SALIENT ASPECTS IN BITUMINOUS ROAD CONSTRUCTION

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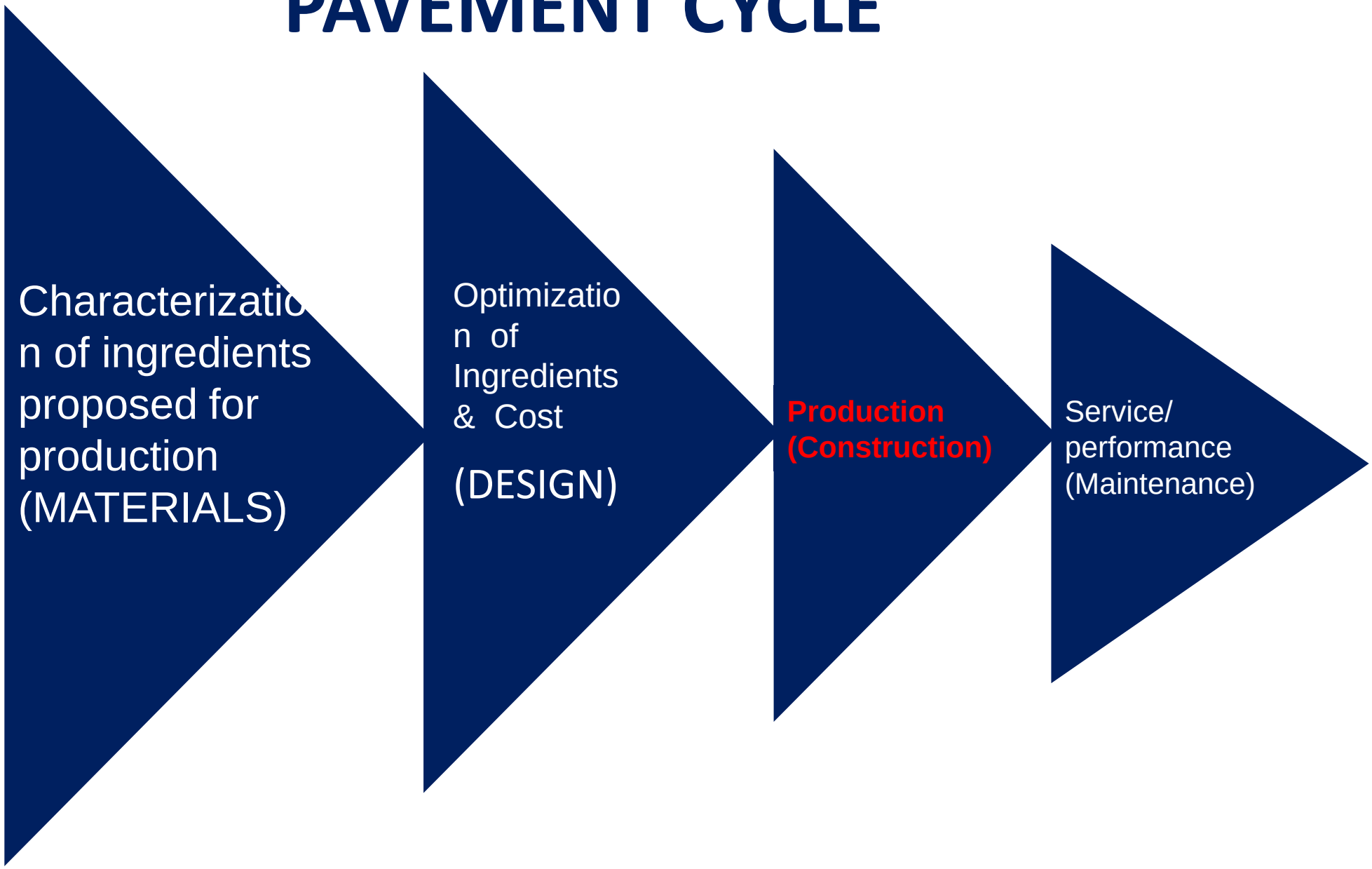
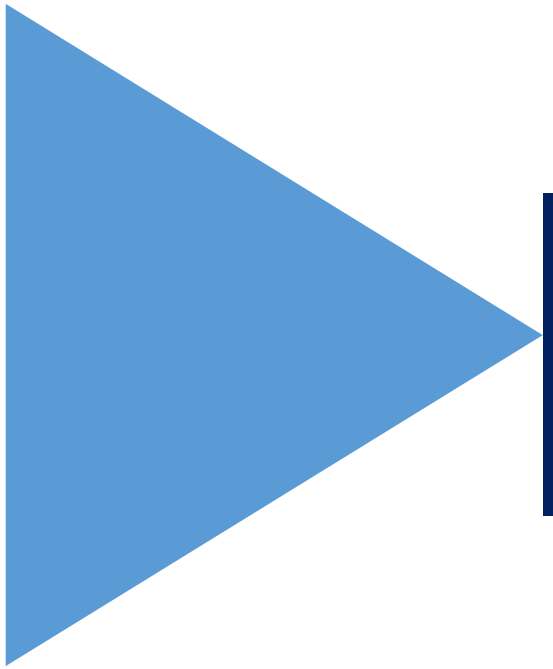
PAVEMENT CYCLE



Road CONSTRUCTION Set Up



Temporary Structure
Mobilized for Short duration and
Ceased to exist once mission is over

ROAD Construction ENVIRONMENT

01 Places of works are spread out

02 Investments involved are large and decisions may involve risks

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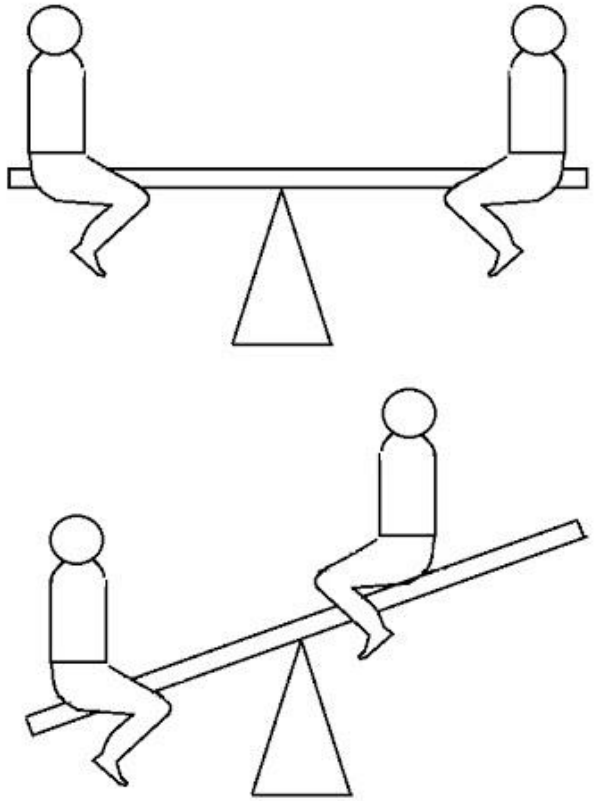
03 Engineering failures due to ill defined scope of work , inadequate field investigations

