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A CONCENTRATE ON IMPACT OF ZYCOTHERM ON THE PROPERTIES OF BITUMINOUS SUBSTANTIAL BLEND IN WITH VARIOUS ADDED SUBSTANCE MATERIALS

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Abstract: Now a day's infrastructure development plays a major role in the civilization. More over transportation facilities also required for the development. Majorly in developing countries like India it requires an economic way of transportation facilities. In general the roads affected to some problems like wear and tear, less durability and loosing strength due to water absorption. It causes damages to pavements and the fuel consumption to transport the things from one place to another place is more, the vehicle is also affected moreover.

To reduce the problems occurring because of moisture absorption and temperature variations, we require the material to resist the damages on the road surface and to the base courses. For this the material called Zycotherm used to protect the surface of pavement from the characteristic of moisture absorption and temperature failures.

By using this material we can easily reduce the failure of pavement against sunlight, heat, and ignition, source of spark, rain, and standing of water on surface. It reduces the surface tension of asphalt binder and reduces viscosity of binder. Using this Zycotherm can improves field compaction up to 90ºC, eliminates odour & stripping, reduce stickiness and more over the basis of the thesis is to find out change in the physical properties of the bitumen by modifying it with different fillers. The types of fillers used in project are Stone dust, Lime, Brick powder, OPC & Fly ash.

***Index Terms* - bitumen, additives materials, fly ash, brick powder.**

1 INTRODUCTION

1.1 GENERAL

Bitumen is a tacky, black and vastly gelatinous liquid or semi-solid form of petroleum. It possibly motivation be real found during common deposit or could be a distinguished product, Bitumen is a thermoplastic material also its firmness is dependent taking place warmth. The warmth vs solidity liaison of bitumen is reliant lying on the foundation of crude oil with the method of enlightening. It is assess to facilitate the at hand humankind consumption of bitumen is at home the region of 102 million-tones every year. Approximately 85% of every bit of the bitumen twisted is utilize as the cover as a ingredient of black-top on behalf of streets. It is furthermore utilized as a piece of other unfurnished regions, on behalf of example, airplane terminal runways, auto parks and footways. Customarily, the conception of black-top includes alliance sand, rock and in receivership rock amid bitumen, which goes about as the union operator. Distorted tools, on behalf of paradigm, polymers, may perhaps be auxiliary to the bitumen to amend its property as indicate by the domestic device for which the black-top is sooner or later future. A good quality intend of bituminous mix is accepted to upshot in a mix which is satisfactorily

- Strong
- Durable
- Resistive to exhaustion and everlasting
- Deformation environment friendly
- Economical and the rest.

The quantity of bitumen, padding, fine aggregates and coarse aggregates to convey into being a mix which is doable, brawny, hard-wearing and convincingly priced. a unite trendy tries to accomplish these desires throughout a figure of tests on the amalgamate among dappled extent likewise firm up with the overriding one. The at tender make exploration work tries to label a a small amount of of the issue occupied in this art of bituminous merge have it in psyche in addition to the inclination of existing scrutinize. Asphalt concretes are far and wide worn in pavements. Permanent buckle happen while pavement does not have ample eternalness, inappropriate compaction and lacking pavement strength. From practical experiences it is prove that the amendment of tarmac binder in the midst of polymer additives, offer quite a lot of benefits. To augment an assortment of engineering property of asphalt immeasurable modifiers such at the same time as styrene based polymers, polyethylene based polymers, poly chloroprene, assorted oils have been used in asphalt.

Zycotherm substance seeing that an additive allow the amalgamation lay down, furthermore compaction of asphalt mixes at significantly lower temperatures compared to hot mix asphalt. Initially overview of pavement types, layers furthermore their functions are discussed followed via succinct prologue on lukewarm unite design. Zycotherm is WMA preservative urbanized by Zydex Industries, Gujarat, India. This is an whiff free, substance lukewarm muddle up preservative with the intention of have been engineered to afford extensively enhanced recompense over contemporary WMA technologies by bequest inferior fabrication and compaction temperatures, whereas concurrently enhancing the moisture resistance of pavements by serving as an antis trip. Mixes that have been tailored with Zycotherm canister be fashioned at 120°C - 135°C pro and squashed at 90°C - 120°C. on the whole, Zycotherm offer fever reduction depending on the property of the merge Zycotherm has built in anti's trip device that allow it to dually utility as an antis expedition seeing that able-bodied as a lukewarm merge preservative.

1.2 OBJECTIVES

- To determine the Marshall properties of Bitumen concrete at optimum binder content in addition of filler materials and additive (Zycotherm) .
- To compare Marshall Properties of Asphalt mix prepared using stone powder, lime stone powder, fly ash, brick powder and OPC as filler and Zycotherm as an additive at various percentages.

2 LITERATURE REVIEW

Following observations were made from the literate review. It is observed that Although Super pave mix design method is used in determining Marshall Properties for Warm asphalt material mix, Marshall Method of mix design can also be adopted in determining Marshall Properties. It is seen that type of aggregate, binder, mixing temperature and compaction temperature have a significant effect over the Marshall properties of WMA.

Rohith N. and J.Ranjitha (2007) studied on Marshall Stability properties on warm mix asphalt using Zycotherm a chemical additive. They find out optimum binder content and temperature after adding suitable dose of Zycotherm.

Devendra K. patel (2013) studied on Experimental– Investigation of warm mix using Rediset as additive with PMB-40 in warm mix design. They find out optimum binder content of HMA as well as WMA and find out optimum dosage rate of Rediset at optimum temperature by Marshall Stability.

Bhargav N. Gautama (2013) studied on warm mix– design of bituminous firm using Rediset WMX. In this swot they find out reduction in amalgamation with compaction temperature using suitable prescribed quantity rate of Rediset at optimum temperature by Marshall Stability.

