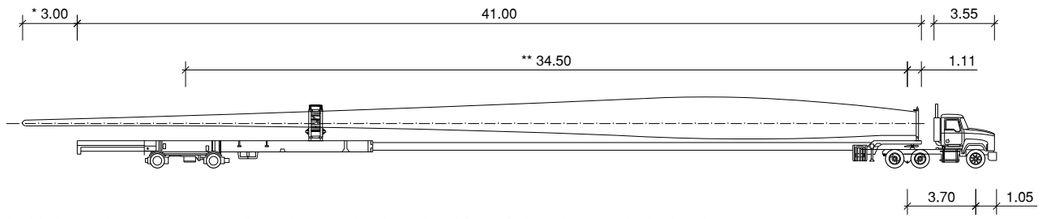
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
40m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve parametther	Kv.= L / | i_1 - i_2 |= 300
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	40m
Min. straight length before/after the bend *	75m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

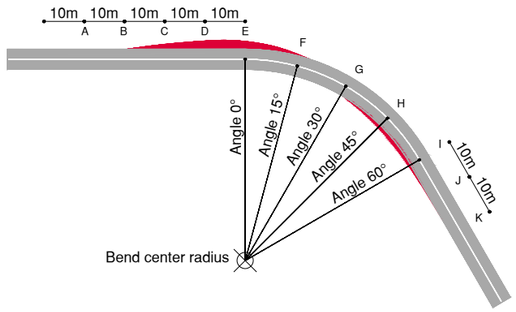
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V90 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	1,0	1,3	0,6	-	-	0,3	-	-
50m	-	-	-	0,8	1,0	0,5	-	-	-	-	-
55m	-	-	-	0,2	0,6	0,4	-	-	-	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,1	0,4	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

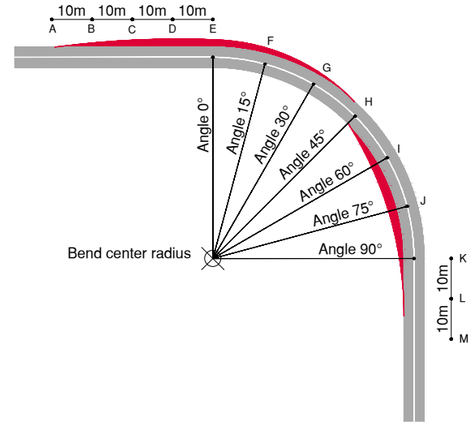


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.5	0.7	0.9	0.6	-	-	-	0.3	-	-
50m	-	-	-	0,1	0,2	0,5	0,4	-	-	-	-	-	-
55m	-	-	-	-	-	0,2	0,2	-	-	-	-	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.1	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º Bend widening diagram:

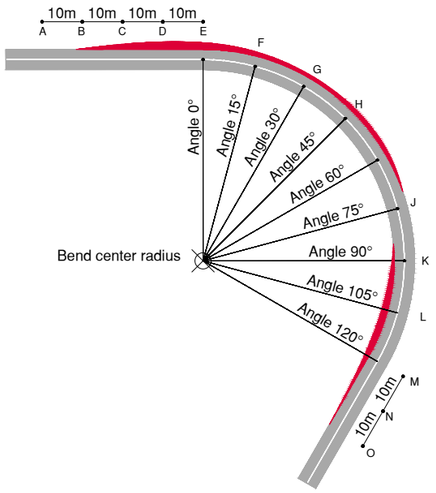


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.2	0.9	0.7	0.5	0.5	0.5	0.3	-	-	0.2	0.4	-	-
50m	-	-	0.1	0.5	0.3	0.3	0.2	0.2	0.2	-	-	-	0.3	-	-
55m	-	-	-	0.4	0.2	-	-	-	-	-	-	-	0.1	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

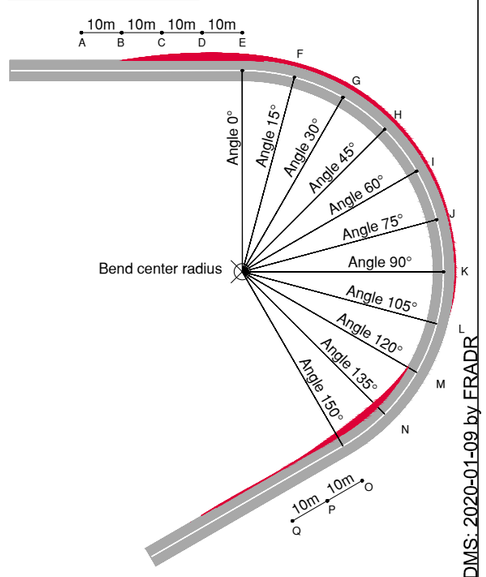


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.2	1.0	0.9	0.7	0.7	0.6	0.6	0.4	0.4	-	-	0.1	0.7	0.3	-
50m	-	-	0.2	0.6	0.4	0.4	0.3	0.3	0.3	0.2	0.2	-	-	-	0.3	0.1	-
55m	-	-	-	0.4	0.3	0.3	0.2	0.2	-	-	-	-	-	-	-	-	-

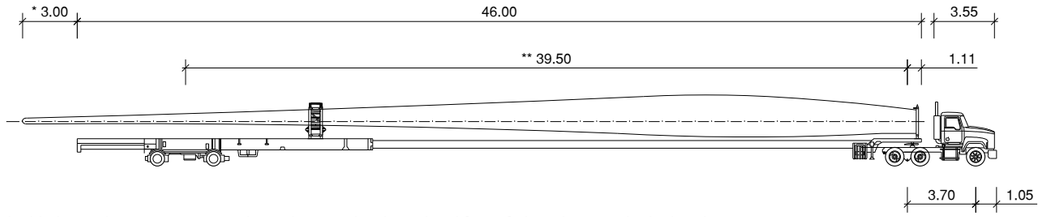
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 350$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	75m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

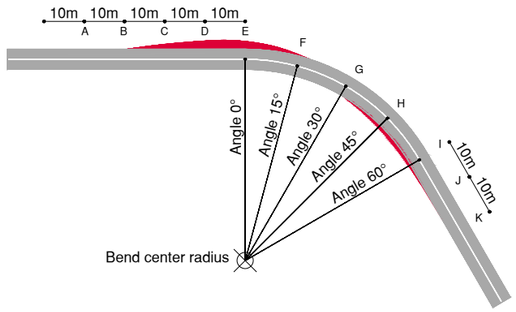
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V100 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	0,6	1,2	1,4	-	-	0.6	-	-	-
50m	-	-	0,4	1,0	1,2	-	-	0,4	-	-	-
55m	-	-	-	0,6	0,8	-	-	-	-	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,2	0,4	-	-	-	-	-	-
50m	-	-	-	-	0,2	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

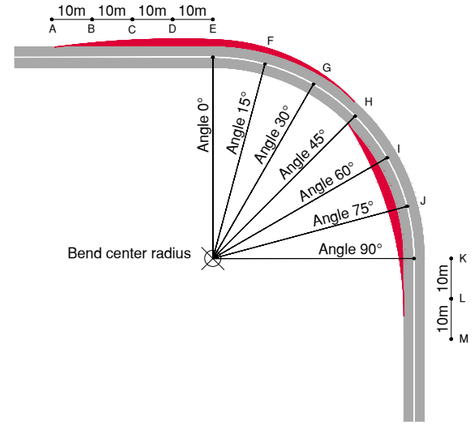


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	0.6	1.0	1.0	0.6	0.2	-	0.4	0.8	0.4	-	-
50m	-	-	0.2	0,8	0,8	0,2	-	-	-	0,6	0,2	-	-
55m	-	-	-	0,6	0,4	0,2	-	-	-	-	0,2	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	-	-	-	-	-	-	0.2	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

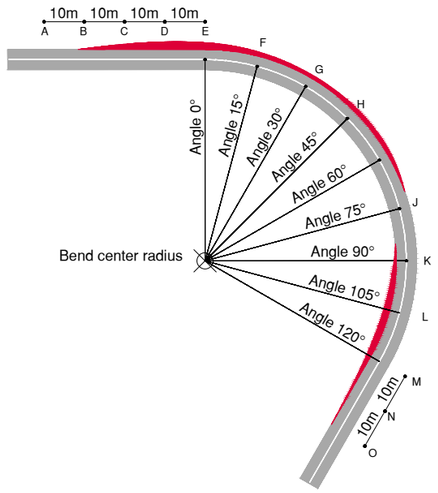


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.8	1.6	1.4	1.0	0.6	0.6	0.4	-	0.2	0.6	0.6	-	-
50m	-	-	0.4	1.0	0.8	0.4	0.2	0.2	0.2	-	-	0.4	-	-	-
55m	-	-	0.2	0.6	0.2	-	-	-	-	-	-	0.2	-	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.4	0.6	-	-	-	-	-	-	0.4	0.2	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

