All About WHITETOPPING

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Contents

CURRENT CHALLENGES

Potholes pose a bigger threat than terrorism to India

Pothole-related deaths 3,597 as compared to 803 in terror-related incidents in 2017

Judging by fresh data released by the states, Indians should fear potholes more than they do terrorists.

While terrorism, including Naxal attacks, killed 803 people in 2017 (including civilians, security forces as well as terrorists), all states combined recorded 3,597 pothole-related deaths last year.

That's nearly 10 deaths every day - a whopping 54% rise over the 2016 figure of 2,324, TOI reports.

Good Roads : A Fundamental Right !

‘अच्छी सड़कें मौलिक अधिकार’

मुंबई। बांबे हाईकोर्ट ने बुधवार को कहा कि अच्छी सड़कें नागरिकों का मौलिक अधिकार है। गड्ढों से मुक्त सड़कें मुहैया कराना राज्य सरकार का वैधानिक दायित्व है।

जस्टिस एएस ओका व सीवी भदांग की खंडपीठ ने महाराष्ट्र में सड़कों की खराब स्थिति और गड्ढायुक्त सड़कों के कारण हादसे में होने वाली मौतों पर दायर एक जनहित याचिका पर यह टिप्पणी की। कोर्ट ने कहा, यह सही समय है जब सभी संबंधित पक्ष स्पष्ट रूप से समझें कि अच्छी सड़कों का अधिकार मौलिक अधिकारों का हिस्सा है। (एजेंसी)

- **On a PIL regarding accidental deaths due to pot holed roads, Hon’ble High Court of Maharashtra observed that this is the right time for all concerned to understand that ‘Right to Good Roads’ is a part of Fundamental Rights of Indian Citizens (20th May, 2015)**

Pavement Types

- ***Flexible (Bituminous)***
- ***Rigid (Concrete)***

Past Choice

- ***Flexible pavement because of***
  - **Lack of funds**
  - **Amenability to stage construction**
  - **Correction to defective construction – possible**
  - **Shortage of Cement**
  - **Lack of mechanisation in Concrete Production and Paving**

Present Conditions Call for Reappraisal of Pavement Choice

- *Heavy overloading*
- *High design life (20-30 years)*
- *Lack of resources for maintenance*
- *Life cycle costing is gaining acceptance*
- *Sustainability*

Marine Drive CC Road (Mumbai)- First Constructed in 1939

Re-constructed as CC Road in 2012 after more than 70 Yrs.

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OUTSTANDING EXAMPLE

Mumbai - Pune Expressway (Toll)

- All new alignment - concrete pavement built
  - Based on economic analysis of life cycle cost

Yamuna Expressway

Noida – Mathura – Agra (165 kms)

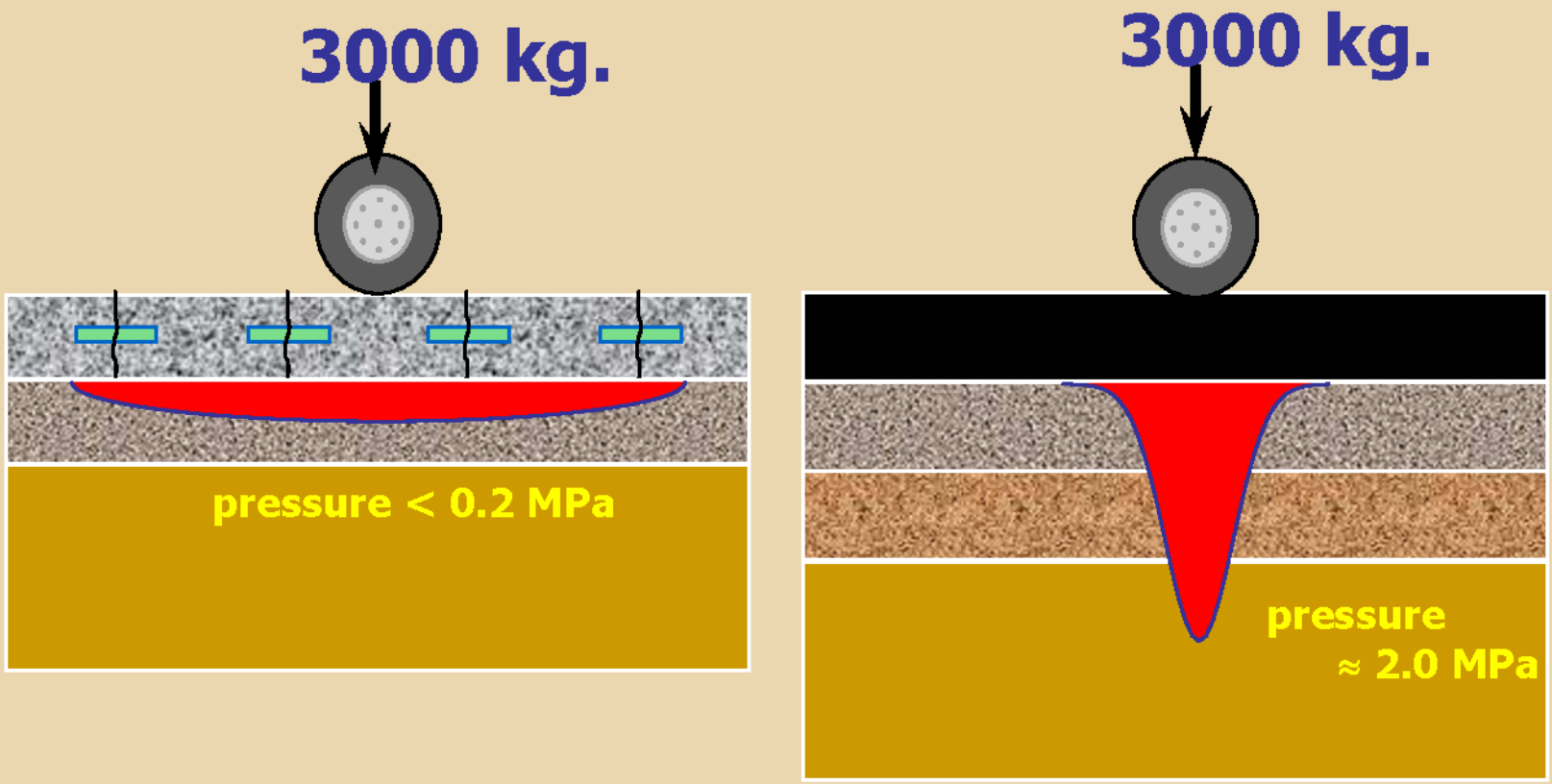
BITUMINOUS PAVEMENTS: Problems

PONDS IN ROADS - RAIN WATER HARVESTING?

Concrete Roads

- **Concrete Pavements Offer a**
  - ***Cost-Effective***
  - ***Sustainable***
- **Option in Modernising India's Roads**

How Pavements Carry Loads



Concrete's Rigidness spreads the load over a large area and keeps pressures on the sub-grade low.

WHO DAMAGES ROADS MOST ?

WHY PRESSURE IS IMPORTANT?