The WMA technologies can be classified broadly as those

i. That use water in the mix

ii. That use organic additive or wax in the mix

iii. That use chemical additives or surfactants mix.

XijuanXu, (2011) Warm Mix Asphalt is low-carbon, environmentally friendly asphalt mixture. This kind mixture not only save resources, reduce harmful gap emissions, but also to maintain the asphalt mixture in a better use of quality. In the article, by adding additives to reduce the viscosity of asphalt, we reach the effect of reducing the temperatures of mixture mixing and compaction. At the same time, we do experiment on study high temperature stability, low temperature crack resistance and water stability, the result show that Warm Asphalt Mix gets excellent performance.

Brain D. Prowell (2007) studied on The International– Technology Scanning program summary report. They find out % reduction in emissions and fuel usage due to use of Warm mix technology

Stacey Amy (2008) evaluated warm mix asphalt technology by using Sasobit. In this study the nominal maximum aggregate size of Super pave 9.5mm and 12.5mm were used. The mix is produced using penetration grade 64-22 binder, designated by VDOT SM-9.5A mixture and VDOT SM-12.5A mixture. The super pave gyratory compactor was used for the compaction. Mix production was carried out at different temperatures of 149ºC, 162ºC and 121ºC. WMA additive Sasobit was added at a rate of 1.5% by weight of the binder. The results concluded using of the additive lowered the air voids and improved the compatibility.

Elie and Edward (2011) conducted laboratory test for the CECABASE Warm Mix Additive using an aggregate of a size 19.0mm as specified by Caltrans Standard specification and NDOT specification for Road and Bridge construction. PG 64-28 polymer modified asphalt binder was used for the study. Temperature of 160ºC and 132ºC were maintained for the preparation of HMA and WMA mixes respectively. CECABASE warm mix additive was added to asphalt binder at a rate of 0.4% by weight of binder. Mix design was carried out according to Caltran and NDOT specification for the HVEEM design method.

Magdi M. E. Zumrawi The performance of pavement is very responsive to the characteristics of the soil subgrade. For that reason, weak subgrade is enhanced by adopting the most efficient stabilization technique. Based on the literature review, stabilization with fly ash activated with cement was found to be an effective option for improvement of soil properties. In this regard an experimental program was undertaken to study the effect caused by the combined action of fly ash and cement stabilization on the geotechnical characteristics of expansive subgrade soils. Expansive soil treated with varying percentages of fly ash, 0, 5, 10, 15, and 20 percent combined with 5% cement content were studied. Consistency limits, compaction, California Bearing Ratio, swell potential and swell pressure tests were conducted on treated and untreated soils. The experimental results show that addition of cement-fly ash admixture to the soil has great influence on its properties. It was found that the optimum dosage of fly ash is 15% mixed with 5% cement revealed in significant improvement in strength and durability and reduction in swelling and plasticity properties of the soil. Based on the results, it is recommended that cement-fly ash admixture be considered a viable option for the stabilization of expansive subgrades.

3 MATERIALS AND THEIR CHARACTERISTICS

3.1PRODUCTION OF BITUMEN

Bitumen is the residue or by-product when the crude petroleum is refined. A wide variety of refinery processes, such as the straight distillation process, solvent extraction process etc. may be used to produce bitumen of different consistency and other desirable properties. Depending on the sources and characteristics of the crude oils and on the properties of bitumen required, more than one processing method may be employed.

3.1.1 DIFFERENT FORMS OF BITUMEN

- ✓ **Cutback bitumen:** Normal practice is to heat bitumen to reduce its viscosity. In some situations preference is given to use liquid binders such as cutback bitumen. In cutback bitumen suitable solvent is used to lower the viscosity of the bitumen. From the environmental point of view also cutback bitumen is preferred. The solvent from the bituminous material will evaporate and the bitumen will bind the aggregate. Cutback bitumen is used for cold weather bituminous road construction and maintenance. The distillates used for preparation of cutback bitumen are naphtha, kerosene, diesel oil, and furnace oil.

  There are different types of cutback bitumen like rapid curing (RC), medium curing (MC), and slow curing (SC). RC is recommended for surface dressing and patchwork. MC is recommended for premix with less quantity of fine aggregates. SC is used for premix with appreciable quantity of fine aggregates.
- ✓ **Bitumen Emulsion:** Bitumen emulsion is a liquid product in which bitumen is suspended in a finely divided condition in an aqueous medium and stabilized by suitable material. Normally cationic type emulsions are used in India. The bitumen content in the emulsion is around 60% and the remaining is water. When the emulsion is applied on the road it breaks down resulting in release of water and the mix starts to set. The time of setting depends upon the grade of bitumen. The viscosity of bituminous emulsions can be measured as per IS: 8887-1995. Three types of bituminous emulsions are available, which are Rapid setting (RS), Medium setting (MS), and Slow setting (SC).Bitumen emulsions are ideal binders for hill road construction. Where heating of bitumen or aggregates are difficult. Rapid setting emulsions are used for surface dressing work. Medium setting emulsions are preferred for premix jobs and patch repairs work. Slow setting emulsions are preferred in rainy season

- ✓ **Bituminous primers:**In bituminous primer the distillate is absorbed by the road surface on which it is spread. The absorption therefore depends on the porosity of the surface. Bitumen primers are useful on the stabilized surfaces and water bound macadam base courses. Bituminous primers are generally prepared on road sites by mixing penetration bitumen with petroleum distillate.

3.2 ZYCOTHERM

Zycotherm Anti stripping Additive is a organ silicon compound new generation antistripping agent. Zycotherm is an anti-stripping Additive, changes surface of aggregates from hydrophilic to hydrophobic at a nano level at processing (HMA at about 165 – 1750C). Zycotherm has a positive effect on mixing, workability and compaction of warm mix asphalt. Its superior aggregate wetting and coating properties, ensures uniform bind film thickness and better lubrication of the warm mix.

