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# Study Of Bituminous Mix With Crumb Rubber Its Design, Production And Laying At Site.

A DISSERTATION

SUBMITTED IN PARTIAL FULFILLMENT OF THE

**REQUIREMENTS FOR THE DEGREE OF** 

Master of Technology

In

**Civil Engineering** 

By



Student Name – Mr. Su<mark>dhir Sharma</mark>

Roll No-21 PGCEC10

Under the Guidance of

Prof Shri Chitranjan Kumar



#### ABSTRACT

In urban region, the crumb rubber materials is causing alarming environmental issues and can be utilized as a partial replacement of bitumen with waste crumb rubber materials to reduce the cost of top layer of flexible pavements the comparison of pure bitumen and modified bitumen using waste crumb rubber is studied experimentally and discussed about the resistance against fatigue cracks, rutting cracks, strength of bitumen road and durability of modified bitumen at both high temperature & low temperature using Marshall stability analysis waste crumb rubber material are added to pure bitumen using wet process with % 5%, 10%, 15% and 20% Crumb rubber of size of 0.300 MM – 0.150 MM Laboratory results indicated the crumb rubber can incur high elastic behavior, low penetration and high softening point compared to pure bitumen. It is concluded that addition of crumb rubber which is environmental pollutant, in conventional bitumen have the modify the the values of penetration and softening values significantly and added advantage in pavement layers

#### Chapter no 1

#### Introduction

India has a road network of over 5.9 Million kilometers in 2019, the second largest road network in the world. It carries about 66% of its road transport and 85% of passenger traffic where flexible pavement primarily constitutes 98% of the road network. In India due to varying climatic conditions, construction materials, terrains and mixed traffic conditions increased traffic factors. The pure bitumen and pure bitumen concrete layer cannot withstand rutting, failure cracking, deformation, potholing & tear problems so the bitumen and bitumen mixes needs to be improved to meet the requirements of flexible pavement by adding of blend of additives which are called bitumen modifiers and the bitumen premixed with these modifiers is known as modified is known as modified bitumen (IS73:2013) JCR

The additives presently used are: -

- 1) Polyethylene (PE)
- 2) Ethylene vinyl acetate (EVA)
- 3) Ethylene butyl acrylate (EBA)
- 4) Ethylene methyl acrylate (EMA)
- 5) Styrene isoprene styrene (SIS)
- 6) Styrene butadiene styrene (SBS)
- 7) Styrene butadiene rubber (SBR)
- 8) Natural rubber (NR)
- 9) Crumb rubber modifiers (CRM) 1RCSPSB-2010

Waste tyres in India are categorized as hazardous waste. Indian is the second largest producer of replenishment rubber after china. In 2011, India produced 90,000 metric tonnes of reclaimed rubber in the form of waste tyres. The amount of waste rubber dumped in open wet land areas causes an ideal breeding ground for mosquitoes and spread various dangerous diseases such as malaria, dengue fever and other viral infections.

Crumb rubber is a recycled rubber products from automotive scrap tires which are primarily natural rubber, synthetic rubber and carbon black rubbers during the recycling process steel and tire lacing are removed, tearing tire rubber with a granular consistency or crack mill process the scrap tyre is shredded into small pieces by the help of crack milk of mechanical blades up to sizes of 1 mm to 0.075 mm. scrap tire rubber can be added into bitumen paring mixer

using two different methods which are referred as the wet process and the dry process. Crumb rubber is added to pure bitumen at 100\* C to 200\* temp by wet process. Addition of crumb rubber to bitumen increases the modified bitumen, softening point and lower susceptibility to temperature variation, higher assistance to cracking to elevated pavement temperature.

> Chapter no 02 Literature survey

CRMB : Crumb Rubber Modified Bitumen (CRMB) is hydrocarbon binder attained through the physical and chemical interaction of crumb rubber which is made by recycling of used tires with bitumen and some particular additives.

Crumb rubber modification also improves the properties of bitumen by increasing the storage and loss modulus and enhancing the high and low temperature susceptibility.

Advantages : lower susceptibility to daily and seasonal temperature variations

Higher resistance to deformation at elevated pavement temperature CR

Better adhesion between aggregate and binder

Prevention of cracking and reflective cracking

Overall improved performance under heavy traffic conditions

Disadvantages: The bitumen- rubber material must be properly selected, designed and produced Construction is more challenging as temperature requirement are more critical Its not possible to store crmb at elevated temperature without equipping storage tank with

agur

Photograph of rutted pavement







#### Penetration Grading

- Adopted in 1903 by ASTM Committee D4 on Road and Paving Materials
- Based on penetration test conducted at 25°C
- conducted at 25 °C



Viscosity grade bitumen



Chapter no 03 Execution at site (case study)

At Bharat mala project of National Highway NH745k from srimandi to chidwai under package Rasisar to Deogarh ,the followings were adopted in design of mix Crmb and laying at site

#### Materials used: -

- 1) VG30 Grade bitumen from HPCC, Bhatinda.
- 2) Crumb rubber ----- M/s Tinna Rubber And Infrastructure Ltd ,Thane Maharastra

- 3) Coarse aggregate Angoloi, stone Crusher Jodhpur, Rajasthan
- 4) Fine aggregate Angoloi, stone Crusher Jodhpur, Rajasthan
- 5) filler material stone crusher dust
- 6) Anti stripping agent used Zyco therm from Zydex industries, Jodhpur , Rajasthan

Plants and equipment's in use :-

Hot mix plant :	Make Ammann Apollo 2000
Sensor laying paver:	Make Vogelle 1800 super
Tandem roller:	Make Hamm, HD 99
Compressor:	Make Atlas crop
Pneumatic tire roller:	Make Hamm
Bitumen Boozer :	Make Apollo
Hyva dumper	Make TATA

Chapter no 04 Methodology: Mix design

Mix design and trials are conducted in our in- inhouse lab equipment with all necessary lab equipments. 1500gm. Bitumen is heated to a fluid condition in a 3- liter metal container. CRMB is produced by wet process in which in which bitumen heated at a temperature of around 160\* c to 180\* c and crumb rubber is added. Crumb rubber particles added to the plain bitumen with % 5%, 10%, 20% with size of 0.300 mm to 0.150 mm in preparing the 5% CRMB mixture is stirred manually for 15 minutes at 160\* c temp with the help of Gas store until there is a radian between the bitumen and crumb rubber after that 5% CRMB sample mixture stirred with the help of mechanical stirrer with a speed of 200 rpm stirred for one hour at 180\* c temp. with the help of a hot oven.

Physical properties a pure bitumen and CRMB the physical properties such as softening test, penetration test, ductility test and specific gravity test on the pure bitumen and 5%, 10%, 15%, 20% CRMB are conducted as per IS:1201 \$ 1220 (1978) and results are recorded.

Physical properties of coarse aggregate (20mm, 12.5mm, 6mm, and quarry dust)

The aggregate crushing value test, aggregate impact value test, los- Angeles abrasion test, specific gravity test, nature absorption test, shape test and aggregate stripping value test are conducted as per IS:2386 part I to 5,1963.

Preparation of bituminous mix and crumb rubber bituminous mix bituminous concrete mix gradation and blending is made as per specification started in Morth 5<sup>th</sup> revision table 500-17 for bituminous concrete pavement layers. Aggregate are oven desired and sieved according to be gradation, individual grading and combined grading are conducted as with different % of aggregate to meet the best fit line of BC gradation

once gradation is finalized bitumen / CRMB is and aggregate are heated to 160\* - 180\* C and 150\* 170\* C receptively the trial with different % of bitumen / CRMB is conducted line 5%, 5.5% Bitumen. The mixture of aggregate and bitumen is mixed till a uniform coating is obtained on aggregate, the temp is maintained around 170\* C during mixing shree specimens of 100mm dia and 63.5 (+-3) mm height are made in Marshall molds. These specimens are prepared for each trial and avg. of three specimens is considered for stability, flow density, and voids analysis. The specimen mold and compaction hammer and cleaned thoroughly and, would assembly is heated in hot air oven at a temp. of 160\* C

#### Density, Air voids calculations and marshall stability tests.

Before testing the specimen, their dimensions are measured to note the volume and their weight of specimen in air, weight of specimen in water, and weight of specimen saturated and dry conditions are taken the following quantities are work out for analysis will, bulk specific gravity of compacted mixture. These radical may specific gravity, percent of air voids, percent of air voids in mineral aggregates (VMA), percent of voids filled with bitumen (VFB) and further the results are plotted in graph.

After that the specimens are kept in water bath maintained at 60\* for 60 minutes the specimen are tested 3 to 4 min after taken out from water bath. The specimen is put in Marshall stability and flow dial gauge readings are observed according to ASTM D 6927-15 Standards. Repeat the same for remaining specimen. The marshal observations of pure bituminous mixes and ERMB bituminous mixes are mentioned in table-

3.

S/No.	Bituminous	Pure	5%	10%	15%	20%	Morth
	Mix	Bitumen	Replacemen	Replacemen	Replacemen	Replacement	Replacemen
	Properties		t with crumb	t with crumb	t with crumb	with crumb	with ci
			rubber	rubber	rubber	rubber	rubber
1	Bulk	2.401	2.38	2.363	2.378	2.365	-
	Density						
	G/CC						
2	Stability Kv	12.73	14.32	16.80	20.3	25.8	12 %
3	Flow, MM	3.26	2.5	2.8	3.15	4.1	2-4 %
	,						
	1		1	1	1		1

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4	Air voids %	3.7	3.6	3.8	4.0	4.6	3.5 %
5	VMA%	16.1	14.4	14.6	14.8	15.3	12 %
6	VFM %	77.2	79.9	73.4	72.8	7.	65-75 %

Softening Point of crumb rubber mixed with bitumen VG 30 with different percentage:

VG30	% Crmb	Achieved	Rec
88%	12 %	58.40	Miı
87.5 %	12.5 %	59.60	Miı
87 %	13 %	60.90	Miı
86.5	13.5 %	62.50	Miı
86 %	14.0 %	64.10	Mir

VG 40 VRS Crumb Rubber			
Test	VG40 requirement	Crmb 60 requirement	Achieved at lab
Penetration	35	50	40
Softening Point	50	60	64
Elastic Recovery	-	60	65
Ductility	25		<u></u>
Resilience Modules Mix	3000 mpa	3000 mpa	3165 mpa
MR			
Kinematic viscosity	4 Poise	5-9 Poise	-

## Chapter no 05 Methods to Mix Crumb Rubber

Two methods are used to add crumb rubber to the bitumen: -

1) Wet Process – involves addition of Crumb rubber directly to the bitumen prior mixing with the aggregate.

Where as in the dry process solid crumb rubber is added at the same time bitumen in blended with aggregate.



Figure 1 Wet process method



Figure 2 Dry process method

#### Chapter no 06

#### **Cost Comparison**

Crumb  $60 - VG \ 30 - 88 \ \%$ 

Crumb Rubber- 12%

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Density of Mix = 2280Kg/ Per Cubic Meter

Bitumen % in BC= 5.45 % As per Morth rev 5

Bitumen = 124.26 kg

In Crmb 60, Vg30 = 0.88 x 124.26 = 109.348 kg.

Crumb rubber  $= 0.12 \times 124.26 = 14.9 \text{ kg}.$ 

Cos of VG30 = 109.348 @ 40.40 kg = Rs. 4417.659

Cost of Rubber = 14.9 @ 27.50 kg = Rs 409.75

Total cost of Crmb 60 = Rs 4827.409/ cumtr

Pure Bitumen VG 40

Qty of Bitumen =124.26 kg

Vg40 Cost =124.26 x 40.942 = Rs.5087.45 / cumtr

Difference between CRMB 60 and VG 40 = Rs. 260.041 / M3

(5087.45 - 4827.409)

Saving = 260.041/5087.45 = 5.1 %

Hence saving of 5.1 % per cu mtr

(Rate Refences for VG30, VG40, CRM enclosed)

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MAGNOVA		1A				Dated		1
G-25A, LGF, V			MAG-103-20	022-23		10/01/2023		
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GST IN-07AA	BCL2089G1ZJ		Denveryno			7813 1046 6439		
STATE- DELH	II , CODE-07	Supplier's R	ef.		Other Ref	erence	]	
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NKC PROJEC	T PRIVAT LIMITED		HR55AK607	5		10/01/2	023	
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1	BITUMEN	/G 30	27132000	27210 KGS	40.40	KGS	1099284.00	
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					Тах	able Value	1099284.00	
						IGST 18%	197871.12	2
						R/OFF	-0.12	-
						Total	1297155.00	-
						Total	1297133.00	1
Amount Char	rgeable (in words)	on Thousand One h	Jundrod Eifty I	ive Only				
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Please draw of	cheque /PO/DD in favour	of "MAGNOVA PET	ROCHEM	BANK NAM	IE -INDUSI	ND BANK		
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accepted.	ncy shall be intimated wit	hin three days	BRANCH & IFSC- RAJOURI GARDEN ,					
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Customer's	Seal and Signature				MAGNO	VA PETRO	CHEM PVT LTD	
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#### 1.0 SCOPE

This work shall consist of construction in a single course having 50 mm to 100 mm thickness of compacted crushed aggregates premixed with Modified bitumen binder on a previously prepared base to the requirements of contract Specifications.

