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EXPERIMENTAL ANALYSIS OF ULTRA THIN WHITE TOPPING

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Abstract: The increasing truck weights and tyre pressures on our pavements in recent years have pushed the demand on the performance of our pavements to a higher level. Many asphalt pavements have experienced rutting while many others have experienced longitudinal cracking. One of the possible solutions to this problem is the use of white topping (WT). which is a cement concrete layer placed over an existing asphalt pavement, Concrete overlays have been used to rehabilitate bituminous pavements since 1918 in USA. There has been a renewed interest in white topping, particularly on Thin White Topping (TWT) and Ultra-Thin White Topping (UTWT) over Conventional White Topping.

KEYWORDS, Alccofine 1203, Robo Sand, Recycled Coarse Aggregate, thin white topping

OBJECTIVE

- To compare the mix designs (Results) of normal concrete and partially replaced concrete (Cement with ALCCOFINE 1203, Natural sand by rob sand and natural aggregates by C&D aggregates).

INTRODUCTION

The white topping can be classified into three types namely Thin White Topping (TWT) and Ultra-Thin White Topping (UTWT) over Conventional White Topping.

I. Conventional White topping- which consists of PCC overlay of thickness 200 mm or more, which is designed & constructed without consideration of any bond between existing overlay & underlying bituminous layer (without assuming any composite action)

II. Thin White topping (TWT)- which has PCC overlay between 100 200 mm. It is designed either considering bond between overlay & underlying bituminous layer or without consideration of bond. High strength concrete (M 40 or higher) is normally used to take care of flexure requirement. Joints are at shorter spacing of 0.6 to 1,25 m.

III. Ultra-Thin White topping (UTWT)- which has PCC overlay of less than 100 mm. Bonding between overlay & underlying bituminous layer is mandatory. To ensure this, the existing layer of bitumen is either milled (to a depth of 25 mm) or surface scrapped (with a non-impact scrapper) or gently chiselled. Joints are provided at a spacing of 0.6 to 1.25 m.

Ultra-thin white topping is one of the types of white topping in which a thin layer of concrete varying from 50 to 100mm thick with fibers is placed over a prepared surface of distressed asphalt pavement. In addition to the thickness of the concrete overlay, other factors differentiate UTW from conventional concrete overlays are: (a) a substantial degree of bond between the concrete overlay and the prepared asphalt surface, and (b) much closer joint spacing. Ultrathin White topping is an emerging and innovative technology for asphalt pavement rehabilitation in India.

LITERATURE SURVEY

M. Patel, P. P. S. Ramanuj, B. Kumar and A. Parmar, "White Topping as a Rehabilitation Method: A Case Study of Budhel-Ghogha Road," International Journal of Advanced Engineering Research and Studies, vol. I, no. 4, 2012.

The Authors, Mitesh D. Pate 1, Prof. P.S. Ramanuj2, Bhavin Parmar3, Akashi Parmar4 explains UTWT as a treatment for the recovery of the Asphalt pavement. They define UTWT as a revolutionary method with less cost investment and maintenance. They suggest to use this technique in the rural or regional areas, so that the poverty level will decrease as Road is the one of the main source of transportation which connects rural to urban areas.

Assessment of Wisconsin's white topping and ultra-thin white topping project
By: Haifang Wen, PhD. P. Xanjun Li, Wilfing Martono.

The primary objectives of this study are to catalog the white topping (WT) and UTW projects in document pertinent design and construction elements, assess performance and estimate a service life of these projects. A comprehensive literature review was performed.

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A K. Sehgal and S. N. Sachdeva 2015 A Review of Using Thin White Topping Overlays for Rehabilitation of J. Basic Appl. Eng. Res., 2, 182-187, S. K. & R. K. J

A K Sehgal et al have studied the advantages and benefits of Thin White Topping over bituminous overlays and have done comparison between the two considering the sustainability as the main criteria. The other factors considered are design life, life cycle cost and other environmental factors. Their study concludes that TWT overlays are considered more environmentally and economically sustainable as compared to that of bituminous overlays.

V K Sinha et al attempted to bring forth the concept of white topping over existing bituminous pavement.