3.2.1 DOPING OF ZYCOTHERM

For the present study 0.1% was adopted as the additive dosage for preparation of the specimens. Zycotherm was added 0.1% volumetrically or by weight (Zycotherm density: 1.01 gm/cc) using 2.5ml plastic syringe and the molten bitumen 1550C (311 0F) was stirred manually using a glass rod while adding Zycotherm and additional stirring for 10 minutes was done for uniform mixing of the additive with the bitumen. The doping of additive with the binder is shown in Fig. 3.3.

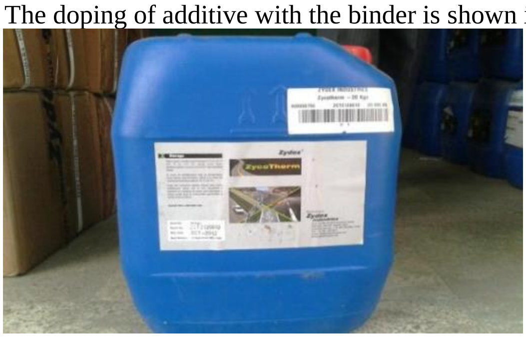


Fig. 3.1: Zycotherm, In Packed Condition

Fig. 3.2: Doping of Zycotherm

The road construction is one of the most material demanding industries with great economic as well as environmental impacts and for this reason significant efforts are seen in terms of recycling and reuse of industrial by-products and/or waste materials in road construction.

Asphalt concrete is strong enough to handle years of vehicle traffic, and is relatively easy to repair or refinish. It also provides a smoother and quieter ride than cement surfaces, which helps to reduce noise pollution around highways and other busy roads. Asphalt materials are extensively used for roadway construction, primarily because of their excellent binding characteristics and water proofing properties and relatively low cost.

Warm Mix Asphalt (WMA) is a fast emerging new technology with potential of revolutionizing the production of asphalt mixtures. WMA technology allows the mixing, and compaction of asphalt at 30°C to 40°C lower temperatures compared to Hot Mix Asphalt (HMA). WMA is produced by incorporating additives into asphalt mixtures to allow production and placement of the mixture at temperatures well below the temperatures of conventional hot mix asphalt (HMA). Warm Mix Asphalt (WMA) is the process of using additives to reduce the mixing temperatures of HMA by 10ºC to 35ºC.

As stated above different types of additives and different technology of application of additives are used in WMA process. Zycotherm is the additive which has been used in the present study. Zycotherm is WMA additive developed by Zydex Industries, Gujarat, India.

This is an odor-free, chemical warm mix additive that has been engineered to provide significantly improved benefits over current WMA technologies by offering lower production and compaction temperatures, while simultaneously enhancing the moisture resistance of pavements by serving as an ant strip. Mixes that have been modified with Zycotherm can be produced at 120°C - 135°C for and compacted at 90°C - 120°C.

Overall, Zycotherm offers temperature reductions depending on the properties of the mix. Zycotherm has built in anti-strip mechanism that allows it to dually function as an anti-strip as well as a warm mix additive. The additive is universally compatible with all types of modified as well as unmodified binders. This includes Polymer Modified Bitumen and Crumb Rubber Modified Bitumen binders. It does not affect binder grading or change any other binder properties. Filler acts as one of the major constituents in Asphalt concrete mixture. Fillers not only fill voids in the coarse and fine aggregates but also affect the ageing characteristics of the mix. Suitable material combinations have been found to result longer life for wearing courses depending upon the percentage of filler and type of fillers used.

4 MARSHALL METHOD OF MIX DESIGN

Marshall Stability test of a mix is defined as maximum load carried by a compacted specimen at a standard test temperature at 60 degree Celsius. This method used to stability test applicable to hot mix design of bitumen and aggregates larger than 25mm. In this method, resistance to plastic deformation of cylindrical specimen of bituminous mixture is measured when the same is loaded at a rate of 5 cm per minute. The flow value is the deformation the Marshall Test specimen under goes during the loading up to the maximum load in 0.01mm units. The Marshall Stability test is applicable for hot mix design using bitumen and aggregates with maximum size of 25mm. The method used to measure the optimum bitumen content. There are two major features of Marshall Stability method of designing mixes are:

1. **Density voids analysis**
2. **Stability flow test**

- **Apparatus** A container vacuum bowl (made of metal or plastic) with diameter of 180 to 260 mm and height of at least 160mm. The bowl shall be equipped with a stiff, transparent cover fitted with a rubber gasket and a connection to a vacuum line. The hose connection shall be covered with a small piece of fine wire mesh to minimize loss of any fine material from the mix. Alternately a vacuum flask for weighing in air, consisting of thick walled volumetric glass flash with a capacity of about 4000ml, fitted with a rubber stopped with a connection for the vacuum line. The hose connection shall be covered with a small piece of fine wire mesh to minimize loss of any fine material from the mix. Balance to read up to 0.1g,with a suitable suspension arrangement for weighing the sample while suspended in water.

Vacuum pump, capable of evacuating air from the vacuum container to a residual pressure of 4.0kpa (30 mm of Hg) or less. A suitable trap is provided between the pump and container to minimize water vapors entering the vacuum pump.

Manometer or calibrated absolute pressure gauge with a bleed valve to adjust the vacuum level Water bath capable of maintaining a constant temperature of 25+- 10c and suitable for immersion of the suspended container.