#### 2.0 Reference: -

Reference Documents:-

- I. Ministry of Road Transport & Highway Specifications.
- II. Concession Agreement Vol. I, Schedule D.
- III. IRC: SP:87-2013

IV. IRC:111-2009

V. MS-2 6<sup>th</sup> Revision

#### **3.0 RESOURCE ARRANGEMENT**

PLANT & EQUIPMENTS: Batch type Hot Mix Plant of Capacity 200 TPH.

The other key Equipments are listed as under:

Sl. No.	Name of the Equipment	Nos.
1	Sensor paver	01
2.	Pneumatic Tyred Roller	01
3.	Tandem Vibratory roller	02
4.	Bitumen Sprayer	01
5.	Compressor /Hyd Broom	01
6	Water Tanker	01
7.	Tipping Trucks	As Required.

Note: The above requirement is for 1 team only. As and when the workload warrants, additional equipment, men, and machineries shall be put in to action.

#### 4.0 MATERIALS

1.	Aggregates	aggregate as approved source
2.	Filler	lime or cement as approved source
3.	Bitumen/Modified bitume	en approved source
4.	Tack coat	approved source

#### SOURCE OF MATERIALS

The coarse aggregates and fine aggregates will be sourced from approved quarry.

Tack coat material will be Bituminous Emulsion rapid setting from approved source

Bitumen will be from approved source. The Mix will be composed of a mixture of coarse and fine aggregates, modified bitumen, and mineral filler and other additives when required. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading and physical requirement of the specifications.

The percentage of Bitumen/modified bitumen and other additives shall be as approved by the Authority's Engineer prior to use.

#### 5.0 JOB MIX FORMULA

The job mix formula will be designed in the site laboratory along with the Contractor / AE Rep. The job mix binder shall be as per the job mix formula approved.

#### 6.0 HOT MIX PLANT

The hot mix plant shall be of the Batch mixing type having computerized controls and capacity to produce mix of about 200 TPH shall be so designed, equipped, and operated that the weighing, proportioning, and mixing of the materials will result in a uniform and satisfactory bituminous mix. The Batch mixer process combines the heating and drying of the aggregates and it's mixing with liquid bitumen within the drying drum. The different aggregate sizes shall be kept separated until they have been delivered to the cold feeder. When mineral filler is required in the mix, it shall be fed in separately or from the other aggregates. The dried and heated aggregates, and mineral filler, when required, shall be introduced into the drum mixer until in amounts and at temperatures such that the mixture produced is within the specified limits. Mixing time shall be controlled to obtain a complete uniform coating and mixing of the aggregate particles and thorough distribution of the bitumen throughout the aggregates.

#### 6.1 EQUIPMENT FOR STORAGE OF BITUMEN/MODIFIED BITUMEN [If Any]

The Bitumen/Modified Bitumen will be sourced from reputed manufacturer delivered to and stored in automatic temperature-controlled storage tanks. A circulating system for bituminous material shall be provided and shall be capable of proper mixing of additives.

#### 6.2 COLD AGGREGATE FEED EQUIPMENT

Cold bins and a feeder system shall be used to proportion the aggregates and feed them to the dryer. Separate cold bins shall be used for each size aggregate and dust being used and shall provide a uniform and continuous flow.

#### 6.3 DRYER

The plant shall have a dryer, which continuously agitate the aggregate during the heating and drying process maintaining temperature of aggregate between 150°C to 170°C

#### 6.4 CONTROL UNIT FOR FILLER (CEMENT)

Weighing system shall be provided to introduce the proper amount of filler in the mix.

#### 6.5 THERMOMETRIC EQUIPMENT

A thermometric device shall be fixed in the bitumen feed line. The dryer shall be equipped with an automatic burner control device, which shall use an approved thermometric instrument, located in the discharge chute, to actuate the controls.

#### 6.6 POLLUTION CONTROL EQUIPMENT

The plant shall be equipped with such pollution control equipment as is necessary to meet applicable pollution requirements.

#### 6.7 SAFETY REQUIREMENTS

Adequate safety devices shall be provided at all points where accessibility to plant operations is required. Accessibility to the top of truck bodes shall be provided by a platform or other suitable device to enable the Q.C persons to obtain sampling and mixture temperature data. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area.

#### 7.0 MIXING

The essential ingredients in the process are aggregates, binder, and flame combines in the mixing drum where conditions suitable for the addition of binder are established. The binder and aggregate are combined in an inert atmosphere from which oxygen has been excluded by steam and the products of combustion.

Sophisticated cold feed and binder control systems provide the ability to meet grading requirements accurately with complete control over binder content and aggregate grading. Aggregate rate of flow indicators and binder flow meters monitor and maintain aggregate grading and bitumen content in accordance to job mix formula requirements.

The parallel flow where the aggregate and exhaust air flow in the same direction results a better and more immediate heat transfer from the heating medium to the aggregates. These results in lower fuel consumption, reduced requirements for exhaust air and consequently a reduction in the fuel consumption for any given moisture removal. Since mixing is carried out in a steam laden inert atmosphere, the releases of dust and particulate matter during the drying process is minimized and as a result, the maximum amount of very fine dust particles are maintained in the mix where they are required instead of being released to the atmosphere.

Temperature of bitumen to be maintained between  $160^{\circ}$ C to  $170^{\circ}$ C. Aggregate temperature to be maintained between  $160^{\circ}$ C to  $175^{\circ}$ C. Provided also that at no time shall the difference in temperature between the aggregate and binder not exceed  $14^{\circ}$ C.

#### 8.0 TRANSPORTATION OF BITUMEN MIXTURE

The mix from the hot mix plant will be loaded in the tippers having capacity to load up to suitable capacity. The mixture having maximum temperature 170<sup>o</sup>C shall then be transported from the mixing plant to the point of use in vehicles which will have tight, clean, smooth metal beds that have been sprayed with an approved release agent, or other approved material, to prevent the mixture from adhering to the beds. Each load of mixture shall be fully covered with a tarpaulin or other suitable material.

#### 9.0 PREPARATION OF BASE

The base on which Bituminous Concrete is to be laid shall be prepared in accordance with specifications. The surface shall be thoroughly swept clean by a hydraulic broom, and dust removed by sweeping / air.

Tack coat will be applied with mechanical sprayer using approved rapid setting bituminous emulsion. The application of tack coat shall be at the rate 0.20 to 0.25 Kg/m<sup>2</sup>. The temperature of emulsion shall be 20°C to 70°C. It will be checked at site by doing tray test for which one Q.C person will be available at site of work with the required testing equipments. Sufficient time will be allowed for emulsion to cure until volatiles have evaporated before BC layer is started. After which laying of BC will be done with sensor paver as per most specifications.

#### 10.0 SPREADING AND FINISHING

Sensor wire will be fixed over brackets having 10m intervals. The brackets will be kept away from the paver at suitable distance so that paver movement is not affected. The levels will be fixed for sensor wire and brackets in such a way that the designed levels are obtained for the layer to be laid. The levels of laid surface and that of sensor brackets/wire will be continuously checked during laying. Bitumen mix will be transported to site and will be unloaded by the tippers into the hopper of sensor paver in such a way that no material falls outside the hopper. After the unloading is over the next tipper will be brought for unloading of mix.

The bitumen mixture shall be spread and finished to the required grades, cross sections, thickness, and widths shown on the drawings, by paver. The temperature of mix at the time of laying shall not be less than 150°C. The paver shall be equipped and operated with a fully activated screed plate. The screed shall be extendable up to full width requirement of site. For loose thickness around 25 % allowance will

of be given to achieve required compacted thickness. The paver shall be equipped with a receiving hopper and an automatically controlled distribution system which is capable of uniformly maintaining a proper head of material in front of the full length of the screed. The screed is fitted with tampers and vibrators and has an automatic control system. The paver shall be operated at forward speeds consistent with satisfactory laying of the mixture, plant production, and material delivery in order to provide a uniform and continuous lay down operation. Coordination of the paving operation and the loading operation shall be adjusted to maintain an adequate amount of bitumen mixture in the paver hopper. Paver shall be equipped with a screed control system, which will automatically control the longitudinal profile and cross slope of the pavement.

Manual operation will be used in the construction of irregularly shaped and minor areas. Paver shall not be used for spreading and finishing where irregularities or obstacles make their use impractical. Manual methods shall be used to spread, and level and compact the mixture in these areas.

Control on compacted thickness will be kept by checking the laid thickness regularly with the helpdepth gauge, which will be available at site.

#### 11.0 **COMPACTION**

Immediately after the bitumen mixture has been spread, struck off, and surface and edge irregularities adjusted rolling and uniformly compacted. The degree of compaction required shall be in accordance with the applicable section of the specifications for the type of mixture being placed. Laid surface shall be compacted using Vibratory Tandem and PTR. Vibratory roller shall have variable frequency and amplitude capability. The roller will be equipped with controls, which automatically disengage the vibration mechanism before the roller stops when being used in the vibratory mode.

Roller used to compact the mixture shall be in good condition. The roller shall be operated with the drive wheels nearest the paver and of uniform speeds slow enough to avoid displacement of the mixture. The weight of roller shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Rolling shall be done from the lower end first and roller will move towards higher side during rolling. The number of passes for tandem roller for initial rolling and final rolling and for number of passes for PTR will be determined at site during the trials. Compaction rolling shall be completed prior to the mixture cooling. Finish rolling shall be performed to remove roller marks resulting from the compaction rolling operations. In areas inaccessible to equipment, the mixture shall be thoroughly compacted by the use of hand tampers or hand operated mechanical tampers. However, rolling shall be completed before temperature fall below 100°C.

Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller. The required frequency of testing is defined in MORT&H, Section 900. C.R

#### 12.0 **QUALITY CONTROL**

Testing of aggregates will be carried out for approval in site laboratory.

During production of bituminous concrete, for every consignment of Bitumen, tests like Softening point, Penetration and viscosity shall be tested jointly at manufacturer's laboratory after sampling the bitumen at delivery point. The remainder of the requirements as per IS: 73 will be covered by test certificates provided the manufacturer. Core cutting shall be done after 24 hours and density will be checked in laboratory.

As per MORT&H, Section 900 - Control test for Bituminous mixes and their frequency as given below.

Type of Test	Frequencies
Quality of binder	Initially two sample per lot subsequently on as required basis.
Aggregate Impact Value	One test per 350 cum or at least one test for one production day (MORT&H Section 900).

Flakiness/ Elongation Index	One test per 350 cum or at least one test for one production day (MORT&H Section 900).
Stripping value	Initially one set of 3 samples from each source and subsequently on required basis or change of source.
Soundness (Magnesium and Sodium Sulphate)	Initially one determination by each method from each source and subsequently on required basis or change of source.
Water absorption	Initially one set of 3 samples from each source and subsequently on required basis or change of source.
Sand Equivalent Test	As on required basis.
Plasticity Index	As on required basis.
Mix Gradation	One set of tests on individual constituents and mixed aggregates from the dryer for each 400 tons of mix subject to a minimum of two tests per plant per day.
Stability of Mix	A set of 3 Marshal specimens per 400 tonnes of mix production subject to a minimum of two sets per plant per day.
Water sensitivity of mix	As on required basis
Swell test on mix	As on required basis for bituminous concrete.
Stone polishing value	As on required basis for bituminous concrete or change of source.
Temp control	At regular intervals
Binder Content	One test @ 400 tonnes of mix subject to a minimum of two tests per day per plant.
Rate of spread of mixed Material	After every 5 <sup>th</sup> Truck load
Density of compacted layer	One test @ 700 m <sup>2</sup> area
Percentage of fractured faces	When gravel is used, one test per 350 cum of aggregate.

