An innovative solution by using a laying machine (paver) to improve the construction process and quality for Road Base layer

By

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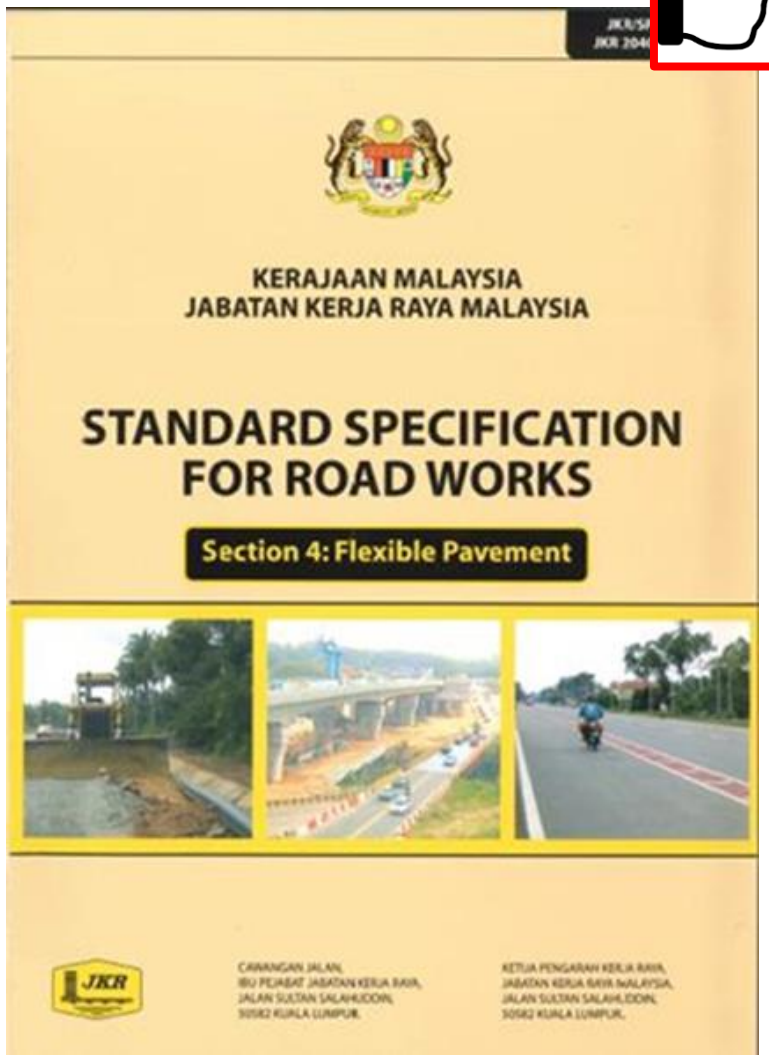
Selangor Darul Ehsan
Malaysia

Construction requirements and compliances

JKR standard specification for road works



Section 4.2 PAVED ROADS

Unbound Pavement Courses

4.2.1 Drainage Layer
4.2.2 Sub-base
4.2.3 Crushed Aggregate Roadbase
4.2.4 Wet-mix Roadbase

Bound Pavement Courses

4.2.5 Bituminous Roadbase
4.2.6 Cement-Treated Base

Section 4.3 BITUMINOUS PAVEMENT COURSES

4.3.3 Asphaltic Concrete

Section 4.4 SHOULDERS

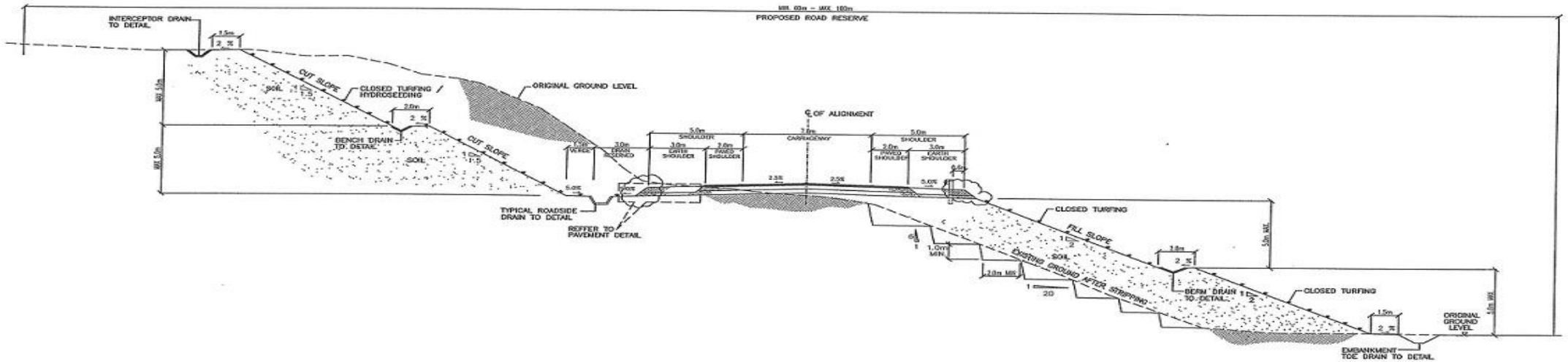
4.4.1 Description
4.4.2 Materials
4.4.3 Construction methods

Section 4.5 HORIZONTAL ALIHNMENT, SURFACE LEVELS AND SURFACE REGULARITY OF PAVEMENT COURCES

4.5.1 Horizontal Alignment
4.5.2 Surface Levels of Pavement Courses
4.5.3 Surface Regularity

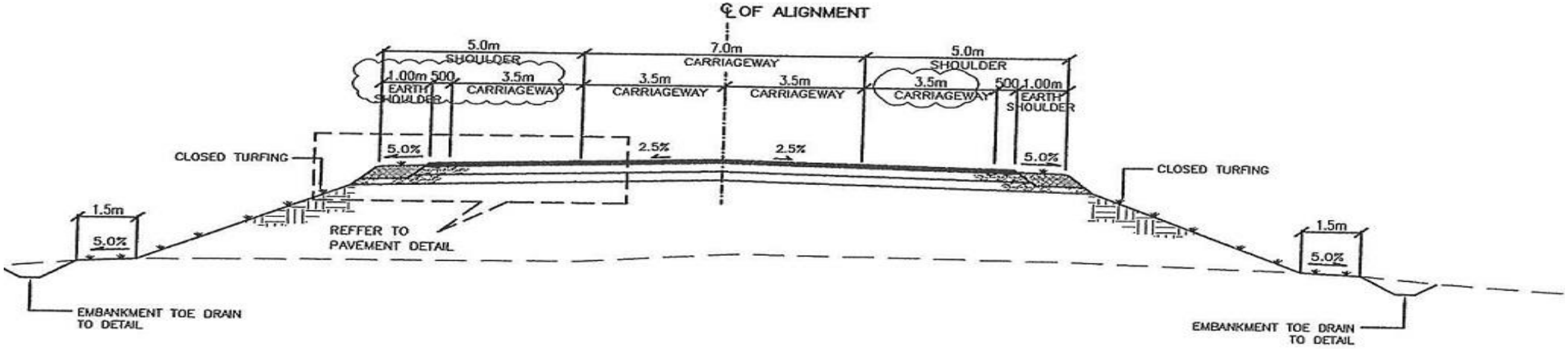
Compliance (Level & Finishes)

Typical Pavement Cross Section- Pan Borneo (2 lanes dual carriage way)



TYPICAL CUT AND FILL EMBANKMENT CROSS SECTION (RURAL)

SCALE 1 : 125(A1)
1 : 250(A3)



TYPICAL OVERTAKING LANE CROSS SECTION

SCALE 1 : 125(A1)

Compliance (Level & Profile)

Road Pavement Details- Pan Borneo

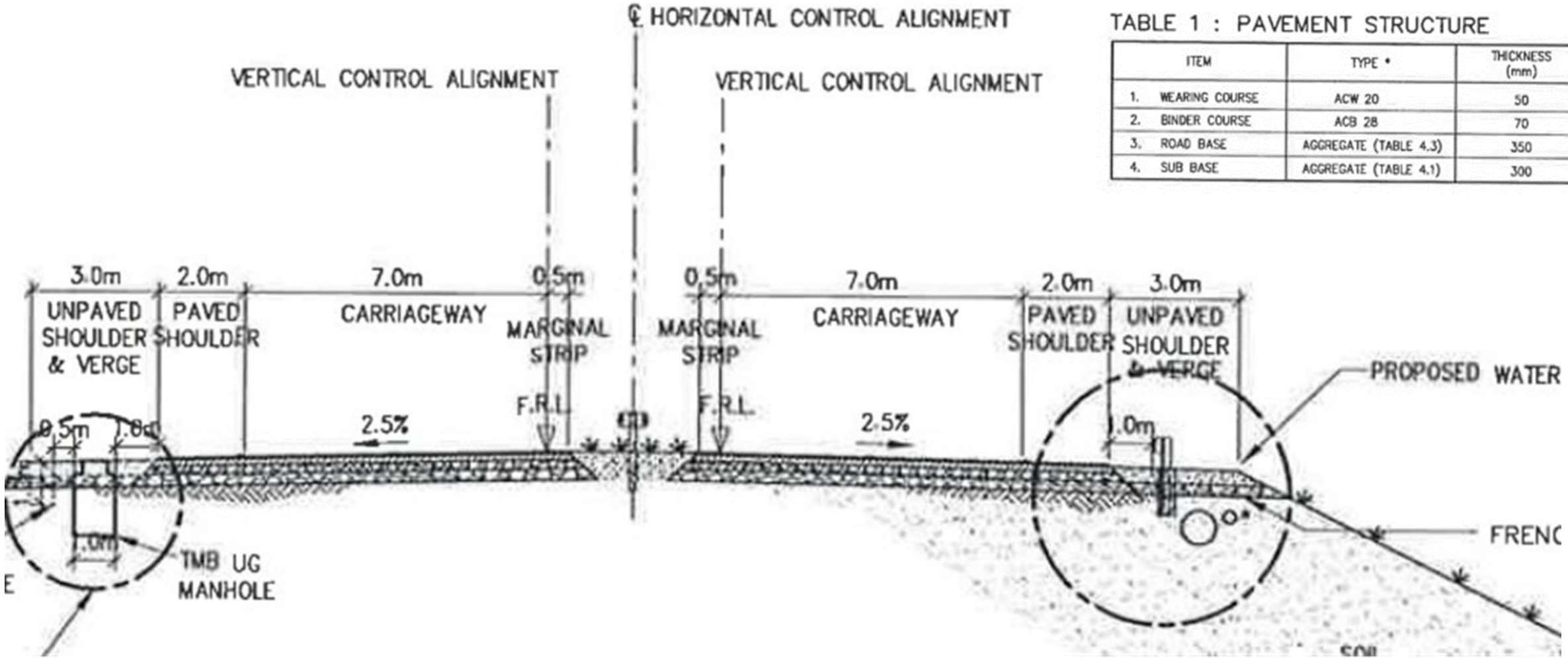


TABLE 1 : PAVEMENT STRUCTURE

ITEM	TYPE *	THICKNESS (mm)
1. WEARING COURSE	ACW 20	50
2. BINDER COURSE	ACB 28	70
3. ROAD BASE	AGGREGATE (TABLE 4.3)	350
4. SUB BASE	AGGREGATE (TABLE 4.1)	300

Let’s look at JKR specification
- Sub-base
- Road-base

4.1.2 Sub-Base

4.1.2.1 Description

This work shall consist of furnishing, placing, compacting and shaping sub-base material on a prepared and accepted subgrade in accordance with this Specification and the lines, levels, grades, dimensions and cross-sections as shown on the Drawings and/or as directed by the S.O.