Balancing Production in ROUGH situations

- Materials
- Hot mix plant
- Transportation
- Paving
- Compaction

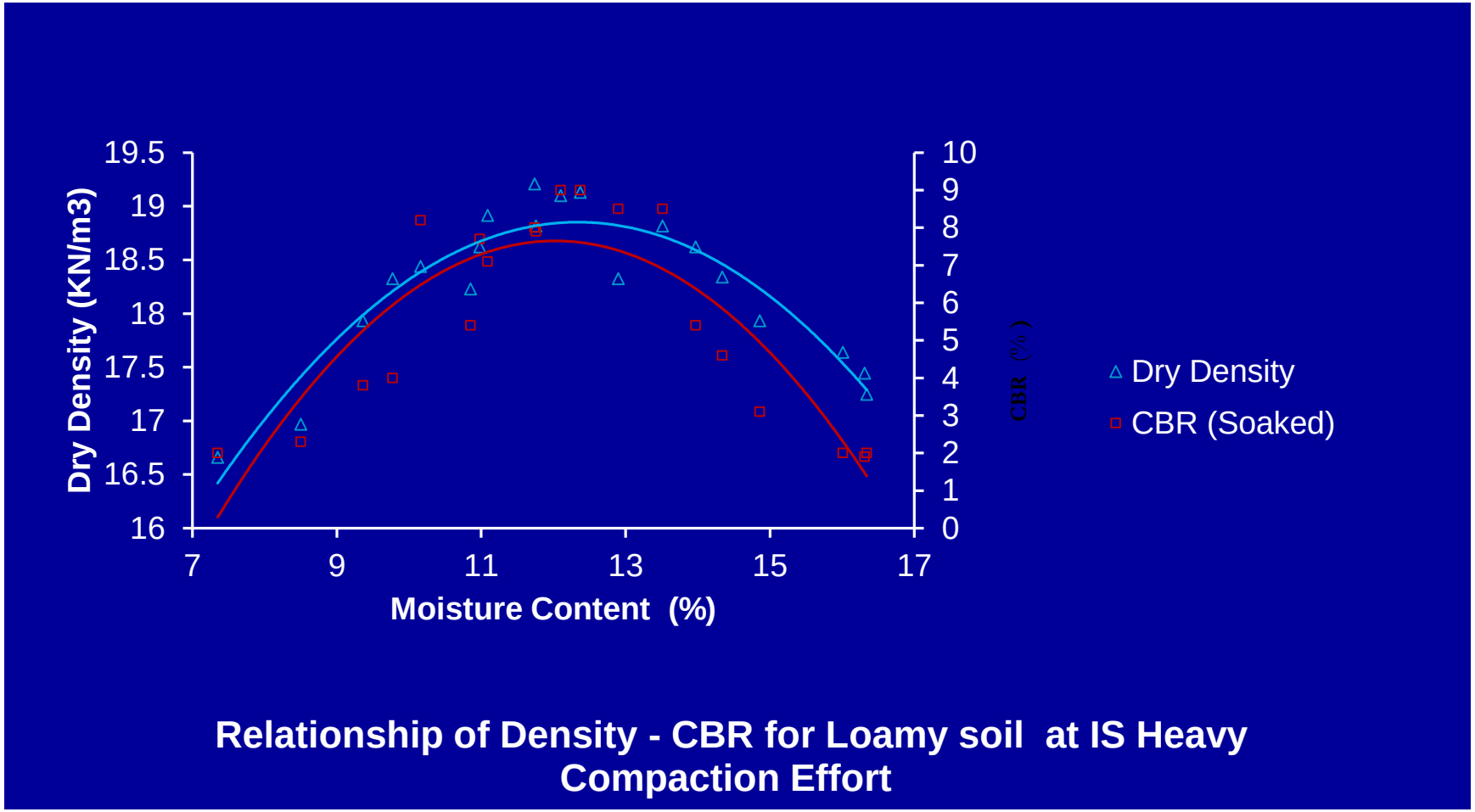


PAVEMENT LAYERS

CONSTRUCTION OF EMBANKMENT / SUBGRADE

Density requirements of the embankment and subgrade materials (As per MoRTH Table 300-1)

Type of work	Maximum laboratory dry unit weight tested as per IS 2720 – part 8
Embankments up to 3 m height, not subjected to extensive flooding	Not less than 15.2 kN/cu.m
Embankments exceeding 3 m height or embankments of any height subjected to long periods of inundation	Not less than 16 kN/cu.m
Subgrades/earthen shoulders/verges / backfills	Not less than 17.5 kN/cu.m



For same soil, using same compacting equipment higher density can be achieved , hence higher CBR