AISHWARYA RAI

- **Weighs 60 kg.**
- **Stands on shoes of pointed heels & toes**
- **Pressure = 60/(2 shoes x 2 points x 5 sq cm/ point)**
- **Presssure = 3 kg/sq cm**

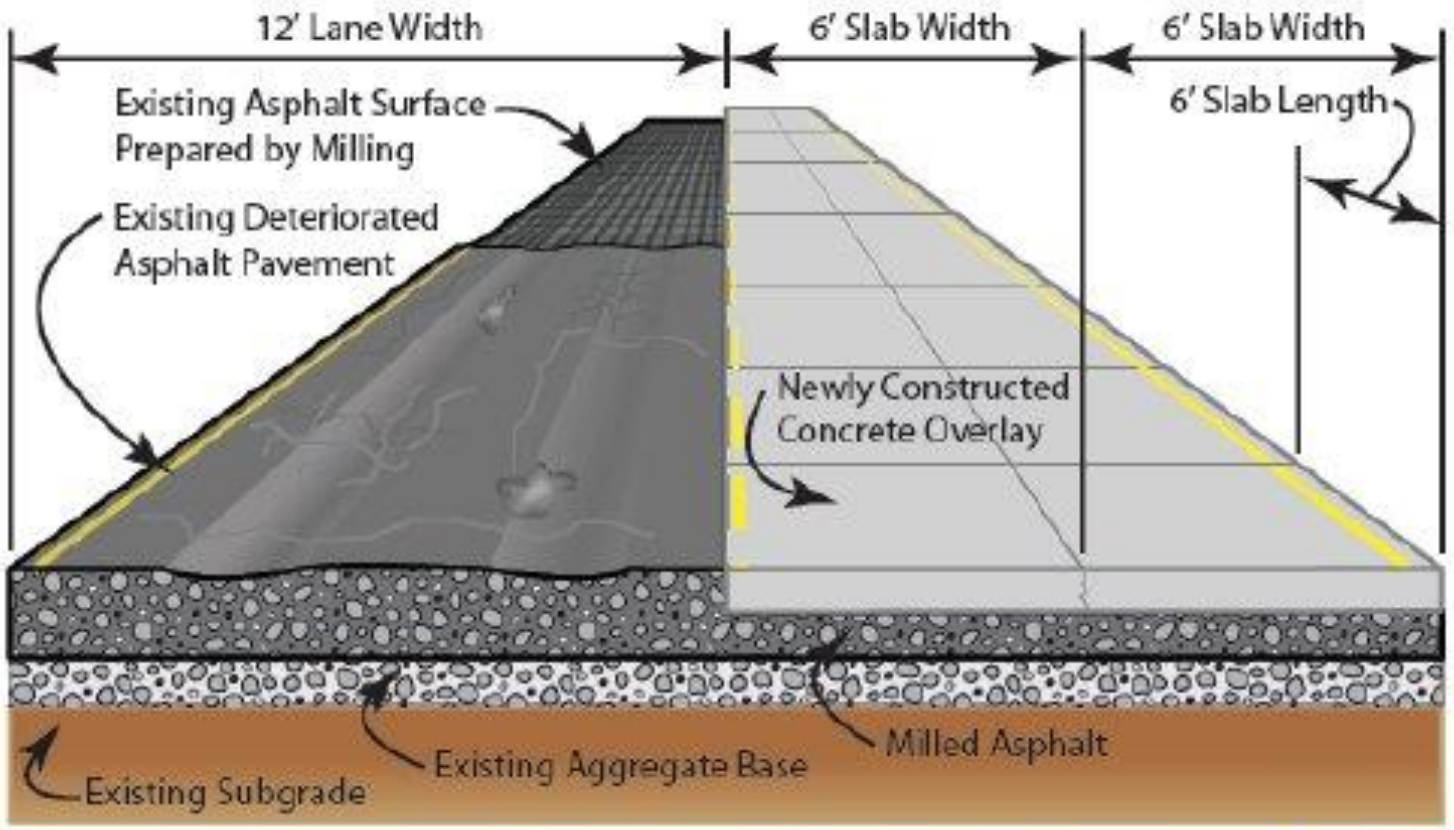
ELEPHANT

- **Weighs 4000 kg.**
- **Stands on Four legs**
- **Pressure = 4000/{4 legs x (20x20 sq cm/leg)}**
- **Pressure = 2.5 kg/sq cm**

- ***Damage occurs due to pressure not due to load***
- ***Damage occurs due to high axle loads not due to gross loads***


INTRODUCTION
TO WHITE-TOPPING

WHITE TOPPING



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Whitetopping

- *Concrete Overlay on an existing Bituminous Pavement*
- *Started in 1918 in USA & Europe*
- *Used for*
  - *Inter-state roads,*
  - *Primary & Secondary highways,*
  - *Urban roads*
  - *Airport*
- *PCC overlay may be or may not be bonded to the layer below*

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Whitetopping in India

- *Started around the year 2000.*
- *Urban roads in Mumbai, Pune, Nagpur, Jaipur, Chennai, Bangalore*
- *First IRC Special Publication: SP:76 – 2008*
- *Revision in 2015*

IRC:SP:76-2008

TENTATIVE GUIDELINES FOR CONVENTIONAL, THIN AND ULTRA-THIN WHITETOPPING

INDIAN ROADS CONGRESS
2008

ADITYA BIRLA GROUP

IRC:SP:76-2015

GUIDELINES FOR CONVENTIONAL AND THIN WHITETOPPING

(First Revision)

INDIAN ROADS CONGRESS
2015

https://irc.gov.in

Economics of Whitetopping

Cost comparison for Whitetopping for City Roads (1 km x 2 lane of 3.5 m wide)

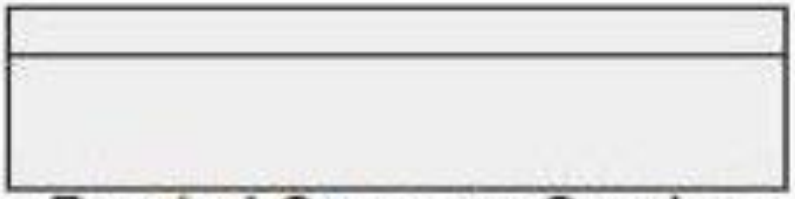
Item	Bituminous Road Rs. In Lakhs	Concrete Road Rs. In Lakhs
Dense Bituminous Macadam (DBM)	33.8	--
Bituminous Concrete (BC)	28.9	--
PQC	--	70.3
Others (Tack coat/ Laying charges)	0.8	6.4
Total	**63.5**	**76.7**
Difference in Cost = 21 % (approx)		

Life Cycle Costing - Whitetopping for City Roads (1 km x 2 lane of 3.5 m wide)

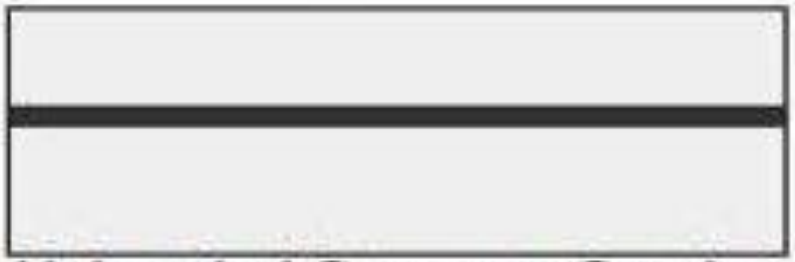
Item	Bituminous Road Rs. In Lakhs	Concrete Road Rs. In Lakhs
Initial Cost	63.5	76.7
Overlay after 5 years (BC – 25 mm)	18.0	5.0
Overlay after 10 years (DBM-40 & BC-25 mm)	45.1	5.0
Overlay after 15 years (BC – 25 mm)	18.0	5.0
Total (for 20 years Life Cycle)	**144.6**	**91.7**