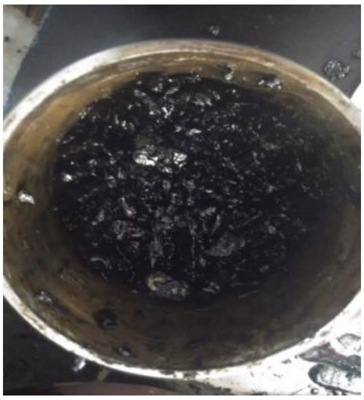


Fig4.1: Bitumen mix in a mould

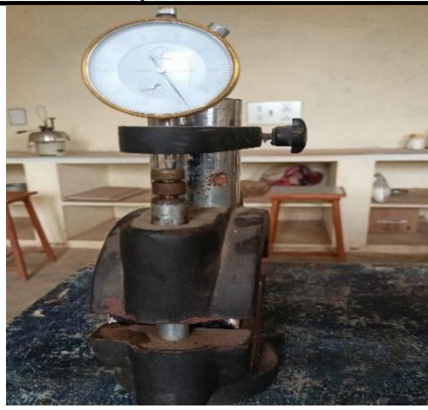
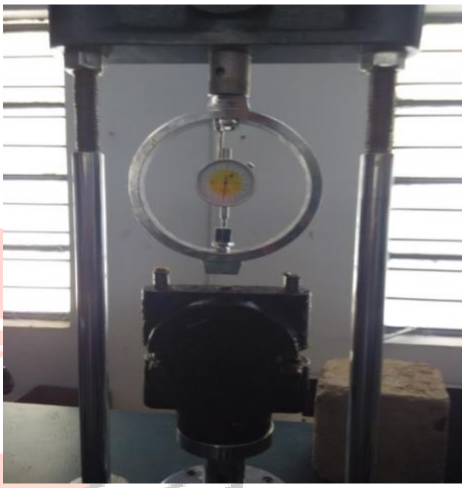


Fig 4.2 Testing made with specimen

- **Procedure**



The sample of bituminous mix to be compacted in the field is collected and the particles of the loose paving mixture (while it is warm) are separated out by had so that the particles are not larger than about 6mm. The aggregates should not be fractured. A minimum sample size of 1500g is needed for mixes with nominal maximum aggregates should not be fractured. A minimum sample size of 1500 g is needed for mixes with nominal maximum aggregate size of 12.5 mm and 2500 g for mixes with nominal maximum aggregate sizes 19 to 25 mm. sufficient water is added at 250c to cover the sample completely. The mix sample is placed directly into the bowl or flask of known weight.

The container is weighed and the net weight of the sample only is determined (A). The cover or stopper is placed on the containers. The container with the sample and water is placed on a mechanical agitator and vibrated. Alternately the container is agitated manually for 2 to 3 minutes. The entrapped air is removed by gradually applying vacuum and increasing the vacuum pressure until the residual manometer reads 3.7+- 0.3 kappa (27.5+- 2.5 mm of Hg). After achieving this level within 2 minutes, the vacuum and agitation are continued for 15+- 2 minutes.

Calculations:

- ***Bulk density of the compacted specimen***

The bulk density of the sample is usually determined by weighting the sample in air and in water. It may be necessary to coat samples with paraffin before determining density. The specific gravity Gbcm of the specimen is given by

$$G_m = \frac{W_{mix}}{W_m - W_w}$$

where, Wa = weight of sample in air (g).
Ww = weight of sample in water (g).

- ***Theoretical specific gravity of the mix*** G_t

Theoretical specific gravity G_t is the specific gravity without considering air voids, and is given by:

$$G_t = \frac{W_1 + W_2 + W_3 + W_b}{\frac{W_1}{G_1} + \frac{W_2}{G_2} + \frac{W_3}{G_3} + \frac{W_b}{G_b}}$$

where

W_1 is the weight of coarse aggregate in the total mix,
W_2 is the weight of fine aggregate in the total mix,
W_3 is the weight of filler in the total mix,
W_b is the weight of bitumen in the total mix,
G_1 is the apparent specific gravity of coarse aggregate,
G_2 is the apparent specific gravity of fine aggregate,
G_b is the apparent specific gravity of bitumen.

- ***Air voids percent*** **V_v**

Air voids **V_v** is the percent of air voids by volume in the specimen and is given by:

$$V_v = \frac{(G_t - G_m)100}{G_t}$$

Where

G_t is the theoretical specific gravity of the mix,

G_m is the bulk or actual specific gravity.

- ***Percent volume of bitumen*** **V_b**

The volume of bitumen **V_b** is the percent of volume of bitumen to the total volume and givenby

$$V_b = \frac{\frac{W_b}{G_b}}{\frac{W_1+W_2+W_3+W_b}{G_m}}$$

Where,

W_1 is the weight of coarse aggregate in the total mix,

W_2 is the weight of fine aggregate in the total mix,

W_3 is the weight of filler in the total mix,

W_b is the weight of bitumen in the total mix,

G_m is the bulk or actual specific gravity,

G_b is the apparent specific gravity of bitumen.

- ***Voids in mineral aggregate*** **VMAS**

Voids in mineral aggregate VMA is the volume of voids in the aggregates, and is the sum of air voids and volume of bitumen, and is calculated from

$$VMA = V_v + V_b$$

Where

V_v is the percent air voids in the mix,

V_b is percent bitumen content in the mix.

- ***Voids filled with bitumen*** **VFB :**

Voids filled with bitumen VFB is the voids in the mineral aggregate frame work filled with the bitumen, and is calculated as:

$$VFB = \frac{V_b X100}{VMA}$$

Where,

V_b is percent bitumen content in the mix,

VMA is the percent voids in the mineral aggregate.