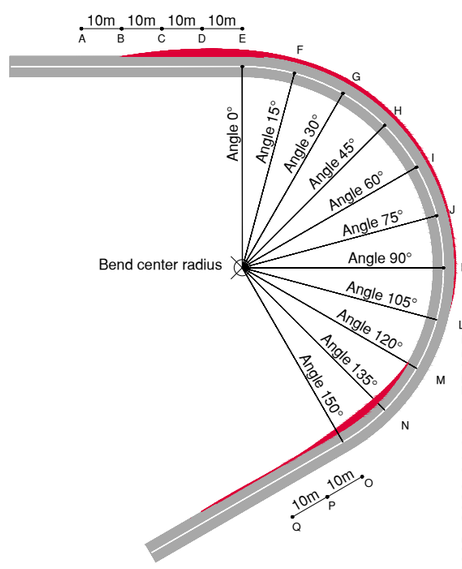


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.4	1.2	1.4	1.0	0.8	0.6	0.6	0.4	0.2	-	-	0.6	1.0	0.6	-
50m	-	-	0.2	0.8	1.0	0.6	0.6	0.4	0.4	0.2	0.2	-	-	-	0.6	0.2	-
55m	-	-	-	0.6	0.6	0.2	-	-	-	-	-	-	-	-	0.4	-	-

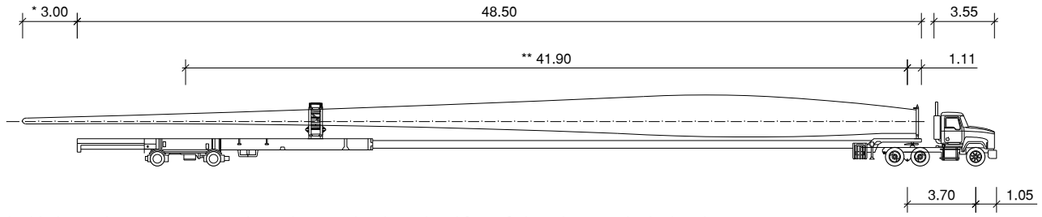
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.4	0.6	0.2	-	-	-	-	-	-	-	0.4	0.6	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve parametther	$Kv.= L / \lvert i_1 - i_2 \rvert = 400$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	80m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

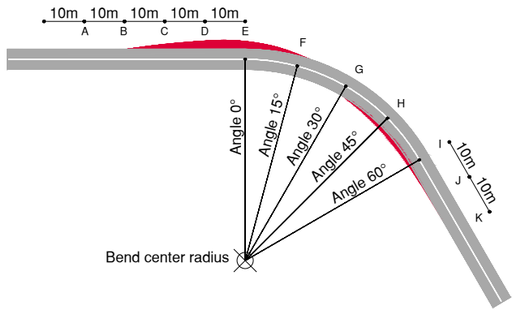
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:	DRAW UP: RGOBA DATE:	EDITION:	DRAWING Nº:
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V105 BEND WIDENING	CHECK BY: LUSPR DATE:	V6	1.2
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	1,0	1,6	1,8	0,2	0.2	1.0	0,2	-	-
50m	-	-	0,6	1,4	1,6	-	-	0,6	-	-	-
55m	-	-	-	0,8	1,0	-	-	0,2	-	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,4	0,6	-	-	-	-	-	-
50m	-	-	-	0,2	0,4	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

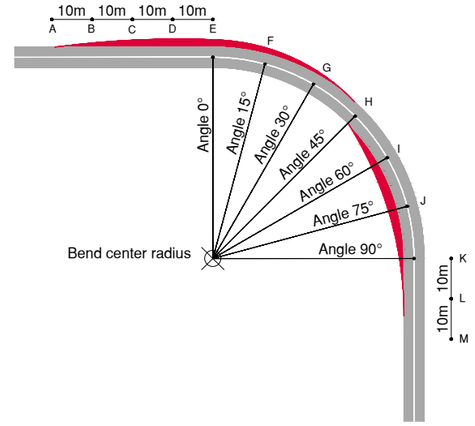


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	0.8	1.4	1.4	0.8	0.4	-	0.6	1.2	0.6	-	-
50m	-	-	0.4	1,0	1,0	0,4	-	-	-	0,8	0,4	-	-
55m	-	-	0.2	0,8	0,6	0,4	-	-	-	-	0,4	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.2	0.2	-	-	-	-	0.4	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90º Bend widening diagram:

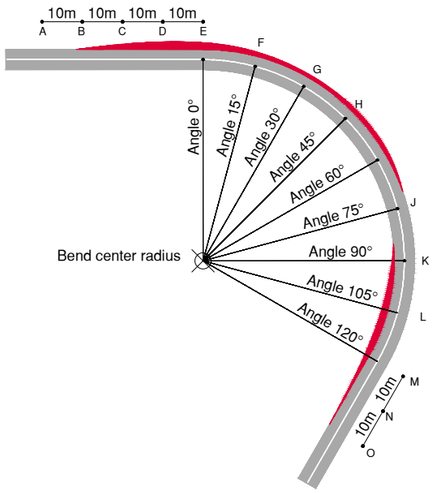


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	1.2	2.0	1.8	1.4	0.8	0.8	0.6	-	0.4	0.8	0.8	-	-
50m	-	-	0.6	1.4	1.0	0.6	0.4	0.4	0.4	-	-	0.6	0.2	-	-
55m	-	-	0.4	0.8	0.4	0.2	-	-	-	-	-	0.4	0.2	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.6	0.8	-	-	-	-	-	0.2	0.6	0.4	-	-
50m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

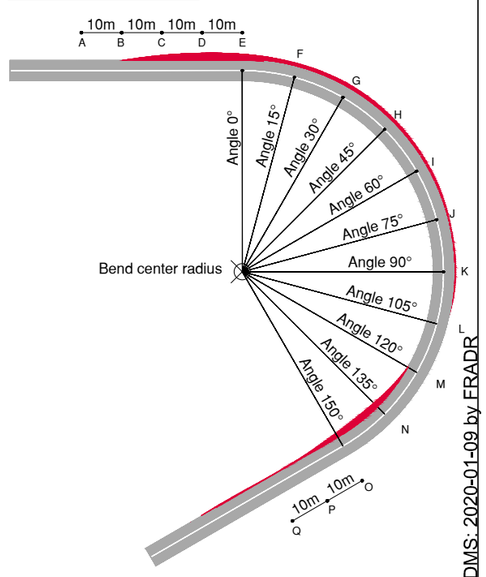


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.6	1.6	1.8	1.4	1.2	0.8	0.8	0.6	0.4	-	-	1.0	1.4	0.8	-
50m	-	-	0.4	1.2	1.4	0.8	0.8	0.6	0.6	0.4	0.4	-	-	-	1.0	0.4	-
55m	-	-	-	0.8	0.8	0.4	0.2	0.2	0.2	0.2	0.2	-	-	-	0.6	0.2	-

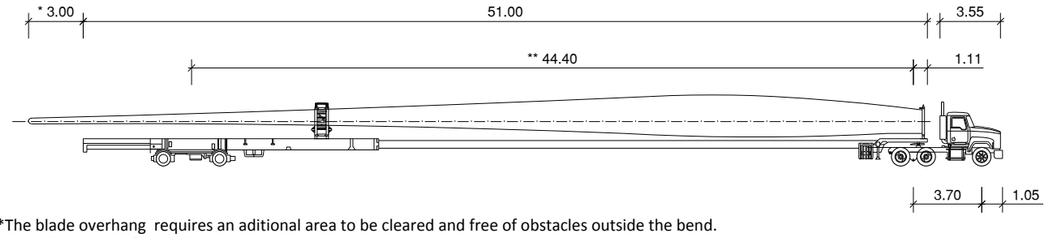
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.6	0.8	0.4	-	-	-	-	-	-	-	0.5	0.8	0.2	-
50m	-	-	-	0.2	0.2	-	-	-	-	-	-	-	-	-	0.2	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.2	0.2	-	-	-	-	-	-	-	-	0.2	0.4	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 400$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	80m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

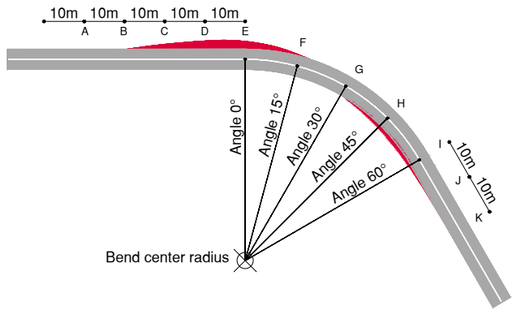
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V110 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	0.1	1,1	1,8	1,9	0,4	0.4	1.1	0,3	-	-
50m	-	-	0,7	1,6	1,7	0,2	-	0,7	0,2	-	-
55m	-	-	0.2	0,9	1,1	0,1	-	0,3	0,1	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,5	0,7	-	-	-	-	-	-
50m	-	-	-	0,3	0,6	-	-	-	-	-	-
55m	-	-	-	-	0,2	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	-	0,2	-	-	-	-	-	-
50m	-	-	-	-	0,2	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

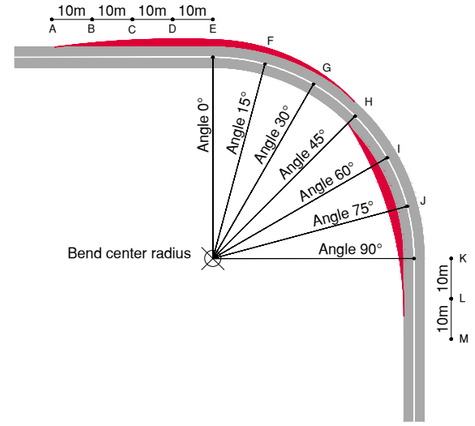


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	1.0	1.6	1.5	1.0	0.5	-	0.7	1.3	0.7	-	-
50m	-	-	0.6	1,2	1,1	0,6	0,2	-	-	0,9	0,6	-	-
55m	-	-	0.4	0,9	0,8	0,5	0,2	-	-	-	0,5	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.4	0.3	-	-	-	-	0.6	-	-	-
50m	-	-	-	0,2	0,2	-	-	-	-	0,2	-	-	-
55m	-	-	-	-	0,2	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.2	0.1	-	-	-	-	0.1	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