SOIL LAYERS

01 Uniform thickness, Density

02 Maximum compacted thickness 250 mm,

03 Lower side of OMC needs more compaction effort

,

SOIL LAYERS

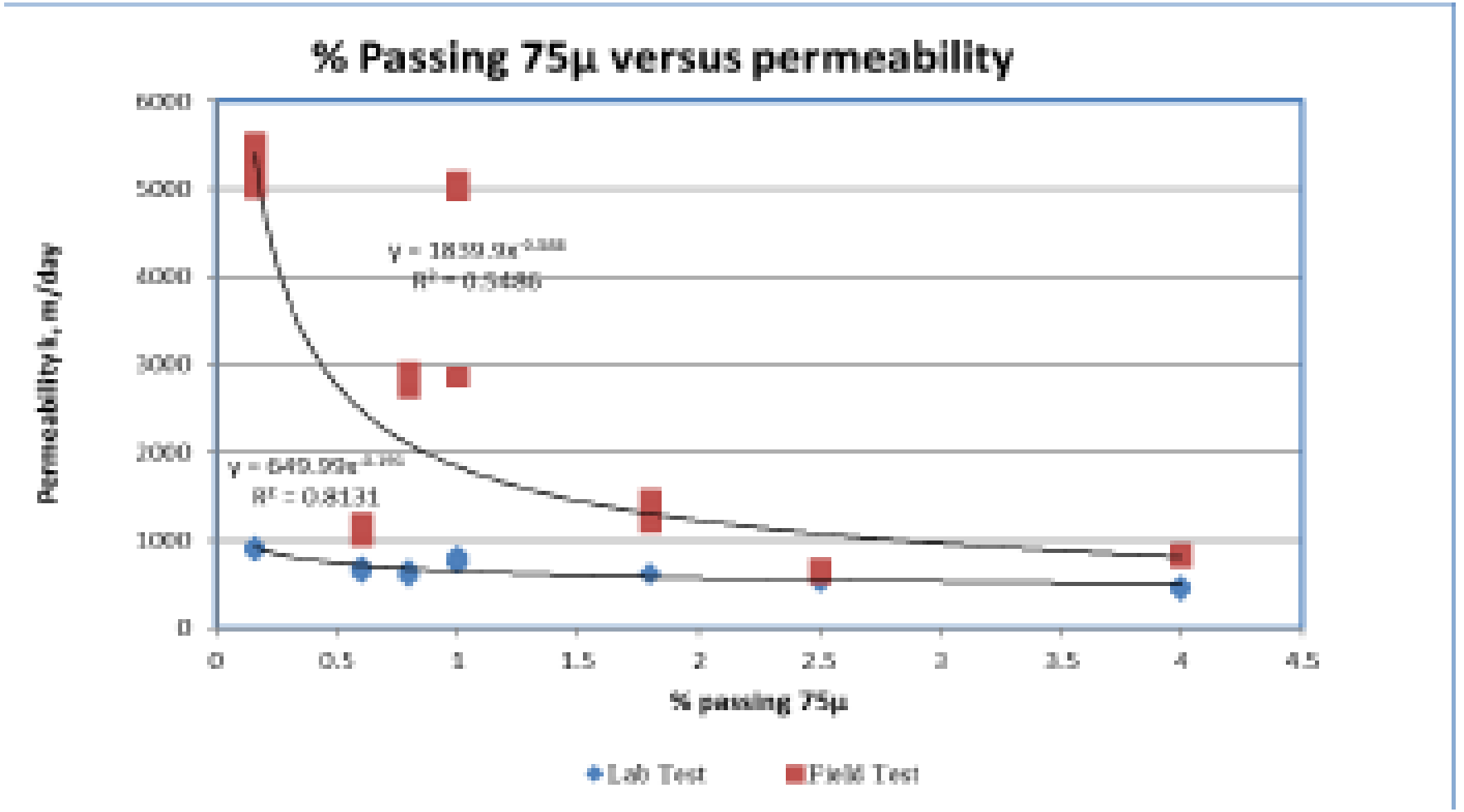
04 **Water consumption > 1 lakh litres** / kilometre / lane

05 **Most precious construction material – WATER**

PERMEABILITY - Granular Sub Base Layers

Grades	i =0.025	0.035	0.04
	$K_{20,}$ m/day		
Grade I	668	720	718
Grade II	839	893	880
Grade III	5018	5001	4980
Grade III+V	4760	4718	4650
Grade III+VI	3812	3747	3652
Grade IV	2840	2522	2485
Grade IV+V	3563	3582	3415
Grade IV+VI	2882	2880	2793
Grade V	1104	1250	1212
Grade VI	1323	1401	1385

Source : G Kavitha @el , RASTA



Source : G Kavitha @el , RASTA

GRANULAR LAYERS

1

Strength by Aggregate Interlocking

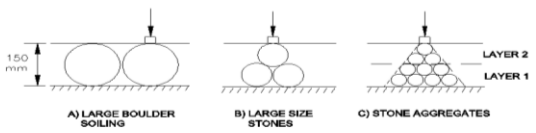


FIG. 1 PRESSURE DISTRIBUTION THROUGH TYPICAL GRANULAR MATERIALS

2

Lateral confinement important

3

Exposure of e Layer without bituminou s layers for longer duration

4

Compactin g already compacted layer

5

Control of segrega tion

BITUMINOUS LAYERS

1 Overheating

wastage of water, power, and disinfectants used in treating water to prevent contamination

Heating for longer duration 2

through the reduction of pumping and treatment costs of the precious resource

3 Improper gradation

by limiting the possibility of crossed connections or infiltration of sewage

Exposure of DBM for heavy axles and rains for longer durations 4

when leakage volumes are recovered through the sewerage system

5 Stop and Go Paving

High VPM & Compaction at low temperature compaction 6

Grading	DBM – Grade I	DBM – Grade 2	BC – Grade 1	BC – Grade 2
Nominal Size (mm)	40	25	19	13
Layer Thickness (mm)	80-100 mm	50-75 mm	50-65	30-45
Sieve Size (mm)	% Passing			
45	100	-		
37.5	95-100	100		
26.5	63-93	90-100	100	
19	-	71-95	79-100	100
13.2	55-75	56-80	59-79	79-100
9.5	-	-	52-72	70-88
4.75	38-54	38-54	35-55	53-71
2.36	28-42	28-42	28-44	42-58
1.18	-	-	20-34	34-48
0.6	-	-	15-27	26-38
0.3	7-21	7-21	10-20	18-28
0.15	-	-	5-13	12-20
0.075	2-8	2-8	2-8	4-10
Bitumen content (%)	Min.4	Min 4.5	5.0-6.0	5.0-7.0
Grade of Bitumen	65-90	65-90	65	65

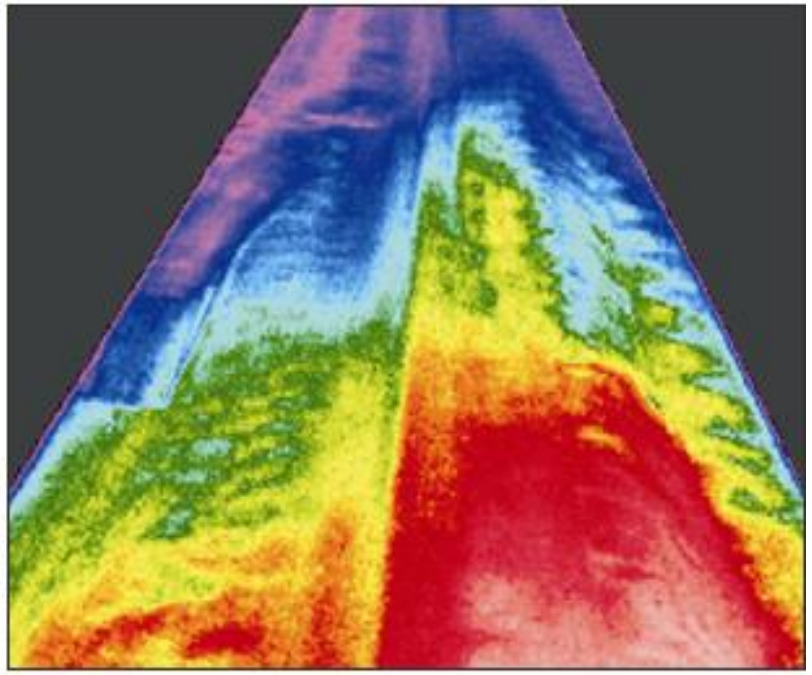
Permissible Variations by Job Mix Formula