4.1.2.2 Materials

Sub-base shall be a natural or artificial mixture of locally available materials such as sand, gravel, crushed aggregate etc, free from organic matter, clay lumps and other deleterious materials. It shall be well graded and conform to Table 4.1.2 and the following quality requirements;

4.2.3 Crushed Aggregate Roadbase

4.2.3.1 Description

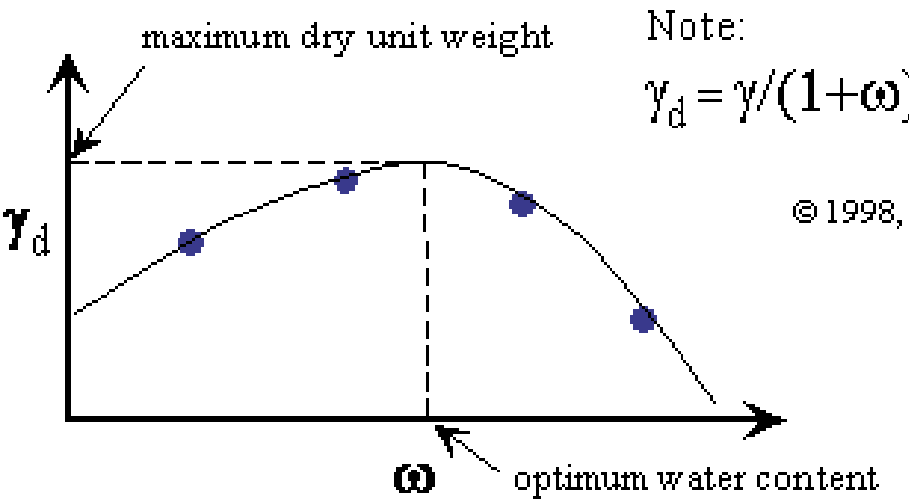
This work shall consist of furnishing, placing, compacting and shaping crushed aggregate roadbase material on a prepared and accepted subgrade or sub-base in accordance with this Specification and the lines, levels, grades, dimensions and cross-sections as shown on the Drawings and/or as directed by the S.O.

4.2.3.2 Materials

Crushed aggregate roadbase material shall be crushed rock, crushed gravel or a mixture of crushed rock and gravel, which shall be hard, durable, clean and essentially free from clay and other deleterious materials.

Compliance (level & finishes):
for good compaction on road base material

Proctor curve



4.2.3.3 Construction Methods

Prior to placing any crushed aggregate roadbase material, the subbase shall have been constructed in accordance with the provisions of Section 4.2.2.3.

Crushed aggregate roadbase shall be placed to the required width and thickness as shown on the Drawings or directed by the S.O. in one layer or more, each layer not exceeding 200 mm compacted thickness.

Where two or more layers are required, each layer shall be of approximately equal thickness and none shall be less than 100 mm compacted thickness.

The material shall be spread using a motor grader of sufficient capacity or other approved mechanical spreader, at the optimum moisture content ±1%.

Compaction shall be carried out using suitable approved equipment, in a longitudinal direction, and begin at the lower edges and progress towards the crown, or in the case of superelevation towards the upper edge, in such a manner that each section receives equal compactive effort, sufficient to produce a density of not less than 95% of the dry maximum density as determined by BS 1377: Test 13.

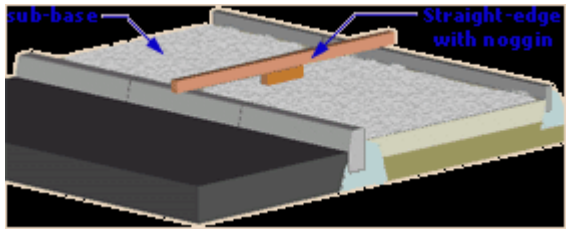
Throughout the placing, adjustment of moisture content and compaction of crushed aggregate roadbase material, care shall be taken to maintain a uniform gradation of the material and prevent its separation into coarse and fine parts, all to the satisfaction of the S.O.

The crushed aggregate roadbase width shall be everywhere at least that specified or shown on the Drawings on both sides of the centre-line; and its average thickness over any 100 metre length shall be not less than the required thickness.

The typical construction method for sub base and road base layers

Structural layers for a typical pavement work:

1) Subgrade
2) Sub base
3) Road base (bound and unbound)



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Alternative solution


VÖGELE
SUPER 3000-2
cnhdnm.en.alibaba.com

Success criteria for the alternative method

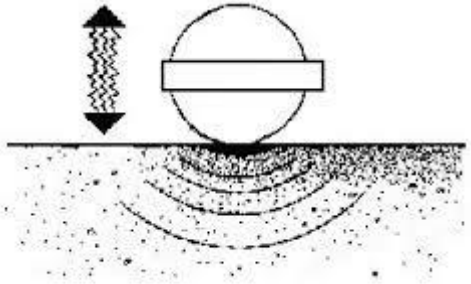
1

Able to provide the required
WIDTH & THICKNESS

2

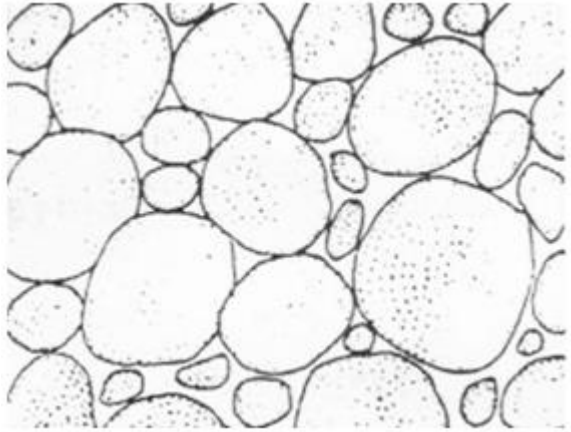
Able to provide the required
WATER FOR OMC

3



Able to provide the required
COMPACTION

4

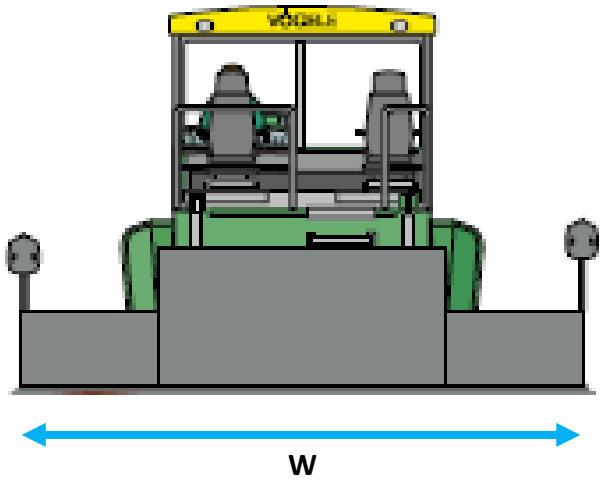


Able to provide the required
HOMOGENEITY OF GRANULAR MATERIAL

Feature to address the application need-
Provision of extendable (AB) and fixed (SB) screed

1

Able to provide the required
WIDTH & THICKNESS



Paving dimension (m)	
Height	< 300mm
Width	2.5m to 6m
Slope	2D, -2.5% to 5.0%

Feature to address the application need –
Provision of water spraying system

Able to provide the required
WATER FOR OMC

Feature to address the application need –
Provision of water spraying system

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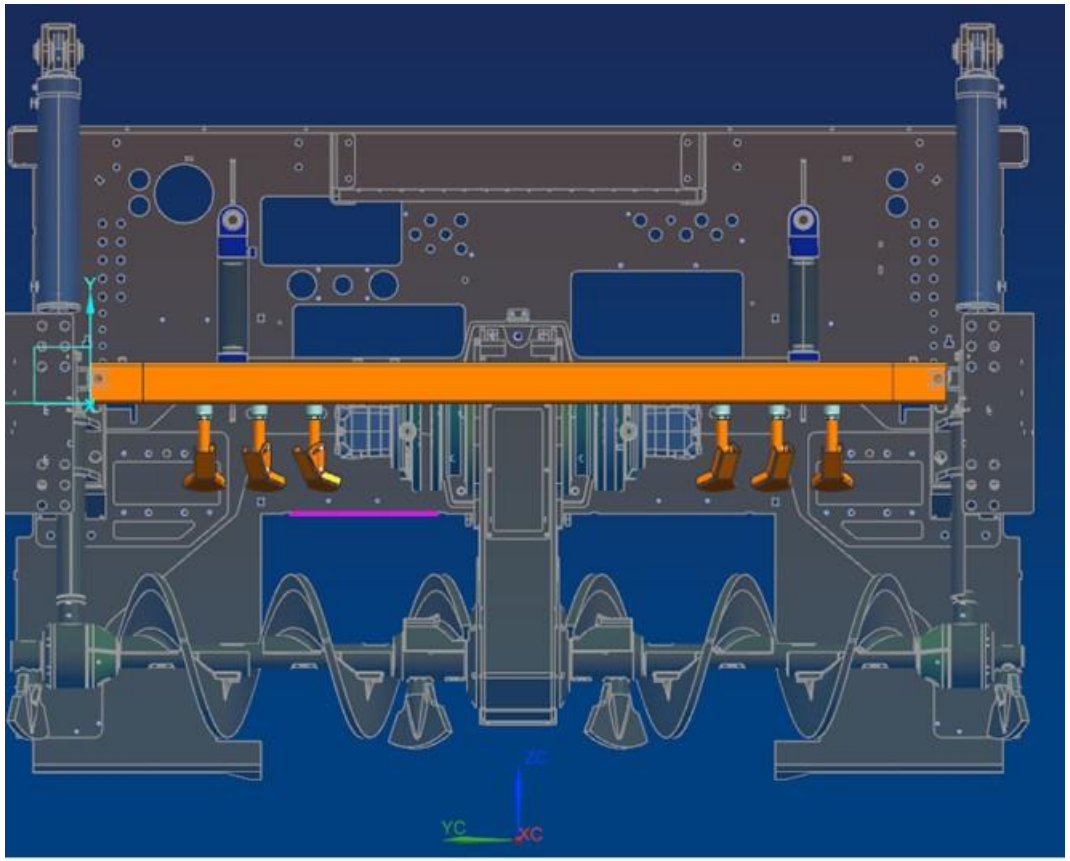
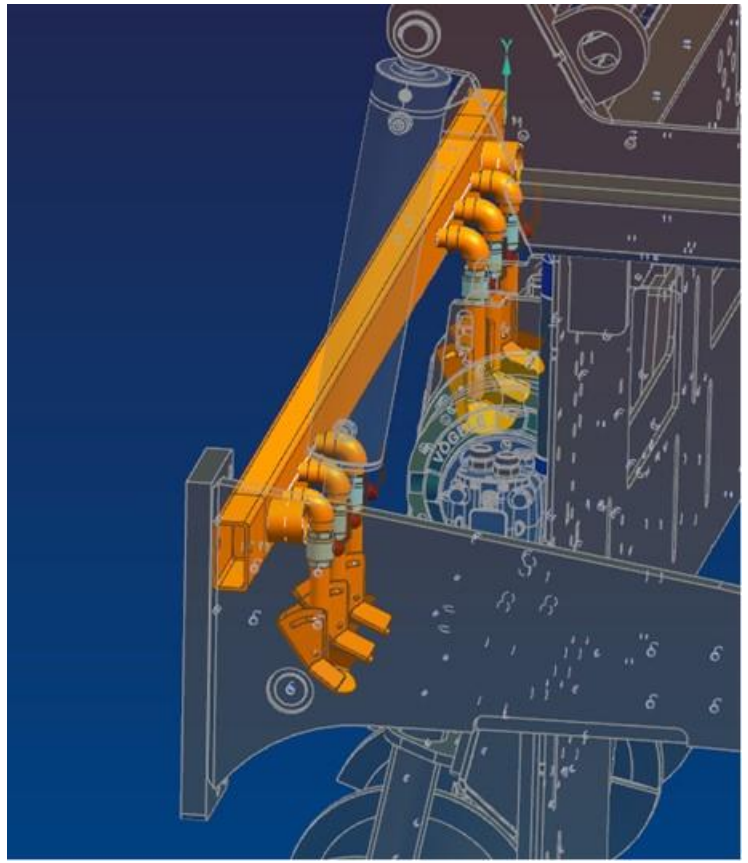
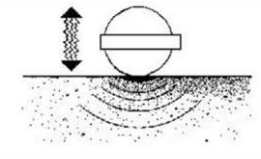
WATER FOR OMC