They computed the thickness for the bituminous overlay as well as for the concrete overlay and cost estimation for both. In their study. comparison is done based on total life cycle cost. And from the paper, it is noted that the savings in the construction cost of doing white topping against bituminous overlay is evidently convincing and hence life cycle cost is more economical.

Abhijith C.C study dealt with the performance of UTWT overlays of different combinations over bituminous concrete layer.

From this study, the direct tensile test indicated that the ROFF cement interface improved the bond strength in all the combinations when compared to that of plain cement concrete beams. Also the results of Modified Immersion Wheel Tracking test indicated that the performance of composite beams directly depended upon the thickness of the cement concrete layer (as the thickness increases, yields very low rut value), radius of stiffness of the composite beams and also the admixture used and its percentage.

Mitesh D. patel, P.S. Ramanauj White topping as a rehabilitation method: a case study of budhel-ghogha road. 2012.

Size	Cost (bitumen)	Cost (UTWT)	Saving
90 mm	53 lakh	42.69 lakh	10.31 lakh
150 mm	1.07 Cr	35.26 lakh	21.24 lakh
200 mm	1.41 Cr	98.64 lakh	42.36 lakh

- For 90 mm bituminous overlay and 100 mm white topping overlay saves 19.04 % cost.
- For 150 mm bituminous overlay and 150 mm white topping overlay saves 20.32 % cost.
- For 200 mm bituminous overlay and 200 mm white topping overlay saves 30.04 % cost.

Zidan Ahmed1, Syed Khaja Yaser Ali2, Mohammed Ahmed uddin3, Mr. Ahmed Abdul Ahad Experimental Study on Recycled Concrete Aggregates

1. With the same w/c ratio, the slump value decreases if percentage of demolished aggregates is increased.
2. The compressive strength of Recycled Aggregate Concrete was lower than that of Natural Aggregate Concrete but if 20% demolished waste is used then it will give more characteristics strength to that of natural aggregate used concrete.
3. Strength decreases with 30% replacement and with 10% and 20% of demolished waste it gives more result as compared to normal aggregate concrete.
4. The relationship of w/c ratio and compressive strength of demolished waste concrete is inversely proportional.

Sheetal B. Bhosale, Madhulika Sinha. An Experimental Analysis and Comparison of Properties of Concrete with Recycled Aggregates and Partial Replacement of Cement with Alccofine.

Conclusion: 6 4.00 The examination investigates the effect of 10% Alccofine on the properties of recycled Mix 6 aggregate concrete by replacing 25% and 50% natural coarse aggregates. The outcomes demonstrate that there is an improvement in the compressive strength of concrete because of the high pozzolanic nature of the Alccofine and its void filling ability. Also there is an increase in the Flexural Strength as compared to normal concrete. Its use should be promoted for better performance as well as for environmental sustainability. There is an increase in compressive strength up to 8 % in recycled aggregate Concrete and flexural strength is increased by 5 flexural % when 10% Alccofine is replaced by cement. From the above experiment, it is concluded that mechanical property of RAC for 25% and 50% recycled aggregate is improved when 10% alccofine is added. It is suggested that 10% Alccofine as partial cement replacement in concrete containing RCA from construction and demolition wastes can produce structural grade concrete that is able to perform without any drawbacks to its mechanical properties.

Shaik Rofa, Posam Rukesh Experimental Investigation on Robo Sand Concrete

Based on results obtained, the conclusions are:

1. The replacement of sand as has been done up to 40 percent as a fine aggregate in concrete by using quarry dust.
2. The results have been highly encouraging in the case of concrete with natural sand and its replacement with Robo sand up to 40 percent.
3. Coming to workability it is observed that workability is increasing when compared to conventional concrete.
4. A compressive strength result there is a nominal increase in the Robo sand concrete up to 40 percent replacement.
5. From the split tensile strength results there is a nominal increase in the Robo sand concrete with reference to conventional concrete at 28 days.
6. This indicates that Robo sand can be replaced for fine aggregate without any correction while designing the concrete mix.

METHODOLOGY

4.1 MATERIAL USED

4.1.1 ALCCOFINE 1203

- ALCCOFINE 1203 has a partial replacement of cement
- It is the new material in the concrete industry produced by ambuja cement pvt ltd.
- It is mainly used to increase the compressive strength of concrete.
- The ultrafine particle of ALCCOFINE 1203 provides better and smooth surface.