BONDED AND UNBONDED OVERLAYS

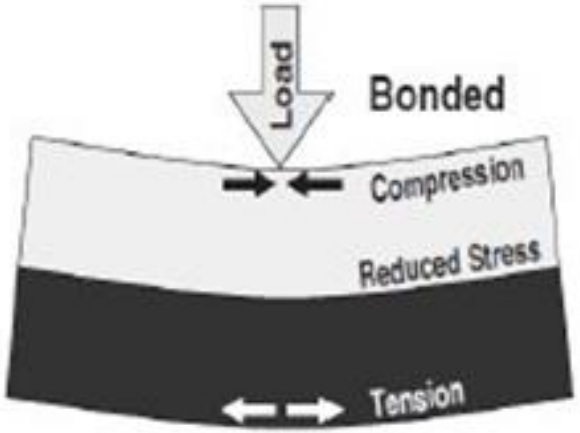
Whitetopping

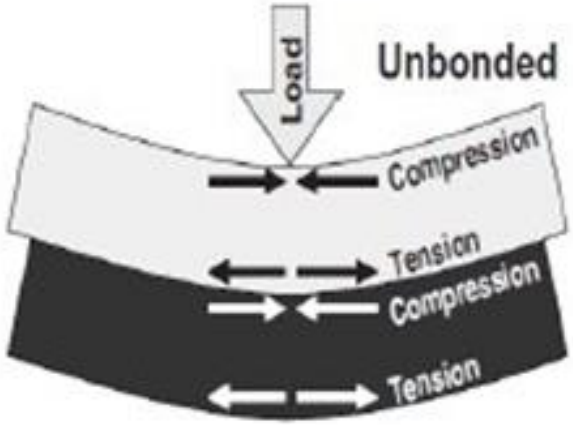


Bonded Concrete Overlay



Unbonded Concrete Overlay





TYPES OF WHITE-TOPPING

CONVENTIONAL WHITETOPPING

- **Overlay thickness:** greater than 200 mm
- Treats the existing bituminous surface as overlay, similar to DLC
- Condition of existing surface is not significant
- Bond between layers not accounted for. Hence, no composite action

THIN WHITETOPPING

- **Overlay thickness:** between 100-200 mm
- Bond between layers considered, but not mandatory. Not considered in the design
- High strength concrete (M 40 & above) with fibres is used
- Joints at shorter spacing: 0.6 to 1.25 m, both ways

ULTRA-THIN WHITETOPPING

- **Overlay thickness:** less than 100mm
- Not recommended for Indian roads
- Suitable only for interior roads of a colony, where heavy traffic is not expected
- Consideration of bonding between old & new layers is mandatory.
- Joints at shorter spacing: 0.6 to 1.25 m, both ways

150mm thick white topping over existing BT road laid for 1km on Banjara Hills road no.10 in Hyderabad. Joint spacing is 1m by 1m

Bond Between Composite Layers

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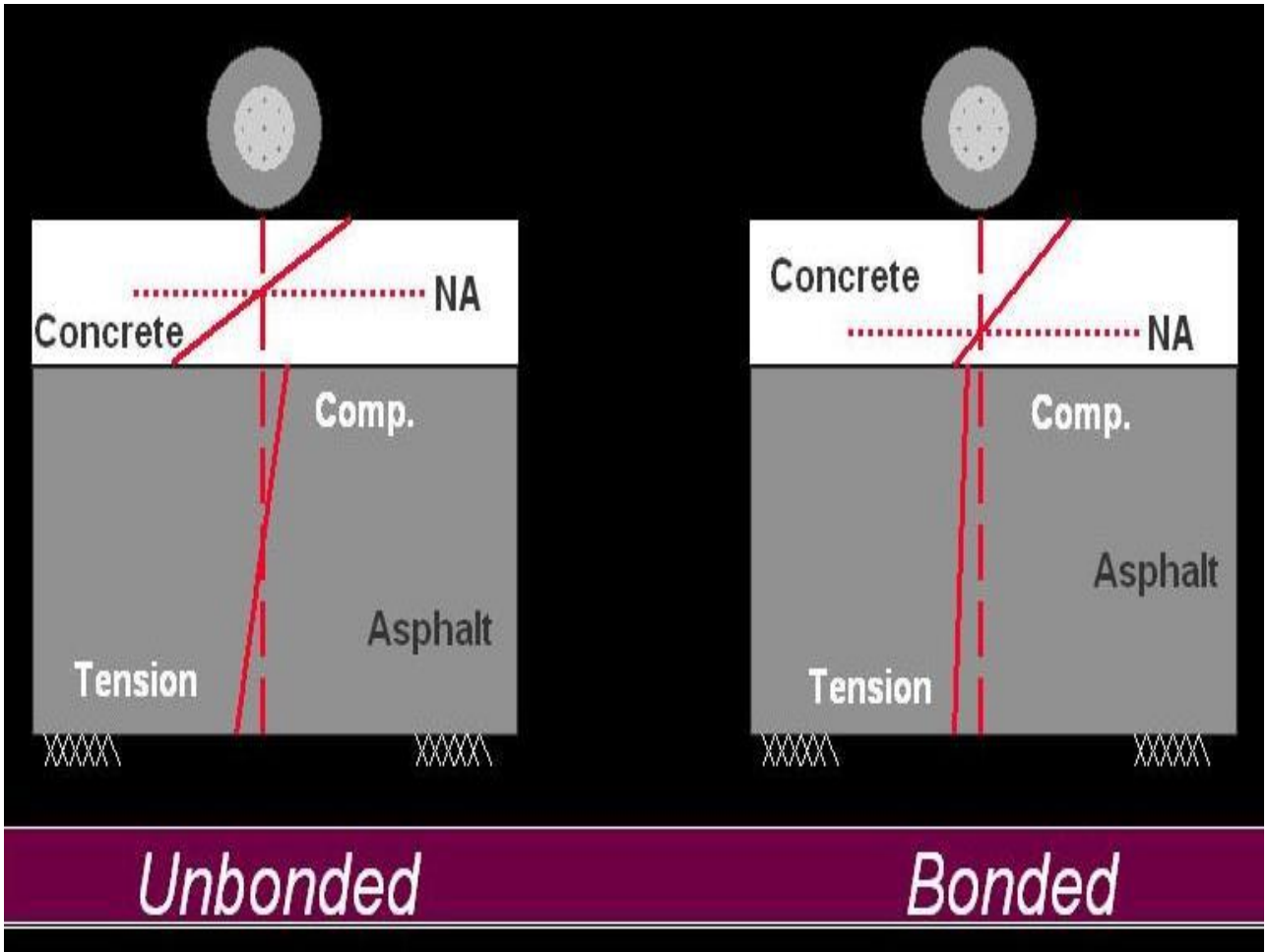
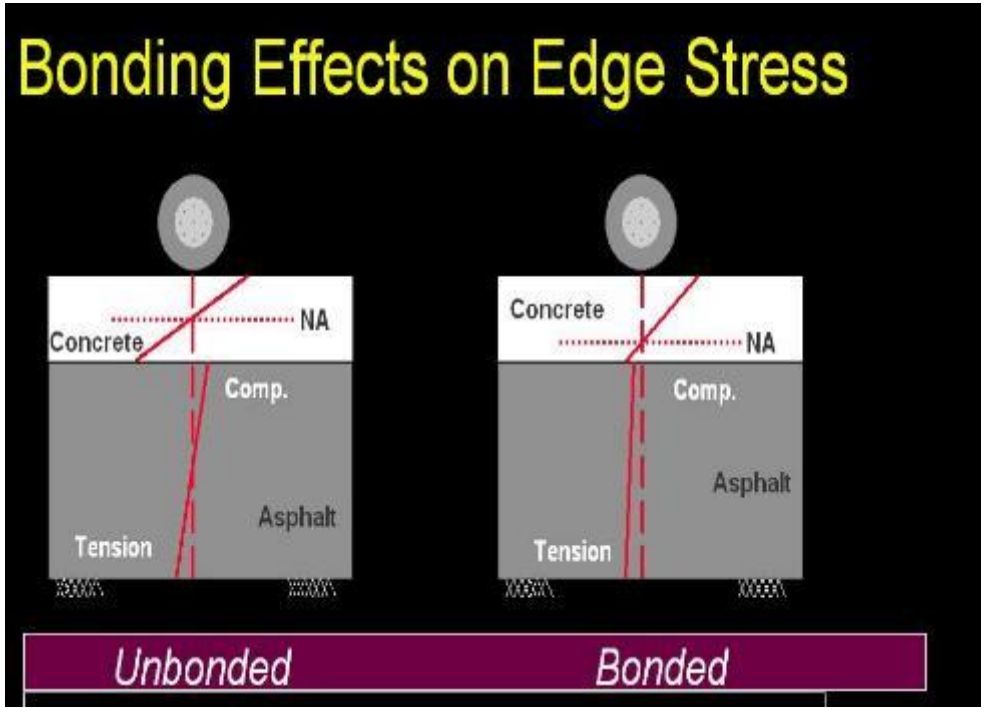
- *It ensures composite action between Asphalt & Concrete*
- *Stresses in top concrete layer are low in view of the composite action*