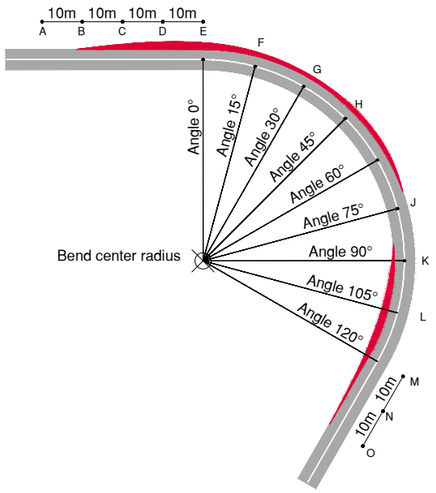


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	1.3	2.1	2.0	1.5	1.0	1.0	0.8	-	0.5	1.0	1.0	0.2	-
50m	-	-	0.8	1.6	1.2	0.8	0.5	0.5	0.5	-	0.2	0.8	0.4	-	-
55m	-	-	0.5	1.0	0.6	0.3	0.2	-	-	-	-	0.5	0.3	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.8	1.0	-	-	-	-	-	0.3	0.7	0.6	-	-
50m	-	-	-	0.3	0.2	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	-	0.3	0.6	-	-	-	-	-	-	0.1	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

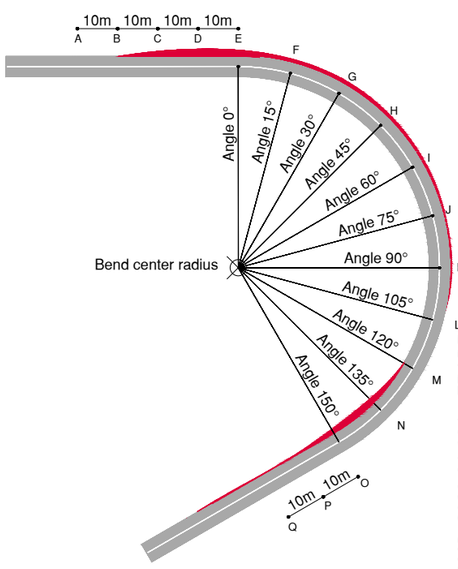


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.7	1.7	1.9	1.6	1.3	1.0	1.0	0.8	0.6	-	-	1.2	1.5	0.9	-
50m	-	-	0.5	1.4	1.5	1.0	0.9	0.8	0.7	0.6	0.6	-	-	0.2	1.1	0.6	-
55m	-	-	0.1	1.0	1.0	0.5	0.4	0.4	0.4	0.3	0.3	-	-	-	0.7	0.4	-

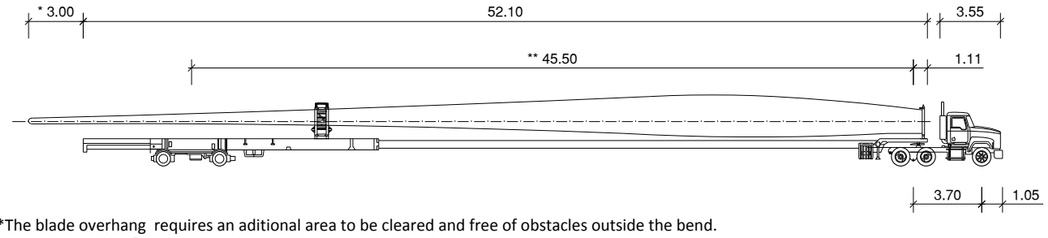
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.8	1.0	0.5	-	-	-	-	-	-	-	0.7	1.0	0.3	-
50m	-	-	-	0.4	0.3	-	-	-	-	-	-	-	-	-	0.4	-	-
55m	-	-	-	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.3	0.4	-	-	-	-	-	-	-	-	0.3	0.6	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



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DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 400$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	80m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

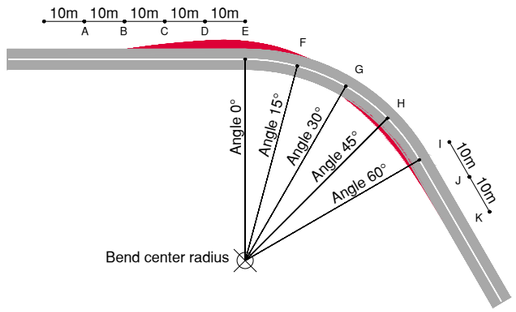
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V112 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	0.3	1,2	2,0	1,8	0,4	0.6	1.6	0,8	-	-
50m	-	-	1,1	2,0	1,8	0,2	-	0,8	0,4	-	-
55m	-	-	0.4	1,4	1,6	0,2	-	0,6	0,4	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	0,3	0,9	0,9	-	-	0.5	-	-	-
50m	-	-	-	0,7	0,8	-	-	0,2	-	-	-
55m	-	-	-	0,2	0,5	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,4	0,4	-	-	0.4	-	-	-
50m	-	-	-	0,2	0,3	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

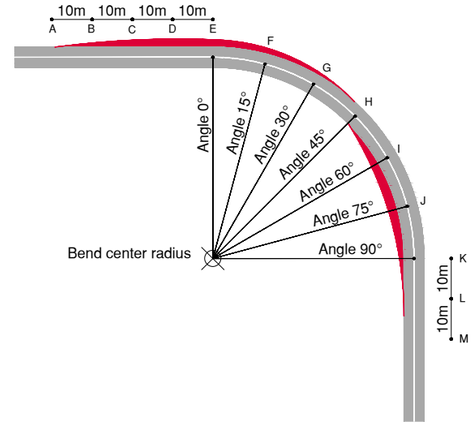


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	0.2	1.7	2.0	1.8	1.3	0.9	-	0.9	1.8	1.2	-	-
50m	-	-	0.9	1,8	1,6	1,2	0,8	-	0,2	1,0	0,6	-	-
55m	-	-	0.5	1,4	1,6	1,2	0,6	-	-	0,4	0,2	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	0.4	1.0	0.6	0.4	0.2	-	0.2	0.8	0.2	-	-
50m	-	-	-	0,8	0,6	0,4	0,2	-	-	0,2	-	-	-
55m	-	-	-	0,6	0,6	0,4	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.4	0.2	-	-	-	-	0.5	-	-	-
50m	-	-	-	0,2	0,2	-	-	-	-	-	-	-	-
55m	-	-	-	-	0,2	-	-	-	-	-	-	-	-

90° Bend widening diagram:

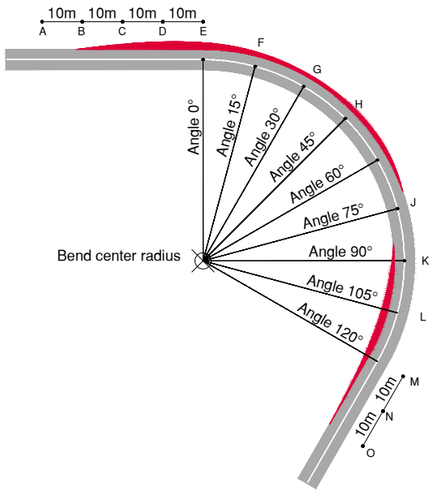


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	0.4	1.6	2.4	2.0	1.2	0.7	0.5	0.4	-	1.0	1.8	1.4	0.4	-
50m	-	-	1.2	1.6	1.4	1.0	0.5	0.4	0.4	-	0.4	1.4	1.0	0,2	-
55m	-	-	0.4	1.2	1.4	0.9	0.5	0.4	0.2	-	-	0.6	0.2	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.6	1.4	1.2	0.2	-	-	-	-	0.2	0.8	0.5	-	-
50m	-	-	-	0.6	0.6	-	-	-	-	-	-	0.7	0.2	-	-
55m	-	-	-	0.4	0.4	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.2	0.8	0.6	-	-	-	-	-	-	0.5	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

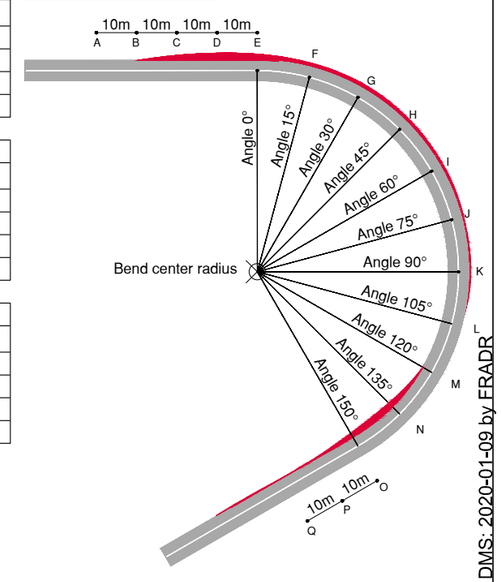


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	0.2	1.5	2.4	2.0	1.6	1.4	1.0	1.0	0.8	0.6	-	0.5	1.8	1.6	0.8	0.2
50m	-	-	1.2	1.6	1.6	1.0	0.9	0.9	0.8	0.5	0.4	-	-	1.2	1.0	-	-
55m	-	-	0.6	1.2	1.2	0.8	0.8	0.6	0.6	0.4	0.2	-	-	0.6	0.4	-	-

