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A Study On Strength Properties Of Concrete By Partial Replacement Of Cement By Bethamcherla Stone Powder

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Concrete has the largest production of all manmade materials. It is a composite mixture containing cement paste and aggregates as its main components. Nowadays, common Cement is quite expensive so the main emphasis of this study is to find an alternative of Cement..

Concrete is the most important component used in the construction industry throughout the world. Due to excessive mining, natural resources are getting exhausted results in increase in scour depth and sometimes flood possibility. Thus, it is becoming inevitable to use alternative material in concrete.

The various studies have been done using either stone power or marble powder as a replacement of sand. To reduce the solid waste minimization and waste recovery, a combination of Bethamcherla Stone Powder has been attempted in this study. The percentages of Bethamcherla Stone Powder added to replace Cement were 5%, 10%, 15%, 20% and 25% of the Cement by weight. In this present examination had been made to talk about the Workability, Compressive Strength, Split Strength, Flexural quality of concrete by supplanting Cement with Bethamcherla Stone Powder with various substitution levels 0%BSP, 5%BSP, 10%BSP, 15%BSP, 20%BSP,25%BSP for M20 Grade of Concrete.

Key Words: Bethamcherla Stone Powder, M20 Grade Concrete, Split Rigidity, Flexural Strength.

I. INTRODUCTION

General

Concrete is a composite material made up of loose materials known as aggregates that provide strength and are formed into a homogenous mixture using water and a binder in the form of cement to withstand loads of various forms. The ability to use recycled waste material to form concrete brings in a new dimension to construction and helps for sustainability of the built environment. In the housing, transportation and energy infrastructure, Portland cement is a material most widely used in construction. Industry and academia have come together to develop stronger concrete, raw material used as filler and admixture or aggregate in concrete. The essence of each of the constituents of concrete is to provide adequate strength throughout its life cycle and maintain favorable design properties. PCC (Portland Cement Concrete) is made up of raw materials such as limestone, shale, clay for cement production, river sand which is the Fine aggregates, granite stones as the coarse aggregates and are diminishing as a result of continuous and enormous usage in construction activities. New methods of construction must be devised due to the thinning of various resources from overuse and a lack of subsequent replenishment. With the use of more economical and recyclable materials in building, the construction industry aims at cutting costs and reducing disposal costs of the used wastes from other industries. Certain materials when used in concrete produce favorable results in comparison to regular use concrete while saving on several environmental and financial fronts. Supplementing Cementous materials helps to meet the increase demand of cement also reducing green gas emission

In the present years, the growth in the structural construction and the consequent increase in consumption have lead to fast decline in available natural resources on the other hand, a high volume of production has generated a considerable amount of course material which have adverse impact on the environment. The construction industries are to be one of the most potential consumers of mineral recourses, thus generating a great amount of solid waste as a byproduct stones. India offers large varieties of a natural stone, Sand stone, Granite, Slates, Basalt, Marbles, Quartzite, Bethamcherla stones in large varieties of colours, shapes and sizes.In this study, the scope of the research will be concentrated on the use of Bethamcherla stone power.

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STONE POWDER:

Crushed stone is a major basic raw material used by construction, agriculture, and other industries. Despite the low value of its basic products, the crushed stone industry is a major contributor to and an indicator of the economic well-being of a nation.[5] The demand for crushed stone is determined mostly by the level of construction activity, and, therefore, the demand for construction materials.

Stone resources of the world are very large. High-purity limestone and dolomite suitable for specialty uses are limited in many geographic areas. Crushed stone substitutes for roadbuilding include sand and gravel, and slag. Substitutes for crushed stone used as construction aggregates include sand and gravel, iron and steel slag, sintered or expanded clay or shale, and perlite or vermiculite.

Crushed stone is a high-volume, low-value commodity. The industry is highly competitive and is characterized by many operations serving local or regional markets. Production costs are determined mainly by the cost of labor, equipment, energy, and water, in addition to the costs of compliance with environmental and safety regulations. These costs vary depending on geographic location, the nature of the deposit, and the number and type of products produced. Crushed stone has one of the lowest average by weight values of all mineral commodities. The average unit price increased from US$1.58 per metric ton, f.o.b. plant, in 1970 to US$4.39 in 1990. However, the unit price in constant 1982 dollars fluctuated between US$3.48 and US$3.91 per metric ton for the same period. Increased productivity achieved through increased use of automation and more efficient equipment was mainly responsible for maintaining the prices at this level.