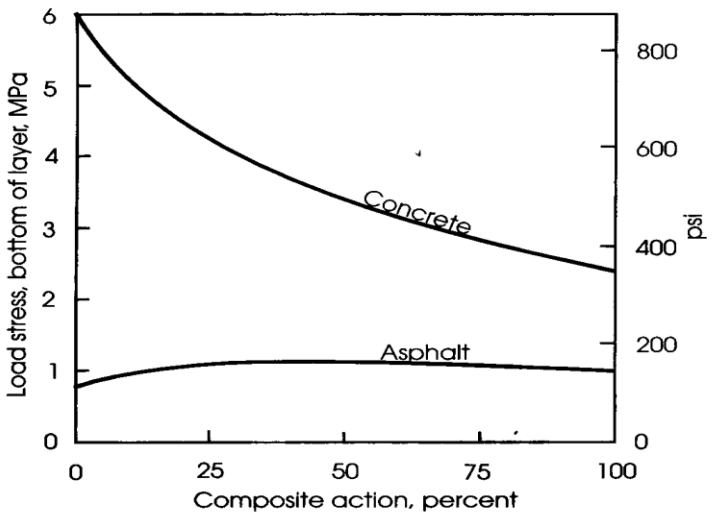
Reduction in Stresses - Bond

(as per IRC: SP-76-2008)

- *Between no bonding and 25% bonding = 6 – 4.4 = 1.6/6 = 26.66%*
- *Between 100% bonding and no bonding = 6 – 2.5 = 3.5/6 = 58.33%*



Sl. No.	Degree of Bonding	Stresses
1	0 percent	6.0 MPa
2	25 percent	4.4 MPa
3	100 percent	2.5 MPa



Reduction in Stresses – Panel Size (as per IRC: SP-76-2008)

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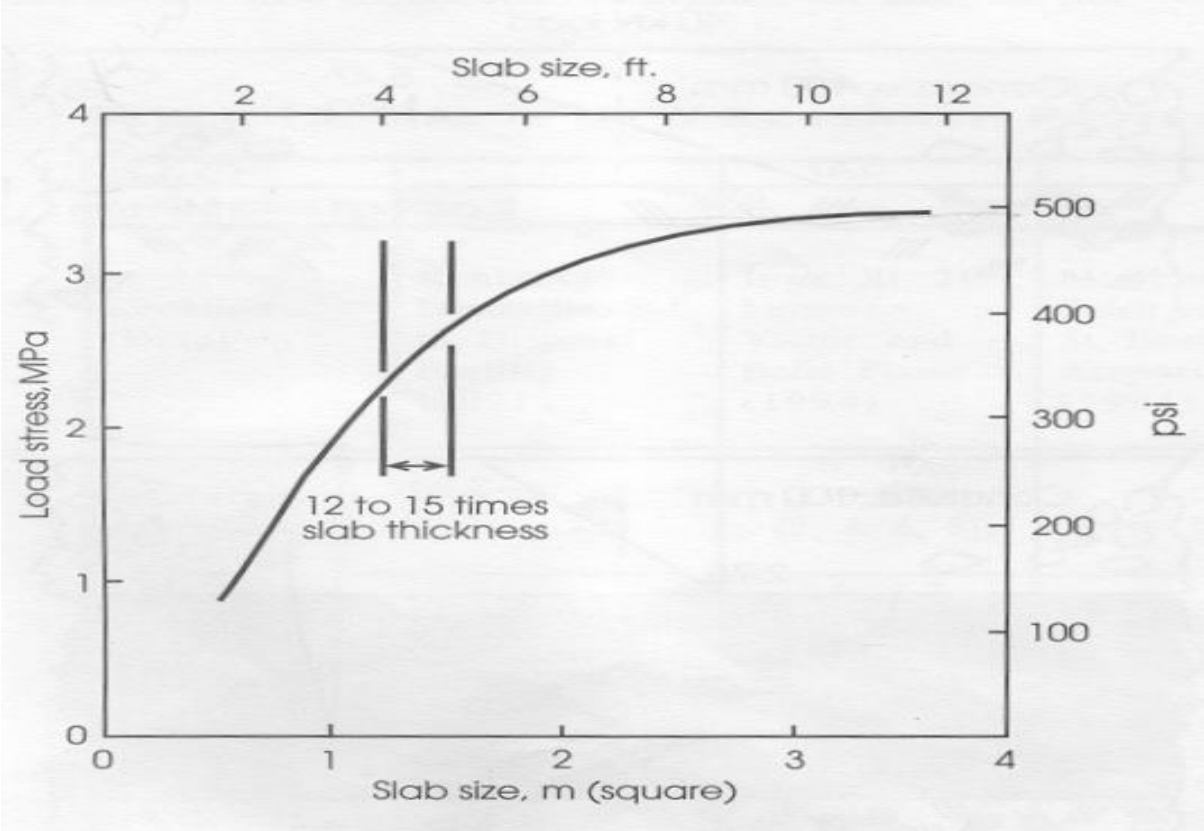
- *Reduction in stress due to smaller panel size of 1m x 1m as compared to the panel size of 4m x 4m is = 42.85%*
- *Reduction in stresses is = 26.66% + 42.85% = 69.51%*



When Whitetopping is not an option ?

- ***Subgrade / Sub-base continuity is not there***
- ***Condition of the existing bitumen surface should be sound (free from wide cracks)***
- ***After milling, there should be a min. of 75 mm bitumen for good composite action…if less, this can be corrected.***


BENEFITS OF
WHITE-TOPPING

LIFE & LIFE CYCLE COST

Average maintenance period for asphalt road is 2-4 years while for White Topping is minimum

Average resurfacing period for asphalt road is 8-10 years while for White Topping is 20-25 years

Lifetime cycle cost (25 yrs) for Bituminous Topping is ~4.5 times the cost of White Topping

FUEL SAVING & EMISSION REDUCTION

Concrete overlays have **lesser pavement deflection** resulting in reduced vehicle fuel consumption (10-15%)

Lower fuel consumption results in reduced CO2, SOx & NOx emissions

ENERGY SAVING

Concrete pavements have **better reflectivity** resulting in reduced illumination load/km thus **saves energy** (20-30%)

Reduced Heat Island Effects on concrete pavements results in lesser energy consumption for air conditioning to cool urban buildings (8-10 degrees of temperature difference)

ROAD SAFETY

Reduces accidents caused due to potholes

Surface reflectance of concrete overlays is 4-5 times higher **enhancing driver visibility during night**

Braking distance for concrete overlays is lesser in both wet & dry conditions

SUSTAINABILITY

Bituminous pavements result in 2-5 times more **energy consumption** as compared to concrete pavements

Concrete pavement is a **100 per cent recyclable** material and can be crushed and re-used

Continuous aggregate consumption is required to maintain bitumen roads

Cost Comparison

Bitumen & Concrete Roads (2 lane road per km)