5 ANALYSIS OF DATA

Marshall Tests were conducted on asphalt concrete mix prepared using Stone dust, Lime powder, brick powder, OPC, fly ash, as filler materials. and to determine optimum bitumen content, Marshall Stability, Flow, bulk density, total air voids, voids in mineral aggregates and voids filled at optimum binder content with additive filler and Test results are presented in following tables

Table 5.1 @2%of Stone dust with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	998.15	2.55	1200.05	2.47	1414.59	3.10	1521.00	3.81
5.0%	1427.30	3.12	1633.87	3.75	1483.21	3.222	1532.19	3.96
5.5%	1441.53	3.57	1354.00	2.56	1460.35	3.94	1421.46	2.79

6.0%	1321.66	3.20	1311.56	2.49	1422.22	3.19	1408.06	2.47

Table 5.2 @4%of Stone dust with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	990.33	2.05	1256.00	2.97	1456.08	2.83	1592.00	3.91
5.0%	1459.56	3.24	1676.34	3.53	1578.97	3.95	1621.92	3.82
5.5%	1432.73	3.16	1421.09	2.69	1445.68	3.92	1562.44	3.94
6.0%	1352.64	3.02	1412.57	2.75	1409.00	2.65	1598.18	3.55

Table 5.3 @6%of Stone dust with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1100.03	2.04	1260.10	3.54	1292.85	2.63	1322.11	3.15
5.0%	1463.34	3.52	1572.43	3.79	1574.57	3.95	1426.86	3.54
5.5%	1421.90	2.95	1429.66	3.63	1398.33	2.88	1674.35	3.62
6.0%	1393.64	3.42	1414.72	3.28	1372.45	3.12	1419.94	2.59

Table 5.4 @8%of Stone dust with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1112.33	2.56	1272.00	2.05	1295.06	2.53	1532.10	3.79
5.0%	1425.56	3.04	1452.44	2.11	1489.96	3.62	1672.93	3.82
5.5%	1444.74	3.59	1484.09	3.52	1634.34	3.59	1575.68	3.74
6.0%	1399.32	2.98	1408.57	2.65	1491.03	2.49	1521.15	3.07

Table 5.5 Optimum binder content of Stone dust with Zycotherm

S.No	Type of Filler	0.2%		0.4%		0.6%		0.8%	
	Stone dust	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg
1	2%	5.5	1441.53	5.0	1532.19	5.0	1483.21	5.0	1633.87
2	4%	5.0	1459.56	5.0	1562.14	5.0	1576.97	5.5	1634.34
3	6%	5.0	1463.34	5.0	1572.43	5.0	1574.57	5.5	1581.02
4	8%	5.5	1444.74	5.5	1484.00	5.5	1575.68	5.5	1675.35

Table 5.6 Final Optimum binder content of stone dust values

S.no	Stone dust	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	2%	0.4	1633.87	5.0	3.75
2	4%	0.4	1675.35	5.5	3.53
3	6%	0.8	1581.02	5.5	3.62
4	8%	0.6	1643.34	5.5	3.50

Table5.7 @2%of Lime powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1119.20	2.12	1214.10	2.56	1256.00	2.53	1312.38	2.59

5.0%	1217.56	2.44	1489.43	3.74	1577.25	3.66	1409.54	3.21
5.5%	1349.21	2.57	1545.04	3.72	1499.21	3.68	1551.62	3.50
6.0%	1032.52	2.19	1494.55	2.29	1484.46	2.59	1498.04	3.16

Table 5.8 @4%of Lime powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1256.94	2.14	1309.05	3.11	1351.26	3.50	1420.45	3.11
5.0%	1497.46	3.09	1420.23	3.24	1419.44	2.64	1521.23	3.87
5.5%	1327.11	3.01	1512.87	3.67	1537.25	3.86	1522.26	3.29
6.0%	1310.25	2.58	1419.85	3.27	1424.65	2.95	1435.42	3.30

Table 5.9@6%of Lime powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1281.00	2.95	1328.00	3.49	1358.43	3.12	1419.22	3.16
5.0%	1326.56	3.05	1490.32	3.50	1408.86	3.40	1525.95	3.59
5.5%	1499.41	3.14	1550.65	3.54	1528.45	3.76	1460.98	3.18
6.0%	1350.26	3.12	1320.58	3.28	1485.32	3.72	1453.00	2.90

Table 5.10@8%of Lime powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1250.34	2.56	1346.21	2.59	1356.21	2.56	1420.62	2.86
5.0%	1332.89	3.12	1532.40	3.84	1420.54	3.01	1529.74	3.01
5.5%	1429.30	3.29	1420.72	2.99	1532.86	3.53	1561.96	3.53
6.0%	1350.23	3.30	1416.23	3.14	1468.21	2.95	1498.60	2.95

Table 5.11 Optimum binder content of Lime powder with Zycotherm

S.No	Type of Filler	0.2%		0.4%		0.6%		0.8%	
	Lime powder	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg
1	2%	5.5	1349.21	5.5	1545.04	5.0	1576.24	5.5	1551.62
2	4%	5.0	1497.49	5.5	1512.87	5.5	1221.23	5.0	1536.23

3	6%	5.5	1499.41	5.5	1525.95	5.5	1528.45	5.0	1549.60
4	8%	5.5	1429.30	5.0	1532.40	5.5	1532.86	5.5	1560.18

Table 5.12 Final Optimum binder content of Lime powder values

S.no	Lime powder	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	2%	0.6	1576.24	5.0	3.66
2	4%	0.6	1536.23	5.0	3.86
3	6%	0.4	1549.60	5.5	3.54
4	8%	0.8	1560.98	5.5	3.53

Table 5.13@2%of brick powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1029.56	2.09	1085.23	2.55	1102.05	2.85	1209.09	2.44
5.0%	1100.91	3.12	1164.52	3.14	1209.16	2.46	1221.56	2.56
5.5%	1131.49	2.54	1185.02	2.67	1124.20	3.23	1226.12	3.19
6.0%	1090.72	2.59	1088.11	2.19	1666.15	3.11	1196.25	2.98