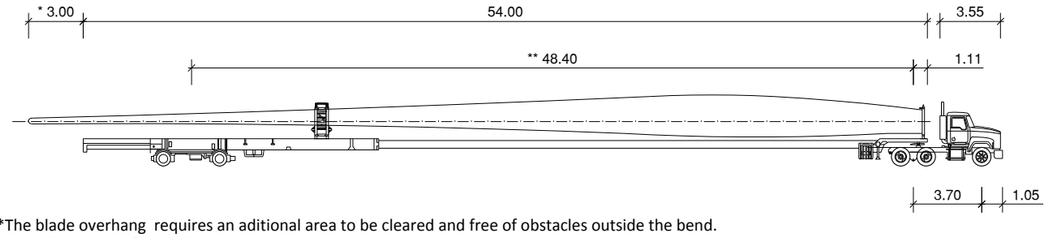
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.2	0.9	0.8	0.2	-	-	-	-	-	-	-	0.9	0.6	-	-
50m	-	-	-	0.6	0.4	-	-	-	-	-	-	-	-	0.3	-	-	-
55m	-	-	-	0.2	0.2	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.5	0.4	-	-	-	-	-	-	-	-	0.7	0.4	-	-
50m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 400$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	85m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

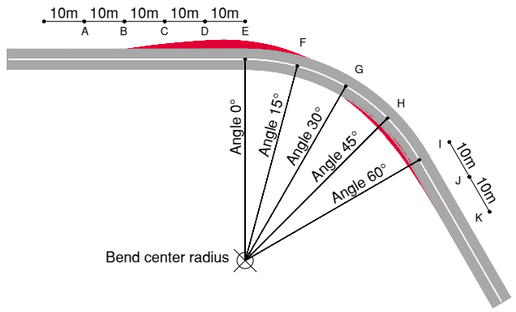
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V116 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	0.4	1,4	2,0	1,9	0,5	0.7	1.6	0,9	-	-
50m	-	-	1,2	2,0	1,9	0,3	-	0,8	0,5	-	-
55m	-	-	0.5	1,4	1,8	0,3	-	0,7	0,4	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	0,3	1,0	1,0	-	-	0.6	-	-	-
50m	-	-	-	0,8	0,9	-	-	0,2	-	-	-
55m	-	-	-	0,2	0,6	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
45m	-	-	-	0,5	0,4	-	-	0.5	-	-	-
50m	-	-	-	0,3	0,3	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

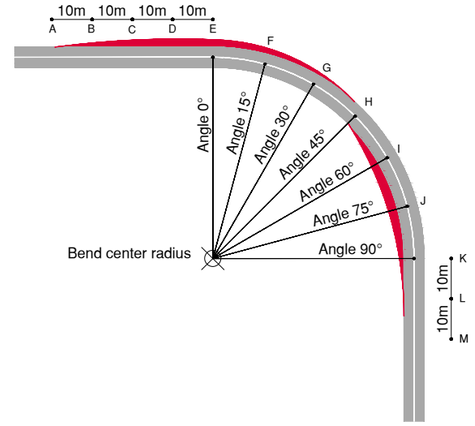


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	0.3	1.8	2.2	1.8	1.4	1.0	-	1.0	1.9	1.3	0.2	-
50m	-	-	1.0	1,9	1,7	1,3	0,8	-	0,3	1,1	0,7	-	-
55m	-	-	0.6	1,6	1,7	1,2	0,7	-	-	0,5	0,3	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	0.5	1.1	0.8	0.4	0.3	-	0.2	1.0	0.3	-	-
50m	-	-	-	0,8	0,7	0,5	0,2	-	-	0,3	-	-	-
55m	-	-	-	0,6	0,7	0,5	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
45m	-	-	-	0.6	0.3	-	-	-	-	0.6	-	-	-
50m	-	-	-	0,3	0,2	-	-	-	-	-	-	-	-
55m	-	-	-	-	0,2	-	-	-	-	-	-	-	-

90° Bend widening diagram:

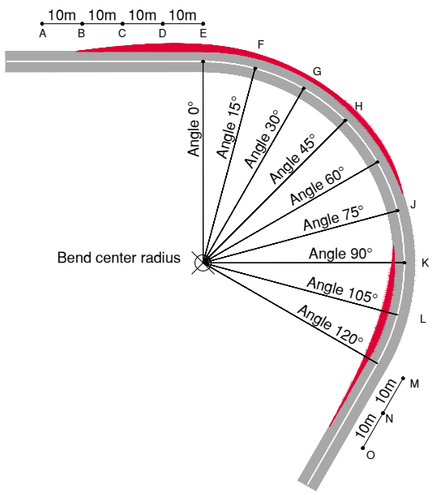


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	0.5	1.7	2.5	2.1	1.2	0.8	0.6	0.4	-	1.1	2.0	1.5	0.4	-
50m	-	0.2	1.3	1.6	1.4	1.0	0.6	0.6	0.4	-	0.5	1.5	1.0	0,3	-
55m	-	-	0.4	1.4	1.5	1.0	0.6	0.5	0.4	-	-	0.6	0.3	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.7	1.5	1.3	0.3	-	-	-	-	0.2	1.0	0.6	-	-
50m	-	-	-	0.7	0.7	-	-	-	-	-	-	0.8	0.3	-	-
55m	-	-	-	0.4	0.5	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45m	-	-	0.2	0.9	0.6	-	-	-	-	-	-	0.7	-	-	-
50m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

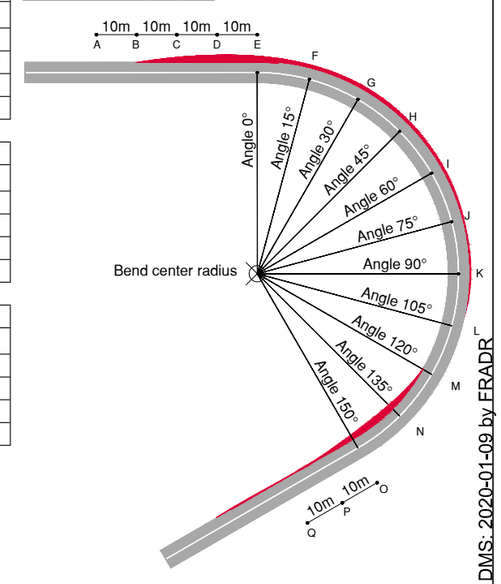


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	0.3	1.6	2.4	2.1	1.7	1.4	1.1	1.1	1.0	0.7	-	0.6	1.9	1.7	0.8	0.3
50m	-	-	1.3	1.8	1.6	1.0	1.0	1.0	0.8	0.6	0.5	-	0.1	1.3	1.1	0.2	-
55m	-	-	0.7	1.4	1.3	1.0	1.0	0.7	0.6	0.5	0.3	-	-	0.7	0.4	-	-

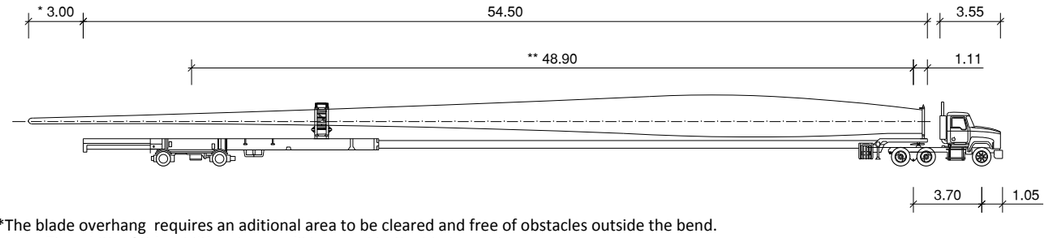
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	0.3	1.0	0.8	0.3	0.1	-	-	-	-	-	-	1.0	0.7	-	-
50m	-	-	-	0.7	0.4	-	-	-	-	-	-	-	-	0.4	-	-	-
55m	-	-	-	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
45m	-	-	-	0.6	0.4	-	-	-	-	-	-	-	-	0.8	0.5	-	-
50m	-	-	-	0.2	0.1	-	-	-	-	-	-	-	-	-	-	-	-
55m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	Kv.= L / | i_1 - i_2 | = 400
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	45m
Min. straight length before/after the bend *	85m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

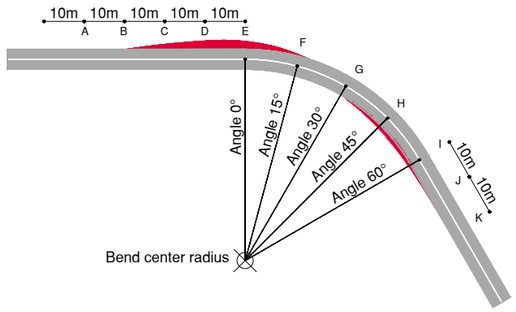
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V117 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	0.6	1,8	2,2	2,0	0,2	0.2	0.4	0,6	0.2	-
55m	-	0.4	1,2	1,8	1,4	0,2	-	0,4	0,4	-	-
60m	-	0.2	0.8	1,2	0,8	-	-	0,2	-	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	-	1,0	1,4	1,2	-	-	-	-	-	-
55m	-	-	0.6	1,0	0,8	-	-	-	-	-	-
60m	-	-	0.2	0,8	0,6	-	-	-	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	-	0,6	1,0	0,8	-	-	-	-	-	-
55m	-	-	0.2	0,6	0,4	-	-	-	-	-	-
60m	-	-	-	0,4	0,2	-	-	-	-	-	-