Transportation is a major factor in the delivered price of crushed stone. The cost of moving crushed stone from the plant to the market often equals or exceeds the sale price of the product at the plant. Because of the high cost of transportation and the large quantities of bulk material that have to be shipped, crushed stone is usually marketed locally. The high cost of transportation is responsible for the wide dispersion of quarries, usually located near highly populated areas. However, increasing land values combined with local environmental concerns are moving crushed stone quarries farther from the end-use locations, increasing the price of delivered material. Economies of scale, which might be realized if fewer, larger operations served larger marketing areas, would probably not offset the increased transportation costs.

Stone powder is finely pulverized stone that has been screened and is typically used as a base material for leveling. Stone dust is easy to grade and once it is compacted, it can be walked directly on while laying stone, pavers or bricks.

The crushed stone dust waste as a fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. The basic mixes were chosen for natural sand to achieve M20 grades concrete. The equivalent mixes were obtained by replacing cement by stone dust partially or fully. Test results indicate that crushed stone dust waste can be used effectively to replace cement in concrete. Concrete made this replacement attain the same compressive strength, comparable tensile strength.

Concrete required for extensive construction activity can always be made available, since all the ingredients of concrete are of geological origin. In the production of concrete, granite/basalt stone and river sand are used as coarse and fine aggregate, respectively. Although these materials are usually available, at some places it is economical to substitute these materials by locally available ones. River sand which is most commonly used as fine aggregate in the production of concrete and mortar poses the problem of acute shortage I many areas. At the same time increasing quantity of crushed stone dust as available from crushers as waste. The disposal of this dust is a serious environmental problem. If it is possible to use this crushed stone dust in with partially/ fully replacement of natural river sand, then this will not only save the cost of construction but at the same time it will solve the problem disposal of dust. For satisfactory utilization of stone dust the various phages of examination have to be

- Durability of processed concrete.
- Economic feasibility.

There has been inadequate utilization of large quantities of crushed stone as a alternative material left out after crushing of stone to obtain coarse aggregate/ ballast for concrete. Crushed stone dust does not satisfy the standard specification of fine aggregate in cement mortar and concrete. Efforts have been made to replace cement by stone dust. The manufacture of coarse aggregate by rushing stone ballast produce large amount of crushed stone dust as waste material. This poses a serious disposal problem. In many reason of India acres of land have become barren due to disposal of crushed stone dust on it. This study mainly directed towards exploring the possibility of making effective use of the discarded crushed stone dust in concrete. The test result generated through a well planned and carefully executed programme indicate good prospects of utilizing this crushed stone dust as a partial replacement of cement in making quality concrete.

Crushed stone dust is a material obtained from stone crusher. In the crusher machine after crushing of stone the product retained known as crushed stone dust. If can be used as a fine aggregate in cement concrete as a replacement of sand it may be replace fully or partially as a percentage of 20%, 40%, 50%, 60%, 80% of gives the higher strength as that of sand gives with the help of suitable admixtures. Crushed stone dust is a waste product generated in crusher machine and it is very cheap as compare to the sand. The fineness modulus crushed stone dust is 2.2 to 2.6 as same as that of sand and specific gravity is 2.4. Due toutilization of crushed stone dust we can reduces the cost of construction at the same time we try to solve the problem on disposal of crushed stone dust because of the waste material generated in crusher the manufacturer collected it and dispose any were so that the land on which the crushed stone dust dispose becomes unusable.

The crushed stone powder is advantages over sand due to following points.

1. The cost of sand is very high as compare to the crushed stone powder.
2. It gives the better result with the help of suitable admixtures.
3. Due to non-availability of well specified sand near by the construction site.
4. It reduces the cost of construction at the same time it solve the problem of disposal of crushed stone dust.
5. The crushed stone dust is cheaply available and application is very easy.