#### 13.0 TRAFFIC DIVERSION ARRANGEMENTS

Proper arrangements for traffic diversion will be made by using safety cones, plastic/ nylon rope and caution boards etc. Flagmen will be engaged on start and end of the diversions.

#### 14.0 JOINTS

#### 14.1 TRANSVERSE JOINTS

When the laying of the mixture is to be suspended long enough to permit the mixture to become chilled, a transverse joint shall be constructed. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter/ pavement breaker and surface painted with hot bitumen before placing fresh material.

The joint shall be constructed square to the lane alignment and all excess materials shall be removed and cut back into the previously constructed pavement to the point of full pavement depth. The exposed edge of the previously constructed pavement shall then be lightly coated with tack coat.

#### 14.2 LONGITUDINAL JOINTS

The paver used by us covers up to required width. There will be no longitudinal joints. However, if, in any case longitudinal joints are to be made longitudinal joints edges shall be constructed true to the delineating line parallel to the centreline of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 90<sup>o</sup> C before laying of adjacent material.

#### 15.0 Surface Finish and Quality Control of Work

The surface finish of the completed construction shall conform to the requirements of Clause 902. For control of the quality of materials supplied and the works carried out, the relevant provisions of Section 900 shall apply.

#### **16.0 OPENING TO TRAFFIC**

The final surface will be allowed for traffic movement after 24 hours

#### Chapter no 08

# MORT&H specifications:

	garn (near bhandhan) Raj	asthan under Bharatma	ala Pariyojana (Ph	ase-1) (AJ/RD-Pa	ckage-5)	
	EPC CONTRCTOR	AUTHORITY'S	ENGINEER		CLIENT	
NKC	PROJECTS PVT. LTD.	SA INFRASTRUCTURE	CONSULTANT PVT.	NATIONA	L HIGHWAYS AU	THORITY OF INDIA
	MAXIMU	SP. GRAVITY	OF BITUMIN	OUS PAVIN	IG MIXTU	RES
		(AA)	ASTHO T 209, AST	M D 2041)	aen	COMB-LO
ate of	Sampling	: 04108121		Source of Mate	erial	Tippa Rubber
ate of	Testing	: 06/08/2/	La Cam Pl	Kind of Materia	al	BC Mix
ocation	n Of Test	: 146+200CH3(B	aze camp	1		
	-	DESCRIPTION		OBSER	2	Remarks
51. 140.				5	5	
	Weight of Elask + C	orks	(g)	2433.0	\$423.0	
6	Weight of Flask + C	orks + Water	(g)	10127.0	10127.0	
0	Weight of Sample it	n air	(g)	2514.5	2497.0	
5	Weight of Elask + C	Corks + Water + Samp	le (g)	11579.2	11570.0	
-	The sectors of wa	tor	°C	27.00	27.00	
	Moight of Replace	d Water (D-(E-C))	(g)	1062.3	1054.0	
	Max SP. Gravity of	Material (D/G)		2.367	2.369	
<u> </u>	Augusta Max Spa	cific Gravity of Materia	als	23	68	
	Average Max. Spe	July July			A.E	/Client Rep.

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Effe	C PROJECTS PVT.		AUTHORITY'S EN	GINEER	
Effe		LTD. SA INI	RASTRUCTURE	CONSULTANT	NAT
	ctive Specific	Gravity & Maxin	num Specifi	Gravity of F	Paving
					aving
Eff	ective Specific	Gravity (Gse)	Gse =	Pmm - Pb	
-				Pmm - Pb	
At 5 0% F	Bitumen Conte	nt Gmm	- 3 370		
Ge	se =	100 - 5.0/((100/2.	379)-(5.0/1.1	100)) = ;	2.534
At 5.5 %	Bitumen Conte	ent Gmm	= 2.368		
Gs	ie =	100 - 5.5/((100/2.	368)-(5.5/1.1	100)) =	2.538
	Varage Con				
<b></b> ^	iverage Gse	:- 2.536			
	Maxi	mum Specific 6	ravity of Pa	aving Mix (G	Smm)
		Pmm	,		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
	= -	(P <sub>s</sub> / G <sub>se</sub> + 1	P <sub>b</sub> / G <sub>b</sub> )		
-					
	SI.No	Bitumen Co (%)	ontent	Maximun Pav	ing M
	1	4.0	*		2.4
	2	4.5	10 - C		2.3
	3	5.0			2.3
	4	5.5			2.3

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EPC CONT	RCTOR	AUTHORITY	'S ENGINEER	
NKC PROJECTS	S PVT. LTD.	SA INFRASTRUCT	URE CONSULTANT	NA
Effective Spe	cific Gravity	& Maximum Spe	cific Gravity of I	Paving
Effective Spe	ecific Gravity (C	Gse) Gse =	Pmm - Pb	
			Gmm - Gb	
t 5.0% Bitumen C	ontent	Gmm = 2.379	÷	
Gse =	100 - 5.0/	((100/2.379)-(5.0	)/1.100)) =	2.534
t 5.5 % Bitumen C	Content	Gmm = 2.368		
Gse =	.100 - 5.5/0	((100/2.368)-(5.5	5/1.100)) =	2.538
Average	Gse :-	2.536		
P	laximum Spo	ecific Gravity o	f Paving Mix (O	Gmm)
	=	Pmm		
	(P <sub>s</sub> /	$G_{se} + P_b / G_b$		
SI.No	Bitu	(%)	Maximun Par	n Spe ving M
SI.No	Bitu	(%) 4.0	Maximun Par	n Spe ving N 2.4
<b>SI.No</b> 1 2	Bitu	4.0 4.5	Maximun Par	n Spe ving N 2.4 2.3
SI.No 1 2 3	Bitu	4.0 4.5 5.0	Maximum Par	n Spe ving N 2.4 2.3 2.3
SI.No 1 2 3 4	Bitu	4.0 4.5 5.0 5.5	Maximun Par	n Spe ving 1 2.4 2.3 2.3 2.3

	EPC COI	VTRCTOR	AITUAN	Pro cuonera		6.6
			MOUTON	IT'S ENGINEER		CLIENT
	NKC PROJEC	CIS PVT. LTD.	SA INFRASTRUCTUR	E CONSULTANT F	VT. LTD.	NATIONAL HIGHWAYS AUTHORITY OF INDIA
T		Test Pr	operty Curves for Hot Mix	Design Data b	y the Marshall I	Method
ž	Air voids %	Figure:1 (Modified Bit	umen vs Air voids )	Binder %	VMA %	Figure:2 (Modified Bitumen vs VMA )
-		10.0 545% Modified Situmen (c	RMB-60) @ Air voids= 3.50%			18.0
	8.92	80		4.0	15.81	- VXA @ 5.458 Modfed Bitumen (2MB-60) = 13.5 %
	6.47	60		45	14.53	16.0
	437			5.0	13.58	150
	3.42	20		55	13.73	HO
	2.98	0.0 AD AC EA		6.0	14.30	011
						30 35 40 45 50 55 60 65
*	VFB %	Figure:3 (Modified B	ftumen vs VFB)	Binder %	Unit weight	Figurest (Modified Bitumen vs Unit Weiehth £/cc)
		100 on VFB @ 5.45% Modified Bitume	n (COMB-60) = 74.0%		0	335
	43.58	8		4.0	2,195	1325 Unit version finance (2006.0) = 2.38y/cc
	55.47	2		45	224	282
-	67.82	20		5.0	2277	
	75.09	8		5.5	2.285	115 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
	79.16	30 35 40 45 50	0 55 60 65 70	6.0	2282	30 35 4.0 4.5 5.0 5.5 6.0 6.5 7.0
	-					
	Stabillity Kg.	Figure:5 (Modified Bitu	men vs Stability )	Binder %	Flow (mm)	Figure:6 (Modified Bitumen vs Flow )
-		Stability @ 5.45% Modified Bitumen	(CRM8-60) = 1350Kg			8.0 Flow Value @ 5.455 Modified Bhumen (Couns. kn) = 2.4444
-	1189	1400	4	4.0	237	60 60
-	1249	1200	1	45	2.70	50 40
	1325	100		5.0	3.17	30
-	1357	8		55	3.30	10
_	1301	25 3.0 3.5 4.0 4.5 5	0 CC K0 KC 70			

2

120

		4							Average Flaw	(100)			3.37										23
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	ENI	AUTHOR		.786	536	586	.100	9.08.2021 &		Average Load (OO)			1380					1267				1	Je.
ackage-5	3	HIGHWAY			T					(RN)		1323	1425	1391			1255	1255	1289				the star
(AJ/RD-P		ATIONAL							farshall Stabil	American (		100	1.00	1:00			100	00. 1	1:00				
Phase-I)		-	24 hrs							(KG)		1323	1425	1391			1255	1255	1289				
iyojana (			c. for		(Gse)	e (Gsa)	avity			Preven ring reading		195	210	205			185	185	190				
mala Par		Ë	60 deg		of aggregate	of aggregat	RMB-60 Gr		oid's filled by Blumen (VFB)(%)	VFB=100X VAM-Va)/ VMA			74.13		22.94			74.13		9	9		
ler Bharat	EER	TANT PVT.	3C-1)@	g Ring Facto	ive Sp.gravity	ent sp.gravity	ied Bitumen	f Testing	in Miserel V gragate MA) (%)	Melto- brobytes			13.72		/Flow:4	3		13.72		1380 K	1267 K	6 1816	
than und	Y'S ENGIN	CONSUL	sheet (F	Provin	Effecti	Appar	Modif	Date o	Void's Ag	Ommo (Gai vy	5		s		Satbility	60 deg		55					
of Rajas	NUTHORIT	RUCTURE	Data :	-	74	80	8.8	8 8	calMan. Adr. antig (Ya)	A1 Comb	60 de		368		otient =	iter at		368	-				
the state		A INFRASI	trengt	GRAVITY	2.5	2.5	2.5	57	st balls Theorie dity Sp. g. (0)		ater at		34 2		irshal Qu	n in wa		2.					
orridor in		ŝ	insile S	SPECIFIC (	+	$\left  \right $	-	+	Average detail	Cash	n in w	25	85 22	84	Ma	ecimeı	8	84 22	86	×	٨	e Strength	
nomic Co	-	-	ined Te		2.532	2.527	2.511	2.403	Partie Bulk D	in the second	becime	0 22	5 22	0 22		test sp	.0 2.2	0 22	5 23	all Stabilit	all Stabilit	ned Tensil	
agar Eco			Reta		-			+	pht of Balk V		e test s	0 52	0 520	521		se the	52	25	52	min. Mars	hrs Marsl	tivity/Reta	
sarJam	~	Ë		PROPORTIC	14	22	10.5	2	ef SSD Wei in specia	EW .	rse the	196	1611	0		immeı	6611 0	611	1611	e after 30	e after 24	later Sensi	
of Amrit	DNTRCTO	ECTS PVT.		XIM %					Weight air specimen	3.73	imme	672.(	670.	671.0		hours	671.0	671.1	119	Averag	Averag	% of M	·
	EPCO	NKC PROJ		EGATE					Weight o specimen in (gm)	Į.	30 mir	1192.0	1189.5	1:90.0		fter 24	1191.5	1192.0	1000				
				E OF AGGR	o 20MM)	( 12MM)	(MWL o	Dust)	Bitumen Costent (%	£	0-1, @		5.45			p-2, A		5.45					Z
				S	K-1 (30MM	K-2 (20MM	K-3 (12MM	Filler (Rock	Test Specime	ź	Groul	-	13	e	2	Grou	4	~	ø				Remark:-