60º Bend widening diagram:

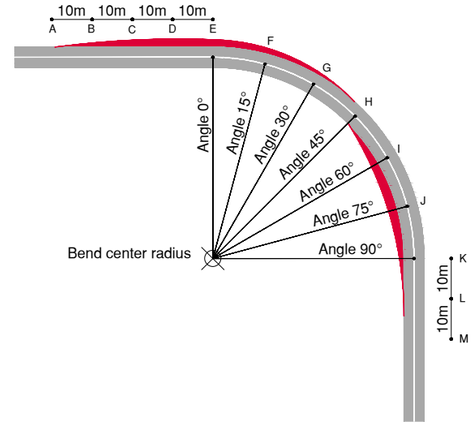


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	0.6	1.8	2.2	2.0	1.6	1.0	-	0.2	1.0	0.8	0.2	-
55m	-	0.4	1.4	2,0	1,6	0,8	0,4	-		0,8	0,4	-	-
60m	-	0.2	0.8	1,6	1,2	0,4	0,2	-	-	0,5	-	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	-	0.8	1.4	1.2	0.8	0.4	-	-	0.4	-	-	-
55m	-	-	0.6	1,0	0,8	0,2	0,2	-	-	-	-	-	-
60m	-	-	0.4	0,8	0,6	0.2	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	-	0.6	0.8	0.6	0.2	-	-	-	-	-	-	-
55m	-	-	0.4	0,6	0,4	-	-	-	-	-	-	-	-
60m	-	-	-	0,4	0,4	-	-	-	-	-	-	-	-

90° Bend widening diagram:

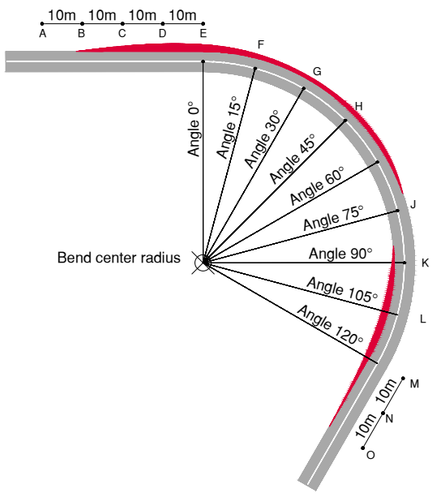


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	0.8	2.0	2.4	1.8	1.2	0.6	0.4	-	-	0.8	1.6	1.0	0.2	-
55m	-	0.4	1.4	2.0	1.6	0.6	0.2	-	-	-	0.4	1.0	0.2	-	-
60m	-	0.2	1.0	1.6	1.0	0.4	-	-	-	-	-	0.6	-	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	-	2.0	1.8	1.6	0.6	-	-	-	-	0.4	0.4	0.2	-	-
55m	-	-	0.8	1.4	0.8	0.2	-	-	-	-	-	0.2	-	-	-
60m	-	-	0.6	1.0	0.4	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	-	0.6	1.0	0.8	-	-	-	-	-	-	-	-	-	-
55m	-	-	0.4	0.8	0.6	-	-	-	-	-	-	-	-	-	-
60m	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

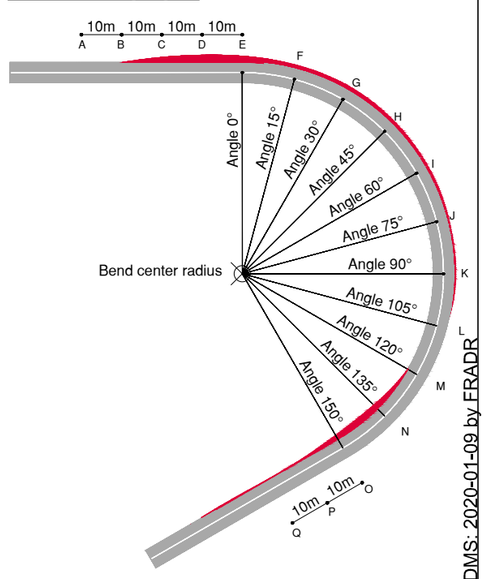


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	0.8	2.0	2.6	2.0	1.0	0.6	0.2	0.2	-	-	-	0.8	1.2	0.6	0.2	-
55m	-	0.6	1.6	2.2	1.6	0.6	0.2	0.2	-	-	-	-	0.4	0.8	0.4	-	-
60m	-	0.2	1.2	1.4	1.0	0.4	0.2	-	-	-	-	-	-	0.4	-	-	-

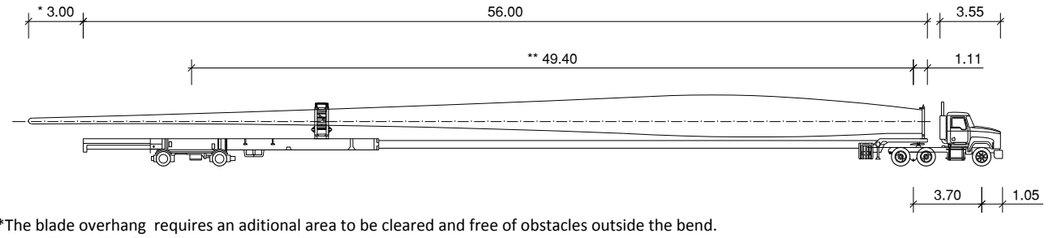
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	-	1.0	1.6	1.6	0.8	0.2	-	-	-	-	-	0.4	0.8	-	-	-
55m	-	-	0.6	1.0	0.8	0.2	-	-	-	-	-	-	-	-	-	-	-
60m	-	-	0.4	0.8	0.4	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	-	0.6	1.4	0.8	0.2	-	-	-	-	-	-	-	0.6	-	-	-
55m	-	-	0.2	0.8	0.4	-	-	-	-	-	-	-	-	-	-	-	-
60m	-	-	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	Kv.= L / | i_1 - i_2 |= 450
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	50m
Min. straight length before/after the bend *	90m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

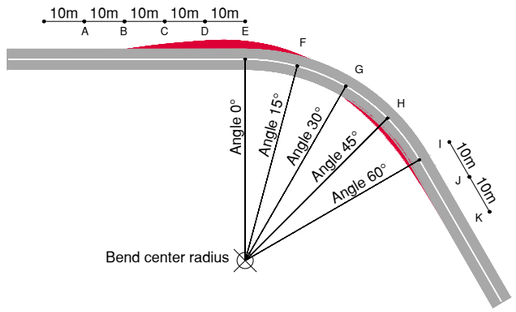
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:	DRAW UP: RGOBA DATE:	EDITION:	DRAWING Nº:
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V120 BEND WIDENING	CHECK BY: LUSPR DATE:	V6	1.2
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	1.3	2,7	3,1	3,0	0,5	0.6	1.0	1,1	0.5	-
55m	-	1.1	2,1	2,8	2,3	0,5	-	1,0	0,8	0.3	-
60m	-	0.6	1.7	2,3	2,1	0,5	-	0,8	0,5	-	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	0.2	1,6	2,1	2,0	-	-	0.3	0.1	-	-
55m	-	0.1	1.2	1,5	1,3	-	-	0,3	-	-	-
60m	-	-	0.7	1,3	1,1	-	-	0.3	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
50m	-	-	1,1	1,6	1,6	-	-	0.2	-	-	-
55m	-	-	0.7	1,0	0,8	-	-	0,1	-	-	-
60m	-	-	-	0,9	0,6	-	-	-	-	-	-

60º Bend widening diagram:

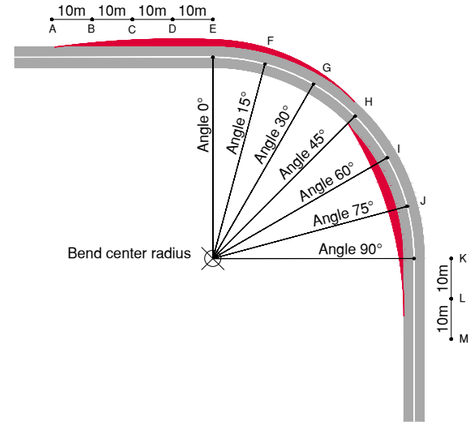


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	1.2	2.6	3.3	3.1	2.6	1.8	-	0.7	1.7	1.3	0.5	-
55m	-	1.0	2.2	3,0	2,4	1,5	1,1	-	0,7	1,5	0,9	0.2	-
60m	-	0.4	1.7	2,4	2,1	1,0	0,9	-	0.2	1,0	-	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	0.2	1.6	2.2	1.9	1.2	1.0	-	-	0.8	-	-	-
55m	-	-	1.3	1,8	1,4	0,6	0,6	-	-	-	-	-	-
60m	-	-	0.9	1,6	1,4	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
50m	-	-	1.1	1.6	1.3	0.7	0.6	-	-	0.5	-	-	-
55m	-	-	0.8	1,2	0,9	0,2	-	-	-	-	-	-	-
60m	-	-	0.5	1,1	0,9	-	-	-	-	-	-	-	-