4.1.2 RECYCLED COARSE AGGREGATE

- The recycled coarse aggregate is obtained from construction & demolition waste.
- After collecting these used concrete, it is then crushed & graded into required size.
- These aggregate can be used as replacement for coarse aggregate.
- One of the main reasons to use RCA in concrete is to make the construction more “green” and also to make environmental friendly.

4.1.3 ROBO SAND

- It is also known as manufactured sand, is a type of sand that is produced by crushing rocks and quarry stones into small particles.
- It is an alternative to natural sand and is becoming increasingly popular in construction projects. Robo sand has several advantages over natural sand.
- First, it is free from impurities such as clay, silt, and organic matter, which can affect the quality of the construction.
- Second, it has consistent particle size and shape, which improves the workability of the concrete mix.
- Third, it is cheaper than natural sand, which can help reduce the cost of constructio

4.2 TEST CONDUCTED ON MATERIALS

4.2.1 Cement

Test procedure to determine the specific gravity of cement.

The flask is allowed to dry completely and made free from liquid and moisture. The weight of the empty flask is taken as W1. The bottle is filled with cement to its half (Around 50gm of cement) and closed with a stopper. The arrangement is weighed with stopper and taken as W2.

To this kerosene is added to the top of the bottle. The mixture is mixed thoroughly and air bubbles are removed. The flask with kerosene, cement with stopper is weighed and taken as W3. Next, the flask is emptied and filled with kerosene to the top. The arrangement is weighed and taken as W4.

The most important use of cement is the production of mortar and concrete, which is a combination of cement and an aggregate to form a strong building material that is durable in the face of normal environmental effects. In the present investigation OPC 43 grade cement is used.

Table. 4.1 specific gravity of cement & Alccofine 1203

Sl No.	Test conducted	Results Obtained
1.	Specific gravity (OPC)	3.15
2.	Specific gravity of (OPC + 15% Alccofine 1203)	3.53
3.	Specific gravity of (OPC + 20% Alccofine 1203)	3.38
4.	Specific gravity of (OPC + 25% Alccofine 1203)	3.68

Table 4.2 Normal consistency of Cement & Alccofine 1203

Sl No.	Test conducted	Results Obtained
1.	Normal consistency (OPC 43 graded)	33%
2.	Normal consistency Alccofine 1203	48.5%

Test procedure of determination of initial setting time of cement

Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle (C); lower the needle gently until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block. In the beginning, the needle will \ completely pierces the test block

Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block beyond 5.0 ± 0.5 mm measured from the bottom of the mould. The period elapsing between the time when water is added to the cement and the time at which the needle fails to pierce the test block to a point 5.0 ± 0.5 mm measured from the bottom of the mould shall be the initial setting time.

Determination of Final Setting Time

Replace the needle (C) of the Vicat apparatus by the needle with an annular attachment (F).

The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression thereon, while the attachment fails to do so.

The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so shall be the final setting time.

In the event of a scum forming on the surface of the test block, use the underside of the block for the determination.

Table 4.3 initial and final setting time of cement & Alccofine 1203

Sl No.	Test conducted	Result Obtained
1.	Initial and final setting time of OPC 43	33 min & 10 hrs.
2.	Initial and final setting time of alccofine 1203	85min &3hours

4.2.2 Aggregate

Procedure for Specific Gravity of fine Aggregate

A clean, dry pycnometer is taken and its empty weight is determined. About 1000g of clean sample is taken into the pycnometer, and it is weighed. Water at 27-degree C is filled up in the pycnometer with aggregate sample, to just immerse sample. Immediately after immersion the entrapped air is removed from the sample by shaking pycnometer, placing a finger on the hole at the top of the sealed pycnometer. Now the pycnometer is completely filled up with water till the hole at the top, and after confirming that there is no more entrapped air in it, it is weighed. The contents of the pycnometer are discharged, and it is cleaned. Water is filled up to the top of the pycnometer, without any entrapped air. It is then weighed. For mineral filler, specific gravity bottle is used and the material is filled upto one-third of the capacity of bottle.