LIFE & LIFE CYCLE COST

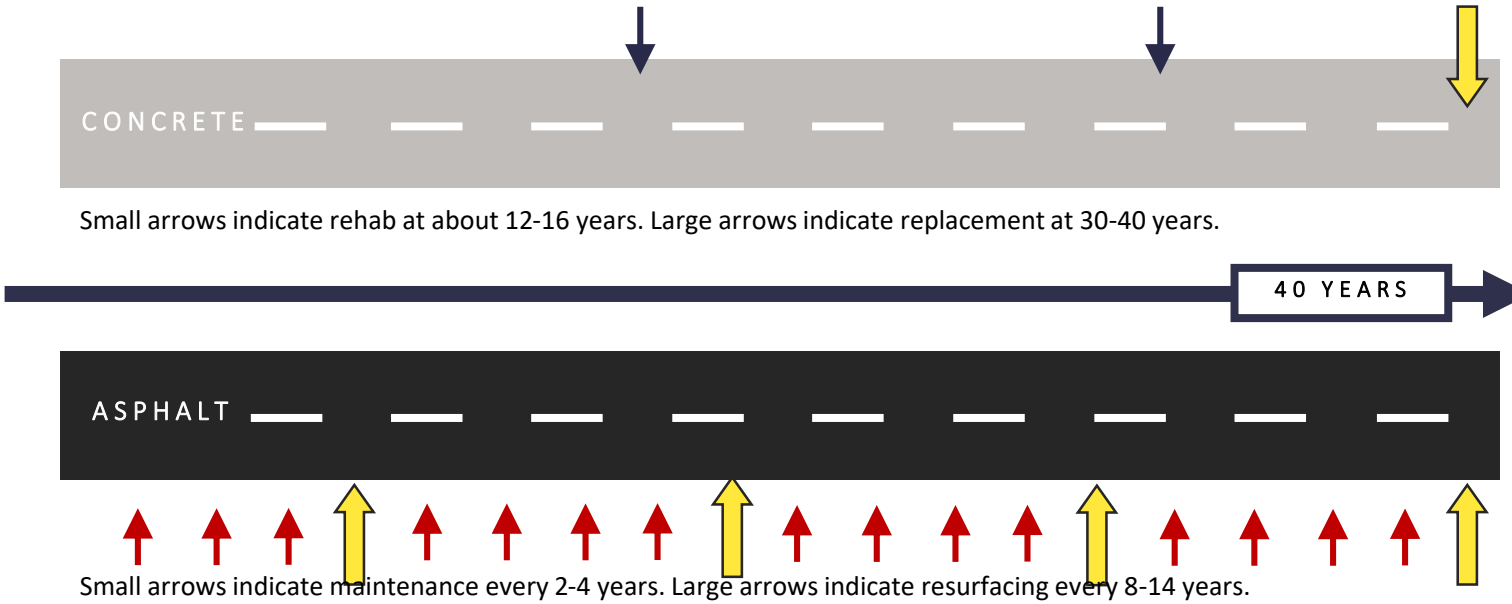
No.	Description	ASPHALT (IN LAKHS)	DESIGN LIFE (YRS)	CONCRETE (IN LAKHS)	DESIGN LIFE (YRS)	MAINTENANCE
1	New Road	231.33	8 -10	258.76	35-40	Asphalt - 3.4 Lakh/km Concrete - 0.5 Lakh/km
2	Overlay	71.66	3 - 5	98.0	20-25	

Long lasting concrete overlay does not require rehabilitation frequently & thus consumes less raw materials in the long run.

Long lived concrete overlays demonstrates economic advantage in terms of life cycle cost.

Lifetime cycle cost (25 yrs) for Bituminous Topping is ~4.5 times the cost of White Topping (Concrete Overlay).

WHITE TOPPING

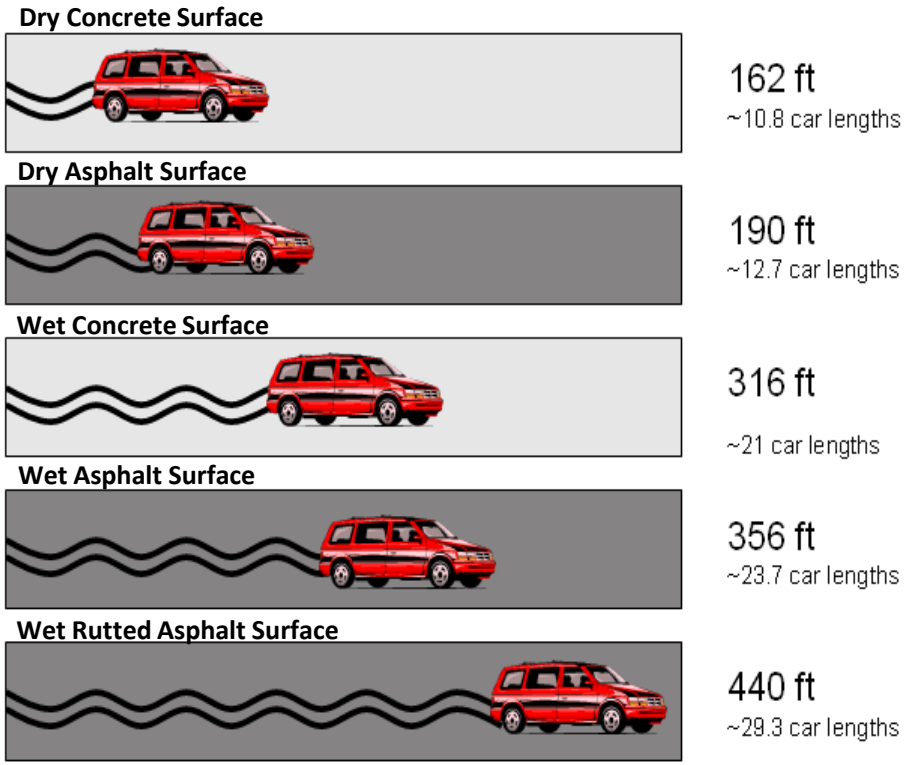


Small arrows indicate rehab at about 12-16 years. Large arrows indicate replacement at 30-40 years.

Small arrows indicate maintenance every 2-4 years. Large arrows indicate resurfacing every 8-14 years.