Description	Permissible Variation	
	Base / Binder course	Wearing Course
Passing 19 mm / larger	+/- 8 %	+/ - 7%
Passing 13.2 mm, 9.5 mm	+/ - 7%	+/ - 6%
Passing 4.75%	+/- 6%	+/- 5%
Passing 2.36,1.18 & 0.6 mm	+/-5 %	+/- 4%
Passing 0.3 mm & 0.15 mm	+/- 4%	+/- 3%
Passing 0.075 mm	+/- 2%	+/- 1.5%
Binder content %	0.3%	0.3%
Mixing temperature	+/- 10 Deg	+/- 10 Deg

Segregation

Mechanical Segregation

When large stones separate
From smaller stones and fines



Temperature Segregation

When there is a temperature
differential behind the screed

Segregation at Plant

- Hang –up of feeder bins (moisture)
- Inadequate mixing time in pug mill
- Lack of replacement of broken/ twisted/ ineffective paddles
- Level of material in pug mil
- Mix in motion (free fall to hopper / truck)

- **Segregation in Transport**
  - During movement coarser materials roll down
  - Small batch in large truck
  - During discharging in to paver hopper if rear gate does not open fully . Partial openings prevent smooth flow, cause hang up
  - Segregation on both sides of truck & material being dropped in paver in same condition

Segregation in Transport

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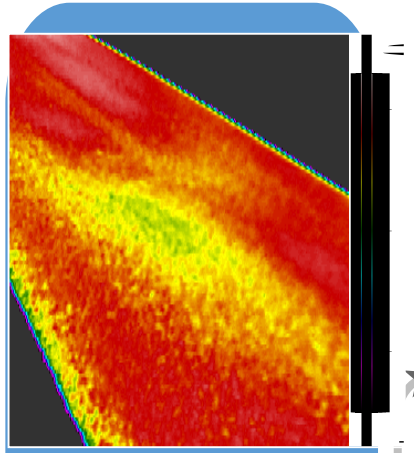


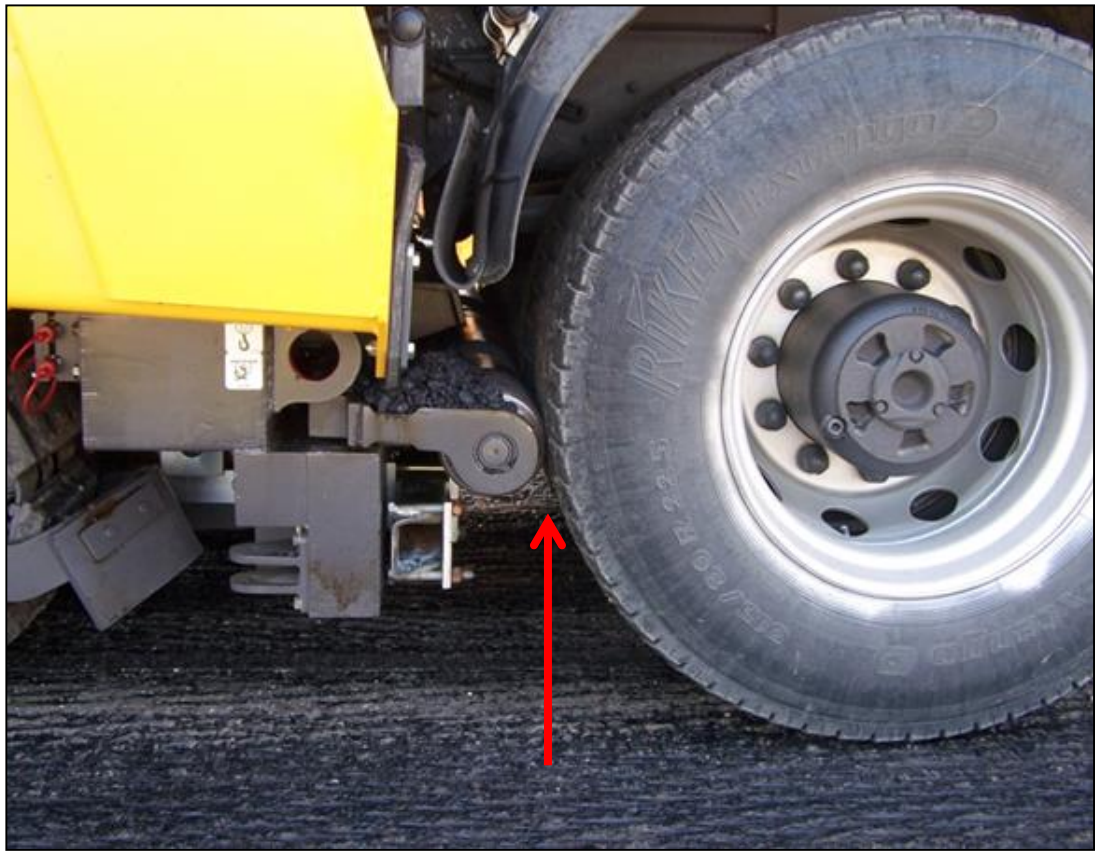
Segregation in truck

Segregation in Paver Finisher

- Insufficient material in hopper
- Material above the level of auger
- Coarser mixes / lean mixes are more prone to segregation