Table 4.4 specific gravity of Fine Aggregate

Sl No.	Tests conducted	Results Obtained
1.	Specific gravity (natural sand)	2.65
2.	Specific gravity of ROBO sand	2.81

Test procedure for determination of crushing test

Put the cylinder in position on the base plate and weigh it (W). Put the sample in 3 layers, each layer being subjected to 25 strokes using the tamping rod. Care being taken in the case of weak materials not to break the particles and weigh it (W1).

Level the surface of aggregate carefully and insert the plunger so that it rests horizontally on the surface.

Care being taken to ensure that the plunger does not jam in the cylinder. Place the cylinder with plunger on the loading platform of the compression testing machine.

Apply load at a uniform rate so that a total load of 40T is applied in 10 minutes.

Release the load and remove the material from the cylinder.

Sieve the material with 2.36mm IS sieve, care being taken to avoid loss of fines. Weigh the fraction passing through the IS sieve (W2).

Table 4.5 crushing test of Coarse Aggregate

Sl No.	Tests conducted	Results Obtained
1.	Crushing test	4 KN/mm^2
2.	Crushing test on (coarse aggregate + R.C.A)	4.2 KN/mm^2

4.3 Experimental investigation

4.3.1 General

In the present study we are partially replacing the cement by Alccofine 1203 by 15%, 20% & 25%, coarse aggregate by recycled coarse aggregate (RCA) 20% and fine Aggregate by ROBO sand 50% for M40 Grade concrete cubes of 150mm x 150mm x150mm were casted and cylinders of 150mm x 300mm. To achieve the objectives of the investigation the experimental program was planned to cast Specimens. And the specimen was tested under 2000 KN compression testing machine to study the compressive strength & split tensile strength of the specimen,

4.4 CONCRETE MIX DESING

4.4.1 TARGET STRENGTH FOR MIX PROPORTIONING

f’ck = fck + 1.65 s where f’ck = target average compressive strength at 28 days, fck = characteristics compressive strength at 28 days, ands = standard deviation. From Table I of IS 10262:2009, Standard Deviation, s = 5 N/mm2. Therefore, target strength = 40 + 1.65 x 5 = 48.25 N/mm2

THE CONCRETE MIX DESIGN RATIO IS 1:1:2:0.38 (with refrence to IS 10262:2009)

4.4.2 MATERIAL REQUIRED FOR 1 STANDARD CUBE:

Vol= $0.15\times0.15\times0.15 = 3.375\times10^{-3}$ m^3 Density of concrete =

2400kg/m^3

Weight of material = volume × density

= $3.375\times10^{-3} \times 2400 = 8.1$kg

Add 10% wastage = 8.91≈ 9.0kg

Using designed mix proportion

Weight of cement = 9/1+1+2 = 2.25kg

Weight of fine aggregate = 2.25×1= 2.25kg

Weight of coarse aggregate = 2.25×2 = 4.5kg

4.4.3 MATERIALS REQUIRED FOR 1 STANDARD CYLINDER:

Diameter = 15cm

Volume of cylinder= $\pi/4\times0.15^2\times0.3 = 5.30\times10^{-3}m^3$

Weight of material = volume × density

$= 5.30\times10^{-3} \times 2400 = 12.72$kg

Add 10% wastage = 12.71×1.1 = 14kg

Using required mix proportion

Weight cement = 14/1+1+2 = 3.5kg

Fine aggregate = 3.5 x 1 = 3.5 kg

Coarse aggregate = 3.5 x 2 = 7kg

4.4.4 TOTAL MATERIAL USED

The total quantity of material used for conventional & partially replaced concrete.

CEMENT	134.60 KG
ALCCOFINE 1203	31 KG
FINE AGGREGATE	94.2 KG
ROBO SAND	77.60 KG
COARSE AGGREGATE	284 KG
R.C.A.	62.2 KG
SUPER PLASTICIZER (POLYTANCRETE NGT)	1% OF TOTAL WEIGHT OF CEMENT

TEST PROGRAM

The main objective of the present investigation was to study & compare the mix designs (Results) of normal concrete and partially replaced concrete in terms of compressive strength and split tensile strength with normal water curing and with chemical admixtures in the mixes. The slump test is conducted for each mix, and Performance of the concretes was assessed through: compressive strength & split tensile strength. The specimens were tested for strengths at 7, 14 and 28 days.