Lower braking distance increases commuter safety

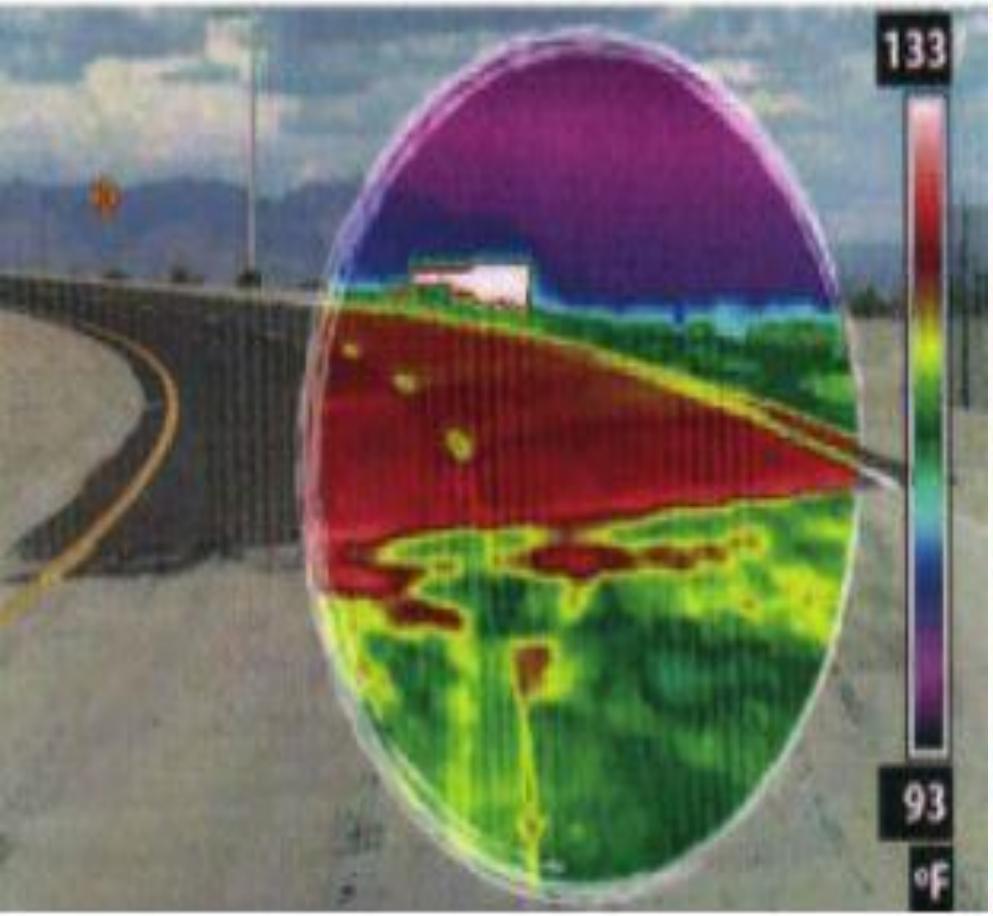
ROAD SAFETY

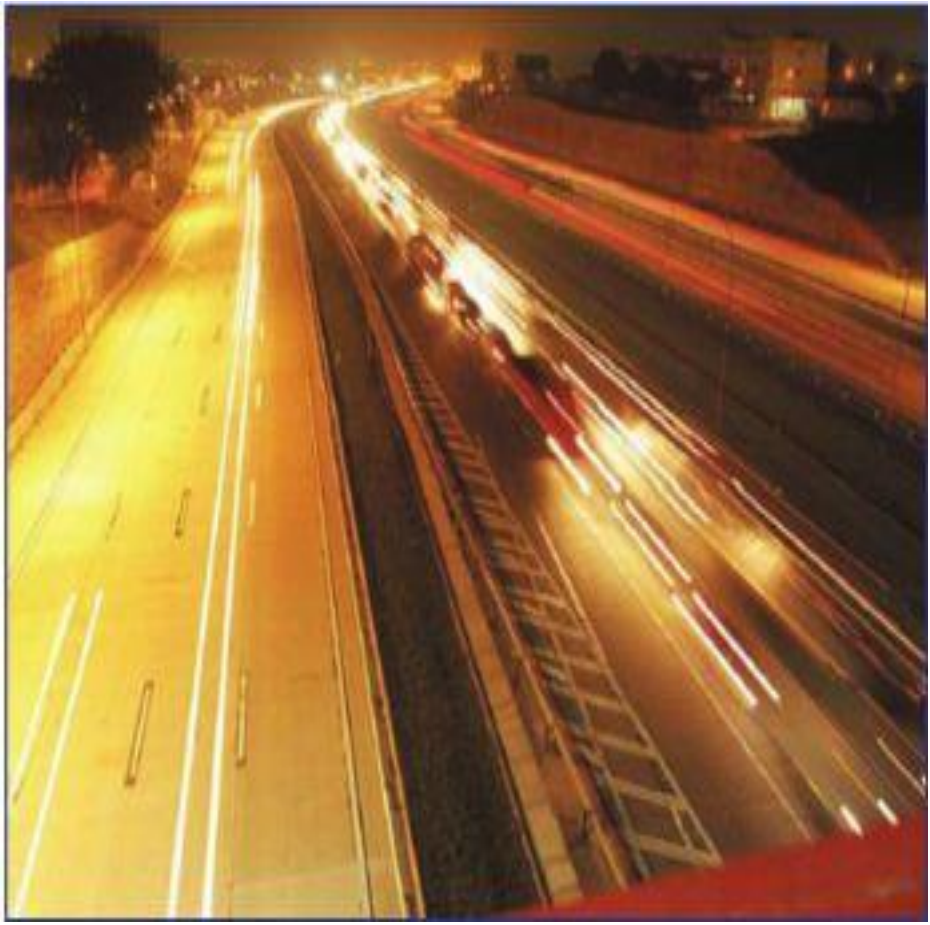


SOURCE: Chevrolet stopping data, department of general engineering, Illinois

- The braking distance for concrete overlays are less compared to asphalt overlays, hence concrete overlays are safe on both dry and wet surface conditions.
- The braking distance increases even with rutted asphalt surface.
- Braking efficiency also converts into less wear and tear of tyres & brake drum and also helps in reducing the consumption of brake oil.

Sustainability – Concrete Pavements





Characterization of Existing Bitumen Pavement Surface

- ***Adequate characterization of Bitumen Surface is essential before White Topping***
- ***Visual Inspection***
- ***Lab. and field Tests***

  - Benkelman beam test

  - Falling weight deflectometer

PQC REQUIREMENTS

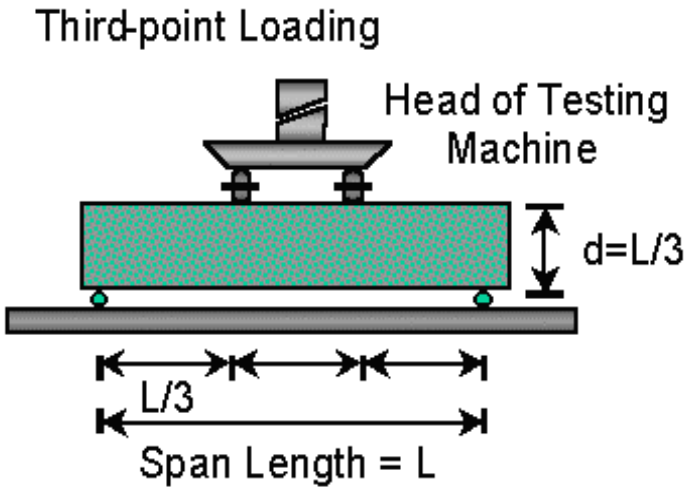
- **Concrete Flexural Strength: 4.5 N/mm^2 (M35 – M45 Grade for PQC)**

- **Slump:** 40-50 mm
- **Cement content:**

} **as required in the field**

- **Use of super-plasticisers**

- **Fly ash admixed concrete**
  - **Low volume (15 - 30%)**
  - **High volume (30 - 60%)**



Quality check – controlled slump most essential

Filling Slump Cone
In three Layers

Measurement of Slump

Mix Proportioning & Strength of PQC

- ***Concrete Grade of M 40 or more***
- ***For Fast Track construction, M 50 grade HPC is preferred***
- ***W/C ratio should be less than 0.4***
  - ***Preferably w/c ratio should be 0.3 to 0.38***
  - ***Workability depends on the type of paving***
  - ***Higher strength is derived not by increasing cement content, but by reduced water content***
  - ***If ⅔ of concrete strength is achieved in 2 days, road can be opened for traffic in 3 days***

Mix Proportioning & Strength of PQC

- ***Concrete roads are designed for Flexure***
  - *Limitation on nominal max size of aggregates (say 20 or 16 mm)*
  - *Flakiness of aggregates should be avoided*
  - *Good gradation of particles upto micron size,*
  - *Enough supplementary cementitious materials to be used…*
  - *Paving of concrete overlay should be done at less than 35° C*

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How to Construct Good Concrete Roads
Or
How NOT to Construct Bad Concrete Roads !!

CONSTRUCTION OF CONCRETE SLABS WITH PQC

- Manual construction method
- Fixed form paving method
- Slip form method

MANUAL METHOD

- Wooden or steel side shuttering
- Needle vibrator
- Screed vibrator
- Concrete mixer
- Texuring brush
- Joint cutting machine

Mobile Batching Plant

MINI-BATCHING PLANT

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Fixed Form Paving

CONSTRUCTION WITH FIXED FORM PAVER

FIXED FORMS AND MACHINERIES REQUIRED

- SIDE FORMS
- TRANSIT MIXER/VEHICLES TO TRANSPORT MIX
- SPREADER
- PAVER
- DOWEL BAR INSERTER(OPTIONAL)
- FINISHER
- TEXTURING MACHINE/CURING COMPOUND SPRAYING M/C
- JOINT CUTTING SAW

FIXED-FORM WITH PAVER

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Slip Form Paving

CONSTRUCTION WITH SLIP FORM PAVER

MACHINES USED IN SLIP-FORM CONSTRUCTION

I) **PAVER**
II) **FINISHER**
III) **DOWEL BAR INSERTER**
IV) **TIE BAR INSERTER**
V) **TEXTURING M/C**
VI) **LIQUID CURING COMPOUND SPRAYING M/C**
VII) **JOINT CUTTING M/C**
VIII) **MOBILE TENT**

SLIP FORM PAVER

TEXTURING

TYPES

- **BRISTLE**
- **TYNE**

  DIRECTION OF TEXTURING
- **TRANSVERSE**
- **LONGITUDINAL**

FLOATING WITH PAVER IN PROGRESS

Paver Floating the surface after compaction by inbuilt pin vibrators (17 Nos) inside the machine

Texturing by using artificial turf dragging (left) Tine Texturing (right)

Finished PQC Surface showing Texturing


Total Video Converter
http://effectmatrix.com

Covering Fresh Concrete with plastic Sheets to prevent moisture loss and wind

C.C Road Curing by ponding.