90° Bend widening diagram:

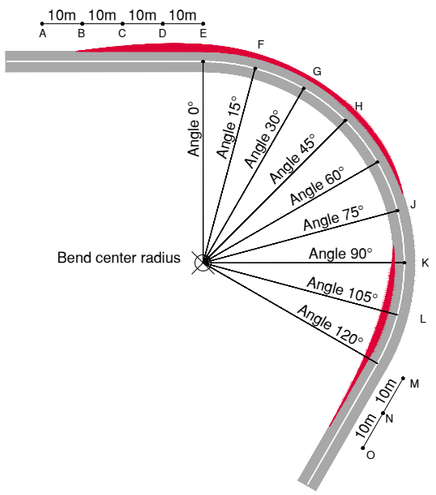


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	1.4	2.8	3.4	2.8	1.7	1.1	1.0	0.5	-	1.6	2.5	1.5	0.2	-
55m	-	1.0	2.2	2.9	2.3	1.0	0.7	0.5	0.4	-	1.1	1.8	0.4	-	-
60m	-	0.8	2.0	2.4	2.0	0.8	0.2	0.2	0.3	-	0.4	1.7	0.4	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	0.3	1.8	2.5	2.0	1.0	0.4	0.4	0.1	-	0.8	1.0	0.5	-	-
55m	-	-	1.2	2.0	1.7	0.5	0.2	0.2	-	-	-	0.1	0.5	-	-
60m	-	-	1.2	1.5	0.9	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50m	-	-	1.3	1.9	1.5	0.6	-	-	-	-	0.4	0.6	-	-	-
55m	-	-	07	1.4	1.1	0.2	-	-	-	-	-	0.2	-	-	-
60m	-	-	0.5	0.9	0.4	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

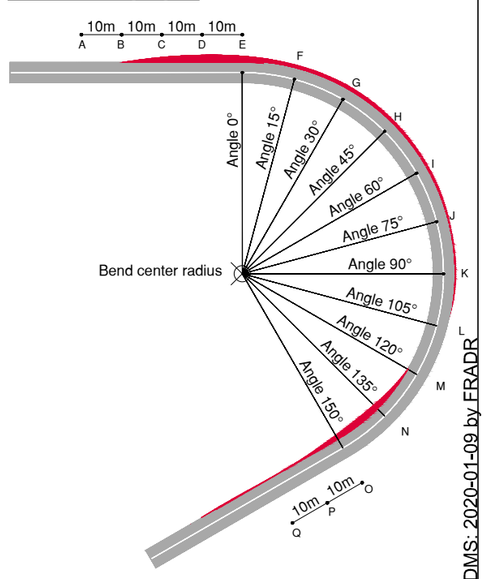


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	1.5	3.0	3.8	3.2	1.7	1.0	0.6	0.6	0.7	0.5	-	1.6	2.1	1.0	0.4	-
55m	-	0.9	2.2	3.0	2.6	1.4	0.5	0.3	0.3	0.5	0.4	-	0.9	1.7	0.8	-	-
60m	-	0.8	2.0	2.5	2.1	0.8	0.3	0.3	-	-	-	-	0.5	1.1	0.3	-	-

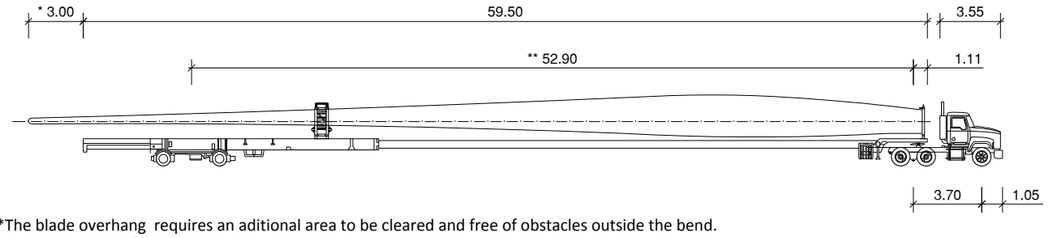
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	0.2	1.6	2.6	2.3	1.3	0.6	-	-	-	-	-	1.2	1.7	0.1	-	-
55m	-	-	1.3	1.9	1.5	0.5	0.3	-	-	-	-	-	0.3	0.2	-	-	-
60m	-	-	1.0	1.7	1.3	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
50m	-	-	1.1	2.1	1.8	0.8	0.2	-	-	-	-	-	07	1.3	-	-	-
55m	-	-	0.8	1.3	1.0	0.2	-	-	-	-	-	-	-	-	-	-	-
60m	-	-	0.5	1.1	0.8	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 450$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	50m
Min. straight length before/after the bend *	90m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

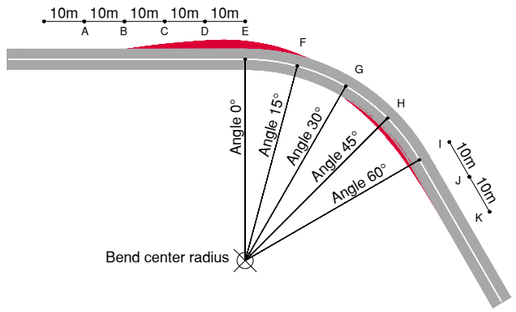
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:	DRAW UP: RGOBA DATE:	EDITION:	DRAWING Nº:
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V126 BEND WIDENING	CHECK BY: LUSPR DATE:	V6	1.2
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
55m	0.2	1.9	3.2	3.7	3.1	0.7	0.8	2.4	1.2	0.9	0.5
60m	-	1.6	2.8	3.4	2.7	0.6	0.4	1.0	1.0	0.5	-
65m	-	1.4	2.4	3.2	2.4	0.6	-	0.8	0.8	0.3	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
55m	-	1.0	2.3	2.8	2.2	-	-	1.5	0.4	0.2	-
60m	-	0.7	1.9	2.5	1.7	-	-	0.2	0.2	-	-
65m	-	0.5	1.5	2.2	1.4	-	-	-	0.2	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
55m	-	0.5	1.8	2.3	1.7	-	-	1.0	-	-	-
60m	-	0.2	1.4	2.0	1.2	-	-	-	-	-	-
65m	-	-	1.0	1.7	0.9	-	-	-	-	-	-

60º Bend widening diagram:

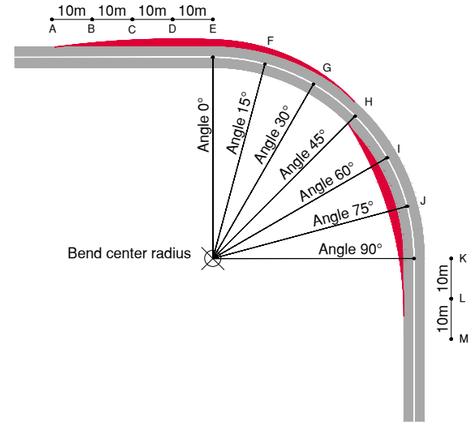


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
55m	0.2	1.6	3.0	3.8	3.5	2.4	1.6	-	1.3	1.9	1.2	0.6	0.3
60m	0.2	1.6	2.4	3.0	2.7	1.6	1.0	-	1.2	1.9	1.1	0.2	-
65m	-	1.4	2.2	2.6	2.5	1.6	1.0	-	1.1	1.8	0.8	-	-

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
55m	-	0.7	2.0	2.9	2.5	1.4	0.6	-	0.4	0.9	0.4	-	-
60m	-	0.7	1.5	2.0	1.7	0.7	0.2	-	0.2	0.9	0.2	-	-
65m	-	0.5	1.3	1.7	1.6	0.6	0.2	-	0.2	0.8	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
55m	-	0.3	1.5	2.4	2.0	1.0	0.2	-	-	0.4	-	-	-
60m	-	0.3	1.0	1.5	1.2	0.2	-	-	-	0.4	-	-	-
65m	-	-	0.8	1.2	1.1	0.2	-	-	-	0.3	-	-	-

90° Bend widening diagram:

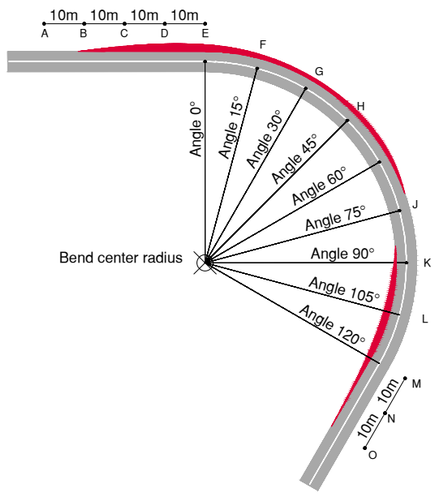


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
55m	0.5	2.0	3.1	3.8	3.4	2.2	1.6	1.3	1.0	-	1.8	2.4	1.4	0.3	-
60m	0.1	1.6	2.8	3.4	2.7	1.5	1.3	1.2	1.0	-	0.8	1.8	1.1	0.3	-
65m	-	1.4	2.6	3.1	2.4	1.0	1.0	0.8	0.8	-	0.6	1.4	0.8	-	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
55m	-	1.1	2.2	2.8	2.4	1.2	0.6	0.4	0.2	-	0.9	1.4	0.4	-	-
60m	-	0.7	1.8	2.4	1.7	0.6	0.4	0.3	0.2	-	-	0.8	0.2	-	-
65m	-	0.5	1.6	2.1	1.4	0.2	0.2	-	-	-	-	0.5	0.2	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
55m	-	0.6	1.7	2.3	1.9	0.7	0.2	-	-	-	0.4	1.0	-	-	-
60m	-	0.2	1.3	1.9	1.2	0.2	-	-	-	-	-	0.4	-	-	-
65m	-	-	1.1	1.6	0.9	-	-	-	-	-	-	0.2	-	-	-