5.1 Workability test

Test procedure for determination of slump cone test

I. Clean the internal surface of the mould and apply oil.
II. Place the mould on a smooth horizontal non- porous base plate.
III. Fill the mould with the prepared concrete mix in 4 approximately equal layers.
IV. Tamp each layer with 25 strokes of the rounded end of the tamping rod in a uniform manner over the cross section of the mould. For the subsequent layers, the tamping should penetrate into the underlying layer.
V. Remove the excess concrete and level the surface with a trowel.
VI. Clean away the mortar or water leaked out between the mould and the base plate.
VII. Raise the mould from the concrete immediately and slowly in vertical direction.
VIII. Measure the slump as the difference between the height of the mould and that of height point of the specimen being tested. Ingredients of mixes are properly mixed so as to produce homogeneous and uniform fresh concrete in macro-scale in order to know its workability using slump test. The results of same test for the conventional concrete, partially replaced concrete (Alccofine 1203 = 15%, 20% & 25%) (ROBO sand = 50%) (R.C.A. = 20%) are shown in table below.

Table. 5.1 slump test values

Sl. No.	% of Alccofine 1203	% of ROBO sand	% of R.C.A.	Slump value (mm)
1.(Conventional concrete)	0	0	0	60
2.(Partially replaced concrete)	15	50	20	50
3.(Partially replaced concrete)	20	50	20	45
4.(Partially replaced concrete)	25	50	20	55

5.2 COMPRESSIVE STRENGTH OF CONCRETE CUBES:

Test procedure for determination of compressive strength of concrete cubes

I. Remove the specimen from the water after specified curing time and wipe out excess water from the surface.
II. Take the dimension of the specimen to the nearest 0.2m
III. Clean the bearing surface of the testing machine
IV. Place the specimen in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
V. Align the specimen centrally on the base plate of the machine.
VI. Rotate the movable portion gently by hand so that it touches the top surface of the specimen.
VII. Apply the load gradually without shock and continuously at the rate of 140 kg/cm2/minute till the specimen fails
VIII. Record the maximum load and note any unusual features in the type of failure.

This test is done to determine the cube strength of concrete mix prepared. The test is conducted on the 7th day and the 28th day and its observation are listed below in the form of a graph. Compressive strength values with replacement of cement by Alccofine 1203 with 15%, 20%, and 25%, coarse aggregates by R.CA. with 20% & Fine aggregate by ROBO sand with 50%.

Table 5.2 Compressive Strength of Concrete Cube

Materials			Compressive strength (N/mm^2)		
% of Alccofine 1203	% of ROBO sand	% of R.C.A.	7 days	14 days	28 days
0	0	0	29.90	35.85	45.74
15	50	20	28.70	35.99	44.91
20	50	20	28.99	38.69	48.91
25	50	20	28.39	38.21	39.94