Courtesy: Volvo

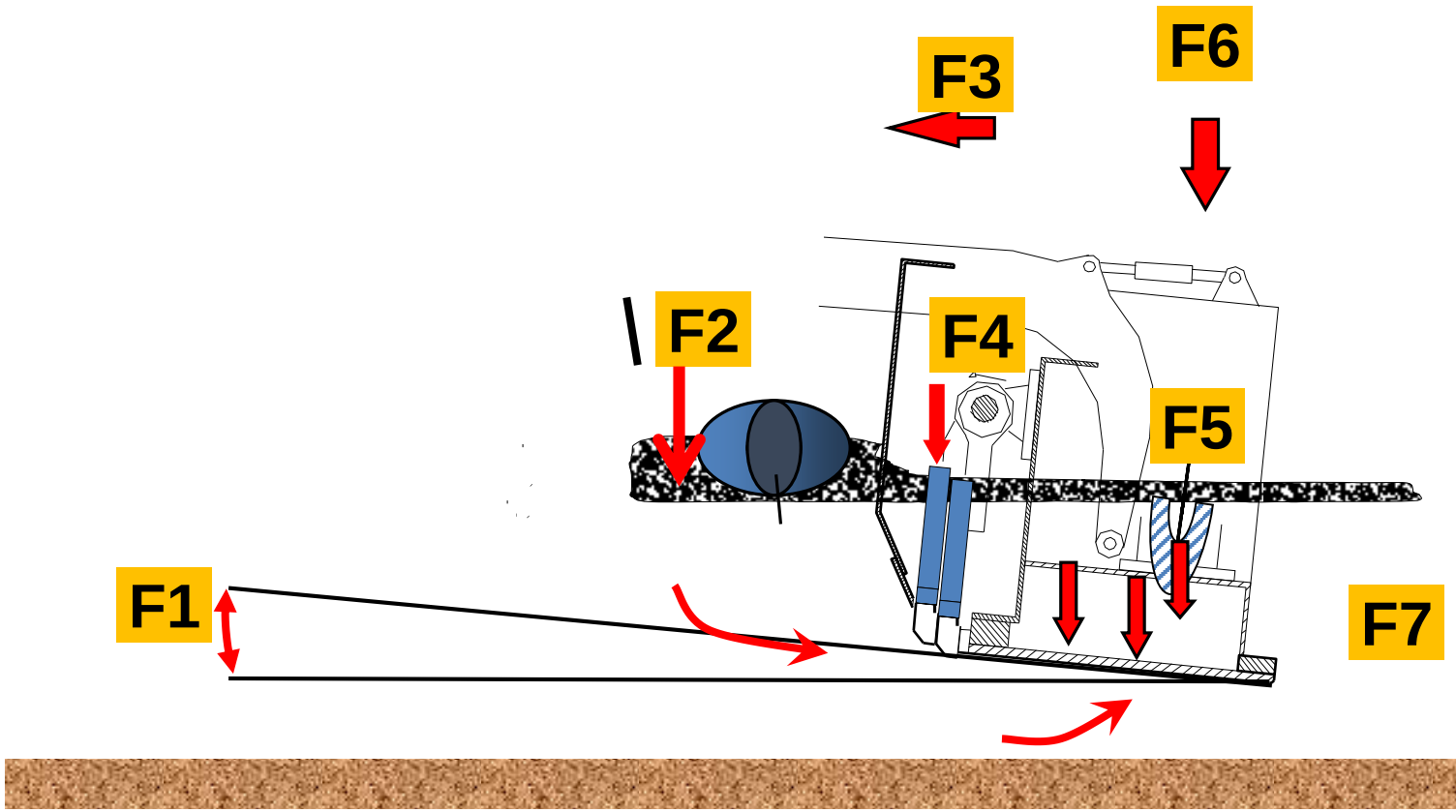
Truck to Paver Echange



Stop the truck short of the paver & let the paver make contact with the truck. Never allow the truck to back into the paver!