120º Bend widening diagram:

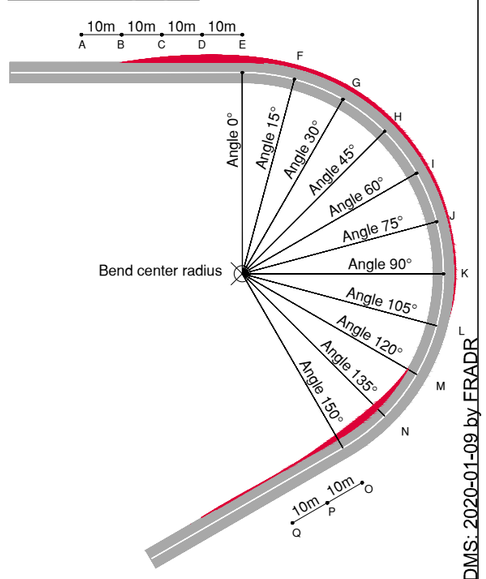


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
55m	0.2	1.9	3.2	3.8	3.5	2.5	1.5	1.2	1.2	1.1	0.9	-	1.9	2.9	1.9	0.4	-
60m	0.2	1.6	2.5	3.0	2.8	1.8	1.2	1.1	1.1	1.0	0.9	-	0.8	1.9	1.0	-	-
65m	-	1.4	2.2	2.8	2.5	1.5	1.1	1.0	1.0	0.9	0.9	-	0.6	1.5	0.6	-	-

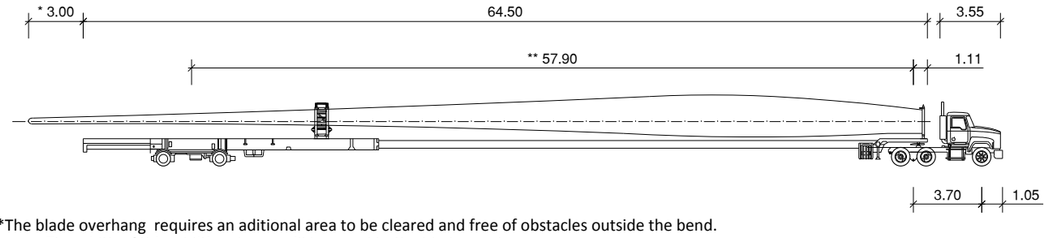
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
55m	-	1.0	2.2	2.8	2.5	1.5	0.6	0.4	0.4	0.2	-	-	1.0	2.0	1.0	-	-
60m	-	0.6	1.5	2.0	1.8	0.8	0.4	0.2	0.2	0.2	-	-	0.2	1.0	0.2	-	-
65m	-	0.4	1.2	1.8	1.5	0.6	0.2	0.2	0.2	-	-	-	-	0.6	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External										Internal						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
55m	-	0.5	1.7	2.3	2.0	1.0	0.2	-	-	-	-	-	0.5	1.5	0.5	-	-
60m	-	0.2	1.0	1.5	1.3	0.3	-	-	-	-	-	-	-	0.5	-	-	-
65m	-	-	0.7	1.3	1.0	0.2	-	-	-	-	-	-	-	0.2	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	$Kv.= L / \lvert i_1 - i_2 \rvert = 500$
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	55m
Min. straight length before/after the bend *	110m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

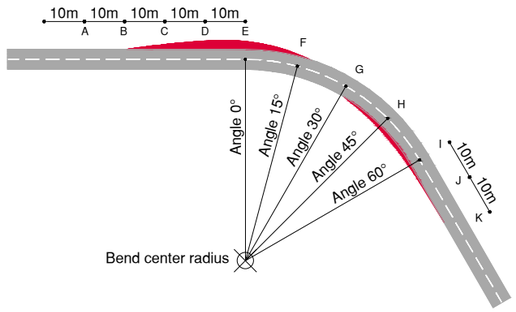
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V136 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	0.2	1.2	1.6	1.2	0.1	-	1.3	1.1	0.4	0.2
75m	-	-	0.8	1.4	0.8	-	-	1.0	0.8	0.3	-
80m	-	-	0.8	1.1	0.7	-	-	1.0	0.7	0.3	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	-	0.4	0.8	0.4	-	-	0.2	0.2	-	-
75m	-	-	0.2	0.6	0.2	-	-	0.2	-	-	-
80m	-	-	-	0.2	-	-	-	0.2	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	-	-	0.4	-	-	-	-	-	-	-
75m	-	-	-	0.2	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

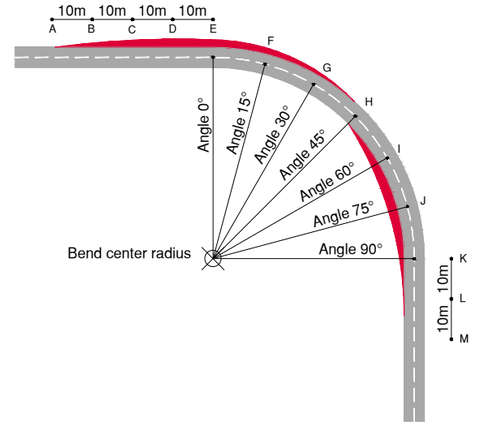


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	0.7	1.5	1.7	1.3	0.2	-	-	-	1.2	1.7	1.1	0.4
75m	-	0.5	1.2	1.4	1.0	-	-	-	-	1.0	1.4	0.8	0.2
80m	-	0.2	1.0	1.3	0.9	-	-	-	-	0.6	0.9	0.6	0.2

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	-	0.5	0.6	0.2	-	-	-	-	0.6	0.1	-	-
75m	-	-	0.4	0.6	-	-	-	-	-	0.4	-	-	-
80m	-	-	0.3	0.6	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.4	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

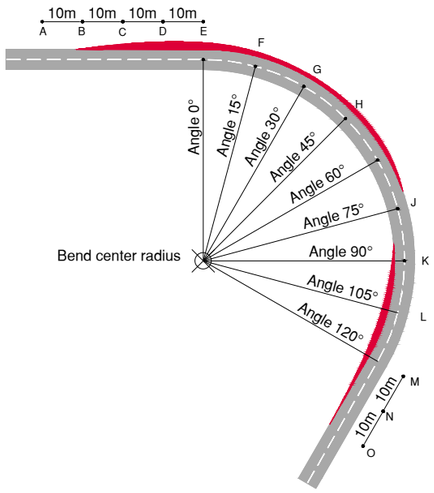


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	0.9	1.8	2.0	1.2	0.1	-	-	-	-	0.7	1.6	0.9	0.2	-
75m	-	0.6	1.5	1.6	1.0	-	-	-	-	-	0.5	1.2	0.8	0.2	-
80m	-	0.3	1.1	1.4	1.0	-	-	-	-	-	-	0.9	0.7	0.2	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	-	0.6	0.8	0.2	-	-	-	-	-	-	0.5	0.3	-	-
75m	-	-	0.4	0.5	-	-	-	-	-	-	-	0.4	0.2	-	-
80m	-	-	0.2	0.3	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

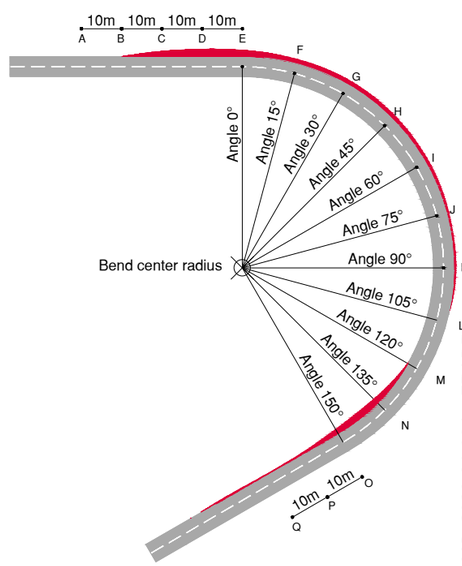


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	0.7	1.7	2.0	1.4	-	-	-	-	-	-	-	0.3	1.3	1.1	0.8	0.4
75m	-	0.5	1.4	1.6	1.2	-	-	-	-	-	-	-	0.2	1.0	0.8	0.6	0.3
80m	-	0.2	1.1	1.3	0.9	-	-	-	-	-	-	-	-	0.6	0.7	0.5	0.3

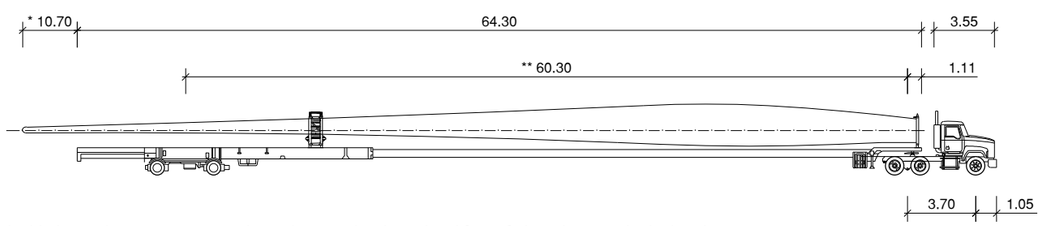
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	-	0.8	1.0	0.4	-	-	-	-	-	-	-	-	0.4	-	-	-
75m	-	-	0.4	0.7	0.2	-	-	-	-	-	-	-	-	0.2	-	-	-
80m	-	-	0.2	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	-	0.4	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



*The blade overhang requires an aditional area to be cleared and free of obstacles outside the bend.
The width of this additional area will be equal to the blade overhang.
This additional area will be paralel to the road extra-widening,

**The distance between the axels requires an aditional area to be cleared and free of obstacles inside the bend.
This additional area will change depending of the truck and the bending radius and should be checked case-by-case.