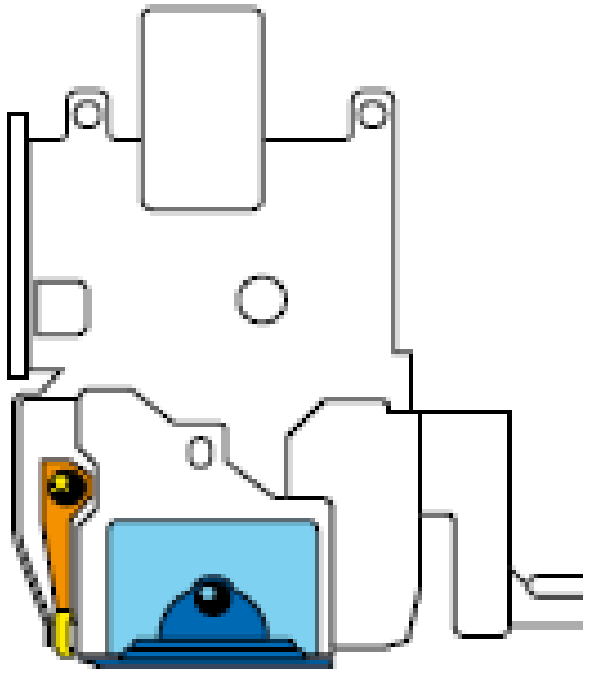


Feature to address the application need-
Provision of TP2 compaction Systems installed in the screeds

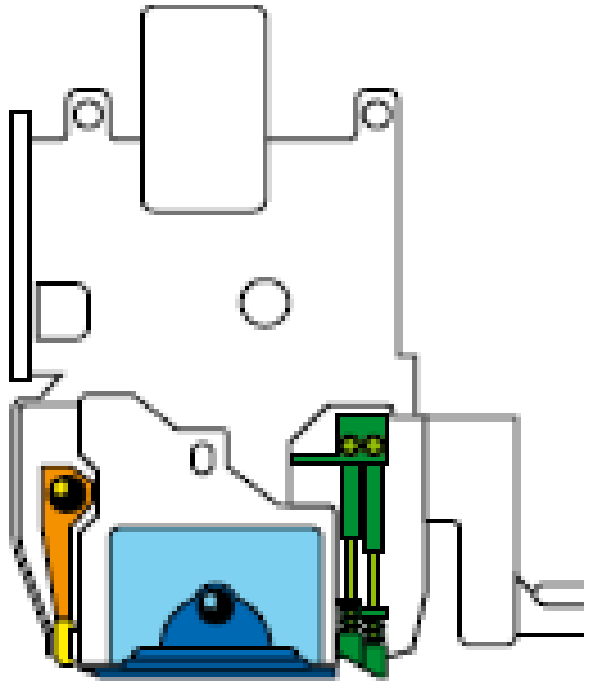
3



Able to provide the required **COMPACTION**



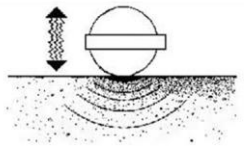
TV screed



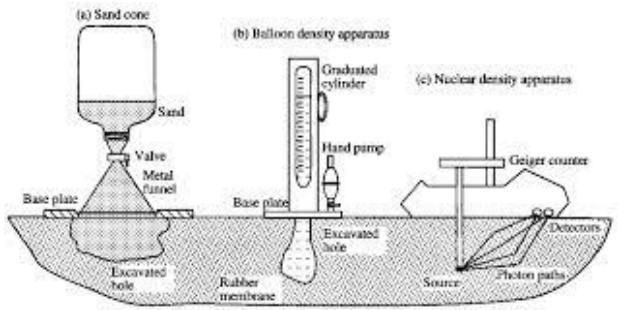
TP2 screed

Compaction results !

3



Able to provide the required **COMPACTION**



Road base compaction post paver :

80%

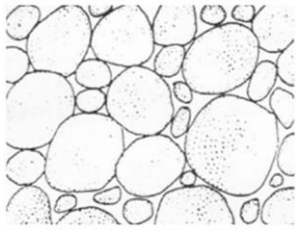
5.5 Recommended Settings for the Compacting Systems

		Kind of Layer		
		Wearing Course	Binder Course	Base Course
Pave Speed	m/min.	> 5	4 – 10	2 – 8
Tamper Speed	Stroke (mm)	2 – 4	4	4 – 7
	Revs/min.	300 – 800	800 – 1,200	1,200 – 1,800
Vibrators	Pressure (bar)	50 – 80	70 – 90	80 – 100
	Revs/min.	1,200 – 2,000	1,500 – 2,500	2,000 – 3,000
Pressure Bar(s)	Pressure (bar)	45 – 70	60 – 90	90 – 110
	Frequency (Hz)	58 – 68	58 – 68	58 – 68

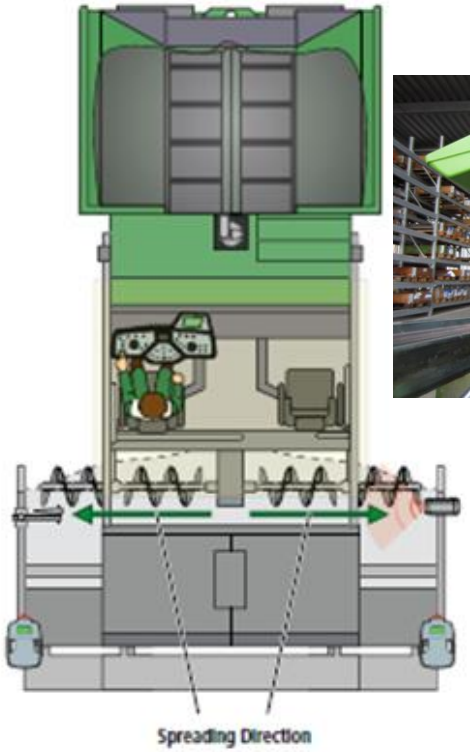
Feature to address the application need-

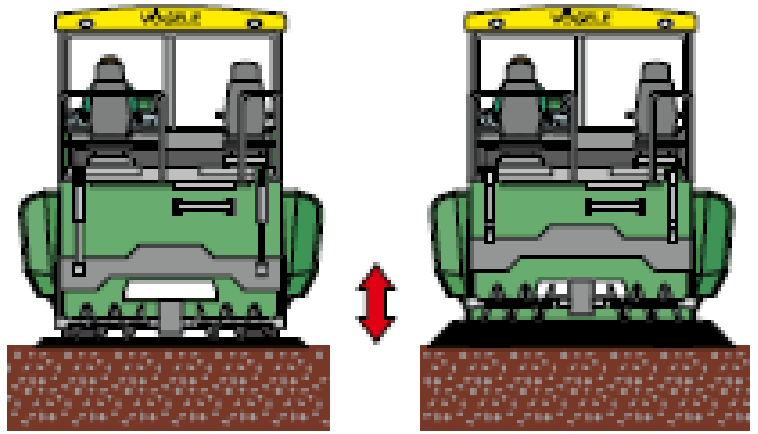
Provision of sonic auger sensor and hydraulic auger height functions