II LITERATURE REVIEW

(1984) R.N. Misra studied the water requirements and compressive strength of cement mortar using manufactured sand as FA, with FM ranging from 0.50 to 2.0 and 75% and 100% flow of mortar. Based on the above extensive experimental investigations, he had concluded that the strength of mortar with manufactured sand is higher than that of the corresponding mix with cement (sand) mortar. He has recommended the use of manufactured sand for mortar and has cautioned the removal of excessive proportions of very fine particles.

(1985) V.M. Malhotra studies the performance of concrete, incorporating limestone dust (obtained from limestone quarries after crushing operations) as a partial replacement for natural sand in concrete. Three series of concrete mixes with w/c ratio 0.70, 0.53 and 0.40 respectively, incorporating lime stone dust from 5-20% were prepared by direct replacement on an equivalent mass of recombined sand basis. The properties of fresh concrete i.e. slump, unit weight and air content (%) were determined. Compressive strength, freezing and thawing, drying and shrinkage, creep was determined for hardened concrete. They have concluded that incorporation of upto 10% limestone dust as a partial replacement for FA in concrete with w/c = 0.70 and 5% limestone dust in concrete with w/c = 0.53 does not significantly affect the properties of fresh and hardened concrete. However, there is considerable loss in slump, irrespective of w/c ratios, if lime stone dust is in excess of 10%.

(1996) T.S. Nagaraj et al. reported that rock dust due to its higher surface area consumes more cement in comparison to sand which increases workability. He studied to effect of rock dust and pebble as aggregate in cement and concrete and found that crushed stone dust could be used to replace the natural sand in concrete. The mix design introduced by Nagaraj T.S reported that there are three possibilities of ensuring the workability namely combination of rock dust and sand, use of super plasticizers and change water content.

(1998) Shukla et al. investigated the behavior of concrete made by partial or full replacement of river sand by crushed stone dust as fine aggregate and reported that 40 percent sand can be replaced by crushed stone dust without effecting the strength of concrete.

(1999) Hudson reported that, ‘‘concrete manufactured with a high percentage of minus 75 micron material will yield a more cohesive mix then concrete made with typical natural sand’’.

(1999) Venugopal et al. examined the effect of rock dust as fine aggregate in cement and concrete mixes. They have suggested a method to proportion the concrete using rock dust as fine aggregate. **(2000) M. Shukla et al.** studied environmental hazardous stone dust utilization in building construction. It is found that partial replacement will not affect the strength and also solve the problem of disposal of stone dust. The workability of concrete reduces with the increase in stone dust and this can be improved by adding suitable admixtures.

(2004) A.K. Sahu et al. investigated the basic properties of conventional concrete and concrete made using quarry dust have compared. They have studied M20 and M30 concretes. Equivalent mixes are obtained by replacing stone dust partially/fully. Test results indicate effective usage of stone dust with same compressive strength, comparable tensile strength and modulus of rupture. Workability of 40% replacement of stone dust with 2% Superplasticizer is equal to the workability of conventional concrete. Workability is increased by the addition of Superplasticizer.

(2008) R. Ilangovana et al. reported that the compressive strength, split tensile strength and flexural strength of concrete made with 40% or 50% replacement of sand with quarry dust is more than that made with other percentage of replacement Natural river sand, if replaced by hundred percent Quarry Dust from quarries, may sometimes give equal or better than the reference concrete made with Natural Sand, in terms of compressive and flexural strength.

Reddy, M.V. (2010) carried out some experiments using waste product like stone dust and ceramic scrap as partial and full replacement of fine aggregate. He prepared six samples of concrete in which first sample was prepared by replacing 100% fine aggregate by stone dust. Other samples were prepared by replacing 10%, 20%, 30%, 40%, 50% and 100% replacement of coarse aggregate by ceramic scrap. Mix proportion of M25 and water cement ratio of 0.48 was chosen for the investigation. He casted cubes of 150mm size, cylinders of 150*300mm size and prisms of 100*100*500mm. These samples were subjected under experimental test of compressive strength, split tensile strength and modulus of elasticity. From the result of experiment, he concluded that stone dust can be effectively used as replacement of fine aggregate but ceramic scrap should not be replaced more than 20% of coarse aggregate in order to achieve significant structural strength.