Table 5.14@4%of brick powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1030.11	2.53	1091.42	3.11	1109.79	3.24	1211.12	2.59
5.0%	1129.44	2.95	1196.24	2.66	1210.40	3.15	1256.48	3.44
5.5%	1110.02	2.89	1202.05	2.98	1258.49	2.95	1242.12	2.89
6.0%	1062.45	2.62	1188.20	2.52	1189.07	2.86	1232.42	3.07

Table 5.15@6%of brick powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1114.02	2.21	1122.21	2.42	1192.87	2.10	1198.11	2.12
5.0%	1124.90	2.19	1189.03	2.19	1271.42	2.25	1243.32	2.41
5.5%	1252.15	3.04	1263.48	3.04	1210.20	3.13	1281.45	2.54
6.0%	1144.09	2.12	1192.22	2.12	1208.56	2.61	1250.00	2.19

Table 5.16@8%of brick powder with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1054.62	2.09	1144.00	2.43	1201.60	2.55	1240.04	2.77
5.0%	1254.09	2.45	1252.84	2.54	1262.34	3.02	1253.66	2.43
5.5%	1248.11	2.16	1256.53	2.65	1258.80	2.97	1284.14	2.95
6.0%	1242.98	2.25	1249.02	2.89	1246.36	2.63	1242.76	2.82

Table5.17 Optimum binder content of Brick powder with Zycotherm

S.No	Type of Filler	0.2%		0.4%		0.6%		0.8%	
	Brick powder	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg
1	2%	5.5	1131.49	5.0	1164.52	6.0	1965.09	5.5	1226.12
2	4%	5.0	1129.44	5.5	1202.05	5.5	1242.12	5.5	1258.49

3	6%	5.5	1252.15	5.5	1263.08	5.0	1271.03	5.5	1282.45
4	8%	5.0	1254.09	5.5	1256.53	5.0	1262.34	5.5	1284.14

Table 5.18 Final Optimum binder content of Brick powder values

S.no	Brick powder	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	2%	0.6	1665.09	5.0	3.11
2	4%	0.6	1258.49	5.5	2.95
3	6%	0.8	1282.45	5.0	2.54
4	8%	0.8	1284.14	5.5	2.95

Table 5.19@2%of Ordinary port land cement with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1272.37	2.53	1292.81	2.95	1295.04	2.52	1298.01	2.54
5.0%	1292.07	2.79	1299.02	2.84	1321.05	3.22	1325.56	3.11
5.5%	1305.11	2.95	1343.86	3.18	1315.11	3.04	1312.21	3.14
6.0%	1070.96	2.34	1127.81	2.26	1211.16	2.49	1289.55	2.68

Table 5.21@4%of Ordinary port land cement with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1285.09	2.49	1294.51	2.57	1299.14	2.27	1300.12	3.26
5.0%	1321.01	3.21	1341.81	2.91	1321.05	3.19	1314.29	2.97
5.5%	1292.14	2.44	1299.07	3.02	1351.14	3.42	1342.56	2.53
6.0%	1121.05	2.29	1245.12	2.95	1333.11	3.25	1325.89	3.12

Table 5.22@6%of Ordinary port land cement with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1298.11	2.44	1305.25	2.84	1314.11	3.49	1309.25	3.68
5.0%	1350.42	2.85	1312.01	3.12	1362.89	3.23	1315.18	3.55
5.5%	1362.71	3.27	1342.55	3.54	1359.50	3.54	1372.49	3.73
6.0%	1341.04	3.18	1375.24	3.63	1356.09	3.46	1351.24	3.44

Table 5.23@8%of Ordinary port land cement with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1286.24	2.60	1314.01	3.11	1318.53	3.17	1320.12	2.78
5.0%	1340.21	3.21	1321.71	3.15	1361.21	3.25	1372.02	3.29
5.5%	1386.40	3.47	1354.92	3.58	1352.30	3.33	1364.11	3.24
6.0%	1352.18	3.39	1333.01	3.36	1355.18	3.54	1358.54	3.15

Table 5.24 Optimum binder content of OPC with Zycotherm

S.No	Type of Filler	0.2%		0.4%		0.6%		0.8%	
	OPC	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg	O.B.C %	Stability Kg
1	2%	5.5	1305.11	5.5	1325.56	5.0	1321.05	5.0	1343.80
2	4%	5.0	1321.01	5.0	1341.81	5.5	1342.56	5.5	1352.14
3	6%	5.5	1362.71	6.0	1374.24	5.0	1362.89	5.5	1372.49
4	8%	5.5	1386.40	5.0	1354.42	5.0	1361.21	5.0	1371.02

Table 5.25 Final Optimum binder content of Ordinary Portland cement values

S.no	OPC	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	2%	0.4	1343.86	5.0	3.18
2	4%	0.6	1352.14	5.5	3.42
3	6%	0.4	1374.24	6.0	3.63
4	8%	0.8	1371.02	5.0	3.29

Table 5.26@2%of Fly ash with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1212.60	2.56	1250.12	3.15	1271.56	2.99	1265.09	2.93
5.0%	1318.54	2.89	1416.07	2.99	1381.02	3.58	1421.11	3.54
5.5%	1456.48	3.04	1409.69	3.04	1414.25	3.62	1412.29	3.29
6.0%	1413.54	3.16	1356.07	2.48	1409.14	3.48	1399.12	3.12

Table 5.27@4%of Fly ash with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1230.15	2.49	1265.09	2.85	1262.81	2.93	1279.54	2.76
5.0%	1322.93	2.65	1315.19	3.24	1422.24	3.15	1382.11	3.82
5.5%	1411.24	3.17	1415.05	3.29	1409.79	3.02	1420.25	3.90
6.0%	1402.15	3.25	1404.26	3.16	1329.10	3.14	1360.12	3.14