Courtesy: Volvo

Screed Performance



F1 Angle of attack

F2 Head of material

F3 Paving speed

F4 Tamper bar

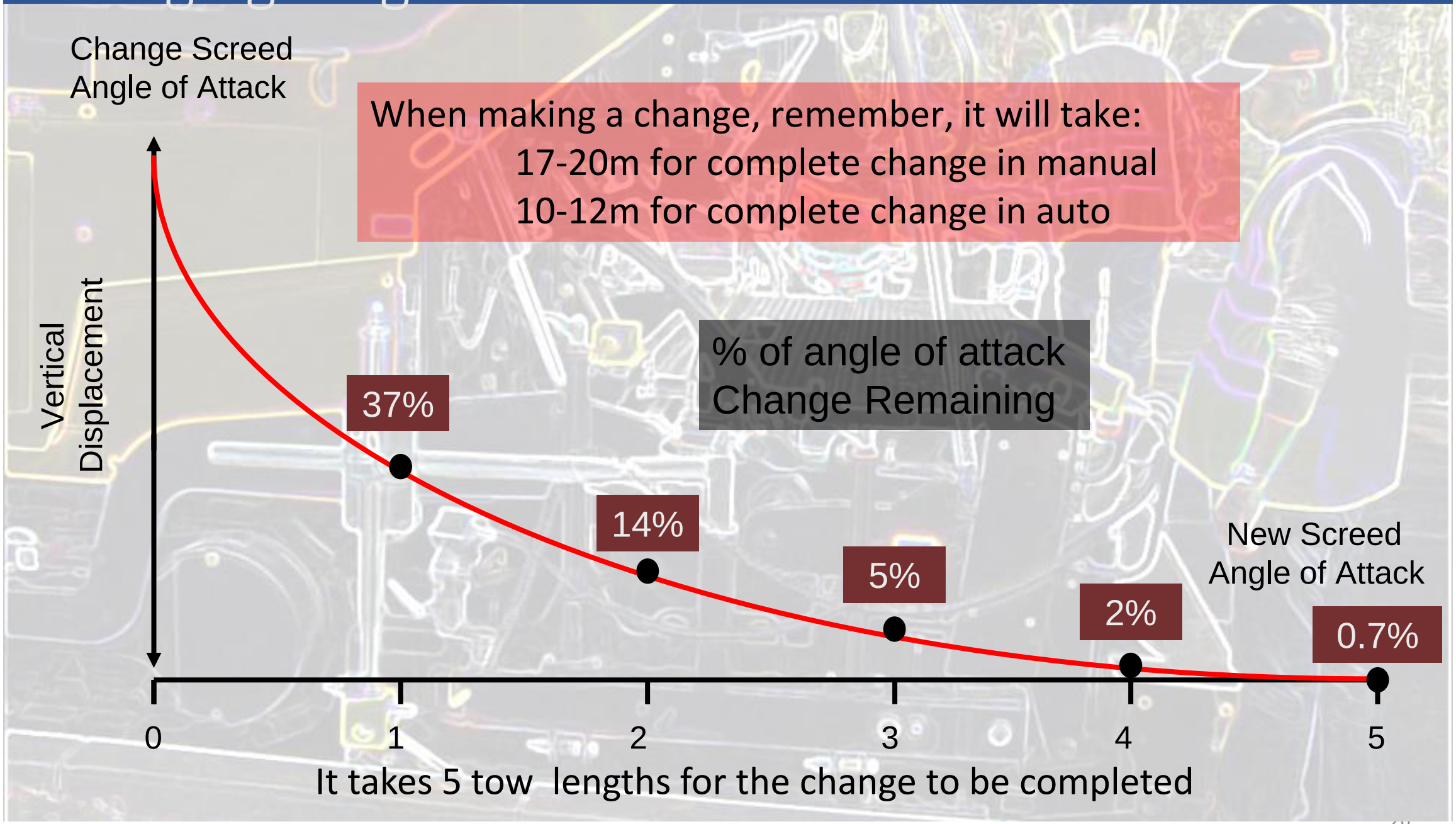
F5 Vibration

F6 Screed weight

F7 Material stability

Courtesy: Volvo

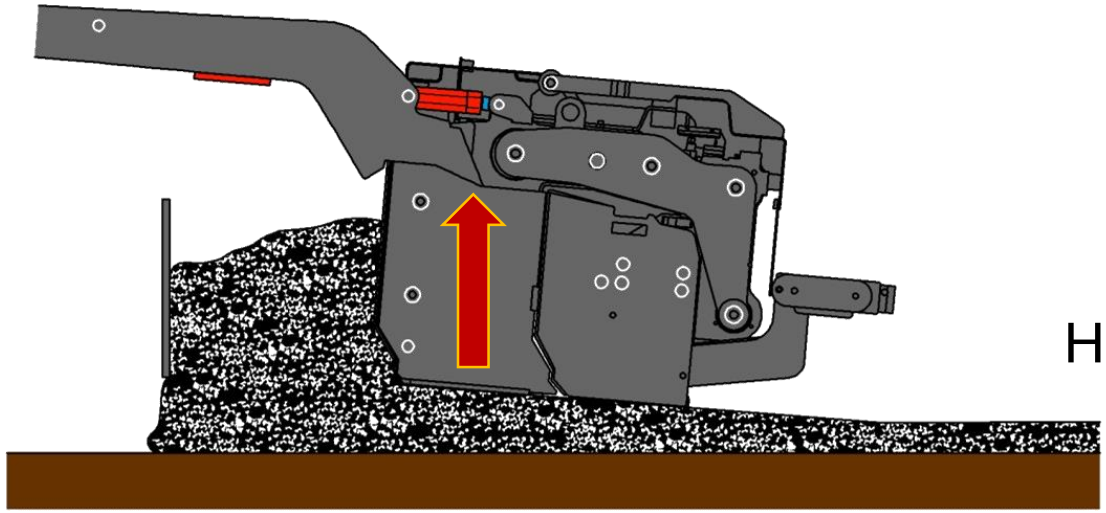
Changing Angle of Attack



Courtesy: Volvo

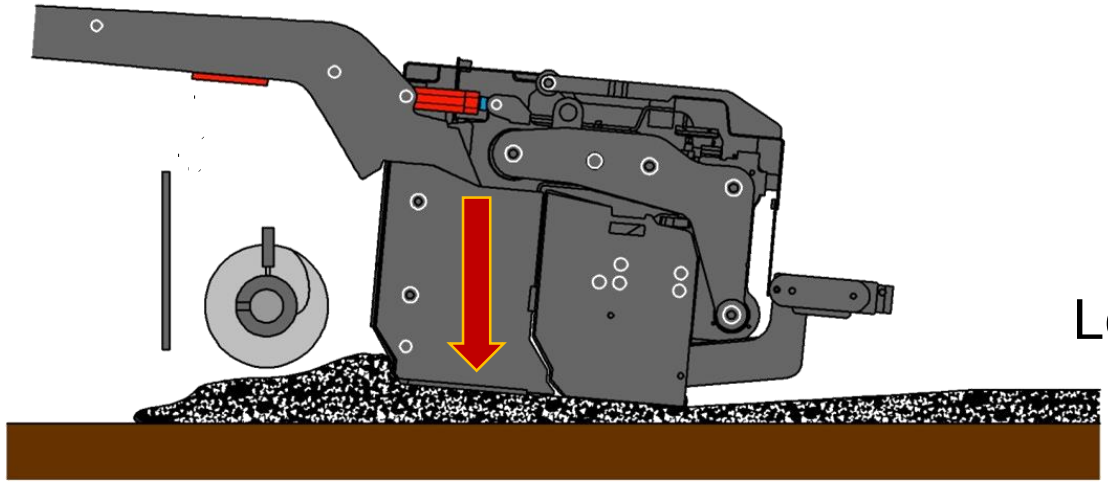
Screed Factor #2- Head of Material

Head of material volume too high



Screed rises
Higher load on screed

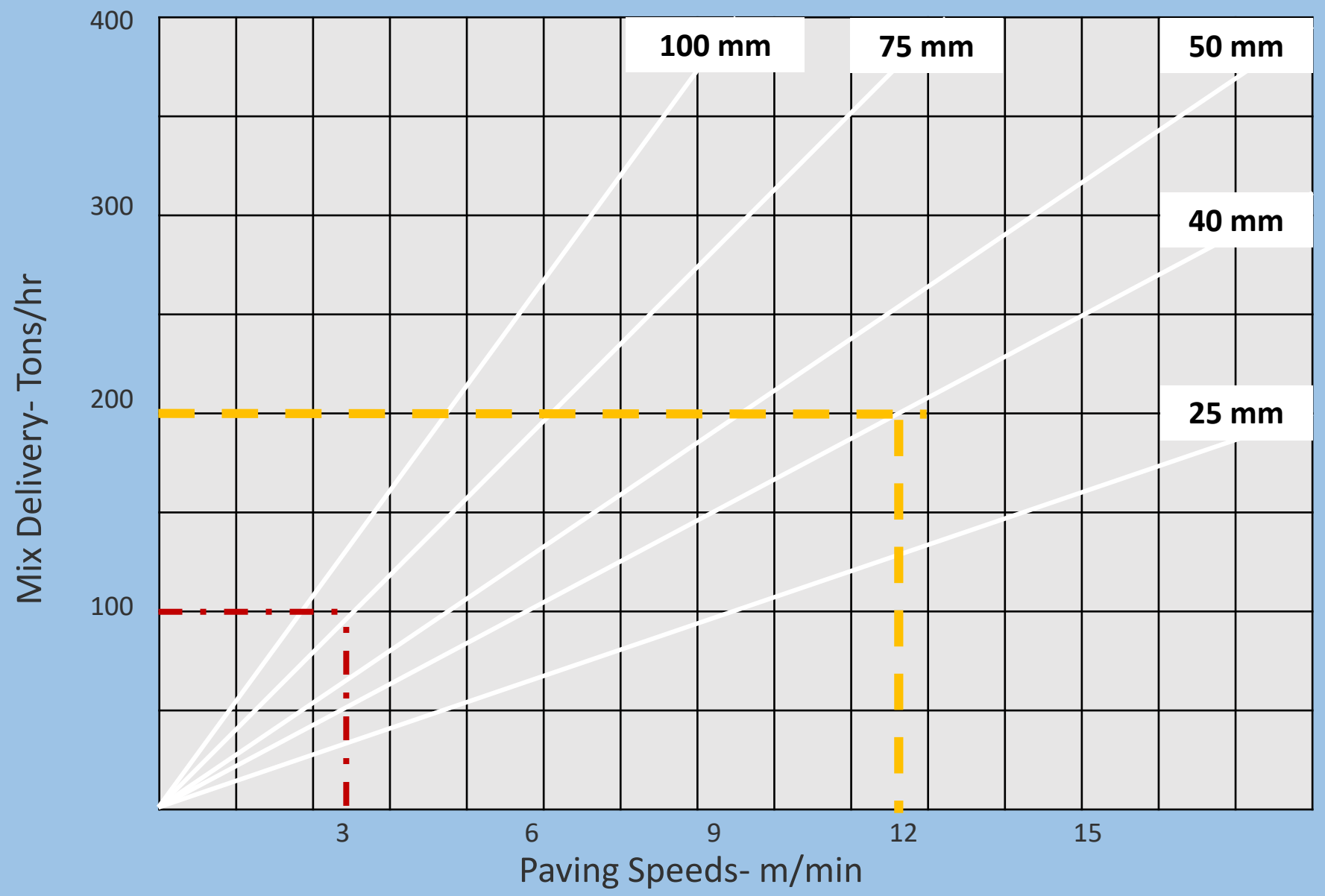
Head of material volume too low



Screed Settles
Lower load on screed

Courtesy: Volvo


S L P



Paving Details

3.7m wide

2400kg/m3

Courtesy: Volvo

COMPACTION

- Improve Stability
- Improve Resistance to Permanent Deformation
- Improve Fatigue Resistance
- Reduce Low-Temperature Cracking Potential
- Reduce Moisture Penetration