(2010) Sivakumar et al. studied The 28 days compressive strength of 100% replacement of sand with quarry dust of mortar cube (CM 1:1) is higher than the controlled cement mortar cube. The 56 days maximum Compressive strength, split tensile strength and modulus of elasticity of concrete for 100% replacement of sand with quarry dust of 400 kg/m3 at F/C=0.6, was higher than the reference concrete.

(2010) Thaniya Kaosol studied on the reuse of concrete waste as crushed stone for hollow concrete masonry units. The main objective was to increase the value of the concrete waste, to make a sustainable and profitable disposal alternative for the concrete waste. Attempts were made to utilize the concrete waste as crushed stones in the concrete mix to make hollow concrete blocks. Various percentages of crusted stones have been tried the amount (i.e. 0%, 10%, 20%, 50% and 100%). From the results they found concrete waste can used to produce hallow concrete block masonry units.

(2011) Ganesha Mogaveera et al. studied the effect of Partial Replacement of Sand by Quarry dust in Plain Cement Concrete for different mix proportions. They have concluded that sand can be replaced effectively by means of quarry dust up to 20% to 25%.

(2011) K. Nagabhushana et al. studied the properties of mortar and concrete in which Crushed Rock Powder (CRP) was used as a partial and full replacement for natural sand. For mortar, CRP is replaced at percentages of 20, 40, 60, 80 and 100. The strength properties of concrete were investigated by replacing natural sand by CRP at replacement level of 20, 30, and 40 per cents.

(2011) M. Devi et al. carried out an investigation on strength and corrosion resistance behavior of inhibitors in concrete containing quarry dust as fine aggregate. The incorporation of inhibitors as admixture did not show any adverse effects on the strength properties and there was an increase in strength up to certain percentage. The addition of inhibitors as admixture to concrete was found to lower the permeability and water absorption.

(2012) Joseph O Ukpata et al. studied the workability of concrete using lateritic sand and quarry dust as fine aggregates was found to have the same trend with normal concrete. The density of hardened concrete using lateritic sand and quarry dust was found to range from 2293-2447 kg/m3.

(2012) Lohani et al. studied the slump value increases with increase in percentage replacement of sand with quarry dust. The increase in dust content up to 30% increases compressive strength of concrete, if the dust content is more than 30% the compressive strength decreases gradually. But the compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents.

(2012) T. Shanmugapriya et al. carried out an investigation on optimization of partial replacement of M-sand by natural sand in high performance concrete with silica fume. It was reported that M-sand and silica fume increased the flexural and compressive strength.

Manchiryal R.K., Dewangan A. and Gupta D.P. (2014) investigated that the physical and chemical properties of stone dust satisfied IS-2386 which could be used as replacement material of fine aggregate. Authors concentrated on cube compressive strength and beam flexure strength in order to give significance to their work. Ordinary Portland cement of 43 grade, Natural River sand with fineness modulus of 2.51 and granite aggregate as a course aggregate were used in the experiments. Quarry dust was obtained from local resource. In the experiments, river sand was 100% replaced by quarry dust and variation in strength was compared. It was concluded that compressive strength from concrete with quarry dust was comparatively 10% -12% more than the conventional concrete. They also concluded that durability under the influence of sulphate and acid attack of quarry dust concrete was higher than conventional concrete. Permeability of concrete decreased due to better relative density of quarry dust than that of conventional concrete.

Ali A Aliabdo et al. (2013) In this research waste marble dust was utilized in cement and concrete production. Marble dust up to 15% as cement replacement has positive effects on steel concrete bond strength and maximum was at 10%. It was also observed that porosity also decreases with addition of marble dust in concrete. There was insignificant change in ultrasonic pulse velocity with use of marble dust in concrete.

Ankita Khatri, Abhishek Kanoungo et al. (2014) In this paper the focus is feasibility of the substitution of marble waste for cement to attain economy and environmental saving. In presence of superplasticizer mixture. Marble waste had negligible effect on mechanical properties. It was also observed that marble dust decreases the porosity of the hardened concrete.