Table 5.28@6%of Fly ash with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1241.43	2.44	1270.12	3.19	1209.46	3.24	1386.00	3.14
5.0%	1362.54	2.68	1453.24	3.13	1392.15	3.09	1342.16	3.09
5.5%	1412.11	3.14	1595.68	3.54	1466.46	2.98	1409.21	3.56
6.0%	1369.28	2.98	1410.15	3.66	1490.11	3.57	1395.76	3.14

Table 5.29@8%of Fly ash with Zycotherm

Bitumen content %	0.2%		0.4%		0.6%		0.8%	
	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm	Marshal stability kg's	Flow in mm
4.5%	1356.21	2.54	1281.09	3.19	1296.26	2.98	1342.19	3.16
5.0%	1462.23	3.56	1368.29	3.46	1429.08	3.13	1509.24	3.09
5.5%	1402.15	3.82	1493.21	3.95	1321.25	3.54	1416.15	3.56
6.0%	1382.61	2.98	1390.15	3.92	1322.45	3.56	1599.24	3.14

Table 5.30 Optimum binder content of Fly ash with Zycotherm

S. No	Type of Filler	0.2%		0.4%		0.6%		0.8%	
	Fly ash	O.B.C	Stability	O.B.C %	Stability	O.B.C	Stability Kg	O.B.C	Stability Kg

		%	Kg		Kg	%		%	
1	2%	5.5	1455.48	5.0	1416.07	5.5	1414.25	5.0	1421.11
2	4%	5.5	1402.15	5.5	1415.05	5.0	1420.15	5.5	1421.15
3	6%	5.5	1412.11	5.5	1596.68	6.0	1490.11	5.5	1409.21
4	8%	5.0	146.23	5.5	1493.21	5.0	1429.08	6.0	1518.24

Table 5.31 Final Optimum binder content of Fly ash values

S.no	Flyash	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	2%	0.2	1455.48	5.5	3.04
2	4%	0.6	1421.25	5.0	3.15
3	6%	0.4	1596.68	5.5	3.54
4	8%	0.8	1598.24	6.0	3.14

Table 5.32 Final obtained optimum binder content values for stone dust, lime powder, brick powder, opc, fly ash

S.no	Filler	Zycotherm dosage %	Stability Kg	O.B.C %	Flow Mm
1	4% of stone dust	0.4	1675.35	5.5	3.53
2	2% of lime powder	0.6	1576.24	5.0	3.66
3	2% of brick powder	0.6	1665.09	5.0	3.11
4	6% of opc	0.4	1374.24	6.0	3.63
5	8% of fly ash	0.8	1598.24	6.0	3.14

Table 5.33 for the optimum percentage of filler material with additive

OBC %	Stability Kg	Flow Mm	Unit wt kg/m^3	VMA %	VFB %
5.5	1675.35	3.53	2545	16.83	74
6	1576.24	3.66	2498	16.94	69
6	1665.09	3.11	2343	17.26	62
6	1374.24	3.63	2560	17.2	72
5.5	1598.24	3.14	2510	16.2	74

6 RESULTS AND DISCUSSIONS

Stone dust:

- In this project to the bitumen concrete mix stone dust added to Zycotherm at various percentages that is from 2%,4%,6%,8%.
- First of all this 2% of stone dust added to bitumen mix to 0.2% of Zycotherm and then the results were found that are stability, OBC & flow values are found.
- Then, later for 2% of stone dust 0.4% of zycotherm added and results were found. This was continued till 0.8% of zycotherm and the results were tabulated in table No's 1,2,3,4 .
- After the stone powder percentage was increased to 4% and to this initially 0.2% of zycotherm added and results were found later the percentage of zycotherm increased from 0.2% till it reaches 0.8%partially all the results were found and tabulated.
- Similarly this was continued for the stone dust having percentages 6%&8 %. All the results were tabulated.
- By observing the results at various percentages, @2% of stone dust with 0.4% zycotherm gives stability value is 1633.35kgs at flow value is 3.75 mm was observed as the maximum .simultaneously @4% of stone dust with 0.4% zycotherm gives stability value is 1676.34kgs flow value 3.53 mm ,@6% of stone dust with 0.8% zycotherm gives stability value is 1674.35, flow value is 3.62 mm was observed as the maximum, @8% of stone dust with 0.6% zycotherm gives stability value is 1634.34, flow value is 3.59mm was observed as the maximum
- From this optimum percentages. We can find the final optimum value by observing a bar chart table no:1.
- Therefore, from that we can say that the maximum and optimum percentage of stone dust 4% and zycotherm 0.4% will give the optimum values of stability value is 1676.34kgs.

Lime powder:

- In this project to the bitumen concrete mix lime powder added to Zycotherm at various percentages that is from 2%,4%,6%,8%.
- First of all this 2% of lime powder added to bitumen mix to 0.2% of Zycotherm and then the results were found that are stability, OBC & flow values are found.
- Then, later for 2% of lime powder 0.4% of zycotherm added and results were found. This was continued till 0.8% of zycotherm and the results were tabulated in table No's 5,6,7,8 .
- After the lime powder percentage was increased to 4% and to this initially 0.2% of zycotherm added and results were found later the percentage of zycotherm increased from 0.2% till it reaches 0.8%partially all the results were found and tabulated in tabulate in table 21.
- Similarly this was continued for the lime powder having percentages 6%&8 %. All the results were tabulated.
- By observing the results at various percentages, @2% of lime powder with 0.6% zycotherm gives stability value is 1577.25kgs at flow value is 3.66mm was observed as the maximum .simultaneously @4% of lime powder with 0.6% zycotherm gives stability value is 1537.25kgs flow value 3.86 mm,@6% of lime powder with 0.4% zycotherm gives stability value is 1550.65, flow value is 3.54mm was observed as the maximum, @8% of lime powder with 0.8% zycotherm gives stability value is 1561.96, flow value is 3.53 mmwas observed as the maximum.
- om this optimum percentages. We can find the final optimum value by observing a bar chart table no:2.
- Therefore, from that we can say that the maximum and optimum percentage of lime powder 2% and zycotherm 0.6% will give the optimum values of stability values 1577.25kgs.