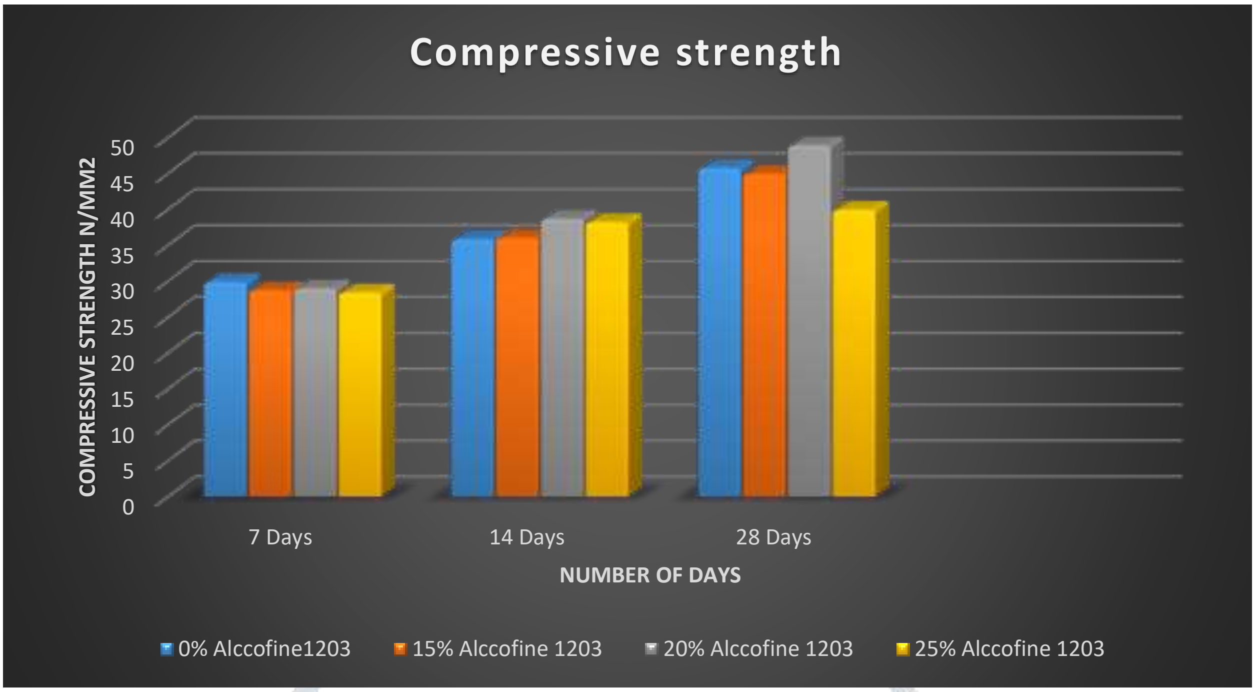


Fig 5.1 Graphical representation of compressive strength of concrete cubes

5.3 SPLIT TENSILE STRENGTH OF CONCRETE CYLINDERS:

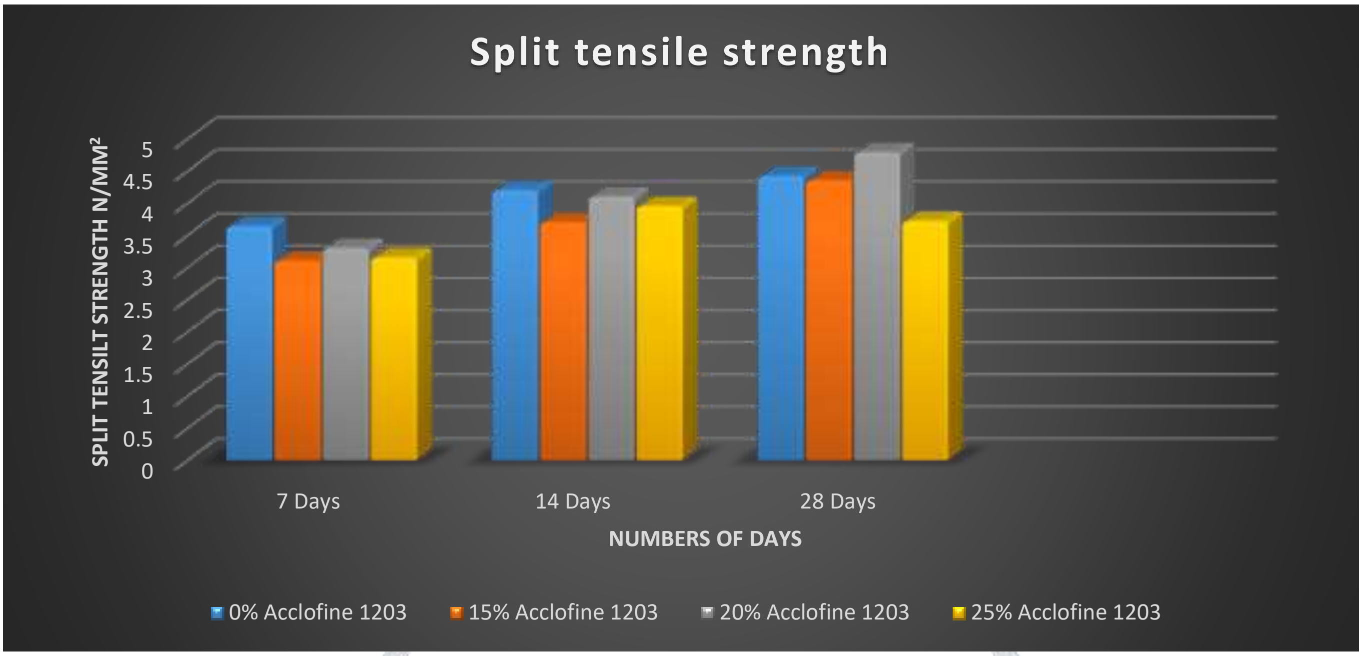
Test procedure for determination of split tensile strength of concrete cylinders