K. Kavita, V.R. Sankar Cheela et al. (2015) In this research quartzite powder was replaced with fine aggregate in concrete up 100%. It was observed that more we replace quartzite with sand the workability start to decrease due to high water absorption in quartzite powder. Increase in compressive strength of up to 18.6% when 100% of sand is replaced. Due to low bulk density the weight of concrete was also low. Quartzite powder also gives smooth surface finish when compared to normal sand in concrete.

K Surendra Babu, G. Nagesh Kumar (2015) In this research crushed quartzite is used as partial replacement to fine aggregates along with fly ash as mineral admixture. Upto 50% replacement of quartzite powder provide positive effect on fresh properties of concrete. It was also observed that 10% to 50% crushed quartzite as fine aggregate does not affect more on strength properties.

Ummar Shareef et al. (2015) In this research silica manganese and quartzite used as alternative material for coarse aggregate. It was observed that quartzite has good resistance in crushing and impact test. Quartzite has higher 28 days compressive strength as compare to conventional aggregates. Quartzite also has higher water absorption as compared to natural course aggregates.

Mrs. Shakaka, S Utkar (2016) This research focus on strengthening concrete by replacing cement by marble powder in most economic way for m20 grade. Research shows marble powder has very good cohesiveness of mortar and concrete. 20% of replacement gives excellent result in strength and quality. Concrete having 20% replacement of marble powder with cement has high compressive strength and improvement of properties related to durability.

Gopi R et al. (2017) In this paper marble powder was used as partial replacement for cement and checked for strength characteristics. It was observed that 15% replacement of cement by marble powder increases compactor factor. Even 15% replacement increases compressive, tensile strength by 14.53% and 14.25% respectively. Modulus of concrete also increases up to 7.1 % when they replaced by 15% of amount.

Bassam A. Tayeh (2018) In this research waste materials like glass, timber and marble powder used as partial replacement of cement in concrete and mechanical and physical properties were investigated. Researcher finds that workability decrease when we increase partial replacement of cement with these materials and optimum percentage is nearly strength of concrete is high when partially replaced by 10%. Use of these materials can diminish the utilization of concrete and the related vitality interest effect on air contamination and CO2 emission.

OM Ofuyanta et al. (2019) In this research marble dust powder was used in concrete by partially replacement with cement along with fly ash, slash silica fume and superplasticizer. 25% of Replacement leads to high degree of slump and 15% and 35% record lowest slump value. When replaced by 25%, compressive and tensile strength increase by 11% and 17% respectively. Waste Marble dust concrete have a resistance to stress and also have greater load bearing capacity.

S.Suresh, J. Revathi (2019) In this research the objective of research was to examine the possibility of utilizing marble powder in concrete production. It was observed that compressive strength flexural strength increased up to 23% 24% and 17.82% respectively when they replaced by 10% of marble powder. It was also observed there is a decrease in chloride penetrations but new significant change in water absorption as compared to standard concrete.

Mes Belouadah saouda et al. (2019) In this research marble and glass powder used as alternates for cement and their effect on physical and mechanical properties were tested. It was observed that compressive strength increase when marble powder use up to 10%. For glass powder up to 5% to 10% compressive strength increases and for 10% it was maximum. So the optimum percentage for waste class and marble is up to 10%.

Rajni, Vipasha Rishi, Himanshu Guleria (2019) In this research waste foundry sand and marble dust powder used as partial replacement for sand and cement respectively and tested for strength characteristics. It was observed that better results are at 10% of marble dust powder and waste foundry sand at 25% replacement and after that strength decreasing. Research also shows that waste marble powder represents good performance due to proficient micro filling ability.

Tamires Galvao Tovares Pereira et al (2020) In this research coconut fibres and quartzite waste was used in fibre cement production. It was observed that modulus of fineness of quartzite is 0.88 and it has filler characteristics after adding these two materials in concrete it can be an option for more resistant and more sustainable fibre cement concrete. This addition also leads to reduce mining waste and environmental impacts.

