



ANALYSING THE PERFORMANCE OF HIGHWAY CONSTRUCTION MATERIALS

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ABSTRACT

This article explains about the different types of highway, highway development in India and mainly explains about the various highway material used for the construction. Selected material was taken and analyzing the test results. In this the following test was conducted, in aggregate Abrasion Test, Aggregate Impact Test, Shape Test (Flakiness Index), Shape Test (Elongation Index), Aggregate Crushing Strength Test, Specific Gravity & Absorption of Coarse Aggregate and the test of bitumen are Penetration Test, Softening Point of Bitumen, Flash and Fire Point Tests, Viscosity Test, Ductility Test, Specific Gravity of Bitumen. The soil strength for foundation layer tests with California Bearing Ratio Test. The test result shows all materials having good quality, so it can be used for construction of highway.

KEYWORDS: Highway, Bitumen, Specific gravity, Road, Material.

INTRODUCTION:

Road transport is one of the most common mode of transport. Roads in the form of trackways, human pathways etc. were used even for the pre-historic times. Since then many experiments were going on to make the riding safe and comfort. Thus road construction became an inseparable part of many civilizations and empires. The lack of a traffic signal is often cited as a contributing factor by drivers who are involved in accidents at intersections. As such, increasing the conspicuity of traffic signals should lead to improved safety performance. Materials that are bound together with bitumen are called bituminous materials. The use of bituminous materials was initially limited to road construction. Now the applications have spread over the area of roof construction, for industrial purposes, carpet tiles, paints and as a special coating for waterproofing.

DEVELOPMENT OF ROAD:

a) **Nagpur Plan (1943-1961):** Classification of roads into national highways, state highways, district roads and village roads and outlining the norms required for these categories. Target of 16 Km per 100 sq Km was set for 1961.

b) **Bombay Plan (1961-81):** It accepted that any village should not be more than one and half miles away from any road in developing agricultural areas, three miles from any road in semi-developed and five miles from any road in the underdeveloped and uncultivable area. Road density target of 32 km of road per 100 sq km was set for 1981.

c) **Lucknow Plan (1981-2001):** Requirements for non-mechanised traffic should be considered, for example bicycles, cycle-rickshaws and bullock carts should be given weightage and provision must be made for them while designing roads. Overall target of 27 lakh km of road network was set. Road density target of 82 km of road per 100 sq km was set for 2001.

d) **Road Development Plan Vision (2001-2021):** Construction of village roads must be given a boost and maintenance of existing road assets. Road safety, energy efficiency and social and environmental implications of road have been given special attention. To develop rural road network emphasize was laid on proper district level master plans. So the target for main roads was specified, but that of rural roads was not specified.

TYPES OF ROADS

Roads

Classification Based on

Materials	Location & function	Traffic volume	Economy	Traffic	Rigidity	Topography
- Earthen roads - Gravel roads - Murum roads - Kankar roads - WBM roads - Bituminous roads - Concrete roads	- National Highways - State Highways - District Roads - Village Roads	- Light traffic roads - Medium traffic roads - Heavy traffic roads	- High Cost Roads - Medium Cost Roads - Low Cost Roads	- Pedestrian ways - Cycle tracks - Motor ways	- Flexible roads - Rigid roads	- Plain roads - Hilly roads

MATERIALS AND METHODS:

Construction of highway first we have to check the soil strength and test the material properties. Here we collected the material from our location the testing was done in our laboratory. The type of test, procedure and results were given below.

4. a) The Soil Strength was calculated by

1. **California Bearing Ratio Test:** The CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and

moisture conditions. The loads, for 2.5mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain C.B.R. value.

Penetration, mm	Standard Load	Unit Standard Load, kg/cm ²
2.5	1370	70
5.0	2055	105

CBR in % =

$$\left[\frac{\text{Unit pressure carried by soil sample at defined penetration level}}{\text{Unit pressure carried by standard crushed stones at above penetration level}} \right] \times 100$$

Generally the CBR value at 2.5mm penetration is higher and the value are adopted.

The CBR value of the given soil sample is = 1.302%.

4.b) The Aggregate Strength was Calculated by the following test:

(i). **Aggregate Crushing Strength Test:** The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load.

Aggregate crushing value = $100 \times w_2/w_1\%$

The mean (average) of the crushing value aggregate is = 7.823%

(ii). **Specific Gravity & Absorption of Coarse Aggregate:** Water absorption gives an idea of strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

$$\text{Specific Gravity} = \frac{(W_3 - W_1)}{(W_2 - W_1) - (W_4 - W_3)}$$

Percentage of water absorbed $(W_2 - W_1) / W_1$

Specific Gravity of coarse aggregate = **2.843**

Percent water Absorption of coarse aggregate = **0.312%**

(iii). **Abrasion Test:** Abrasion is a measure of resistance to wear or hardness. It is an essentially property for road aggregates especially when used in wearing course.

Abrasion tests on aggregates are generally carried out by Los Angeles abrasion test.