-Different dimensions will lead to substantially different results.
-All units provided are in meters.

DESIGN REQUIREMENTS	
Minimum vertical curve paramether	Kv.= L / | i_1 - i_2 |= 500
Maximum slope on gravel road	9%
Maximum slope on concrete road	14%
Minimum radius	70m
Min. straight length before/after the bend *	160m
* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

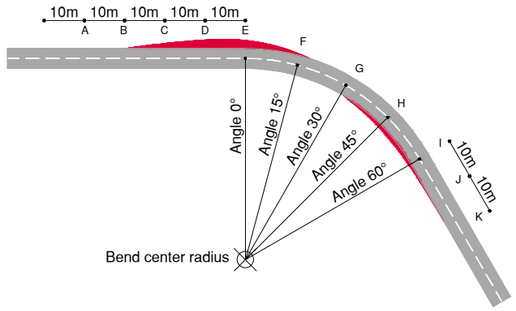
PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	10 - 05 - 2018	V150 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: LUSPR DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1

60º BEND WIDENING - 5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	0.2	1.2	1.6	1.2	0.1	-	1.3	1.1	0.4	0.2
75m	-	-	0.8	1.4	0.8	-	-	1.0	0.8	0.3	-
80m	-	-	0.8	1.1	0.7	-	-	1.0	0.7	0.3	-

60º BEND WIDENING - 6 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	-	0.4	0.8	0.4	-	-	0.2	0.2	-	-
75m	-	-	0.2	0.6	0.2	-	-	0.2	-	-	-
80m	-	-	-	0.2	-	-	-	0.2	-	-	-

60º BEND WIDENING - 6.5 METERS WIDE ROAD											
Radius	External						Internal				
	A	B	C	D	E	F	G	H	I	J	K
70m	-	-	-	0.4	-	-	-	-	-	-	-
75m	-	-	-	0.2	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-

60º Bend widening diagram:

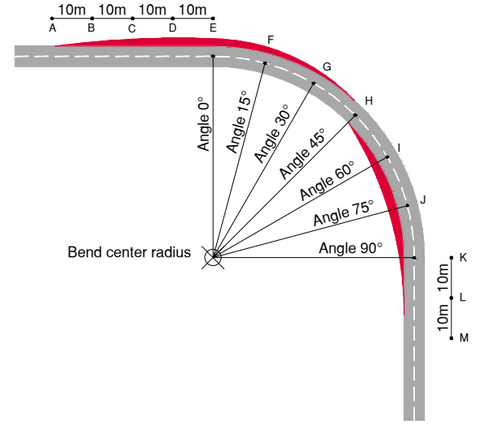


90º BEND WIDENING - 5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	0.7	1.5	1.7	1.3	0.2	-	-	-	1.2	1.7	1.1	0.4
75m	-	0.5	1.2	1.4	1.0	-	-	-	-	1.0	1.4	0.8	0.2
80m	-	0.2	1.0	1.3	0.9	-	-	-	-	0.6	0.9	0.6	0.2

90º BEND WIDENING - 6 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	-	0.5	0.6	0.2	-	-	-	-	0.6	0.1	-	-
75m	-	-	0.4	0.6	-	-	-	-	-	0.4	-	-	-
80m	-	-	0.3	0.6	-	-	-	-	-	-	-	-	-

90º BEND WIDENING - 6.5 METERS WIDE ROAD													
Radius	External								Internal				
	A	B	C	D	E	F	G	H	I	J	K	L	M
70m	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.4	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-

90° Bend widening diagram:

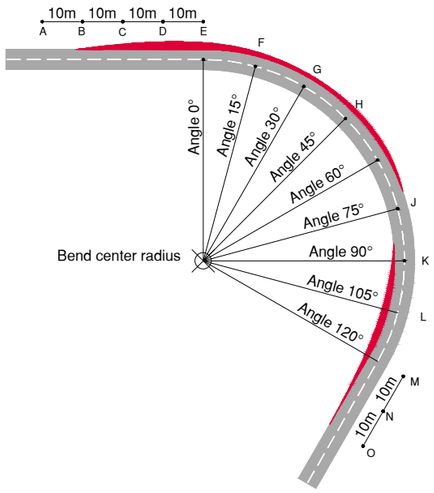


120º BEND WIDENING - 5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	0.9	1.8	2.0	1.2	0.1	-	-	-	-	0.7	1.6	0.9	0.2	-
75m	-	0.6	1.5	1.6	1.0	-	-	-	-	-	0.5	1.2	0.8	0.2	-
80m	-	0.3	1.1	1.4	1.0	-	-	-	-	-	-	0.9	0.7	0.2	-

120º BEND WIDENING - 6 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	-	0.6	0.8	0.2	-	-	-	-	-	-	0.5	0.3	-	-
75m	-	-	0.4	0.5	-	-	-	-	-	-	-	0.4	0.2	-	-
80m	-	-	0.2	0.3	-	-	-	-	-	-	-	-	-	-	-

120º BEND WIDENING - 6.5 METERS WIDE ROAD															
Radius	External									Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
70m	-	-	0.2	0.4	-	-	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

120º Bend widening diagram:

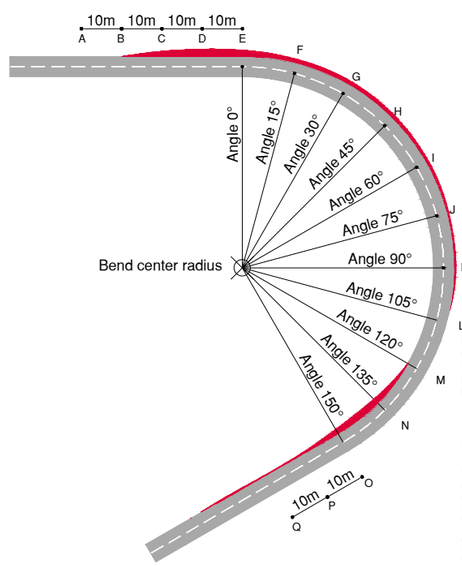


150º BEND WIDENING - 5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	0.7	1.7	2.0	1.4	-	-	-	-	-	-	-	0.3	1.3	1.1	0.8	0.4
75m	-	0.5	1.4	1.6	1.2	-	-	-	-	-	-	-	0.2	1.0	0.8	0.6	0.3
80m	-	0.2	1.1	1.3	0.9	-	-	-	-	-	-	-	-	0.6	0.7	0.5	0.3

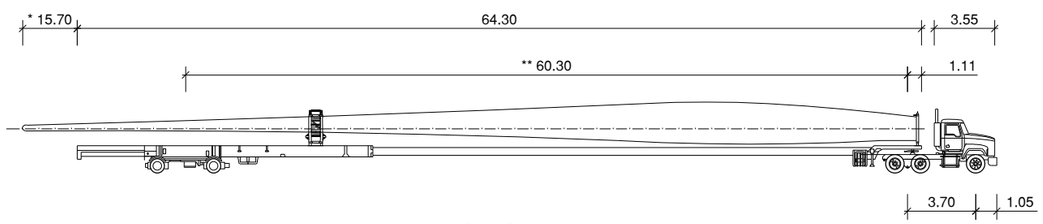
150º BEND WIDENING - 6 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	-	0.8	1.0	0.4	-	-	-	-	-	-	-	-	0.4	-	-	-
75m	-	-	0.4	0.7	0.2	-	-	-	-	-	-	-	-	0.2	-	-	-
80m	-	-	0.2	0.3	0.2	-	-	-	-	-	-	-	-	-	-	-	-

150º BEND WIDENING - 6.5 METERS WIDE ROAD																	
Radius	External											Internal					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
70m	-	-	0.4	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-
75m	-	-	-	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-
80m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

150º Bend widening diagram:



Design has been defined considering the following truck dimensions:



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DESIGN REQUIREMENTS	
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* Additional bend wides provided in this drawing, will not be valid if this minimum straigth length are not respected.	

PROJECT:	AUTHOR:	SCALE:	DATE:	DRAWING:			
TECHNICAL SPECIFICATIONS	Vestas	WITHOUT SCALE	26 - 04 - 2019	V162 BEND WIDENING	DRAW UP: RGOBA DATE:	EDITION: V6	DRAWING Nº: 1.2
					CHECK BY: DDLCO DATE:		
					APPROVAL: LGB/ADMAD DATE:		PAGE 1 OF 1