III TESTS ON MATERIALS

3.1 Tests on Cement

3.1.1 Determination Of Specific Gravity Of Cement (IS : 2720 - Part- 3)

Aim: To determine the specific gravity of cement using Le Chatelier Flask or Specific Gravity Bottle.

Apparatus:

a) Le Chatelier Flask or Specific Gravity Bottle - 100 ml capacity.

b) Balance capable of weighing accurately upto 0.Igm.

Procedure:

Weigh a clean and d1y Le Chatelier Flask or Specific Gravity Bottle with its stopper (Wl). Place a sample of cement upto half of the flask (about 50 gm) and weight with its stopper (W2). Add kerosene (polar liquid) to cement in flask till it is about half full. Mix thoroughly with glass rod to remove entrapped air. Continue stiffing and add more kerosene till it is flush with the graduated mark. D1y the outside and weigh (W3). Entrapped air may be removed by vacuum pump, if available. Empty the flask, clean it refills with clean kerosene flush with the graduated mark wipe d1y the outside and weigh (W4).

Observations & Calculations

Where WI = weight of empty flask =49.2gms

W2 = weight of flask+ cement =101.9gms

W3 = weight of flask+ cement+ kerosene=160.7gms

W4 = weight of flask+ kerosene=128.4gms

0.81= specific gravity of kerosene.

Specific gravity =

$$\frac{(W2 - w1}{(W2 - W1) - (W3 - W4) * 0.81} = \frac{(101.9 - 49.2)}{(101.9 - 49.2) - (160.7 - 128.4) * 0.81}$$

Result: Specific gravity of cement= 3.12.

3.1.2 Determination of standard consistency (IS 4031 (Part 4) 1988).

Aim : Determination of standard consistency (IS 4031 (Part 4) 1988).

Apparatus:

Vicat apparatus with vicat mould, vicat plunger and needles, gauging trowel, measuring jar,weighing balance, stop watch, rice plate, rubber glove and glass plate.

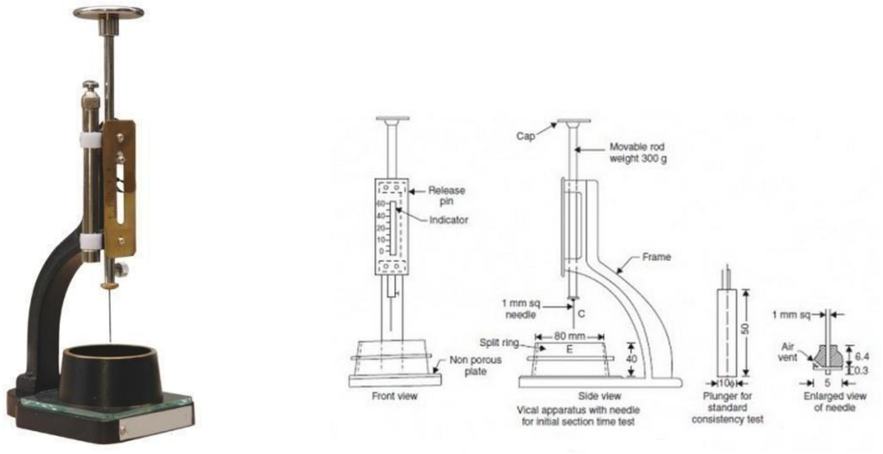


Fig. 3.1. Vicat apparatus with vicat mould

PROCEDURE:

1. Taken 400 gm of cement passing 15850 Micron.
2. Prepared paste with varying percentage of water, starting from 25% by weight of cement;the time of gauging is between 3 to 5 minutes. The gauging time is counted from the timeof adding water to the dry cement.
3. Filled the vicat mould resting upon non-porous plate with this paste after completing fillingthe mould, smooth off, surface of the paste by single movement of plan making with levelwith the top of the mould, the mould may be slighting shaken to explicit.
4. Placed the mould with the non-porous resting plate under the rod attacked with the plunger,lowered the plunger gently to touch the surface of the test block and quickly released, allowing it to sink into the paste.