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asthan under Bharatmala	CLIENT	HIGHWAYS AUTHORITY OF INDIA		Vol.of bitumen in mix Vb bitspgrpf bt/(Wt.of mix/Gmm)	0 11.73				AEJ Client Ren.
tate of Raja		NATIONAL I		g.Eff. Air V( Þ.Gr (Vã Sse (Vã	536 3.5				
dor in the s -5)			itumen)	Agg.App Ag Sp.Gr S Gsa (	2.586 2				
omic Corri -Package		NT PVT. LTD	ne of B	Agg.Bulk Sp.Gr Gsb	2.503	X 100			
gar Econo -I) (AJ/RD		E CONSULTA	(Volun	Mix Max. Sp.Gr Gmm	2.368	en nen (Gb) Gmm)			
sar-Jamna ina (Phase	AUTHORIT	ASTRUCTURI	of Vb	Sp.Gr of Modified Bitumen (CRMB-60) Gb	1.100	odified Bitum Aodified Bitur (t. of Mix avity of Mix ((	X 100	X 100	
part of Amrte Pariyoja		SAINFR	Iculation	Gmb as mentioned in summary	2.284	Wt. of M Sp. Gravity of N W Max. Sp. Gr	64.88 1.100 2.368 2.368	58.98 502.74	11.73
1 0411 03 0			Ca	Wt.of Modified bitumen (CRMB-60)	64.88				
	RCTOR	S PVT. LTD.		Wt.of mix Avg. of marshall specimens	1190.50	9	9	q	2 Pr
han Infram	EPC CONTRCTOR	(C PROJECT)		% OBC	5.45			2	Rep. L
Cliardi		Ň		Mix	3C Grade-I				Chevel



### Chapter no 09

Crmb mix design

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Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC C	ONTRCTOR		AUTHORIT	Y'S ENGI	NEER	CLIENT		
						NATIONAL		
NKC	PROJECTS	PVT <mark>.</mark>	SA	INF	RASTRUCTURE	HIGHWAYS		
LTD.			CONSULT	ANT PVT.	LTD.	AUTHORITY	OF	
						INDIA		
DITUN		DETE						

BITUMINOUS CONCRETE (BC) GRADE-I WEIGHT CHART

-					
SL NO	TYPE OF MATERIAL	Mix Ratio (%)	Combined Mix Ratio (%)	UNIT WEIGHT (kg/M3)	WEIGHT /M3
1	Modified Bitumen CRMB-60 With Anti Stripping 0.05%	5.45	5.45		124.1
2	K-1 ( 30mm to 20mm) Aggregate	14	14		318.8
3	K-2 ( 20mm to 12mm) Aggregate	25	25	2277	569.3
4	K-3 ( 12mm to 7mm) Aggregate	10.5	10.5		239.1
5	K-4 (7mm Down) Aggregate	48.5	48.5		1104.3
6	Filler (Rock Dust)	2	2		45.5
Individ	lual Batch Weight C	hart			

SL NO	TYPE OF MATERIAL	Mix Ratio (%)	Combined Mix Ratio (%)	1200 kg Batch	1500kg Batch	1800kg Batch
1	Modified Bitumen CRMB-60 With Anti Stripping 0.05%	5.45	5.45	65.4	81.8	98.10
2	K-1 ( 30mm to 20mm) Aggregate	14	14	168.0	210.0	252.0
3	K-2 ( 20mm to 12mm) Aggregate	25	25	300.0	375.0	450.0
4	K-3 ( 12mm to 7mm) Aggregate	10.5	10.5	126.0	157.5	189.0
5	K-4 (7mm Down) Aggregate	48.5	48.5	582.0	727.5	873.0
6	Filler (Rock Dust)	2	2	24.0	30.0	36.0

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC		
CONTRCTOR	AUTHORITTSENGINEER	CLIENT
		NATIONAL
NKC PROJECTS	SA INFRASTRUCTURE CONSULTANT	HIGHWAYS
PVT. LTD.	PVT. LTD.	AUTHORITY OF
		INDIA

Summary of Bituminous Concrete (BC-Grade I)

K1 : K2 : K3 : K4 : FILLER(ROCK DUST) (14 : 25 : 10.5 : 48.5 : 2)

1. Material Sources

a Coarse Aggregate

Agolai (Jodhpur)

b.	Fine Aggregat	е	Agolai (Jodhpur)					
С	Anti Stripping	Agent	Zycotherm (Vadodara)					
d.	Modified E (CRMB-60)	Bitumen	Tinna Rub	ber & infrastru	cture Ltd.			
2.Te	emparature Cha	rt During	Mix Desig	n				
Bitu	ımen Grade	Bitumer	า	Aggregate	Mixed Material	Compaction		
		Tempar	ature	Temparature	Temparature	Temparature		
Moo (CR	lified Bitumen MB-60)	165 to 1	85 °C	165 to 185 °C	150 to 170 °C	115 to 155 °C		
3. T	est Summary							
					Specified Limit			
Nan	ne of test		Unit	Test Results	As Per MORT&H	Remarks		
					5 <sup>th</sup> Revision &			
					IRC:SP:53:2010			
Con	npaction Level		75 Blows of	on each face of	the Specimen			
Bin	der Content		%	5.45%	Min. 5.4			
Stat	oility(KN at 60°0	C)	KN	13.53	Min 12.0			
Mar	shall flow (mm)		mm	3.3	2.54			
Mar (Sta	shal billity/Flow)	Quotient		4.10	2.55	1		
Air	/oids	}	%	3.5	3.5			
Void (VFI	ls filled by B)	Bitumen	%	74	6575			
Void (VM	ls in mineral ao A)	ggregate	%	13.8	Min 11.5			
Fille	r-Bitumen Ratio		%	1.03	0.6 - 1.2			
Bulk	Specific Gravity	/ (Gsb)		2.504				
App (Gsa	arent Specific a)	Gravity		2.588				
Volu	ume of Bitumen (	(Vb)	%	11.7	11.2			
Des	ign Density (gmb	<b>b</b> )	g/cc	2.277				
Max Pav	timum Sp. Gra ing Mix (Gmm)	avity of	g/cc	2.361				

PHYSICAL MORT&H Tal	TEST DATA OF COAR ble 500-16 & IRC SP 53 2010	SE A	GGREGAT	E FOR BC	Grade-I
Property	Name of test	Unit	Test Value	Specification	Methode of Test
Cleanliness (Dust)	Graine size Analysis	%	1.52	5 Max.	IS 2386 Part -I
Particle Shape	Combined Flakiness and Elongation Index.	%	28.71	35 Max.	IS 2386 Part -I
Strength	Aggrgate Impact Value	%	18.56	24 Max.	IS 2386 Part -IV
Atterberg	Liquid Limits	%	21.7	-	IS 2386 Part V
Limit	Plasticity Index	%	N/P	Max 4.0%	IS 2386 Part V
Durability	Soundness : Sodium Sulphate	%	0.80%	12 Max.	IS 2386 Part-V
Water absorption	Water absorption	%	1.3	2 Max	IS 2386 Part-III
Stripping Value	Afteradding0.05%ofAntiStrippingAgentbyWeightofBitumen </td <td>%</td> <td>100%</td> <td>Minimum retained Coating 95%</td> <td>IS 14982</td>	%	100%	Minimum retained Coating 95%	IS 14982
Stripping Value	Coating and Stripping of Bitumen Aggregate Mix	%	100%	Minimum retained Coating 95%	AASHTO T-182
Polishing	Polished Stone Value	%	69%	Minimum 55%	BS-812- 114
Indirect Tensile Strength	Indirect Tensile Strength	%	91.22%	Minimum 80%	AASHTO T 283
Resilient Modulus	MR Value	Мра	3165	Min. 3000 Mpa	ASTM D 4123
Water sensitivity	Retain tensile Strength	%	91.76%	Minimum 80%	AASHTO 283

MODIFIED BITUMEN ((CRMB-60) TEST SUMMARY AS PER IS 17079-2019								
Test	Result	Specified Value						
Penetration at 25°C, mm	43.0	20-50						
Softening Point ,ºC	63.3	Min. 60						
Elastic Recovery in Ductilometer at 15 <sup>0</sup> C	65.0	Min. 60%						
Specific Gravity, g/cc	1.100	1.15±0.05						

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amrits Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
NKC PROJECTS PVT. LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.	NATIONAL HIGHWAYS AUTHORITY OF IND

INDIVIDUAL GRDATION K1-(30MM-20MM)(WET SIEVEING)

Date of Sar	mpling					Date of Te	esting	:	
		12.05.2021				12		13.05.2021	
Source		: Ag <mark>olai (Jod</mark>	hpur)			Type of M	laterial	: K1-(30MN	1-20MI
K1 /20NANA	201414)	Total	26320	Sample	K1 (20NAN	4 201414)	Total	24140 gm	Sam
K1-(30101101	-20101101)	weight =	gm	No. 01		/1-20101101)	weight =	24140 gill	No. (
Sieve	Wt	Retained	Cum.	Passing	Sieve	Wt	Retained	Cum.	Dace
Size (	Retained	(0/)	Retained	r assing	Size (	Retained	(0/)	Retained	(0/)
mm)	(gm)	(70)	(%)	(70)	mm)	(gm)	(70)	(%)	(70)
26.5	0	0	0	100	26.5	0	0	0	100
19.0	13434	51.04	51.04	48.96	19.0	12159	50.37	50.37	49.6
13.2	9828	37.34	88.38	11.62	13.2	9335	38.67	89.04	10.9
9.5	2306	8.76	97.14	2.86	9.5	1907	7.90	96.94	3.06
4.75	676	2.57	99.71	0.29	4.75	678	2.81	99.75	0.25
2.36					2.36				

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1.18			1.18		
0.600			0.60		
0.300			0.300		
0.150			0.150		
0.075			0.075		

K1-(30MM	1-201/11/1)	Total	22360	Sample	K1-(30MA	A-20NANA)	Total	24110 gm	Sam
	1 201011017	weight =	gm	No. 03	KI (50MM	20101101)	weight =	24110 811	No.
Sieve	Wt	Retained	Cum.	Passing	Sieve	Wt	Retained	Cum.	Pass
Size (	Retained	(%)	Retained	(%)	Size (	Retained	(%)	Retained	(%)
mm)	(gm)	()0)	(%)	(70)	mm)	(gm)	(70)	(%)	(70)
26.5	0	0	0	100	26.5	0	0	0	100
19.0	11372	50.86	50.86	49.14	19.0	12231	50.73	50.73	49.2
13.2	8300	37.12	87.98	12.02	13.2	9306	38.60	89.33	10.6
9.5	1923	8.60	96.58	3.42	9.5	1912	7.93	97.26	2.74
4.75	707	3.16	99.74	0.26	4.75	583	2.42	99.68	0.32
2.36					2.36			1	
1.18	2				1.18				
0.600	2				0.60		~		
0.300	V.				0.300	C.C.	K .		
0.150		<i>.</i>			0.150	1.3			
0.075				The second se	0.075	•			

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC	AUTHORITY'S	
CONTRCTOR	ENGINEER	CLIENT
NKC PROJECTS	SA INFRASTRUCTURE	NATIONAL HIGHWAYS AUTHORITY OF
PVT. LTD.	CONSULTANT PVT. LTD.	INDIA

INDIVIDUAL GRDATION K2-(20MM-12MM) (WET SIEVEING)

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		:							:	
Date of	Sampling	12.05.202					Date of T	esting	13.05.202	
		1							1	
Sourc									: K2-	(20MM-
е		: Agolai (Jo	anpur)				Type of N	/laterial	12MM)	
				Sampl	ſ			Total		Sampl
K2-(20	MM-	Total	18560	e No.		K2-(	20MM-	weight	17480 gm	e No.
12MM)		weight =	gm	01		12N	IM)	=		02
					1	Sie				
						Ve				
Siovo	\ <b>\/+</b>		Cum			VC Ci7	\ <b>\</b> /+		Cum	
Sizo	Potainad	Retained	Potaina	Passin		512	Potaina	Retaine	Potainod	Passin
(	(am)	(%)		g (%)		e (	d (area)	d (%)		g (%)
( mm)	(gm)		a (%)			(	a (gm)		(%)	
						m				
			<u></u>			m)				
26.5	0	0	0	100		26.	0	0	0	100
	ľ					5				
19.0	397	2 14	2 14	97.86		19.	341	1 95	1 95	98.05
15.0			2.11	57.00		0		1.55	1.00	50.05
12.2	10611	57 17	50.21	40.60		13.	0971	56.47	E9 42	<i>1</i> 1 E0
15.2	10011	57.17	59.51	40.69		2	9871	30.47	56.42	41.50
9.5	3538	19.06	78.37	21.63		9.5	3597	20.58	79.00	21.00
4 75	3703	19.95	98 32	1.68	1	4.7	3367	19.26	98.26	1 74
	0,00		50.02	1.00		5		10.20	50.20	
2 36	215	1 16	00 / 8	0.52		2.3	224	1 28	99 51	0.46
2.30	215	1.10	55.48	0.52		6	224	1.20	55.54	0.40
1 10					Ē	1.1				<u> </u>
1.10						8				
0 600						0.6				
0.000						0				
0.200					ŀ	0.3				
0.300						00				
					F	0.1				
0.150						50				