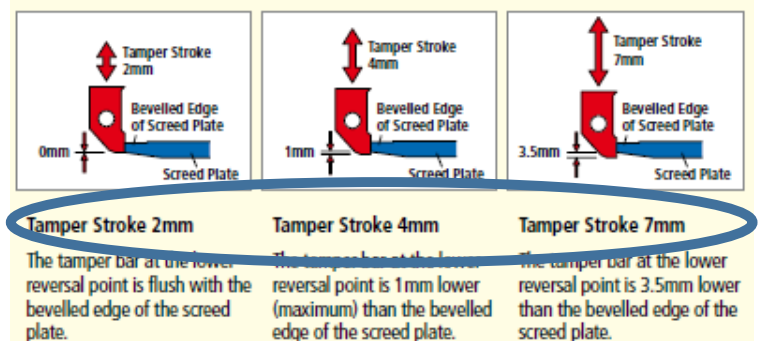
4



Able to provide the required **HOMOGENEITY OF GRANULAR MATERIAL**







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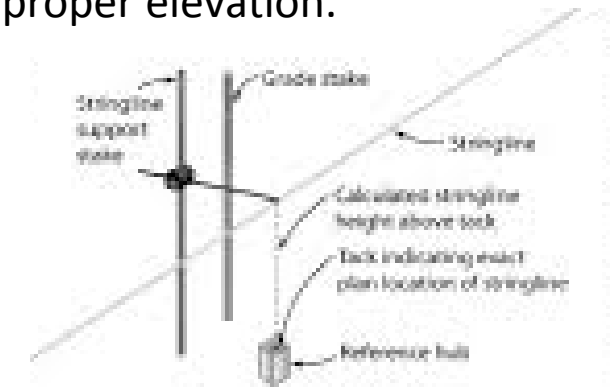
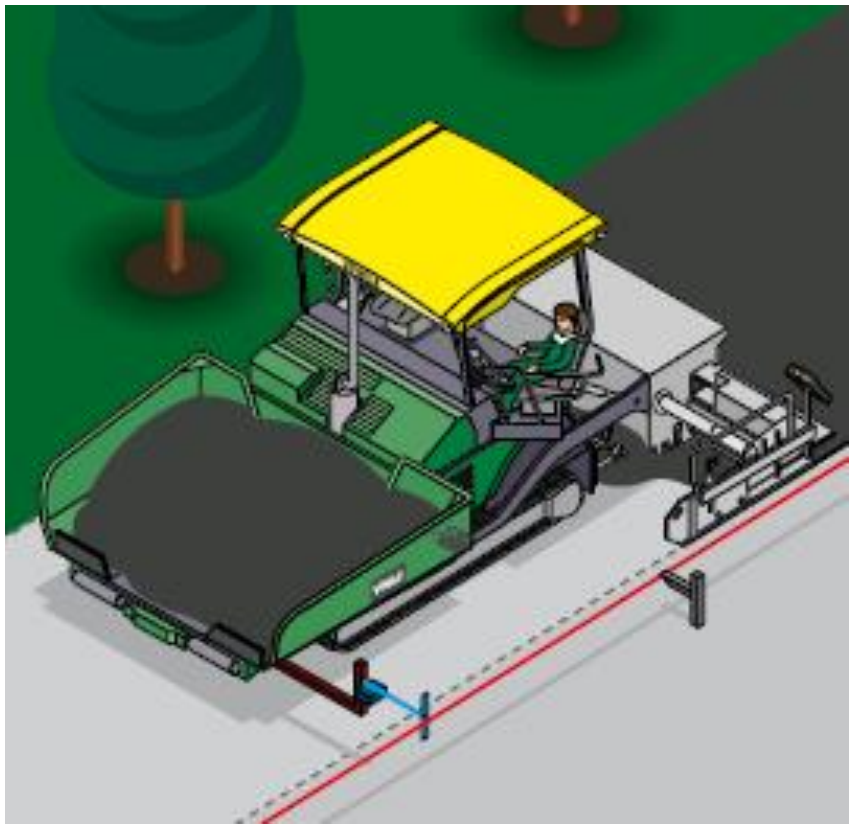
Alternative solution leads to Benefits…….

Benefit 1 – accurate level control

Setting the String-line

1. Set reference hubs at proper interval and place a string-line support take outside of each hub.
2. Set stake arm to the proper elevation.
3. Install string-line.
4. Tighten string-line.
5. Check installation.



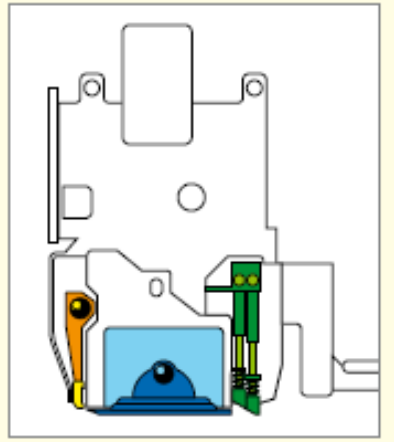


Level control by mechanical sensor and hence reduce working time and independence from high skill motor grader operators.

Benefit 2 – effective spraying of water

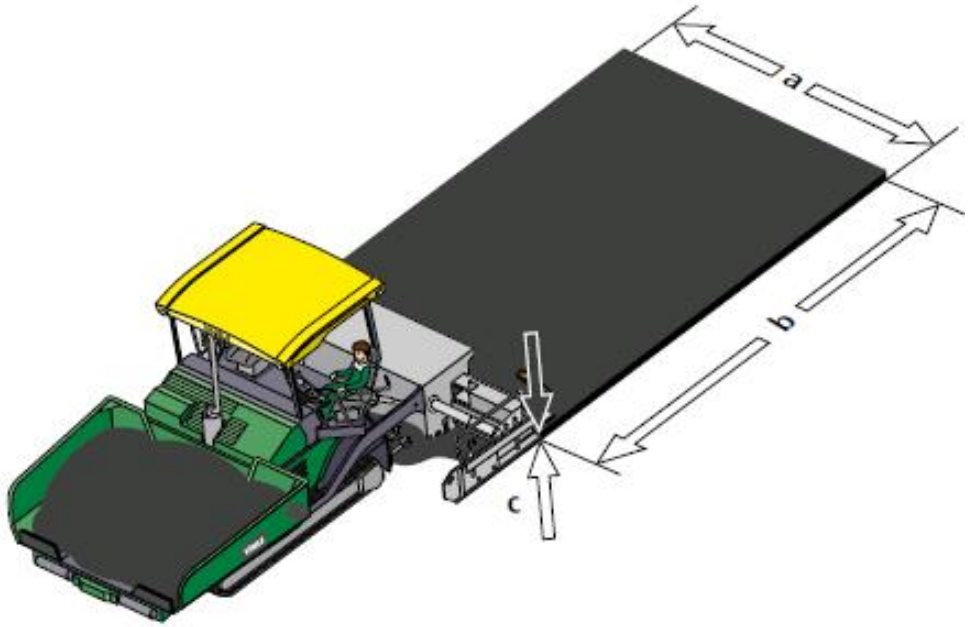
1. Water can be added more effectively to near to optimum moisture content hence improving the workability and compaction.

2. TP2 screed provide good pre compaction.



Benefit 3 – exact control on dimension (x-y-z)

Paving width can be exact that reduces the material wastage.



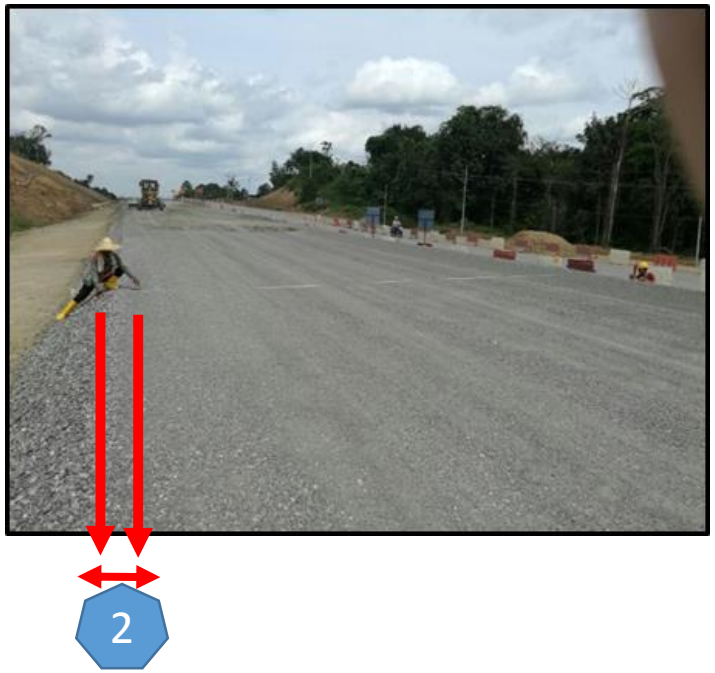
Measurement of an actual width for a laid road base at a new build work site

work by motor grader and back pusher.

Measurement at the edge of the pavement :

1

additional width of approximately
= **300mm**



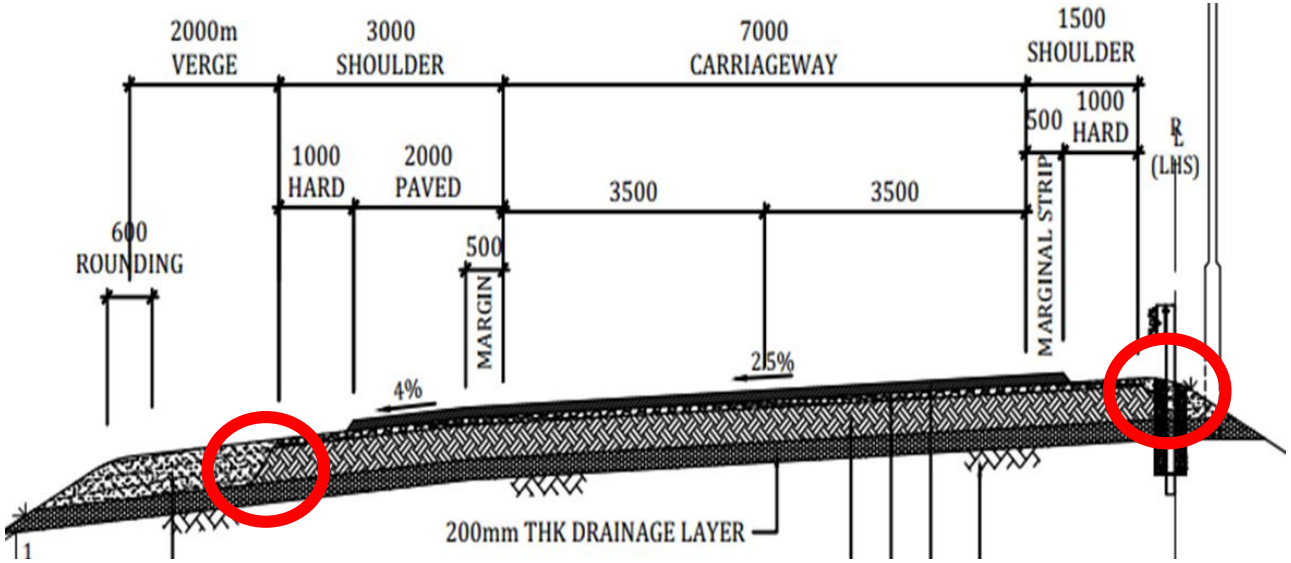
Measurement at the center of the pavement :

2

additional width of approximately
= **100 mm**

$$ Benefits

Calculation for Road Base only !!!



This rate is ex plant, secondary transportation cost not accounted yet ?

<u>Calculation for the material and cost saving :</u>

Overflow of crusher run at the edge by using traditional spreading method.