Fresh CC covered with wet gunny rolls.

Tests on concrete and pavement

- ***Tests on Concrete***
  - **Fresh Concrete**
    - **Slump Test**
  - **Hardened Concrete**
    - **Compressive Strength**
      - **Concrete Cubes – for 1, 3, 7 and 28 days**
    - **Flexure Test**
      - **Beam specimens**

Tests on concrete and pavement

- *Tests on Extracted specimens of Concrete*
  - Core Tests
- *Tests on Pavement quality*
  - Fatigue Test
  - Abrasion Test

Concrete Mix Design

Concrete Strength	M45
Slump	40 – 60MM (at site)
Cement	430 Kgs
Fly Ash	30 Kgs
CA 1 20mm Dn.	680 Kgs
CA 2 12mm Dn	390 Kgs
FA (manufac. Sand)	710 Kgs

Quality Control - Results

Cube Compressive Strength					
Number of cube Samples Taken Till date 936 Nos					
Samples taken for 1 day, 3rd day, 7th day and 28th day's Strength					
Sl. No.	Sample Sizes	Avg. 1 day Strength	Avg. 3day Strength	Avg. 7 day Strength	Avg. 28 day Strength
1	60 cubes per test	22.05 Mpa	43.2 Mpa	51.02 Mpa	61.80

Quality Control - Results

Flexural Strength		
Number of Beam Samples Taken Till date 45 Nos		
Samples taken for 28 day's Strength		
Sl. No.	Sample Sizes	Avg. Flexural Strength
1	45 Beam test	6.297 Mpa

Relocation of Utilities

Flexible	Rigid
Easy to Dig Trenches and Reinstate	**Difficult to Break Concrete**
	But Trenchless Technology Makes it Easy
	Utilities can be Located in a Planned Manner and their Repairs can be Done without Digging Roads

MUMBAI's EXAMPLE

2 Nos RCC pipes 300 mm dia on each side underneath footpath for OFC cables

1.50 m wide 100 mm (removable) section of paver blocks to house utilities like water supply, sewer lines

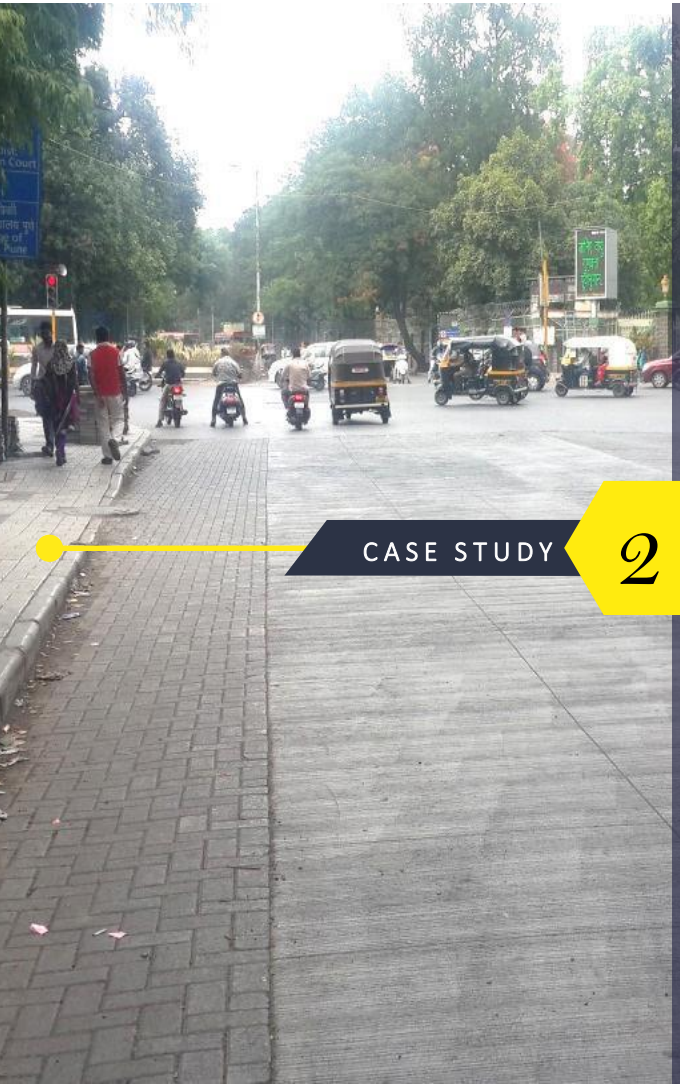

NIKE


07/03/2014


07/03/2014


03/13/2007


CASE
STUDIES



CASE STUDY 2

URBAN ROAD

Pune

PROJECT DETAILS

SALIENT FEATURES

30+ YEARS	8-9 meter wide	150-160 mm	200-250 mm
Road constructed and in use for	Existing bituminous road in fair condition	Average thickness of BT layers	Average thickness of WBM layer

Existing BT surface was well consolidated with minor structural failure due to water supply leakages etc.

HIGHLIGHTS

- Milling of existing BT surface by 50 to 75 mm to match levels of property
- Correction of failed patches by full crust development with GSB and DLC layer (only 1 to 2 % area)
- Average 175 mm TWT layer of M 40 grade PQC with polypropylene fibers (design as per IRC SP 76 2008 guidelines)
- Profile correction provided in PQC layer itself (average 50 to 75 mm at some locations)
- Slab panel size 1m X 1m

DESIGN DETAILS

- BBD testing done on existing BT surface –K value of 11 Kg/sqcm/cm (characteristic deflection –0.90 mm)
- CVPD above 5000 per day (mainly buses)
- Design life considered 20 years
- Thickness design –175 mm M 40 grade concrete with flexural strength of 4.5 N/sqmm
- Panel size 1000 mm X 1000 mm
- Dowel bars provided only at construction joints (25 mm MS bars with plastic cap at one end)
- Tie Bars provided only at central longitudinal joint

TECHNICAL SPECIFICATIONS

Cement - 425kgs

Mineral Additive (GGBS) - 60kgs

20 mm Coarse aggregate - 769kgs

10 mm Coarse aggregate - 513kgs

Manufactured Sand - 726kgs

Water - 157kgs

Poly-propylene Fibre - 0.8 kg/cum.

Chemical admixture (plasticizer) - 3.83L

Water-Cement ratio - 0.37

Observed slump - 75mm

Target mean Strength (MPa) - 48.25 N/sqmm

Design flexural strength - 5.20 N/sqmm

PROJECT DETAILS

Cross pipes at every 50m interval (300 mm and 450 mm RCC class pipes for Utility crossings)

No cutting of central longitudinal joint (left as it is and filled after it opens up by traffic).

1.50 m wide 100 mm (removable) section of paver blocks to house utilities like water supply, sewer lines.