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0.075		

75	0.0		
	75		

K2-(20MM- 12MM)		Total weight =		19340 gm	Sampl e No. 03
Sieve Size ( mm)	Wt Retained (gm)	Retained (%)		Cum. Retaine d (%)	Passin g (%)
26.5	0	0		0	100
19.0	582	3.01		3.01	96.99
13.2	10828	55.99		59.00	41.00
9.5	3856	19.94		78.94	21.06
4.75	3680	19.03		97.97	2.03
2.36	294	1.52		99.49	0.51
1.18					
0.600					
0.300					
0.150					
0.075					

K2-(20MM- 12MM)		Total weight 18410 gm =		Sampl e No. 04
Sie ve Siz e ( m m)	Wt Retaine d (gm)	Retaine d (%)	Cum. Retained (%)	Passin g (%)
26. 5	0	0	0	100
19. 0	446	2.42	2.42	97.58
13. 2	10451	56.77	59.19	40.81
9.5	3804	20.66	79.85	20.15
4.7 5	3343	18.16	98.01	1.99
2.3 6	309	1.68	99.69	0.31
1.1 8				
0.6 0				
0.3 00				
0.1 50				
0.0 75				
Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
NKC PROJECTS	SA INERASTRUCTURE CONSULTANT DVT. I TO	NATIONAL HIGHWAYS
PVT. LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.	AUTHORITY OF INDIA

INDIVIDUAL GRDATION K3-(12MM-7MM) (WET SIEVEING)												
Date of	Sampling	: 12.05.202 : Agolai (Ic	1 odbour)				Date of Te	esting	: 13.05.2021 · K3-(12MM	J -7MM)		
K3-(12N	1M-7MM)	Total weight =	15240 gm	Sample No. 01		K3- (12MM- 7MM)	Total weig	ght =	13690 gm	Sample No. 02		
Sieve Size ( mm)	Wt Retained (gm)	Retained (%)	Cum. Retained (%)	Passing (%)		Sieve Size ( mm)	Wt Retained (gm)	Retained (%)	Cum. Retained (%)	Passing (%)		
26.5	0	0	0	100 100		26.5 19.0	0	0	0	100 100		
13.2	143	0.94	0.94	99.06		13.2	166	1.21	1.21	98.79		
9.5	2758	18.10	19.04	80.96		9.5	2142	15.65	16.86	83.14		
4.75	12024	78.90	97.94	2.06		4.75	11126	81.27	98.13	1.87		
2.36	178	1.17	99.11	0.89		2.36	126	0.92	99.05	0.95		
1.18	73	0.48	99.59	0.41		1.18	86	0.63	99.68	0.32		
0.600						0.60						
0.300						0.300						
0.150						0.150						
0.075						0.075						
					_							
K3-(12MM-7MM)		Total 14250 weight = gm		Sample No. 03	Sample (12MM- No. 03 7MM)		Total weig	ght =	16020 gm	Sample No. 04		

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Sieve	Wt	Deteined	Cum.	Dessing	Sieve	Wt	Detained	Cum.	Dessin
Size	Retained	Retained	Retained	Passing	Size (	Retained	Retained	Retained	Passing
( mm)	(gm)	(%)	(%)	(%)	mm)	(gm)	(%)	(%)	(%)
26.5	0	0	0	100	26.5	0	0	0	100
19.0	0	0	0	100	19.0	0	0	0	100
13.2	162	1.14	1.14	98.86	13.2	139	0.87	0.87	99.13
9.5	2318	16.27	17.41	82.59	9.5	2816	17.58	18.45	81.55
4.75	11490	80.63	98.04	1.96	4.75	12752	79.60	98.05	1.95
2.36	128	0.90	98.94	1.06	2.36	162	1.01	99.06	0.94
1.18	97	0.68	99.62	0.38	1.18	85	0.53	99.59	0.41
0.600					0.60				
0.300					0.300				
0.150					0.150				
0.075					0.075				

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amrits Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phas (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
NKC PROJECTS PVT.	SA INFRASTRUCTURE	NATIONAL HIGHWAYS AUTHORITY
LTD.	CONSULTANT PVT. LTD.	

# INDIVIDUAL GRDATION K4-(7MM DOWN) (WET SIEVEING)

Date of Sampling		: 12.05.202	1	wt		Date of Te	esting	: 13.05.2021	Wt 1150
Source	Sample 1	: Agolai (Jodhpur)		1260 gm	Sample 2	Type of M	aterial	: K4-(7MM [	OWN)
Sieve Size ( mm)	Wt Retained (gm)	Retained (%)	Cum. Retained (%)	Passing (%)	Sieve Size ( mm)	Wt Retained (gm)	Retained (%)	Cum. Retained (%)	Passing (%
26.5	0	0	0	100	26.5	0	0	0	100
19.0	0	0	0	100	19.0	0	0	0	100
13.2	0	0	0	100	13.2	0	0	0	100

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9.5	0	0	0	100	9.5	0	0	0	100			
4.75	100.0	7.94	7.94	92.06	4.75	102.1	8.88	8.88	91.12			
2.36	264.6	21.00	28.94	71.06	2.36	233.1	20.27	29.15	70.85			
1.18	240.4	19.08	48.02	51.98	1.18	235.6	20.49	49.64	50.36			
0.600	187.0	14.84	62.86	37.14	0.60	154.3	13.42	63.06	36.94			
0.300	169.5	13.45	76.31	23.69	0.300	147.2	12.80	75.86	24.14			
0.150	82.8	6.57	82.88	17.12	0.150	93.8	8.16	84.02	15.98			
0.075	114.2	9.06	91.94	8.06	0.075	95.5	8.30	92.32	7.68			
	L	l					L					
VA (7NA)		Total	1210 gm	Sample	K4-(7MN	Л	atal waight -					
K4-(7IVI)		weight =	1310 gm	No. 03	DOWN)		otal weight =	i weight =				
Sieve	Wt	Potainad	Cum.	Dassing	Sieve	Sieve Wt		Cum.				
Size	Retained		Retained	r assing	Size	Retain	ed	Retained	Passing (%			
( mm)	(gm)	(%)	(%)	(%)	( mm)	(gm)	(%)	(%)				
26.5	0	0	0	100	2 <mark>6.5</mark>	0	0	0	100			
19.0	0	0	0	100	1 <mark>9.0</mark>	0	0	0	100			
13.2	0	0	0	100	13.2	0	0	0	100			
9.5	0	0	0	100	9.5	0	0	0	100			
4.7 <mark>5</mark>	109.4	8.35	8.35	91.65	4 <mark>.75</mark>	121.9	9.83	9.83	90.17			
2.3 <mark>6</mark>	273.1	20.85	29.20	70.80	2 <mark>.36</mark>	234.6	18.92	28.75	71.25			
1.18	231.3	17.66	46.86	53.14	1.18	229.3	18.49	47.24	52.76			
0.600	232.0	17.71	64.57	35.43	0.60	217.6	17.55	64.79	35.21			
0.300	149.3	11.40	75.97	24.03	0.300	134.3	10.83	75.62	24.38			
0.150	98.1	7.49	83.46	16.54	0.150	77.1	6.22	81.84	18.16			
0.075	109.4	8.35	91.81	8.19	0.075	124.1	10.01	91.85	8.15			
								-				

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

FPC CONTRCTOR	AUTHORITY'S	
	ENGINEER	OLILINI

NKC	PROJEC	CTS PVT.	LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.				HIGH AUTH INDIA	ONAL WAYS IORITY	OF	I		
INDI	VIDUAL	GRDATIO	N FILL	ER (ROC	CK	DUST	T) (WET S	SIEVEIN	<u>'G)</u>		1		
Date Sampl	of	: 12.05.2 021					Date of	Testing 1	3.05.21		_		
Sour : Agolai (Jodhpur) Type of Material filler rock dust ce													
FILLER DUST)	(ROCK	Total weight =	950 gm	Samp le No. 01		FILLE	r (rock ')	C Total	Total weight =870 gm sample 2				
Siev e Size ( mm)	Wt Retain ed (gm)	Retaine d (%)	C <mark>um.</mark> Retain ed (%)	Passi ng (%)		Siev e Size ( mm )	Wt Retain ed (gm)	Retain ed (%)	Cum. Retain ed (%)	Passi ng (%)			
26.5	0	0	0	100		26. 5	0	0	0	100			
19.0	0	0	0	100		19. 0	0	0	0	100			
13.2	0	0	0	100		13. 2	0	0	0	100			
9.5	0	0	0	100		9.5	0	0	0	100			
4.75	0	0	0	100		4.7 5	0	0	0	100			
2.36	0	0	0	100		2.3 6	0	0	0	100			
1.18	0	0	0	100		1.1 8	0	0	0	100			

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0.60 0	0	0	0	100		0.6 00	0		0	0	100		
0.30 0	0	0	0	100		0.3 00	0		0	0	100		
0.15 0	0	0	0	100		0.1 50	0		0	0	100		
0.07 5	126.0	13.26	13.26	86.74		0.0 75	11:	1.7	12.84	12.84	87.16		
				Samp								86	Samp
FILLER	(ROCK	Total	010 cm	le	ļ	FILLEI	R (	ROC	< Total v	veight =		0	le
DUST)		weight =	910 BIII	No.		DUST	.)		860 gn	n		g	No.
				03								m	04
Siev	\ <b>\</b> /+					Siev	۱۸/+						
e	Potain	Potaino	C <mark>um.</mark>	Passi	-	e Sizo	Pot	ain	Potain	Cum.	Passi		
Size	netain		R <mark>etain</mark>	ng		512E	nei	lain		Retain	ng		
(	eu (am)	u (%)	e <mark>d (%)</mark>	(%)		(	eu (an		eu (%)	ed (%)	(%)	J	
mm)	(gm)					, mm	(gn	1)					
	-					)			2				
26.5	0	0	0	100	1	26. 5	0		0	0	100		
						19.		0					
19.0	0	0	0	100	1	0	0	_	0	0	100		
						13.							
13.2	0	0	0	100		2	0		0	0	100		
9.5	0	0	0	100		9.5	0		0	0	100		
4.75	0	0	0	100		4.7 5	0		0	0	100		
2.36	0	0	0	100		2.3 6	0		0	0	100		
1.18	0	0	0	100		1.1 8	0		0	0	100		
0.60 0	0	0	0	100		0.6 00	0		0	0	100		

1

2

3

100

100

100

100

100

100

99.06

98.79

98.86

80.96

83.14

82.59

2.06

1.87

1.96

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0.30 0	0	0	0	100	0.3 00	0	0	0	100
0.15 0	0	0	0	100	0.1 50	0	0	0	100
0.07 5	122.0	13.41	13.41	86.59	0.0 75	108.8	12.65	12.65	87.35

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of F													58 of Ras
(near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jar													sar-Jamn
Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Pac													D-Packag
EPC CO	NTRC	TOR	A	UTHOR	ITY'S I	ENGINE	ER			CLIE	NT		
NKC P	NKC PROJECTS PVT. SA INFRASTRUCTURE CONSULTANT PVT. NATIONAL												HIGHW
LTD. LTD. AUTHORITY OF IN											NDIA		
AVERAGE % PASSING													
Date of Sampling : Date of Testing : 12 05 2021													
12.05.2021 Date of Testing : 13.05.2021													
IS 26.5 19.0 13.2 9.5 4.75 2.36 1.18 0.60 0.300 0.150 0.075 Rem													
Sieve	20.5	13.0	13.2	5.5	4.75	2.50	1.10	0.00	0.300	0.13		0.075	Kennark
A. K1-(3	OMM-2	20MM)				1				R			
1	100	48.96	11.62	2.86	0.29	0.00	0.00	0.00	0.00	2	0.00	0.00	
2	100	49.63	10.96	3.06	0.25	0.00	0.00	0.00	0.00		0.00	0.00	
3	100	49.14	12.02	3.42	0.26	0.00	0.00	0.00	0.00		0.00	0.00	
4	100	49.27	10.67	2.74	0.32	0.00	0.00	0.00	0.00		0.00	0.00	
Average	100	49.25	11.32	3.02	0.28	0.00	0.00	0.00	0.00		0.00	0.00	
B. K2-(2	20MM-	12MM)	•	•	•		-	•					
1	100	97.86	40.69	21.63	1.68	0.52	0.00	0.00	0.00	0.00		0.00	
2	100	98.05	41.58	21.00	1.74	0.46	0.00	0.00	0.00	0.00		0.00	
3	100	96.99	41.00	21.06	2.03	0.51	0.00	0.00	0.00	0.00		0.00	
4	100	97.58	40.81	20.15	1.99	0.31	0.00	0.00	0.00	0.00		0.00	
Average	100	97.62	41.02	20.96	1.86	0.45	0.00	0.00	0.00	0.00		0.00	
C. K3-(1	2MM-7	7MM)											