Presume road length = 100km @ 100,000.00 m
road width per side = 11.5m
road thickness = 0.35m
density of material = 2.0

The road base quantity, 4 lanes dual carriage way :
= 100,000 x 11.5 x 2 x 0.35 x 2
= **<u>1,610,000 mt.</u>**

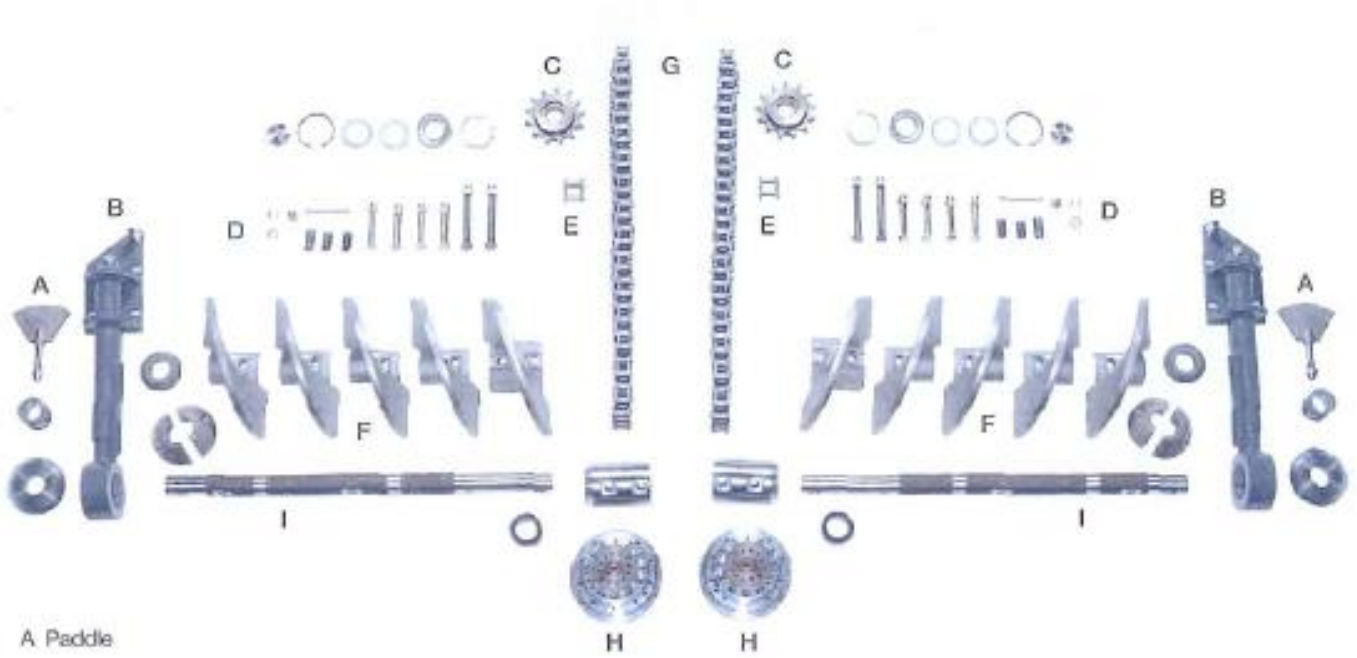
Presume wastage due to over flow at both edge and both side of road (each edge overflow by 0.3m) :
= length x over flow width x 2 edges x 2 sides x thickness x density
= 100,000 x 0.3 x 2 x 2 x 0.35 x 2
= **<u>84,000 mt @ 5.2% wastage</u>**

= 84,000 mt x RM 30 /mt

<u>= RM 2,520,000.00</u>

$$ Benefits

Wear and tear cost for paver !!!



<u>Calculation of wear and tear cost :</u>

Total road base volume = 1,610,000 mt

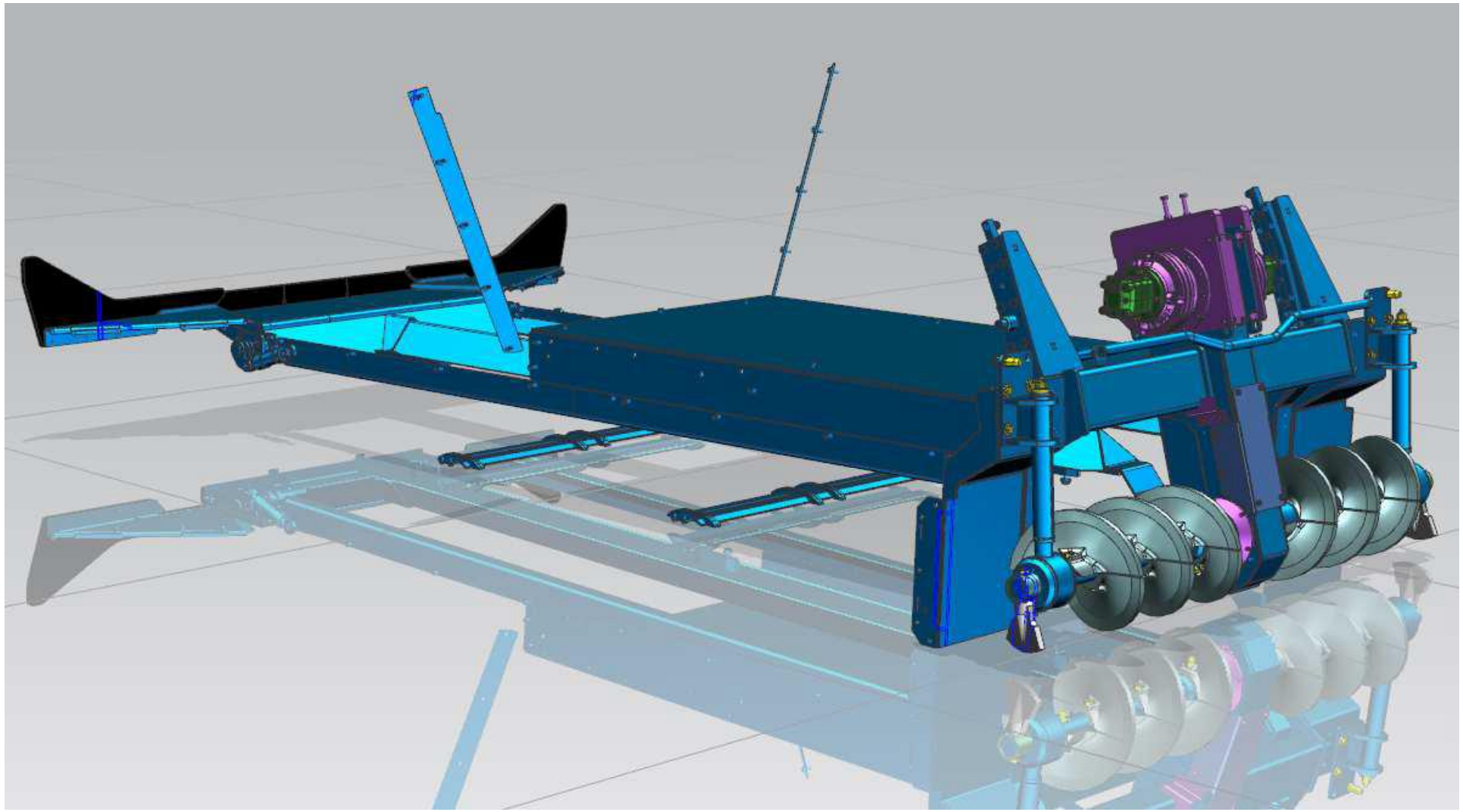
One set of wear and tear kits can last for laying 300,000 mt.

One set of wear and tear kits = RM 160,000

For completing the project required to change 5 times the wear and tear kits :
= 5 X RM 160,000
= RM 800,000

Final saving :
= RM 2,520,000 – RM 800,000
= **RM 1,720,000**

Heavy duty kits



Summary of benefits !

1

2

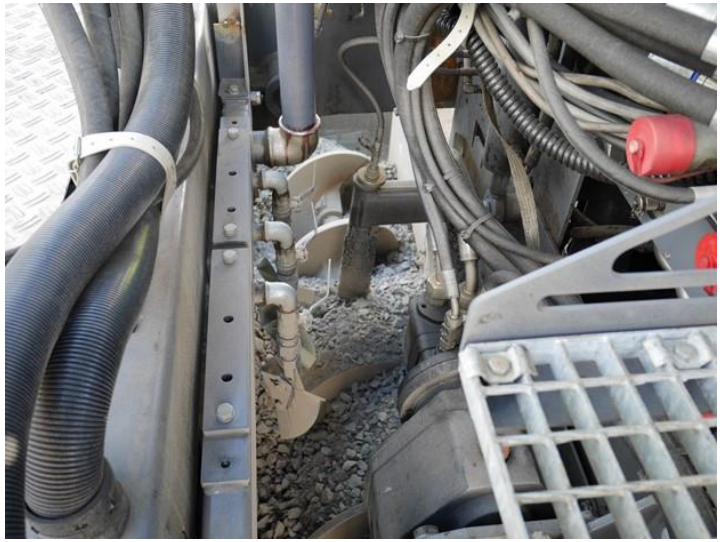
3

As a start
let’s look at the prototype at
Vogele factory at Germany
on Nov 2016

☺

Visited Vogele's CTT (R&D) center on Nov 2016, Ludwigshafen Germany

First trial Nov 2016



First trial Nov 2016 – The results

Water can be added effectively in the range of **near** to **OMC**.

Foot print is not depressed proved that the TP2 screed is compacting the material to high level of pre compaction before roller.

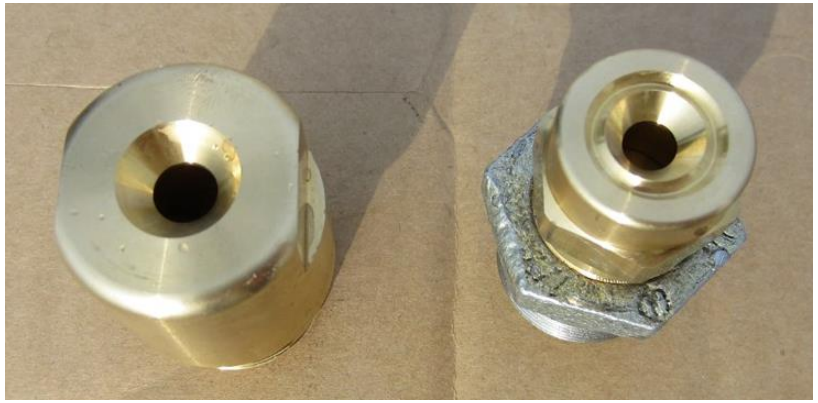
First trial Nov 2016 – learnings

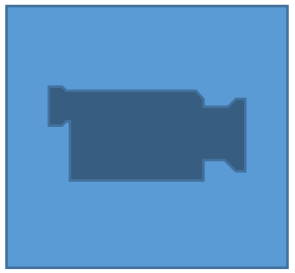
Water spraying rate need to be control to a smaller unit for better mixing of water and granular material.

Granular material used must be the right gradation with sufficient fine and reduce segregation for better simulation.