TYPES OF ROLLERS

- Static Steel Wheel
- Kneading
- Vibratory
- Impact Rollers

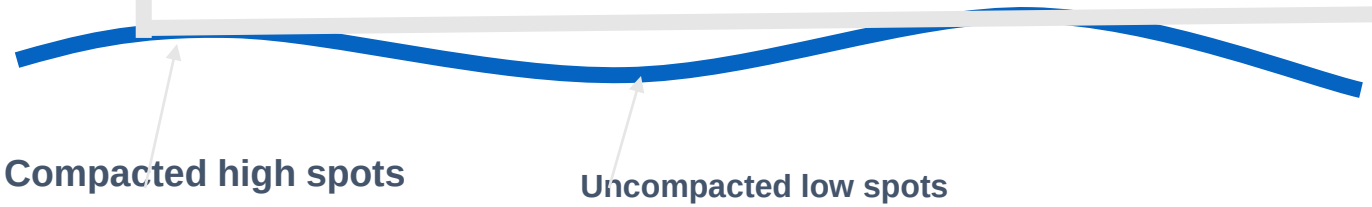
- SOIL COMPACTORS - one Steel drum
- ASPHALT COMPACTORS – Steel drum both front and back
- PNEUMATIC TYRED COMPACTORS

Courtesy: Volvo

PNEUMATIC TIRED ROLLERS

- Wheel load
- Inflation pressure
- Contact area

Drum -Vibratory roller



Courtesy: Volvo

LIGHT COMPACTING EQUIPMENT

Operating weight: 200 - 240 Kgs
Centrifugal force: 750 - 845 Kgs
Frequency: 4000 - 4450 vpm
Travel speed: 0 - 2.4 Kmph

Operating weight:475 - 590 Kgs
Centrifugal force: 1100 - 1200 Kgs
Frequency: 3000 - 3300 vpm
Travel speed: 0 - 3.5 Kmph

Constraint areas

Backfills

Maintenance / Pothole Patching

CONSTRUCTION OF JOINTS

- **Transverse joint**
  - Preferably Vertical Joint
  - Staggering of joints at least by 2 meters
  - Spraying of bitumen on face
  - Heating of Screed
- **Longitudinal Joint**
  - Not be located on same line
  - At 150 mm offset
  - Vertical face
  - Overlap of 25 to 50 mm with previously laid surface

ROLLING SEQUENCE

- Transverse Joint
- Longitudinal Joint
  - Overlap of 150-175 mm
- Lower to Higher edge

ROLLING OPERATION

- Break down rolling
- Intermediate Rolling
- Finish Rolling

BREAKDOWN ROLLING

- Use smooth wheel rollers/ Static passes
- **Breakdown rolling must achieve majority of required compaction**
- An ineffective first pass may make final pass difficult to achieve
- There should not be any horizontal movement of mix

- When movement of mix is observed allow the mix to cool (break down temperature)
- **Compaction helps in retaining the heat**
- Rolling zone at 50 m

INTERMEDIATE ROLLING

- After breakdown rolling when mix still in plastic state

  Pneumatic rollers more suitable
- Pneumatic rollers may not increase the density substantially
- It does increase the stability of mix by kneading and reorientation of particles
- Sealing of layer (tire pressure 0.7 to 0.9 MPa)

FINISH ROLLING

- Carried out while material still in warm condition
- For removal of tire marks

PRECAUTIONS FOR ROLLING

- Uniform speed
- Never allow compactor to stand
- Jerky start , sudden braking, sharp changes not to be made
- Change of lane to made only on already compacted surface
- Steel wheels / pneumatic wheels cause loss of heat
- Small amount of detergent / Vegetable oil
- Performance Chart of the equipments for our construction conditions


VOLVO
75%
VOLVO
VOLVO
93-97%

HIGH EMBANKMENT

PAVEMENT LAYERS


BITUMINOUS BINDER & SURFACE COURSE

1. About 10 lakh cum aggregates for every 100 km four laning

2. 2000 cum /lane/km – New construction

3. 175 cum /km/lane for every 5 years Overlay

4. 2 crore cum for every five years for road network

5. 20 lakh cum of soil for every 100 km new construction

AGGREGATE CRUSHING PLANT

HOT MIXING PLANT

FUEL CONSUMPTION – PLANTS & EQUIPMENTS

Sl No			Diesel Consumption	
			Non Idle	Idle
1	Crusher 320TPH	500KVA DG	68.3 lt/hr	30.23 lt/hr
2		500KVA DG	68.3 lt/hr	30.23 lt/hr
3	Crusher 100TPH	500KVA DG	52.4 lt/hr	20 lt/hr
4	WMM PM 200TPH	160KVA DG	13.28 lt/hr	8 lt/hr
5	HMP 320TPH	725KVA DG	85 lt/hr	20 lt/hr
6		180KVA DG	14.2 lt/hr	8 lt/hr
7	Loader		9.72 lt/hr	6 lt/hr
8	Excavator		18.2 lt/hr	12 lt/hr
9	Dozers		18.6 lt/hr	5.5 lt/hr
10	TATA 10 Tyre Tipper		2.2 kmpl	3 lt/hr
	TATA 6 Tyre Tipper		2.7 kmpl	4 lt/hr
11	MAN 10 Tyre Tipper		2.22 kmpl	5 lt/hr
12	MAN 12 Tyre Tipper		2.08 kmpl	6 lt/hr
13	Bitumen Sprayer Tank		2.0 kmpl	7 lt/hr
14	CAT Grader 120H		12.72 lt/hr	7 lt/hr
15	Paver IR		14.2 lt/hr	10 lt/hr
16	Super Paver		18.5 lt/hr	12 lt/hr
17	IR-12T Roller		8.78 lt/hr	3.2 lt/hr
18	DD-90 Roller		8.78 lt/hr	4 lt/hr
19	RTR		8.2 lt/hr	4 lt/hr
20	KC Machine		9.2 lt/hr	6 lt/hr
21	Sigma Genset		2.5 lt/hr	0 lt/hr
22	BT Tank		19.2 lt/hr	15 lt/hr
23	Water Tanker		2.08 kmpl	3 lt/hr
24	Broomer/tractor		4 kmpl	2 lt/hr
25	Air Compressor		5.5 lt/hr	2 lt/hr