Percentage wear = $((W_1 - W_2) / W_1) \times 100$

The average value of two Los Angeles abrasion test is = **14.223%**

(iv). **Aggregate Impact Test:** Toughness is the property of a material to easiest impact. The resistance of the stones to fracture under repeated impacts may be called Impact test on aggregates. The test can also be carried on cylindrical stone specimen known as a Page Impact test.

Aggregate Impact Value = $(W_2 / W_1) \times 100$ Percent

The mean Aggregate Impact Value is = **7.542%**

(v). **Shape Test (Flakiness Index):** The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. **FLAKINESS INDEX:** The flakiness index of aggregates is the percentage by particles whose least dimension (thickness) is less than 3/5th (0.6) of their mean dimension. The test is not applicable to sizes smaller than 6.3mm.

$$\text{Flakiness Index} = \frac{(w_1 + w_2 + w_3 + \dots)}{(W_1 + W_2 + W_3 + \dots)} \times 100$$

$$= \frac{w}{W} \times 100 \%$$

The flakiness index of the given sample of aggregates is = **14.462%**.

(vi). **Shape Test (Elongation Index):** The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it. **ELONGATION INDEX:**

The elongation index of an aggregate is the percentage by weight of particles whose greatest dimension (length) is greater than 1 and 4/5th times (1.8 times) their mean dimensions. The elongation test is not applicable to sizes smaller than 6.3mm.

$$\text{Elongation Index} = \frac{(x_1 + x_2 + x_3 + \dots)}{(W_1 + W_2 + W_3 + \dots)} \times 100$$

The elongation index of a given sample of aggregate is = **12.63%**.

4.c) The Bituminous Strength was Calculated by the following test:

(i). **Penetration Test:** The consistencies of bituminous materials vary depending upon several factors such as constituents, temperature, etc. As temperature ranges between 25° and 50°C most of the paving bitumen grades remain in semi solid or in plastic states and their viscosity is so high that they do not flow as liquid.

The average penetration value of a given bitumen sample is = **102**

(ii). **Softening Point of Bitumen:** The softening point is the temperature at which the substance attains a particular degree of softening under specified conditions of test.

The softening point value of giving bitumen sample is = **67° C**

(iii). **Flash and Fire Point Tests:**

Flash Point: The flash point of a material is the lowest temperature at which the vapor of a substance momentarily takes on the form of a flash under specified conditions of test.

Fire Point: The fire point is the lowest temperature at which the material gets ignited and burns under specified conditions of test.

The temperature of the sample material when this occurs is recorded at the fire point.

Flash point = **222° C**

Fire point = **253° C**

(iv). **Viscosity Test:** Viscosity is defined as the increase of fluidity. The degree of fluidity of the application temperature greatly influences the ability of bituminous material to spread, penetrate into void and also coat the aggregates and hence affects the strength characteristics of the resulting paving mixes.

The time in seconds for 50ml of the test sample to flow through the orifice = **989 sec.**

(v). **Ductility Test:** The ductility is expressed as the distance in centimeters to which a standard briquette of bitumen can be stretched before the thread breaks.

The ductility value of the given bitumen sample is = **61cm.**

(vi). **Specific Gravity of Bitumen:** The specific gravity is defined by ISI as the ratio of the mass of a given volume of the bituminous material to the mass of an equal volume of water, the temperature of both being specified at 27°C ± 0.1°C.

$$\text{Specific Gravity} = \frac{(W_3 - W_1)}{(W_2 - W_1) - (W_4 - W_3)}$$

The specific gravity of giving bituminous binder is = **0.97**

RESULTS AND DISCUSSION:

The soil strength according to California Bearing Ratio Test is 1.302

The aggregate Strength test results:

The aggregate crushing value is 7.823%, the measured value is less than 30% so it is good for surface course layer construction. Specific Gravity of coarse aggregate 2.843. The value between 2.6 to 2.9, it is having good specific gravity. Water Absorption Percentage of coarse aggregate was 0.312%. It is less than 0.6% so the sample having less water absorption percentage. The Los Angeles abrasion test value is 14.223%. It is less than 30% so the abrasion value is good. The aggregate Impact Value is 7.542%, it is less than standard value so the aggregate can use by any layer. The flakiness index and elongation index of the given sample of aggregates is 14.462%, 12.63%. It is less than 15-25% so the given sample having shape.

The Bituminous Strength test results:

The penetration value of a given bitumen sample is 102 so it having good resistance. The softening point value of giving bitumen sample is 67° C. It is with in the limit of 35° to 70° C.

So the sample having good softening. The Flash point is 222° C, Fire point is 253° C. The time in seconds for 50ml of the test sample to flow through the orifice = 989 sec. The ductility value of the given bitumen sample is 61cm. It is less than 100cm so it is good. The specific gravity of giving bituminous binder is 0.97 it is with in the limit (0.97 to 1.02). So the bitumen having good specific gravity.

CONCLUSION:

This paper describes a project to know the road development in India and types

of roads. The road safety, effectiveness associated with improved quality of highway construction. The quality of highway is mainly depending on the material. Testing of the components of highway indicates the testing of coarse aggregate, bitumen, soil. According to the results of various test it shows all materials having good properties. The collected materials can be used for highway construction. The soil is also having good strength.

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