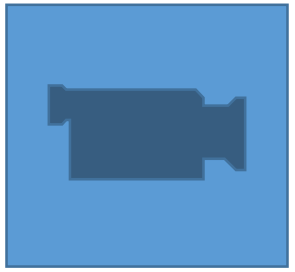
Mixing of water need to be improved.

First improvements :



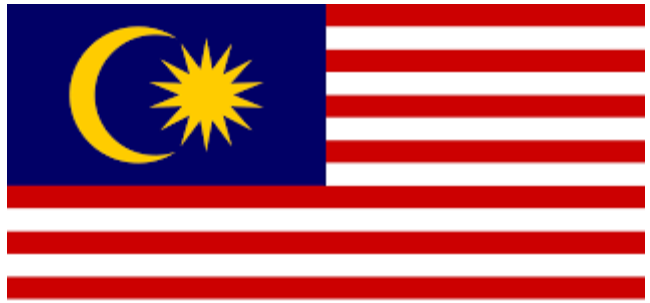


"Large Nozzle Type":
36 l/min per nozzle



“Medium Nozzle Type":
24 l/min per nozzle

“Medium Nozzle Type":
12 l/min per nozzle



First trial in Malaysia
(second trial after Germany)
(further improvement with local touch)
Wirtgen (M) Sdn Bhd
on April and May 2017

☺☺

First Water Jet (Vogele S 1800-3 AB600-3 TP2)

Second improvement :

Components added for water spray system to improve efficiency and effectiveness

Second trial May 2017 –

Calibration of water flow

100
liter per min

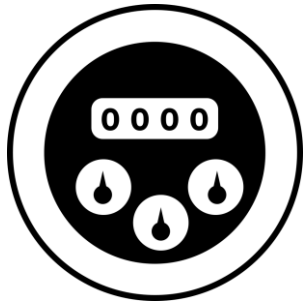
200
liter per min

300
liter per min

Second trial May 2017 –

calibration for small water spray nozzle

100



300

<u>Water spray rate in</u>

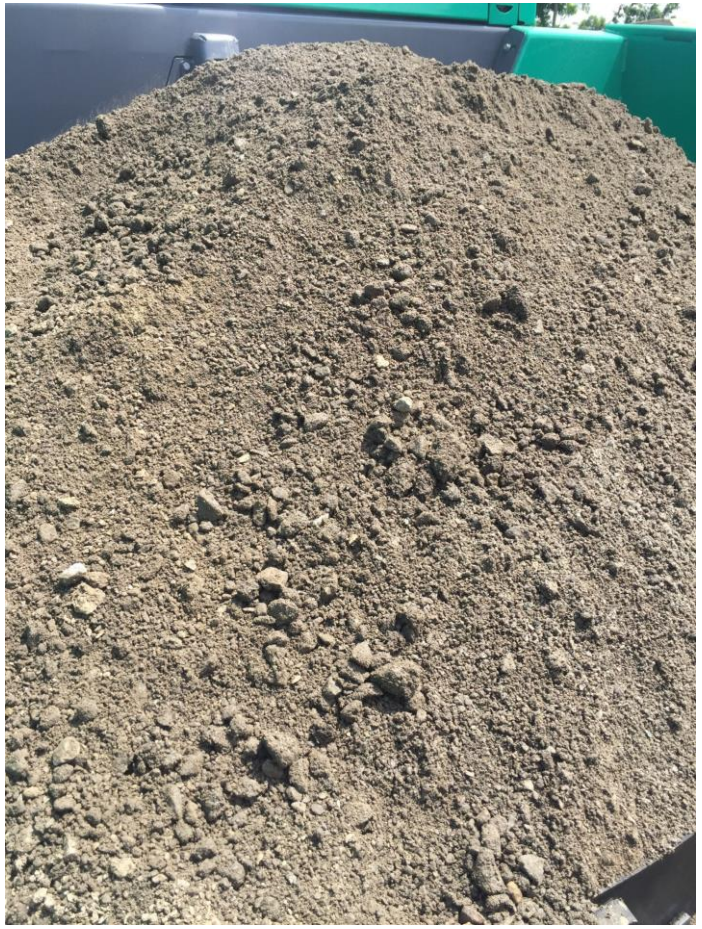
litre per minute (l/min)