DIESEL CONSUMPTION FOR KM/LANE

Activity	Diesel Consumption (Litres)			Main Burner	Baby Burner	Total HSD (Litres)
	Non Idle	Idle	Total	FO (Litres)	HSD (Litres)	
Subgrade*	1805	402	2207			
GSB	1842	149	1991			
WMM	2579	194	2773			
DBM	2162	187	2349	8504.69	755.31	
BC*	379	36	415	2799.96	296.00	
TOTAL	**8769**	**969**	**9738**	**11304.64**	**1051.31**	**10790.72**

CHALLENGES

Good materials: Sources depleting

High transportation costs

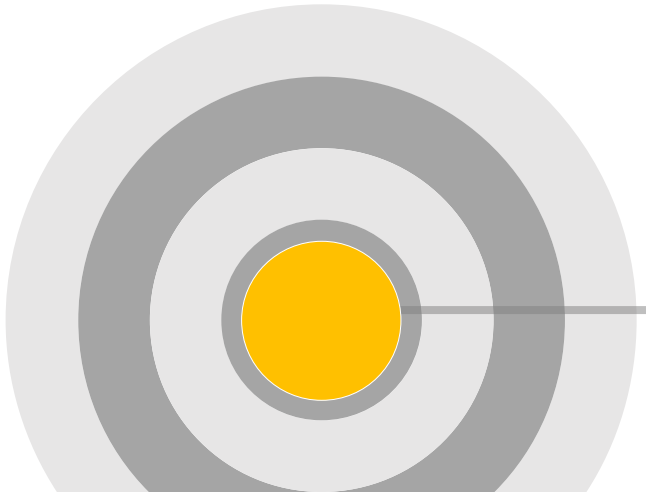
Strict regulations for use of natural materials

Erosion, sedimentation, new stream/course, creation of new ditches & Ponds

NEW TECHNOLOGIES/ SUSTAINABLE TECHNOLOGIES !!!???

LABOUR IS COOK

Best → materials, Design, Expertise, Equipment handled and executed by these resources



Attract and retention of labours in the industry

Need to Train Labours

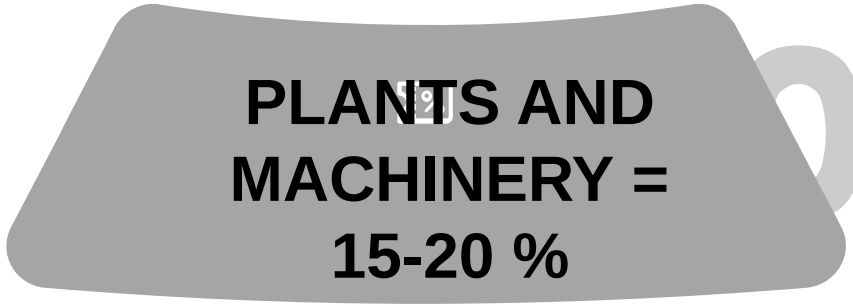
Welfare

Table 1 Workers engaged in Construction Sector

S. No.	Category	1995		2005		2011		2015		Remarks
		Number	Share (%)	Number	Share (%)	Number	Share (%)	Number	Share (%)	
1.	Qualified Engineers	6,87,000	**4.70**	8,22,000	**2.65**	10,50,000	**2.56**	11,48,000	**2.47**	**Significant Drop**
2.	Technicians & Foremen	3,59,000	**2.46**	5,73,000	**1.85**	11,25,000	**2.74**	14,77,000	**3.63**	**Significant Raise**
3.	Secretarial	6,46,000	**4.42**	7,38,000	**2.38**	9,30,000	**2.26**	10,22,000	**2.14**	**Significant Drop**
4.	Skilled Workers	22,41,000	**15.34**	32,67,000	**10.54**	37,27,000	**9.10**	40,27,000	**7.66**	**Significant Drop**
5.	Unskilled	1,06,70,000	**73.08**	25,600,000	**82.58**	3,41,68,000	**83.34**	3,97,36,000	**84.1**	**Significant Raise**
	Total	**1,46,03,000**	**100.00**	**3,10,00,000**	**100.00**	**4,10,00,000**	**100.00**	**4,78,00,000**	**100.00**	

Dec, 2016, Indian Highways

ROAD CONSTRUCTION COST BREAK UP



OPTIMIZATION

SMALL SAVINGS IN HUGE MONEY

UTALIZATION<50% ,

Eg. Crusher : 200 TPH

Pugmill: 100 TPH

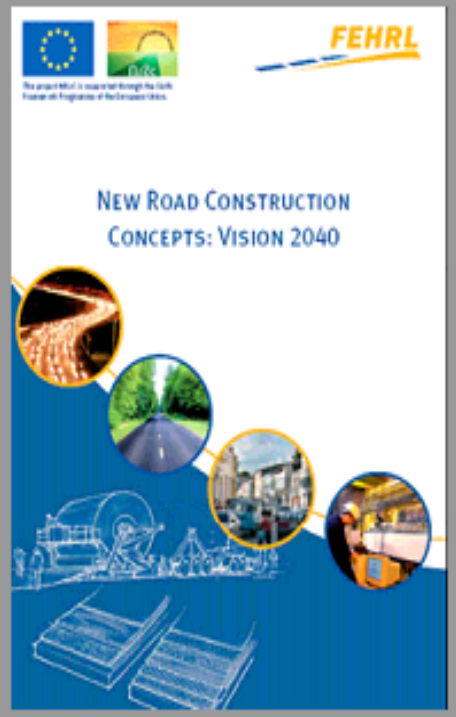
HMP: 200 TPH

Paver : 500 TPH

Compactor : 500 TPH

utalisation factors: **0.5**

VISION 2040

Vision 2040	Characteristics	Construction Concepts	Directions for solutions
	Available Durable Reliable	**Reliable Infrastructure**	• Lifetime engineering • Fast, hindrance-free maintenance • Balancing demand and capacity • Asset management tools
	Energy efficient Sustainable Environment	**Green Infrastructure**	• Saving natural resources • Emission Control
	Accessible Smart Safe	**Safe&Smart Infrastructure**	• Safe design • Smart design • Smart communication • Smart monitoring
Also available on FEHRL website: www.fehrl.org/nr2c	Multi-functional Multi usable Public security	**Human Infrastructure**	• Public security • Multi-functional use • Human design

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- **INDIAN CONCRETE INSTITUTE – BENGALURU CHAPTER**
  - Dr. LR Manjunath, Chairman
  - Dr. RL Ramesh, Secretary

THANK YOU FOR KIND ATTENTION