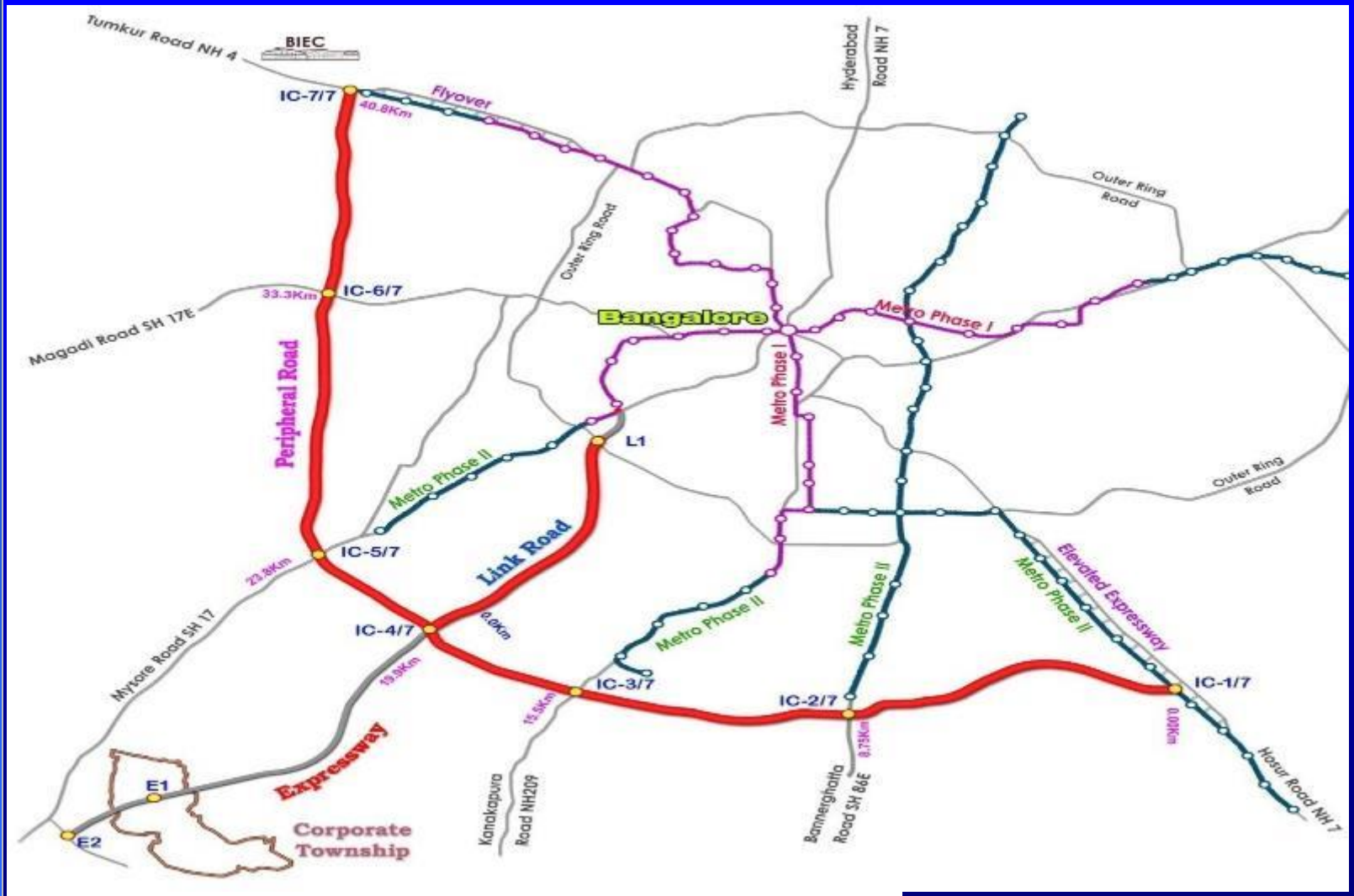
1z

CASE STUDY 1

HIGHWAY ROAD

Bengaluru

Project Implementation

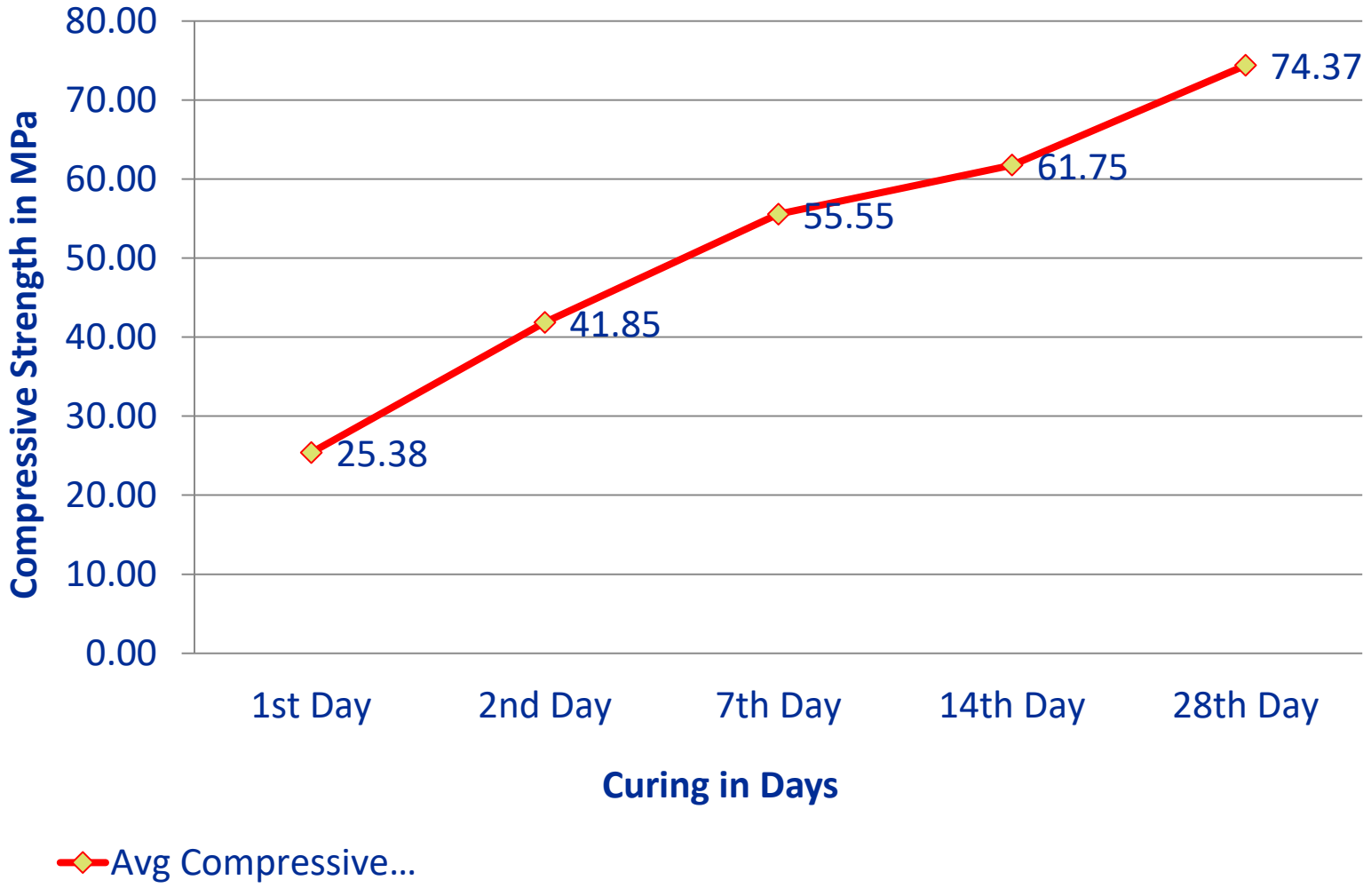


Link Road and Peripheral Road under operation

CASE STUDY OF BANGALORE RING ROAD WHITE TOPPING

- DESIGN LIFE – 20 YEARS
- AXLE LOAD – 18T
- COMMERCIAL TRAFFIC – 8500 cvpd
- THICKNESS OF OVERLAY – 180mm
- JOINT SPACING – 1.2m X 1.2m
- LENGTH OF ROAD – 9km
- 4 LANE TO 6 LANE
- CONCRETE USED – 62,000m^3
- WORK COMPLETED—APRIL' 2013

Test Results of Concrete Cube Samples



Milling in Progress

Milled Bituminous surface

Photographs of Milling & Paving work in progress

Over View of Finished Rigid Pavement

NICE ROAD WHITE TOPPING NEAR BANGALORE -MYSORE CORRIDOR TOLL GATE

COMPLETED PROJECT


CONCRETE ROAD
TOWARDS ECONOMIC GROWTH
BITUMEN ROAD
TAKE U-TURN


Thank You