200

400

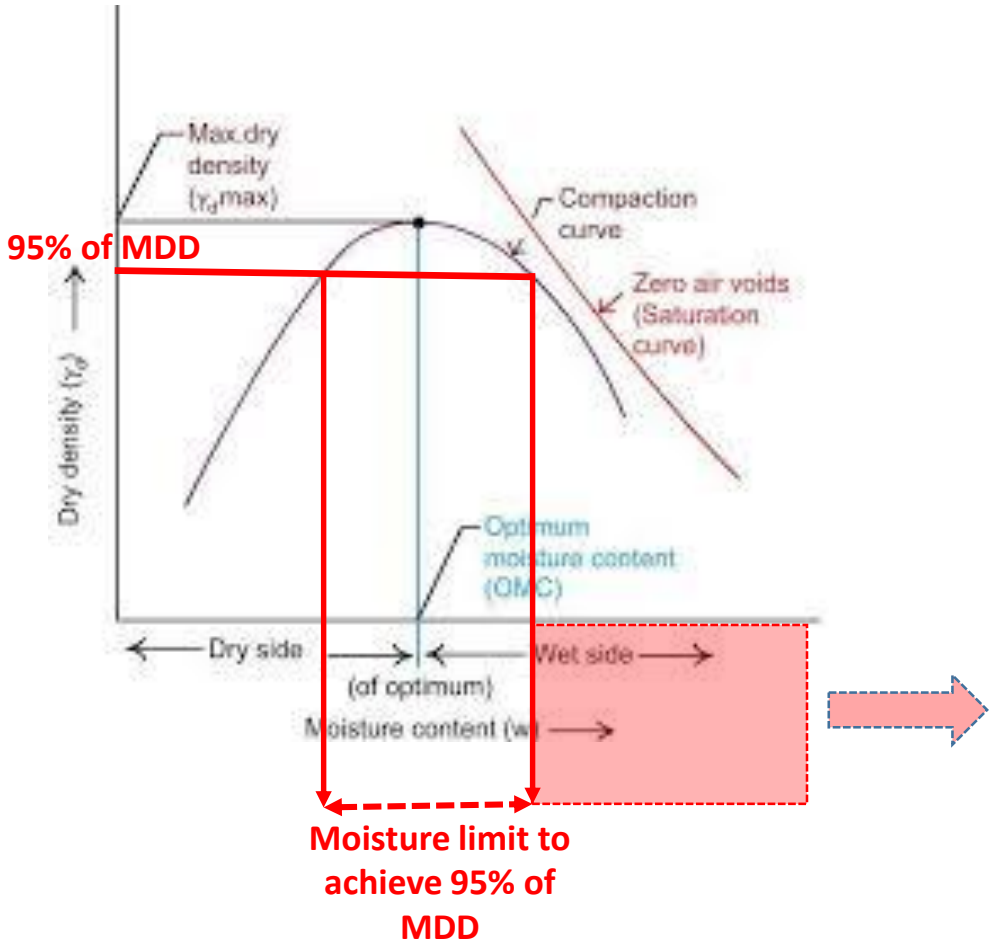
Second trial May 2017 –

water spraying and transfer of material at the screed tunnel



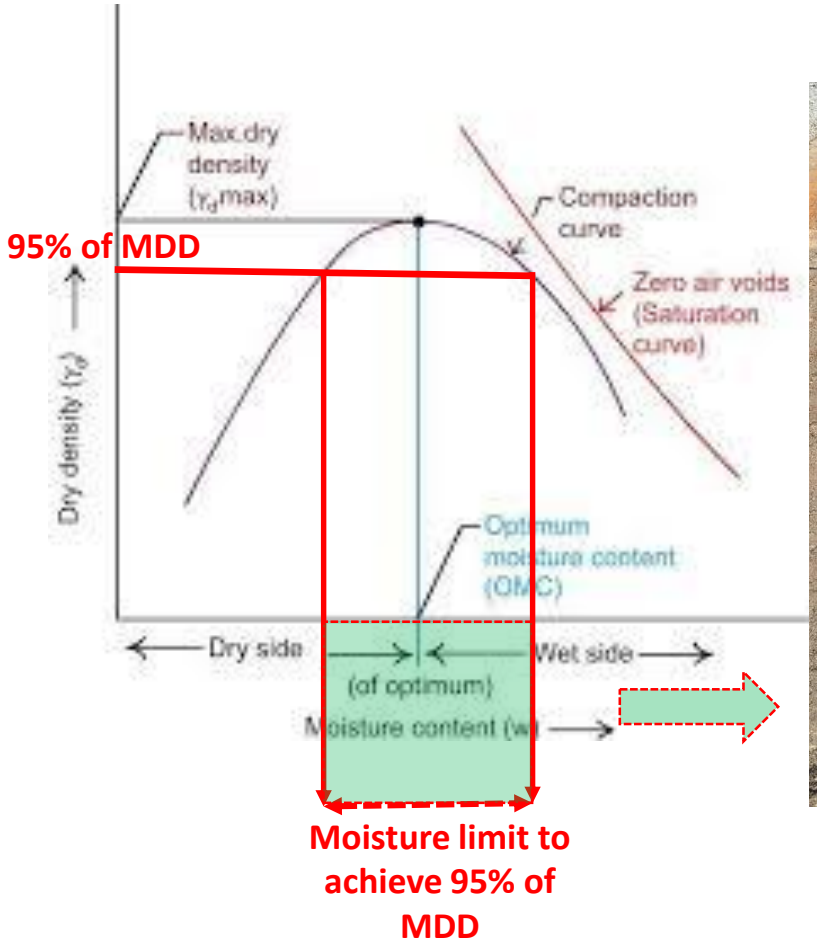
Second trial May 2017 –

Final paved surface for road base material > OMC



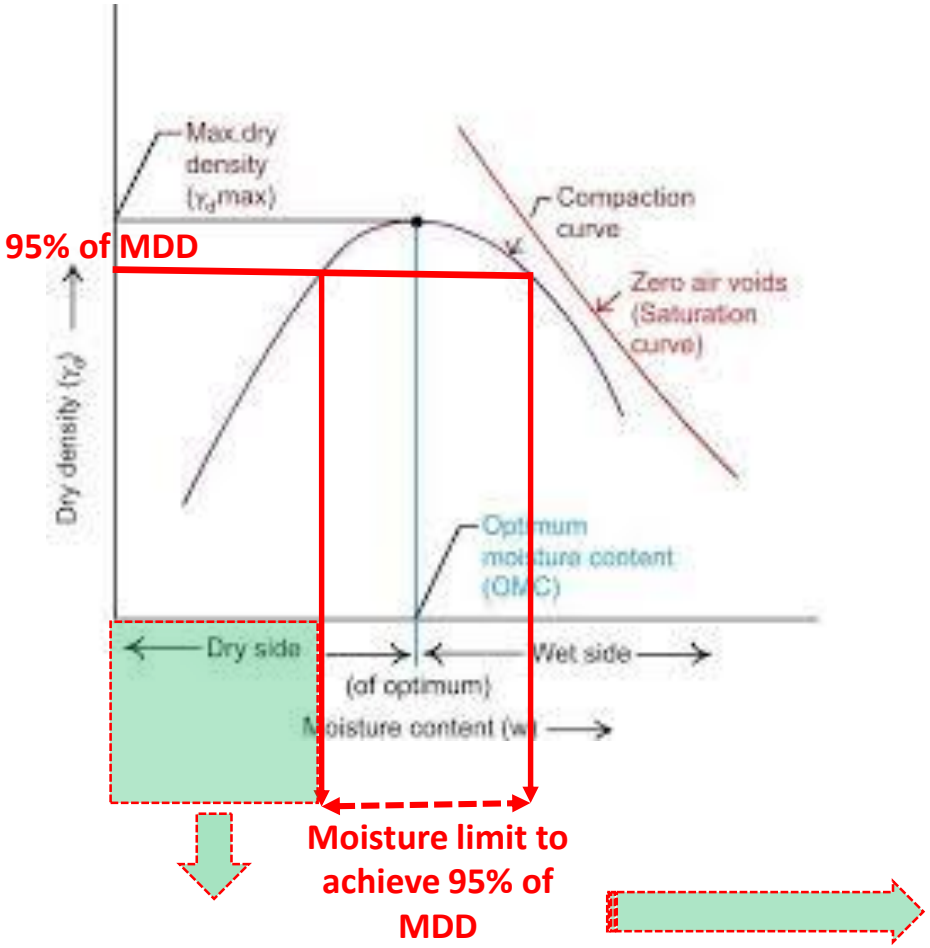
Second trial May 2017 –

Final paved surface for road base material = OMC



Second trial May 2017 –

Final paved surface for road base material < OMC



Second trial May 2017

Calculation for water spraying rate

Microsoft Excel Worksheet

Wirtgen (M) Sdn Bhd *page 1*

Subject : Calculation of water setting for Water Jet Paver, Vogele S 1800-AB600 TP2 Water Jet.
Date of table produced : 4th April 2017

Type of material : Micortonalite 40mm down crusher run comply to Malaysia JKR for road works.
Source of material : CMS Quarry, Gunung Sibanyis.

Section 1 : Input parameters and output data.

In put parameters for material :			In put parameter for water :		
Laying width =	4.00	m	Optimum moisture content (OMC) =	4.60	%
Laying thickness =	0.1750	m	Moisture at existing stockpile	3.00	%
Laying length =	1.00	m	Maximum dry density (MDD) =	2.195	Mg/m3
Laying speed =	5	m/min			
Bulk density =	2.210	Mg/m3			

Out put result for setting paver :					
Quantity of DCR =	7.7	mt/min	Effective moisture to be added =	1.6	%
			Effective moisture to be added =	122.9	litre/min

Note :

DCR	= Down crusher run
	= In put data, variable parameters.
	= Out put data
	= fixed data from lab

Wirtgen (M) Sdn Bhd *page 2*

Subject : Table indicates water tobe added into the laying material.
Date of table produced : 4th April 2017

Type of material : Micortonalite 40mm down crusher run comply to Malaysia JKR for road works.
Source of material : CMS Quarry, Gunung Sibanyis.

Data :
Parameters for the working preparation :

Elaboration :		constant parameter
		variable parameter
		fixed parameter

Data :			
Laying thickness =	0.1750	m	
Laying length =	1.00	m	
Laying width =	variable	m	
Laying speed =	5	m/min	
Bulk density =	2.210	Mg/m3	
Optimum moisture content (OMC) =	4.60	%	
Moisture at existing stockpile	3.00	%	
Maximum dry density (MDD) =	2.195	Mg/m3	

Section 2 : Water to be added based on the above parameters.

In put **VARIABLE** parameter :

In put VARIABLE parameter : Laying width (m)	3	4	5	6
Effective moisture to be added (litre/min) [check flow meter reading]	**92**	**123**	**154**	**184**

Pre implementation stage
(demonstration of the laying of road base by using Vogele Water Jet Paver)

by

CMS Works Sdn Bhd and Wirtgen (M) Sdn Bhd

15th June 2017

☺☺☺

Demonstration on the laying of road base by using a Vogele Water Jet

The location map for the demo site

CMS Pavement Tech Sdn Bhd,
Lot 622, Jalan Tenaga,
Pending Industrial Estate,
Kuching.

Demonstration on the laying of road base by using a Vogele Water Jet paver

Methodology :

The demonstration of laying the road base layer will be conducted by simulating the actual thickness of the Pan Borneo Highway, Sarawak section. The full thickness of the road base layer is 350mm thick and as such the laying will be conducted in two layers at equal thickness i.e. 175mm per layer x 2. The laying width for the demonstration is 3m and it is intended to lay a 25m length.

A 37.5mm nominal size crusher run complied to Pan Borneo Highway specification is used in this demonstration. A compactor / roller will be used to perform the post compaction.

Field density test (FDT) will be carried out before and after the roller compaction to determine the moisture content and level of compaction.

The laying of road base is based on fixed thickness method. Mechanical grade sensor on string line and slope sensor will be used to control the level and elevation.

Demonstration on the laying of road base by using a Vogele Water Jet paver

Objective :

The first layer will be laid in advance and the same process will be repeated during the demonstration day. The objective of the demonstrated are :

1. To exhibit the paving concept are able to meet the specification requirements.
2. To exhibit the efficient water spraying system.
3. To exhibit the effective compaction for the Vogele TP2 screed.
4. To exhibit the Vogele Water Jet paver capable to lay the road base efficiently and effectively.

Demo sequence :

The laying sequence during the demonstration are as follow :

1. To lay a section of road base with water content above, at and below OMC respectively. This is to exhibit the different site condition of the various water content.
2. To lay a section without TP2 compaction from the paver to exhibit the loose road base without pre compaction.

Demo site


Jalan Tenaga
rd Gamers Enterprise
Isuzu
Specasts Industries
United Daily News
Jalan Tekad
Lorong Tekad 1
Syngreen Sdn. Bhd
Jalan Tekad
Jalan Tekad
Jalan Tekad
Jalan Tekad
Ching Weng Enterprise (CWE)
Lorong Tenaga 1
Yee Lee Trading Co
Hap Seng Stars
Mercedes-benz Service Centre Kuching
Hwa Khoon Plastic Industries Sdn Bhd...
Lorong Tenaga 2
Jalan Tenaga
Jalan Tenaga
Westgate Partners
Jalan Tenaga
Jalan Tenun
Avos Stainless Steel Industries
Glomedic EM S

Orientation of demo site

Material

SAMPLE DESCRIPTION: 1½" DCR (37.50mm DCR) - Microtonalite

DATE OF ISSUING REPORT: 20/01/2017

SOURCE: Gunung Sibanyis

SAMPLE REF.: Sample 2

Item	Type of Test		Test Method	Results
1	Sieve Test on Aggregates		*MS 30 : Part 4 : Section 1 : 1995 / BS 812 : Part 103.1 : 1985*	Please refer data & Graph
2	Flakiness Index		*MS 30 : Part 5 : Section 1 : 1995 / BS 812 : Part 105.1 : 1989*	23%
3	Elongation Index		*MS 30 : Part 5 : Section 2 : 1995 / BS 812 : Part 105.2 : 1990*	22%
4	Aggregate Crushing Value		*MS 30 : Part 8 : 1995 / BS 812 : Part 110 : 1990*	19%
5	* Particle Density	Particle Density on Oven-Dried Basic	*BS 812 : Part 2 : 1995*	2.591 Mg/m^3
		Particle Density on SSD Basis		2.628 Mg/m^3
		Apparent Particle Density		2.689 Mg/m^3
	* Water Absorption			1.408%
6	Dry Density - Moisture Content Relationship (Vibrating Hammer)	Maximum Dry Density	*MS 1056 : Part 4 : 2005 : Clause 4.7 / BS 1377 : Part 4 : 1990 : Clause 3.7*	2.195 Mg/m^3
		Optimum Moisture Content		4.60%
7	* Soundness of Coarse Aggregate by use of Sodium Sulfate		*ASTM C 88-05*	1%

Remarks:

1) (*) Not SAMM Accredited

Approved Signatory:

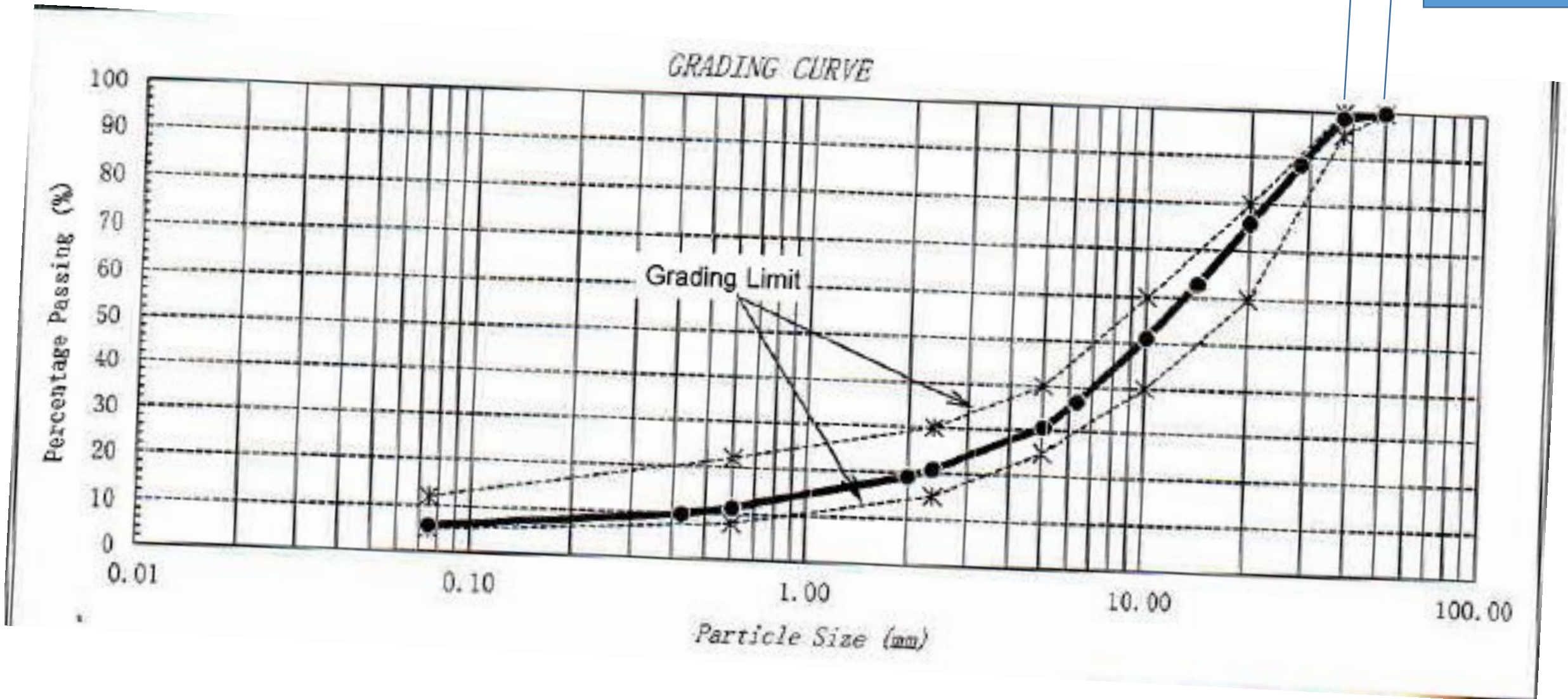
WATIMA TESTING SDN. BHD.