I. Initially, take the wet specimen from water after 7,14, & 28 of curing; or any desired age at which tensile strength to be estimated.
II. Then, wipe out water from the surface of specimen
III. After that, draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
IV. Next, record the weight and dimension of the specimen.
V. Set the compression testing machine for the required range.
VI. Place plywood strip on the lower plate and place the specimen.
VII. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
VIII. Place the other plywood strip above the specimen.
IX. Bring down the upper plate so that it just touches the plywood strip.
X. Apply the load continuously without shock at a rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999)
XI. Finally, note down the breaking load(P)

This test is done to determine the cube strength of concrete mix prepared. The test is conducted on the 7th day and the 28th day and its observation are listed below in the form of a graph. Split tensile strength values with replacement for cement by Alccofine 1203 with 15%, 20%, and 25%, Coarse aggregates by R.CA. with 20% & with Fine aggregate by ROBO sand with 50%.

Table 5.3 split tensile Strength of Concrete cylinders

Materials			**Split tensile strength (N/mm^2)**		
% of Alccofine 1203	% of ROBO sand	% of R.C.A.	7 days	14 days	28 days
0	0	0	3.64	4.20	4.42
15	50	20	3.10	3.70	4.35
20	50	20	3.30	4.10	4.79
25	50	20	3.15	3.95	3.72



5.2 split tensile strength of concrete cylinders

5.4 RESULTS & DISCUSSION

A. SPECIFIC GRAVITY

The specific gravity of cement for the normal concrete is 3.17 as shown in the table the specific gravity increases when alccofine 1203 is replaced up to 15% and and the test results shows that the value decreases when used up to 20% as shown in the table and when alccofine 1203 is replaced up to 25% the value again increases as shown in the table 4.1

B. NORMAL CONSISTENCY

The results of the normal consistency test provide valuable information about the flow characteristics and setting behavior of the cement. These results can be compared to relevant standards or specifications to ensure compliance with the required normal consistency range. By examining the test results, we can determine whether the cement has the appropriate water requirement for its intended use.

The normal consistency of cement is 33% & of Alccofine 1203 is 48.5% as shown in the table 4.2.

C. INITIAL SETTING TIME OF CEMENT & ALCCOFINE 1203

The results of initial setting time tests provide valuable information about the behavior and performance of cement. The data obtained from these tests can be used to determine the suitability of a particular cement for specific construction applications. For example, quick-setting cement may be preferred for situations where rapid strength development is required, such as in cold weather or emergency repairs.

On the other hand, longer setting times may be desired for large-scale construction projects that require extended workability and results are shown in the table 4.3

D. FINAL SETTING TIME OF CEMENT & ALCCOFINE 1203

The final setting time results may involve analysing the impact of various factors on the setting time. For instance, higher temperatures generally accelerate the setting process, while lower temperatures can prolong the setting time. Changes in the water-cement ratio and the use of chemical admixtures can also influence the final setting time. Understanding these influences allows for adjustments in the mix design and construction practices to achieve the desired setting time for specific project requirements the final setting time of cement & alccofine 1203 are shown in the table 4.3

E. SPECIFIC GRAVITY OF FINE AGGREGATE

The test results should be compared with the specified limits for specific gravity. If the values fall within the acceptable range, it indicates that the fine aggregate meets the required quality standards. However, if the values are outside the specified range, further investigation may be needed to determine the suitability of the aggregate for the intended use. The specific gravity of fine aggregate & ROBO sand are 2.65 & 2.81 respectively & the results are also shown in the table 4.4.

F. CRUSHING TEST

The crushing strength tests for both types of aggregate provide valuable information about their individual quality and strength characteristics. These results can be compared to relevant standards or specifications to ensure compliance with the required range. By examining the test results, we can determine whether the coarse aggregate and recycled coarse aggregate meet the necessary criteria for their intended use.