Brick powder:

- In this project to the bitumen concrete mix brick powder added to Zycotherm at various percentages that is from 2%,4%,6%,8%.
- First of all this 2% of Brick powder added to bitumen mix to 0.2% of Zycotherm and then the results were found that are stability, OBC & flow values are found.
- Then, later for 2% of Brick powder 0.4% of zycotherm added and results were found. This was continued till 0.8% of zycotherm and the results were tabulated in table No's 5,6,7,8 .

- After the Brick powder percentage was increased to 4% and to this initially 0.2% of zycotherm added and results were found later the percentage of zycotherm increased from 0.2% till it reaches 0.8%partially all the results were found and tabulated in tabulate in table 21.
- Similarly this was continued for the brick powder having percentages 6%&8 %. All the results were tabulated.
- By observing the results at various percentages, @2% of brick powder with 0.6% zycotherm gives stability value is 1666.15kgs at flow value is 3.11 was observed as the maximum .simultaneously @4% of brick powder with 0.6% zycotherm gives stability value is 1258.49kgs flow value 2.95 ,@6% of brick powder with 0.8% zycotherm gives stability value is 1281.45kgs, flow value is 2.54 mm was observed as the maximum, @8% of brick powder with 0.8% zycotherm gives stability value is 1284.14, flow value is 2.95mm was observed as the maximum.
- From this optimum percentages. We can find the final optimum value by observing a bar chart table no:3.
- Therefore, from that we can say that the maximum and optimum percentage of brick powder 2% and zycotherm 0.6% will give the optimum values of stability values 1666.15kgs.

Ordinary port land Cement :

- In this project to the bitumen concrete mix OPC added to Zycotherm at various percentages that is from 2%,4%,6%,8%.
- First of all this 2% of OPC added to bitumen mix to 0.2% of Zycotherm and then the results were found that are stability, OBC & flow values are found.
- Then, later for 2% of OPC 0.4% of zycotherm added and results were found. This was continued till 0.8% of zycotherm and the results were tabulated in table No's 5,6,7,8 .
- After the OPC percentage was increased to 4% and to this initially 0.2% of zycotherm added and results were found later the percentage of zycotherm increased from 0.2% till it reaches 0.8%partially all the results were found and tabulated in tabulate in table 21.
- Similarly this was continued for the OPC having percentages 6%&8 %. All the results were tabulated.
- By observing the results at various percentages, @2% of opc with 0.4% zycotherm gives stability value is 1343.86kgs at flow value is 3.18 mmwas observed as the maximum .simultaneously @4% of opc with 0.6% zycotherm gives stability value is 1351.14kgs flow value 3.42 ,@6% of brick powder with 0.4% zycotherm gives stability value is 1375.24kgs, flow value is 3.63mm was observed as the maximum, @8% of opc with 0.8% zycotherm gives stability value is 1372.02, flow value is 3.63mm was observed as the maximum.
- From this optimum percentages. We can find the final optimum value by observing a bar chart table no:4.
- Therefore, from that we can say that the maximum and optimum percentage of OPC 6% and zycotherm 0.4% will give the optimum values of stability values 1375.24kgs.

Fly ash:

- In this project to the bitumen concrete mix fly ash added to Zycotherm at various percentages that is from 2%,4%,6%,8%.
- First of all this 2% of fly ash added to bitumen mix to 0.2% of Zycotherm and then the results were found that are stability, OBC & flow values are found.
- Then, later for 2% of fly ash 0.4% of zycotherm added and results were found. This was continued till 0.8% of zycotherm and the results were tabulated in table No's 5,6,7,8 .
- After the fly ash percentage was increased to 4% and to this initially 0.2% of zycotherm added and results were found later the percentage of zycotherm increased from 0.2% till it reaches 0.8%partially all the results were found and tabulated in tabulate in table 21.
- Similarly this was continued for the fly ash having percentages 6%&8 %. All the results were tabulated.
- By observing the results at various percentages, @2% of fly ash with 0.2% zycotherm gives stability value is 1456.48kgs at flow value is 3.04mm was observed as the maximum .simultaneously @4% of fly ash with 0.6% zycotherm gives stability value is 1422.24kgs flow value 3.15 ,@6% of brick powder with 0.4% zycotherm gives stability value is 1595.68kgs, flow value is 3.54mm was observed as the maximum, @8% of opc with 0.8% zycotherm gives stability value is 1599.24, flow value is 3.14mm was observed as the maximum.
- From this optimum percentages. We can find the final optimum value by observing a bar chart table no:5
- Therefore, from that we can say that the maximum and optimum percentage of fly ash 8% and zycotherm 0.8% will give the optimum values of stability values 1599.24kgs
- Finally by comparing all the optimum percentages of all the filler materials at the optimum percentage of the additive we can say that stone dust will give better results than other filler materials after that brick powder will give better results fly ash will better results and then lime powder will results and opc give the final better results.

7 CONCLUSIONS

- Here in this project various filler materials were used. But among all those stone dust give a very good stability Values than other filler materials.

- By observing all the filler materials optimum dosage along with marshal stability values we can say that stone powder is the best filler material along with the additive.
- By observing all the filler materials with optimum binder content with additive OPC gives the more unit weight as comparative other filler materials used.
- And also observing the VMA values is give when fly ash used as a filler in bituminous concrete.

Hence due to the addition of additive the spreading capability of bitumen will get increase on the aggregate and parallel will give better serviceability and stability values along with materials

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