(Company No. 724941-T)

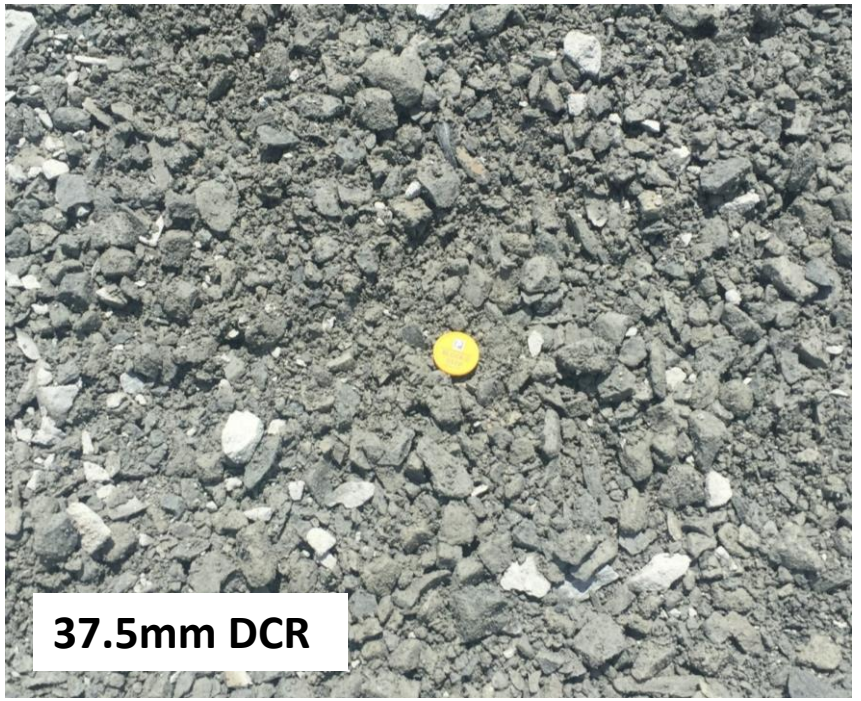
Name: Phang Tze Shing

Designation: Managing Director

Material


37.5mm
50mm
GRADING CURVE
Grading Limit
Percentage Passing (%)
100
90
80
70
60
50
40
30
20
10
0
0.01
0.10
1.00
10.00
100.00
Particle Size (mm)

Material 37.5mm DCR



Scale in CM

Machine

Conventional water tanker :

To supply sufficient water for the laying of road base layer.

HAMM compactor :

With static and vibratory functions.

Minimum 10mt static load.

Vogele paver Super 1800-3 AB 600 TP2 :

With water jet system.

Tamping and vibratory compaction functions.

Under carriage track type.

Pre demonstration – 3rd trial at Kuching

A pre demonstration was conducted on 15th June using the Water Jet to lay first layer of road-base.

Objective of the trial is to further testing and evaluating the capability of the Water Jet in complying to the specification requirement. The trial parameters are :

a)	Laying width	: 4m.
b)	Laying thickness	: 175mm compacted.
c)	Laying length	: 25m.
d)	Material	: 37.5mm nominal size DCR (Microtonalite).
e)	Material parameter	: OMC = 4.6%; MDD = 2.195 Mg/cum
f)	Laying configuration	: Laying at stockpile moisture content.
g)	Level control	: Mechanical grade sensor on string line and slope sensor.

Conditions

Material :

- Microtonalite from Gunung Sibanyis Quarry is used.
- 40mt of 37.5mm DCR was delivered to the trial site on 14th June 2017. It was raining in the evening of 14th June 2017.
- The DCR was stockpile before it was laid on 15th June.
- During laying the moisture content of DCR was 7.5%.
- No stockpile segregation was observed.

Test :

- Moisture content of the DCR at stockpile was tested before laying take place.
- FDT tests were carried out to determine the field density for pre compaction before roller is used.
- Dipping to verify the profile of paved road-base layer was also carried out.

Progress of the pre demo trial

Results

Summary

The Water Jet Paver is capable to meet the four technical criteria as specified in the JKR standard of road works. It was proven that the Water Jet Paver is able to pave the required dimension and the final finish level at a shorter time. It is also proven that the spraying of water can be control to the range as needed. The TP2 screed and the sonic sensor are also capable to produce an improved pre compaction and prevent segregation respectively. With the above success elements, the concept of laying road-base layers by using a Vogele Water Jet Paver is able to provides additional values such as improved construction quality, improved laying efficiency and reduce wastage of material. By using this concept, it gives a good quality of road to the client and help the contractor to improve the working efficiency.












VÖGELE

WATERJET

LEBUHRAYA BORNEO UTARA

Implementation
(First commercial laying of road base layer using Vogele Water Jet Paver)

at

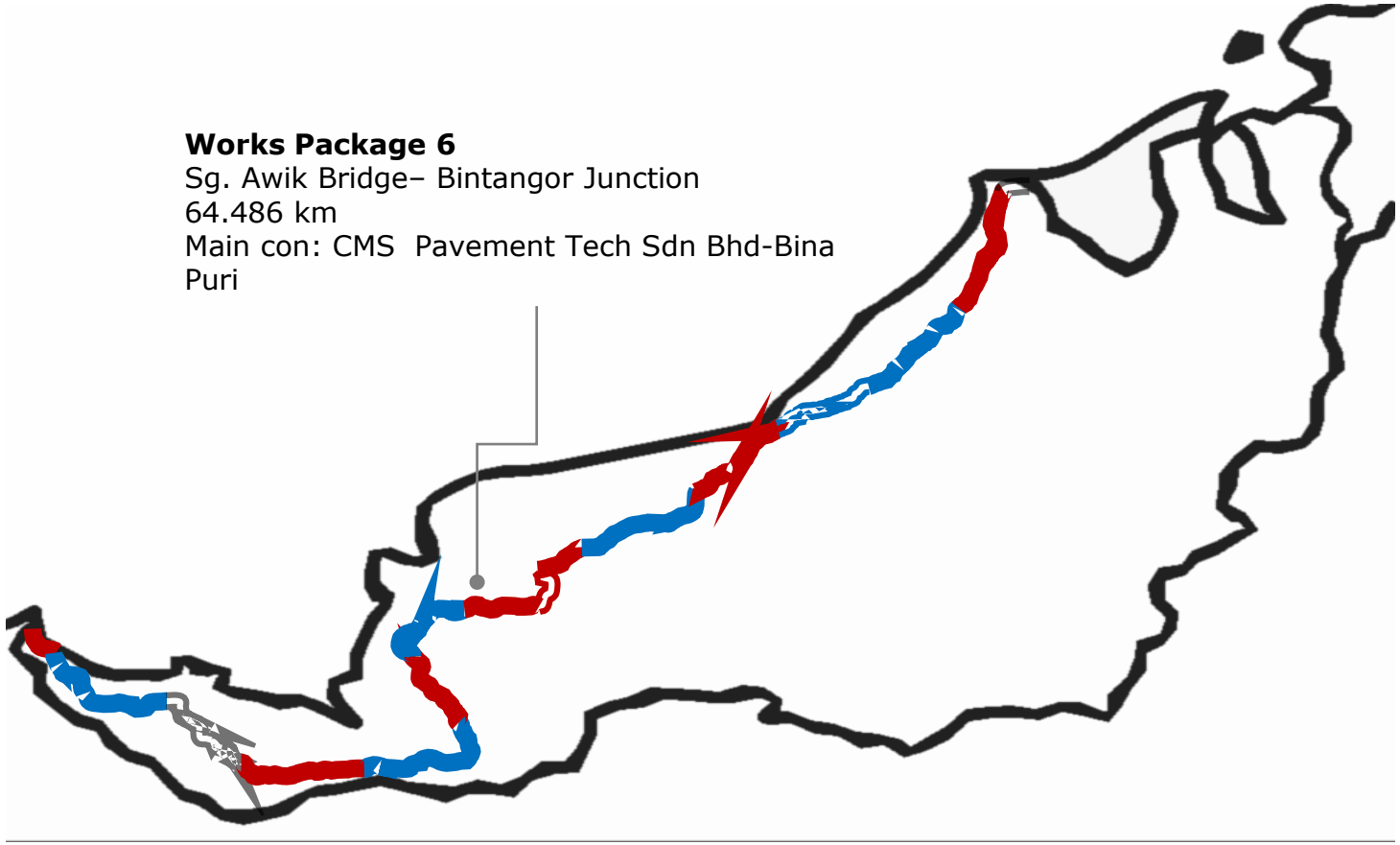
Pan Borneo Highway, Sarawak

2017

CAHYA MATA SARAWAK

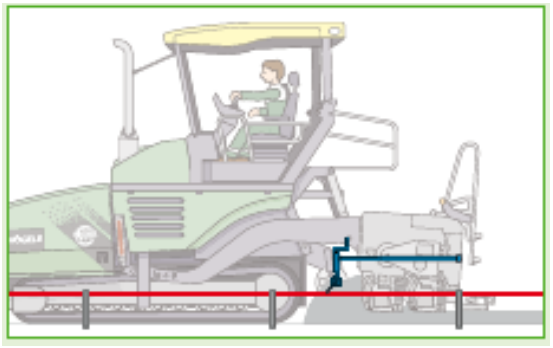
Implementation:

The very first project site to implement the laying of road base layer by using Paver with Water Jet system.



Method statement for the laying of roadbase

Microsoft Word Document



Step 1:
Planning for the work, i.e. :

- Handling over.
- Supply.
- Dimension.
- Slope.
- Measurement for compliance.
- Time needed to complete.
- Etc…..

Step 2:
Commitment in executing the works :

- Material supply.
- Equipment and resources.
- Working processes and methodology.
- QC/QA program.
- Compliance to drawing and specification i.e. compaction and profile.

Step 3:
Certification to start works:

- Trial lay to exhibit and justify the recommendation.
- Trail lay to establish parameters.
- Proposal approved and certified to start work.

Thank you
for your attention

WIRTGEN GROUP

Close to our
customers