The use of recycled coarse aggregate by the replacement of 20% of coarse aggregate gives the better result as the crushing strength increases as shown in the table 4.5

G. WORKABILITY

The results obtained from the Slump Cone Test are as shown in the table 5.1 All mixes give good workability and were readily compacted under laboratory conditions. Only recycle aggregate concrete shows less workability than other mixes. Addition of Alccofine improved workability.

H. COMPRESSIVE STRENGTH

The results of the compressive strength results are presented in the table 5.2 the cubes of each mix design were prepared & tested after 7 days, 14 days & 28 days of curing. The readings are obtained and is presented in the table 5.2. Use of 20% Alccofine 1203 recycle aggregates 20% & ROBO sand 50% proves to be beneficial, giving strengths of 48.91 N/mm^2. Thus the results show that 20% Alccofine 1203 was beneficial for the desired compressive strength of concrete at 28 days.

I. SPLIT TENSILE STRENGTH

The split tensile strength results of 28 days are compared in table 5.3 As we observe, the split tensile strength of recycle concrete aggregate is less than natural aggregate. However, it is improved by incorporation of Alccofine 1203 & ROBO sand. Split Tensile strength improved up to 4.79 N/mm^2 by 20% replacement of cement with Alccofine 1203, 50% sand by ROBO sand & 20% coarse aggregate by R.C.A. So the tensile strength results are also satisfactory with recycle aggregate and 20%, replacement of cement with alccofine 1203 by 20% & replacement of sand by ROBO sand by 50%.

Table 5.3 material and concrete test results

Sl. No.	Test	Result
1. (specific gravity of cement & alccofine 1203)	Specific gravity (OPC)	3.15
	Specific gravity of (OPC + 15% Alccofine 1203)	3.53
	Specific gravity of (OPC + 20% Alccofine 1203)	3.38
	Specific gravity of (OPC + 25% Alccofine 1203)	3.68
2. (normal con-sistency of cement & alccofine 1203)	Normal consistency (OPC 43 graded)	33%
	Normal consistency Alccofine 1203	48.5%
3. (initial & final setting time)	Initial & final setting time of OPC 43	33 min & 10 hrs.
	Initial & final setting time of alccofine 1203	85min &3hours
	Specific gravity (natural sand)	2.65

4. (specific gravity of fine aggregate)	Specific gravity of ROBO sand	2.81
5. (crushing test of)	Crushing test (coarse aggregate)	4 KN/mm^2
	Crushing test on (coarse aggregate + R.C.A)	4.2 KN/mm^2

6. (workability test)	**% of Alccofine 1203**	**% of ROBO sand**	**% of R.C.A.**	**Slump value (mm)**
i. (Conventional concrete)	0	0	0	60
ii. (Partially replaced concrete)	15	50	20	50
iii. (Partially replaced concrete)	20	50	20	45
iv. (Partially replaced concrete)	25	50	20	55

7 (compressive strength)	**Materials**		**Compressive strength (N/mm^2)**		
% of Alccofine 1203	% of ROBO sand	% of R.C.A.	7 days	14 days	28 days
0	0	0	29.90	35.85	45.74
15	50	20	28.70	35.99	44.91
20	50	20	28.99	38.69	48.91
25	50	20	28.39	38.21	39.94

8. **(SPLIT TENSILE TEST)**		**Materials**	**Split tensile strength (N/mm^2)**		
% of Alccofine 1203	% of ROBO sand	% of R.C.A.	7 days	14 days	28 days
0	0	0	3.64	4.20	4.42
15	50	20	3.10	3.70	4.35
20	50	20	3.30	4.10	4.79
25	50	20	3.15	3.95	3.72

CONCLUSION

- There is increase in strength up to 20% of alccofine1203 after that there is slightly reduction in the strength so the optimum replacement of cement by alccofine 1203 is 20%.
- By using alccofine in ultrathin white topping the serviceability of pavement may increase.
- Better visibility in night driving condition due to better reflectance from white topping
- The concrete mix design ratio is same for both the conventional concrete and partially replaced concrete due to the replacement of cement with Alccofine 1203 by 20%, sand with robo sand by 50% and coarse aggregate with recycled coarse aggregate by 20% the partially replaced concrete perform well and gave us the better results for compressive strength and split tensile strength as compared to conventional concrete.

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