IJCF	RT21X0	091	Int	ernation	al Journa	al of Crea	ative Res	earch Th	oughts (	JCRT) w	ww.ijcrt.org	f544

0.89

0.95

1.06

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4		100	100	99.13	81.55	1.95	0.94	0.41	0.00	0.00	0.00	0.00	
Av	erage	100	100	98.96	82.06	1.96	0.96	0.38	0.00	0.00	0.00	0.00	
D.	D. K4-(7MM DOWN)												
1		100	100	100	100	92.06	71.06	51.98	37.14	23.69	17.12	8.06	1
2		100	100	100	100	91.12	70.85	50.36	36.94	24.14	15.98	7.68	
3		100	100	100	100	91.65	70.80	53.14	35.43	24.03	16.54	8.19	
4		100	100	100	100	90.17	71.25	52.76	35.21	24.38	18.16	8.15	
Av	erage	100	100	100	100	91.25	70.99	52.06	36.18	24.06	16.95	8.02	
Ε.	FILLE	ER (RO	DCK DL	IST)	1	1	1	1		1			
1		100	100	100	100	100	100	100	100	100	100	86.74	
2		100	100	100	100	100	100	100	100	100	100	87.16	
3		100	100	100	100	100	100	100	100	100	100	86.59	
4		100	100	100	100	100	100	100	100	100	100	87.35	
Av	erage	100	100	100	100	100	100	100	100	100	100	86.96	

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amrits Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
		NATIONA
	SA INFRASTRUCTURE CONSULTANT	HIGHWAY
NRC PROJECTS PVI. LTD.	PVT. LTD.	AUTHORI
		OF INDIA

# BLENDING OF AGGREGATE FOR BC GRADE (I)

	Individual % Passing										
I.S.Sieve (mm)	K-1 (30.0mm to 20.0mm)	K-2 (20mm to 12mm)	K-3 (12mm to 7mm)	K-4 (7mm Down)	Filler (Rock Dust)						
26.5	100	100	100	100	100						
19.0	49.25	97.62	100	100	100						
13.2	11.32	41.02	98.96	100	100						
9.5	3.02	20.96	82.06	100	100						

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4.75	0.28	1.86	1.96	91.25	100
2.36		0.45	0.96	70.99	100
1.18			0.38	52.06	100
0.600				36.18	100
0.300				24.06	100
0.150				16.95	100
0.075				8.02	86.96

Blending Proportion	14.0%	25.0%	10.5%	48.5%	2.0%	100.0%	MORT&H Limit	Permissible	JMF
IS Sieve (mm)	K-1	K-2	K-3	K-4	Filler (Rock Dust)	Blending Results	Table 500- 17	Variations	Limi t
26.5	14.00	25.00	10.50	48.50	2.00	100	100	±7%	100
19.0	6.90	24.41	10.50	48.50	2.00	92.30	90-100	±7%	90-99
13.2	1.58	10.26	10.39	48. <mark>5</mark> 0	2.00	72.73	59-79	±6%	67-79
9.5	0.42	5.24	8.62	48. <mark>50</mark>	2.00	64.78	52-72	±6%	59-71
4.75	0.04	0.47	0.21	44.26	2.00	46.97	35-55	±5%	42-52
2.36		0.11	0.10	34.43	2.00	36.64	28 <mark>-44</mark>	±4%	33-41
1.18			0.04	25.25	2.00	27.29	20-34	±4%	23-31
0.600				17.55	2.00	19.55	15-27	±4%	16-24
0.300	5			11.67	2.00	13.67	10-20	±3%	11-17
0.150				8.22	2.00	10.22	5-13	±3%	7-13
0.075				3.89	1.74	5.63	2-8	±1.5%	4.1- 7.1

% PASSING LOWERLINNT UPPER LIMIT



Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in th Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
NKC PROJECTS PVT. LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.	NATIONAL HIGHWAY

# COMBINED GRADATION FOR BC GRADE (I)

I.S.Sieve (mm)	Wt. Retained (gm)	Cumm wt. Retained (gm)	Cumm. Wt. Retained %	Passing (%)
26.5	0	0	0	100
19.0	2954	2954	8.44	91.56
13.2	6720	9674	27.64	72.36
9.5	3119	12793	36.55	63.45

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4.75	6066	18859	53.88	46.12
2.36	3150	22009	62.88	37.12
1.18	3689	25698	73.42	26.58
0.600	2296	27994	79.98	20.02
0.300	2086	30080	85.94	14.06
0.150	1470	31550	90.14	9.86
0.075	1628	33178	94.79	5.21



Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

Client

Authority Engineer SA INFRA

NHAI

EPC Contractor NKC

## SPECIFIC GRAVITY & WATER ABSORPTION OF COARSE AGGREGATE

[As per IS 2386, (Part - III)]

Laboratory	: NKC Pkg-6 Lab	Date Sampled	: 12.05.2021
Type of Material	: K1-(30MM-20MM)	Sampled By	: Jointly
Source	: Agolai (Jodhpur)	Date Tested	: 17.05.2021
Location	: 173+500 LHS (Base Camp)	Tested By	: Jointly
Proposed Use	: BC Grade-I	Size of Aggregate	30MM-20MM

	/	1	2	3
Weight of saturated aggregates and Basket in water (W <sub>1</sub> )	(g)	1318.2	1344.0	
Weight of Basket in Water (W <sub>2</sub> )	(g)	0	0	
Weight of saturated surface dry aggregates in air (W <sub>3</sub> )	(g)	2169.0	2210.0	
Weight of oven dried aggregate in air (W <sub>4</sub> )	(g)	2156.0	2196.0	
Specific Gravity = $W_4/[W_3 - (W_1 - W_2)]$		2.534	2.536	
Apparent Specific Gravity = $W_4/[W_4 - (W_1 - W_2)]$		2.573	2.577	
Water Absorption = $100 \text{ x } (W_3 - W_4)/W_4$	%	0.60	0.64	
Average Specific Gravity		2.535		
Average Water Absorption	%	0.62		

Note 1 : A sample of not less than 2000g of the aggregte shall be tested.

	2	:	The	samj	ple	shall	be
com	plet	ely	imme	rsed i	n v	vater du	ring
the	oper	rati	on an	d for	a	subsequ	ient
peri	od o	f					

between  $24\pm1/2h$  .

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

Client: National Highways Authority of India.Authority Engineer: SA Infrastructure Consultant Pvt. Ltd.EPC Contractor: NKC Projects Pvt. Ltd.

## SPECIFIC GRAVITY & WATER ABSORPTION OF COARSE AGGREGATE

[As per IS 2386, (Part - III)]

Laboratory	: NKC Pkg-6 Lab	~	Date Sampled	: 12.05.	2021
Type of Material	: K2-(20MM-12MM)		Sampled By	: Jointly	7
Source	: Agolai (Jodhpur)		Date Tested	: 17.05.	2021
Location	: 173+500 LHS (Base Camp)		Tested By	: Jointly	7
			<u> </u>		20MM
Proposed Use	: BC Grade-I		Size of Aggregat	te	-
					12MM
			1	2	3
Weight of saturate	d aggregates and Basket in water $(\mathbf{W}_1)$	(g	1317.0	1368.	
vielgin of suturate	a aggregates and basket in water (11)	)	1317.0	5	
Weight of Basket i	n Water ( $W_2$ )	(g	0	0	
vergine of Busket		)	0	Ū	
Weight of saturate	d surface dry aggregates in air $(W_3)$	(g	2167.0	2252.	
vergine of succide		)	2107.0	0	
Weight of oven dried aggregate in air $(\mathbf{W}_{4})$			2149 5	2232.	
(Weight of oven dried aggregate in an (W4)				5	
Specific Gravity =	W4/[W3 - (W1 - W2)]	·	2.529	2.527	
				1	

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Apparent Specific Gravity = $W_4/[W_4 - (W_1 - W_2)]$		2.582	2.584	
Water Absorption = $100 \times (W_3 - W_4)/W_4$ %		0.81	0.87	
Average Specific Gravity		2.528		
Average Water Absorption	%	0.84		

Note 1 : A sample of not less than 2000g of the aggregte shall be tested.

2 : The sample shall be completely immersed in water during the operation and for a subsequent period of

between  $24 \pm 1/2h$ .

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

Client	: National Highways
	Authority of India.
Authority Engineer	SA Infrastructure
EPC Contractor	: NKC
	Pvt. Ltd.

VITY & WATER ABSORPTION OF COARSE AGGREGATE SPECIFI

[As per 18 2386, (F	'art - 111)]
Laboratory	: NKC Pkg-6 Lab

TTT\]

г 🛦

Sampled 12.0.	5.2021
Type of Material : K3 (12MM 7MM) Sampled	otly
By	litiy
Source : Agolai (Jodhpur) Date :	
Tested 17.0	5.2021
Location: 173+500 LHS (Base Camp)Tested By: Join	ntly
Proposed Use : PC Grade I Size of 12M	M 7MM
Aggregate 12M	101-/101101

.

		1	2	3
Weight of saturated aggregates and Basket in water $(W_1)$	(g)	1296.5	1363.0	
Weight of Basket in Water (W <sub>2</sub> )	(g)	0	0	
Weight of saturated surface dry aggregates in air (W <sub>3</sub> )	(g)	2135.0	2246.5	
Weight of oven dried aggregate in air (W <sub>4</sub> )	(g)	2108.0	2217.5	
Specific Gravity = $W_4/[W_3 - (W_1 - W_2)]$		2.514	2.510	
Apparent Specific Gravity = $W_4/[W_4 - (W_1 - W_2)]$		2.598	2.595	
Water Absorption = $100 \text{ x} (W_3 - W_4)/W_4$	%	1.28	1.31	
Average Specific Gravity	2.512			
Average Water Absorption%1.30				
Note 1 : A sample of not less than 2000g of the a tested. 2 : The sample shall be completely immersed in water during the operation and for a subsequent period of between $24 \pm 1/2h$ .	aggre	gte shall be		

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

Client: National Highways Authority of India.Authority Engineer: SA Infrastructure Consultant Pvt. Ltd.

l

: NKC

EPC Contractor

Projects Pvt. Ltd.

# SPECIFIC GRAVITY & WATER ABSORPTION OF

# FINE AGGREGATE

[As per IS 2386, (Part - III)]

Laboratory No	· NKC Pkg 6 Lab		Date	:	
Laboratory No.	. NKC FKg-0 Lab		Sampled	12.05.2021	
Type of Material	: K4-(7MM Down)		Sampled By	: Jointly	
Sauraa			Date	:	
Source	: Agoiai (Jodnpur)		Tested	17.05.2021	
Location	: 173+500 LHS (Base	7	Tested	· Jointly	
Location	Camp)		Ву	. Jointry	
Proposed Use	: BC Grad <mark>e-I</mark>				
					4
			1	2	3
Pycnometer Bottle	e Number		1	1	
Wt of SSD sample	e, W1	(g)	625.5	605.0	
Wt of Pycnomet Sample, W <sub>2</sub>	er Bottle + Water +	(g)	2514.2	2502.0	201
Wt of Pycnometer	Bottle + Water, W <sub>3</sub>	(g)	2136.0	2136.0	
Wt of oven dry sa	mple, W <sub>4</sub>	(g)	614.5	594.5	
Specific Gravity =	= W4/[W1 - (W2 - W3)]		2.485	2.487	
Apparent Specific (W <sub>2</sub> - W <sub>3</sub> )]	c Gravity = $W_4/[W_4 -$		2.601	2.602	
Water Absorption (W <sub>1</sub> - W <sub>4</sub> )/W <sub>4</sub>	n (Dry basis) = 100 x	%	1.79	1.77	
Average Specific	Gravity	•	2.486		
Average Water A	bsorption	%	1.78		

Note: The sample shall be completely immersed in water			
during the operation and for a subsequent period of			
between	'		
$24 \pm 1/2h$ .			

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

Client	: National Highways Authority of India.
Authority Engineer	: SA Infrastructure Consultant Pvt. Ltd.
EPC Contractor	: NKC Projects Pvt. Ltd.

# SPECIFIC GRAVITY & WATER ABSORPTION OF FINE AGGREGATE

[As per IS 2386, (Part - III)]

Laboratory No.	: NKC Pkg-6 Lab	Date Sampled	: 12.05.202 1
Type of Material	: Filler (Rock Dust)	Sampled By	: Jointly
Source	: Agolai (Jodhpur)	Date Tested	: 17.05.202 1
Location	: 173+500 LHS (Base Camp)	Tested By	: Jointly
Proposed Use	: BC Grade-I		

		1	2	3
Pycnometer Bottle Number		1	1	
Wt. of Specific gravity bottle (W1)	(g )	31.32	31.32	
Wt. of Specific gravity bottle + Filler (W2)	(g )	56.38	54.78	
Wt. of Specific gravity bottle + Filler+Kerosene (W3)	(g )	88.85	87.76	
Wt. of Specific gravity bottle + Water (W4)	(g )	83.36	83.36	

Wt. of Specific gravity bottle +Kerosene (W5)(g)	71.93	71.93	
Specific Gravity of Kerosene (W6)=(W5 -W1)/(W4-W1)	0.78	0.78	
Specific Gravity of Lime=(W2 -W1)/(W2-W1)-(W3-W5) x	2 402	2 300	
Specific Gravity of Kerosene	2.402	2.379	
Average Specific Gravity of Filler W.r.t. Kerosene	2.401		

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
	SA	NATIONAL
NKC PROJECTS	IN <mark>FRAS</mark> TRUCTURE	HIGHWAYS
PVT. LTD.		<b>AUTHORITY</b>
	PVT. LTD.	

# MAXIMUM SP. GRAVITY OF BITUMINOUS PAVING MIXTURES

# (AASTHO T 209, ASTM D 2041)

			_	
Date of Sampling	: 12.05.2021	Grade Of Bitumen	: CRMB-60	
Date of Testing	18 05 2021	Source of Material	: Tinna Rubber	
Date of Testing	. 10.03.2021		Infrastructure Ltd.	
Location Of Test	: 173+500 LHS	Kind of Matorial		
Location Of Test	(Base Camp)			

SI.	DESCRIPTION		OBSERVATIO	Demerke	
No.	DESCRIPTION		1	2	Remarks
А	% Binder Content		5.0		
В	Weight of Flask + Corks (g)		2433.0	2433.0	
С	Weight of Flask + Corks		10127.0	10127.0	

	+	Water				
	(g)					
	Weight	of				
D	Sample	in air	2524.0	2510.5		
	(g)					
	Weight	of				
F	Flask +	Corks	11588.0	11581.0		
L	+ Wa	ter +	11300.0	11301.0		
	Sample	(g)				
	Temper	ature				
F	of	water	27.00	27.00		
	0C					
	Weight	of				
G	Replace	ed	1063.0	1056 5		
0	Water	(D-(E-	1003.0	1050.5		
	C))	(g)				
	Max	SP.				
н	Gravity	of	2.374	2.376		
	Materia	l (D/G)			)	
	Average	e Max.				
	Specific		2 375			
	Gravity	of	2.010			
	Materia	ls				

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR		AUTHORITY'S	CLIENT				
		ENGINEER					
			SA				
NKC	PROJECTS	PVT.	INFRASTRUCTURE	NATIONAL	HIGHWAYS	AUTHORITY	OF
LTD.			CONSULTANT	INDIA			
			PVT. LTD.				

# MAXIMUM SP. GRAVITY OF BITUMINOUS PAVING MIXTURES

(AASTHO T 209, ASTM D 2041 )

# $\textcircled{\sc c}$ 2023 IJCRT | Volume 11, Issue 5 May 2023 | ISSN: 2320-2882

-			-		
Date of Sampling		: 12.05.2021	Grade Of Bitumen		: CRMB-60
Date	of Testing	: 18.05.2021	Source of Material		: Tinna Rubber & Infrastructure Ltd.
Locati	ion Of Test	: 173+500 LHS (Base Camp)	Kind of N	laterial	: BC Mix
0					
SI.	DESCRIPTION				Remarks
110.			1	2	
A	% Binder Content		5.5		
	Weight of Flask +				
В	Corks		2433.0	2433.0	
	(g)				
	Weight of Flask +				
С	Corks + Water		10127.0	10127.0	
	(g)				
	Weight of Sample in			12	
D	air		2512.0	2495.5	
	(g)				
	Weight of Flask +				
E	Corks + Water +		11574.5	11564.0	2
	Sample (g)			<b>K</b> G	
	Temperature of			13	
F	water		27.00	27.00	
	°C				
	Weight of Replaced				
G	Water (D-(E-C))		1064.5	1058.5	
	(g)				
ц	Max SP. Gravity of		2 360	2 358	
	Material (D/G)		2.300	2.000	
	Average Max.			I	
I	Specific Gravity of		2.359		
	Materials				
		1	1		

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amrits Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	CLIENT
NKC PROJECTS PVT. LTD.	SA INFRASTRUCTURE CONSULTANT	NATIONAL HIGHWAYS AUTHORITY
	PVT. LTD.	

**Bulk & Apparent Specific Gravities** 

		Bulk	Apparent	Water	
Material	P <mark>ercentages</mark>	Specific	Specific	Absorption	Remarks
		Gravity	Gravity	%	
Agg. K-1	1/1%	2 535	2 5 7 5	0.62	
(30mm to 20mm)	1470	2.555	2.373	0.02	
Agg. K-2	25%	2 528	2 583	0.84	
(20mm to 12mm)	2370	2.520	2.303	0.04	
Agg. K-3	10 5%	2 512	2 596	1.30	51
(12mm to 7mm)	10.570	2.512	2.370	1.50	
Agg. K-4	48 5%	2 486	2 601	1 78	Į.
(7mm Down)	+0.5 %	2.400	2.001	1.70	
Filler (Rock Dust)	2%	2.401	2.401	-	

# BULK SPECIFIC GRAVITY OF

 $G_{sb}$  =

**AGGREGATE :** 

P1+P2+P3+P4+P5

		P1/G1 + P2/G2 + P3/G3 + P4/G4+P5/G5
		Specific Gravity for the Total
Where :	$G_{sb}$	aggregate
		Individual Percentages by Wt. of
	$P_1, P_2,, P_n$	Aggregate
		Individual Specific Gravity of
	$G_1, G_2,, G_n$	aggregate

		Specific Gravity for the Total
	$G_{sb} \ = \ $	aggregate
	=	14+25+10.5+48.5+2
		14/2.535 + 25/2.528 + 10.5/2.512 + 48.5/2.486 + 2.504
		2/2.401
APPARENT	SPECIFIC	C GRAVITY
OF AGGRE	CGATE:	
	$G_{sa} =$	P1+P2+P3+P4+P5
		P1/G1 + P2/G2 + P3/G3 + P4/G4+P5/G5
		Apparent Specific Gravity for the
Where :	G <sub>sa</sub>	Total aggregate
		Individual Percentages by Wt. of
	$P_1, P_2,, P_n$	Aggregate
		Individual Apparent Specific Gravity
	$G_1, G_2,, G_n$	o <mark>f aggregate</mark>
		Apparent Specific Gravity for the
	Gsa =	Total aggregate
	=	14+25+10.5+48.5+2
		14/2.575 + 25/2.583 + 10.5/2.596 + 48.5/2.601 + 2.588
		2/2.401
WATER A	ABSORPTIO	N OF COMBINED
AGGREGA	TE:	1.30

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Rasisar (near Bikaner)-Deogarh (near Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'	S ENGINEER	CLIENT	
			NATIONAL	
NKC PROJECTS PVT. LTD.	SA	INFRASTRUCTURE	HIGHWAYS	
	CONSULTAN	IT PVT. LTD.	AUTHORITY	OF
			INDIA	

Ef	fective Specific Gra	vity & Maximum S	Specific Gravity of Paving Mix						
(0	imm)								
	Effective Specific Gravity (Gse) Gse = $Pmm - Pb$ Pmm - Pb $\overline{Gmm} - \overline{Gb}$								
At	5.0% Bitumen Conten	t Gmm = 2.375							
	Gse =	100 - 5.0/ (5.0/1.100)) =	((100/2.375)- <b>2.529</b>						
At	5.5 % Bitumen Conter	nt Gmm = 2.359							
	Gse =	100 - 5.5/ (5.5/1.100)) =	((100/2.359)- <b>2.527</b>						
A١	verage Gse :-	2.528							
M	aximum Specific Grav	vity of Paving Mix ( P <sub>mm</sub> (P <sub>s</sub> / G <sub>se</sub> + P <sub>b</sub> / G <sub>b</sub> )	Gmm)						
		Bitumen Content	Maximum Specific Gravity of						
	51.NO	(%)	Paving Mix (Gmm)						
	1	4.0	2.403						
	2	4.5	2.388						
	3	5.0	2.374						
	4	5.5	2.360						
	5	6.0	2.345						

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 of Economic Corridor in the state of Rajasthan under Bharatmala Pariyojana (Phase-I) (AJ/RD-Pac

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EPC CONTRCTOR					AUTHORITY'S ENGINEER					
NKC	PROJECT	S PVT. I	_TD.			SA INFR	ASTRUC		TANT PV	T. L
<u>SUM</u>	SUMMARY OF MARSHALL TEST RESULT BC GRADE-I									
SIZE OF AGGREGATE			% MI PROPORT	X SPECI I GRAV	FIC ITY	Proving Ring F	actor	6.3		
K-1 (3	K-1 (30MM To 20MM)									
K-2 (2	К-2 (20ММ То 12ММ )									
K-3 (1	12MM To 7	7MM)		Ţ	1			RI		
K-4 (7	MM Dow	n)			48.5	2.486	2.601	2.601		Da
Filler	(Rock Du	st)			2 2.401 2.401				Da	
Test Speci men No.	Bitum en Conte nt (%)	Weigh t of specim en in air (gm)	Weigh t of specim en in water (gm)	SSD Weig t speci en (gm)	h of M (CC)	Bulk Densit y (g/cc)	Avera ge bulk densit y (g/cc)	TheoriticalMa x.Sp. gravity (Gmm)	Air void's (Va) (%)	Va M Aş (V
	Pb	W1	3.73	W3	V	Gmb = (W1 / V)	Gmb <sub>(a</sub> vg.)	Gmm =ADTM-D 2041	Va = 100X(G mm- Gmb) / Gmm	VI (G Ps

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		4								
1		1189.5	648.5	1191.0	542.5	2.193				
2	4.00	1192.0	649.5	1194.0	544.5	2.189	2.192	2.403	8.78	15
3	-	1190.5	649.5	1192.0	542.5	2.194				
		1			1					
1		1192.5	661.0	1194.0	533.0	2.237				
2	4.50	1190.0	661.5	1193.0	531.5	2.239	2.238	2.388	6.28	14
3	-	1191.0	660.0	1192.5	532.5	2.237	_			
1		1189.5	667.5	1191.5	524.0	2.270				
2	5.00	1193.5	668.0	1194.5	526.5	2.267	2.270	2.374	4.38	13
3	-	1188.5	667.0	1190.0	523.0	2.272	_			
1	-	1190.5	670.5	1192.5	522.0	2.281				
2	5.50	1192.0	671.0	1194.0	523.0	2.279	2.280	2.360	3.39	13
3	-	1191.0	670.5	1193.0	522.5	2.279	_			
	100						/	1		
1		1192.5	670.5	1194.0	523.5	2.278				
2	6.00	1190.5	670.0	1192.0	522.0	2.281	2.278	2.345	2.86	14
3		1193.5	671.0	1195.5	524.5	2.276	1			
						L	1	I	1	1

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+658 Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in th Pariyojana (Phase-I) (AJ/RD-Package-6)

EPC CONTRCTOR	AUTHORITY'S ENGINEER	С
NKC PROJECTS PVT. LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.	N. IN
Calculation of Vb (Volume of Bitumen)		•

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Mix	% OBC	Wt.of mix Avg. of marshall specimens	Wt.of Modified bitumen (CRMB- 60)	Gmb as mentioned in summary	Sp.Gr of Modified Bitumen (CRMB- 60) Gb	Mix Max. Sp.Gr Gmm	Agg.Bulk Sp.Gr Gsb	Agg.App Sp.Gr Gsa	Ag Si G
BC Grade-I	5.45	1192.50	64.99	2.277	1.100	2.361	2.504	2.588	2.
		Vb	=	Wt. of Modifie Sp. Gravity o (Gb) Wt. of Mix Max. Sp. Grav	d Bitumen f Modified vity of Mix (	Bitumen Gmm)	X 100		
		Vb		64.99 1.100 1192.5	X 100				
		Vb		2.361		CP			

Construction of 6-lane access controlled Greenfield highway from km 148+000 to km 177+6 Dhandhaniya) section of NH-754K as a part of Amritsar-Jamnagar Economic Corridor in the sta (Phase-I) (AJ/RD-Package-6)

505.08

11.70

Vb

=

X 100

EPC CONTRCTOR	AUTHORITY'S ENGINEER
NKC PROJECTS PVT. LTD.	SA INFRASTRUCTURE CONSULTANT PVT. LTD.



Chapter-10

# Photograph









- Gol-70 Paving Bitumen in use in India.could be VG-10, VG-20 or VG-30. Some NH projects experienced ruting, others did not.
   Pord, Kandhal's lectures on the need for viscosity grading in ITV; CRRI, IRC, NHAL, MORTH Viscosity arguing Intervision and Advisory Council (10 Jan Path) in 2005
   MORTH was asked forequest BIS to adopt viscosity grading in lieu of penetration grading BIS adopted it in 2006 by revising IS73.

Viscosity Grade	General Applications
VG-40	Use in highly stressed areas in lieu of
(40-60 pen)	old 30/40 penetration grade
VG-30	Use for paving in most of India in lieu
(50-70 pen)	of old 60/70 penetration grade
VG-20	Use for paving in cold climate, high
(60-80 pen)	altitude regions of North India
VG-10	Use for surface dressing and for paving
(80-100 pen)	in very cold climate
	Kandad 20



#### Viscosity Grading System

- Introduced during 1970s in the U.S.
   To address construction and high temperature performance problems
   Fundamental rather than empirical units
- Based on viscosity (poises) at 60 °C



## Kinematic Viscosity at 13

- Needed to establish mixing a compaction temperatures du construction
- · Controls temperature susceptibility in conjunction viscosity at 60°C



	Grades
Grade	Viscosity at 60 C, poises
AC-2.5 (softest)	250 +/- 50
AC-5	500 +/- 100
AC-10	1000 +/- 200
AC-20	2000 +/- 400
AC-30	3000 +/- 600
AC-40	4000 +/- 800
	Kandhal







# Penetrat

 Adopted in 19 Committee D4 Paving Materi
 Based on pen conducted at 2







#### Viscosity Grading System

- Introduced during 1970s in the U.S.
- To address construction and high temperature performance problems
  Fundamental rather than empirical
- units
- Based on viscosity (poises) at 60°C



#### Kinematic Viscosity at 135°C

- Needed to establish mixing and compaction temperatures during construction
- Controls temperature susceptibility in conjunction with viscosity at 60°C

	Grades
Grade	Viscosity at 60 C, poises
AC-2.5 (softest)	250 +/- 50
AC-5	500 +/- 100
AC-10	1000 +/- 200
AC-20	2000 +/- 400
AC-30	3000 +/- 600
AC-40	4000 +/- 800
	Kandhal



Chapter 10 PHOTOGRAPHS














































Section 500

#### Bases and Surface Courses (Bit

#### 5J3.4.4 Curing of Tack Coat

The tack coat shall be left to cure until all the volatiles have evaporated before any su construction is started. No plant or vehicles shall be allowed on the tack coat other tiles estimated for the construction.

#### 513.5 Quality Control of Work

For control of the quality of materials and the works carried out, the relevant pro-Section 900 shall apply.

### 503.6 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordate the provisions of Clause 112.

#### 503.7 Measurement for Payment

Tack coat shall be measured in terms of surface area of application in square metre

## 503.8 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the operations including for all components listed in Clause 401.8 (i) to (v) and as app the work specified in these Specifications. The rate shall cover the provision of tack 0.2 kg per square metre or at the rate specified in the Contract, with the provision variation between this quantity and actual quantity of bitumen used will be assessed payment adjusted accordingly.

#### 504 BITUMINOUS MACADAM

#### 504.1 Scope

This work shall consist of construction in a single course having 50 mm to 100 mm to or in multiple courses of compacted crushed aggregates premixed with a bituminor on a previously prepared base to the requirements of these Specifications. S bituminous macadam is an open-graded mix, there is a potential that it may trap moisture vapour within the pavement system. Therefore, adjacent layer (shoulder have proper drainage quality to prevent moisture-induced damage to the BM.

#### 504.2 Materials

#### 504.2.1 Bitumen

The bitumen shall be viscosity graded paving bitumen complying with Indian Specification for paving bitumen, IS:73 or as specified in the Contract. The type and



		20 - 20 a		T.	
	Bases and Surfa	ce Courses (Bituminous)		Section	
	bitumen to be used would depend upon the climatic conditions and the traffic. Guideline selection of bitumen are given in Table 500-1.				
	504.2.2	Coarse Aggregates			
	dust and soft organic and other deleterious substances. The aggregate shall satisfy physical requirements specified in Table 500-6. Where crushed gravel is proposed use as aggregate, not less than 90 percent by weight of the crushed material retaine 4.75 mm sieve shall have at least two fractured faces resulting from crushing operation. Be approval of the source, the aggregates shall be tested for stripping. Where the Contract selected source of aggregates have poor affinity for bitumen, as a condition for the approved of that source, the bitumen shall be treated with approved anti-stripping agents, as per manufacturer's recommendations, without additional payment. <b>504.2.3</b> Fine Aggregates Fine aggregates shall consist of crushed or naturally occurring mineral material, combination of two, passing 2.36 mm sieve and retained on 75 micron sieve. It shall be cl hard, durable, free from dust and soft organic and other deleterious substances. Natural is shall not be used in the binder course.				
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course.	naturally occurring mir retained on 75 micron sle d other deleterious subst	neral material, o eve. It shall be ci tances. Natural s	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper	naturally occurring mir retained on 75 micron sle d other deleterious subst ties of Coarse Aggregat	neral material, e eve. It shall be ci tances. Natural s e	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Test	naturally occurring mir retained on 75 micron sid d other deleterious subst ties of Coarse Aggregate Requirement	neral material, eve. It shall be ci tances. Natural s e Test method	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sieve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Test Grain size analysis	naturally occurring mir retained on 75 micron sle d other deleterious subst ties of Coarse Aggregat Requirement Max. 5% passing 0.075 micron	neral material, eve. It shall be cl tances. Natural s e Test method IS:2386 Part I	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Grain size analysis Combined Flakiness and Elongation Indices	naturally occurring mir retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Requirement Max. 5% passing 0.075 micron Max. 35%	neral material, eve. It shall be cl tances. Natural s e Test method IS:2386 Part I IS:2386 Part I	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and r ro dust and soft organic and in the binder course. Table 500-6 : Physical Proper Grain size analysis Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or	naturally occurring min retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Requirement Max. 5% passing 0.075 micron Max. 35% Max. 40%	Test method IS:2386 Part I IS:2386 Part I	
528	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Grain size analysis Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value	naturally occurring mir retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30%	Test method IS:2386 Part I IS:2386 Part I IS:2386 Part I	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength Durability	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Call Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value Soundness (Sodium or Magnesium)	naturally occurring mir retained on 75 micron sid d other deleterious subst ties of Coarse Aggregate Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30% 5 cycles	Test method IS:2386 Part I IS:2386 Part I IS:2386 Part I	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength Durability	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sieve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Grain size analysis Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value Soundness (Sodium or Magnesium) Sodium Sulobate	naturally occurring mir retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30% 5 cycles Max. 12%	neral material, a eve. It shall be cl tances. Natural s e <u>Test method</u> IS:2386 Part I IS:2386 Part I IS:2386 Part IN	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength Durability	Tine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and r e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Test Grain size analysis Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value Soundness (Sodium or Magnesium) Sodium Sulphate Magnesium Sulphate	naturally occurring min retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Requirement Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30% 5 cycles Max. 12%	Test method IS:2386 Part IN IS:2386 Part IN IS:2386 Part IN IS:2386 Part IN IS:2386 Part IN IS:2386 Part IN	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength Durability Water absorption	Fine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and i e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Cest Grain size analysis Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value Soundness (Sodium or Magnesium) Sodium Sulphate Water absorption	naturally occurring min retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30% 5 cycles Max. 12% Max. 12% Max. 12% Max. 2%	Test method IS:2386 Part I IS:2386 Part I IS:2386 Part I IS:2386 Part I IS:2386 Part I IS:2386 Part V IS:2386 Part V IS:2386 Part V IS:2386 Part I	
	504.2.3 I Fine aggregates combination of tw hard, durable, fre shall not be used Property Cleanliness Particle shape Strength Durability Water absorption	Tine Aggregates shall consist of crushed or ro, passing 2.36 mm sleve and r e from dust and soft organic and in the binder course. Table 500-6 : Physical Proper Combined Flakiness and Elongation Indices Los Angeles Abrasion Value or Aggregate Impact Value Soundness (Sodium or Magnesium) Sodium Sulphate Water absorption Coating and Stripping of Bitumen Aggregate	naturally occurring min retained on 75 micron sid d other deleterious subst ties of Coarse Aggregat Max. 5% passing 0.075 micron Max. 35% Max. 40% Max. 30% 5 cycles Max. 12% Max. 12% Max. 18% Max. 2% Max. 2% Min. Retained Coating 95%	Test material, o ave. It shall be cl tances. Natural s e Test method IS:2386 Part I IS:2386 Part I IS:2386 Part IN IS:2386 Part V IS:2386 Part V IS:2386 Part II IS:2386 Part II IS:2386 Part II	



Section 500 Bases and Surface Courses (Bituminous)

# 504.2.4 Aggregate Grading and Binder Content

The combined grading of the coarse aggregates and fine aggregates, when tested in accordance with IS:2386 Part 1, wet sieving method, shall conform to limits given in Table 500-8. The type and quantity of bitumen and appropriate thickness is also given in Table 500-7.

#### 504.2.5 Proportioning of Material

The combined aggregate grading shall not vary from the lower limit on one sieve to the higher limit on the adjacent sieve to avoid gap grading. The aggregate may be proportioned and blended to produce a uniform mix complying with the requirements in Table 500-7. The binder content shall be within a tolerance of  $\pm$  0.3 percent by weight of total mix when individual specimens are taken for quality control tests in accordance with the provisions of Section 900.

## 504.3 Construction Operation

## 504.3.1 Weather and Seasonal Limitations

The provisions of Clause 501.5.1 shall apply.

# Table 500-7 : Aggregate Grading and Bitumen Content

Grading	1	. 2	
blassing agroupte size*	40 mm	19 mm	
Nominal maximum aggregate size	80 -100 mm	50 -75 mm	
IS Sieve size (mm)	Cumulative % by weight of total aggregate passing		
45	100		
37.5	90-100		
26.5	75-100	100	
19		90 – 100	
13.2	35-61	56 - 88	
4.75	13 – 22	16 – 36	
2.36	4 19	4 19	
0.3	2 - 10	2 - 10	
0.075	0-8	0-8	
Bitumen content ** percent by	3.3**	3.4**	

Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

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# References

- 1. MORT&H Revision  $5^{\text{TH}}$
- 2. IRC SP 053: Guidelines on use of Modified Bitumen in Road
- 3. MS-2 Asphalt Mix Design Methods
- 4. IS: 73, Paving Bitumen