Found the water content at which the plunger penetrates up to 5 mm from the lower side

PRECAUTIONS:

1. Clean appliances shall be used for gauging.
2. Release the plunger gently.
3. The temperature of cement, water and that of test room, at the time when the aboveoperations are being performed, shall be 27 ± 2 ºC.
4. For each repetition of the experiment fresh cement is to be taken.

OBSERVATION AND RESULT:

1.	No. of trials	1	2	3	4	5	6
2.	Percentage of water	25%	27%	29%	31%	33%	35%
3.	Initial reading(mm)	50mm	50mm	50mm	50mm	50mm	50mm
4.	Final reading(mm)	40mm	33mm	27mm	18mm	12mm	6mm
5.	Height not penetrated	40mm	33mm	27mm	18mm	12mm	6mm

Conclusion: consistency of a prepared cement paste is 6mm from the bottom of the vicat mould.

3.1.3 DETERMINATION OF SOUNDNESS OF CEMENT

Theory and Scope:

Unsoundness of cement means, that the cement having excess lime, magnesium sulphates, etc. due to excess of these items there will be volume changes and large expansions, there by reducesthe durability of the structures.

Aim: -To find out the soundness of cement.

Apparatus: - Le-Chatelier Apparatus Cement, Water , Glass plate.

PROCEDURE:

- The cement is gauged with 0.78 times the water required for standard consistency (0.78P) in a standard manner and filled in to the Le-Chateliermould kept on the glass plate.
- The mould is covered on the top with another glass plate.
- The whole assembly is immersed in water at temperature of 27ºC to 32ºC and kept therefor 24 hrs.
- Measure the distance between the indicator points.
- Submerge the mould again in water, heat the water up to boiling point in 30 minutes andkeep it boiling for 3 hrs.
- Remove the mould from hot water and allow it to cool and measure the distance betweenthe indicator points.
- The distance between these two measurements gives the expansion of cement.
- This must not exceed 10mm for OPC, RHC, LHC, etc.
- If the expansion is more than 10mm, the cement is unsound.

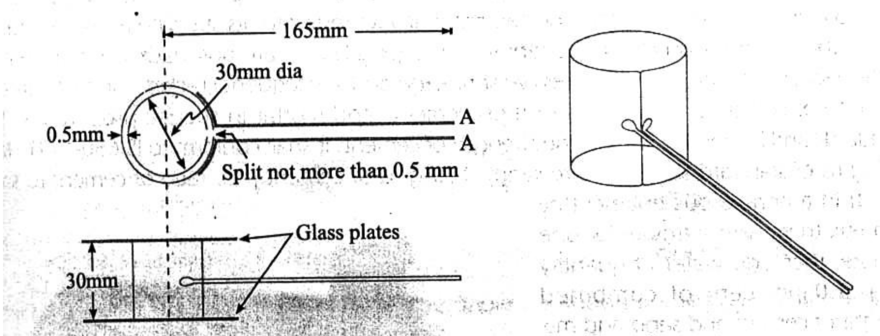


Fig. 2.9. Le-Chatelier apparatus for finding soundness of cement.

CEMENT =100GRAMS

CONSISTENCY OF STANDARD CEMENT PASTE TAKEN AS 35%

= 0.78X35%

= 0.78X35

WEIGHT OF WATER TAKEN AS =27.3GRAMS

L_1 = 20.20MM

L_2 = 16.28MM

TOTAL EXPANSION = 3.92MM

RESULT:

Soundness of given cement = 3.92mm

THEORY AND SCOPE:

The volume of fine aggregate may increase by 1% to 5% due to presence of moisture. This property of increase in volume of fine aggregate due to moisture is called bulking.

3.1.4 To Determine the bulking factor of fine aggregate.

Aim: To find out the bulking factor of fine aggregate.

APPARATUS: CONTAINER, SAND, WATER, MIXING PAN.

PROCEDURE:

- Take about 6 liters of dry compacted sand and weigh it and dump it into a mixing pan.
- Add a certain known percentage of water by weight of dry sand.
- Mix rapidly and thoroughly till a uniform colour is obtained and fill the container withthe wet sand without any tamping.
- Now strike off the top surface and weigh and thus find the weight of wet sand.
- Repeat the experiment No. of times increasing in water content from 1% to 20%.

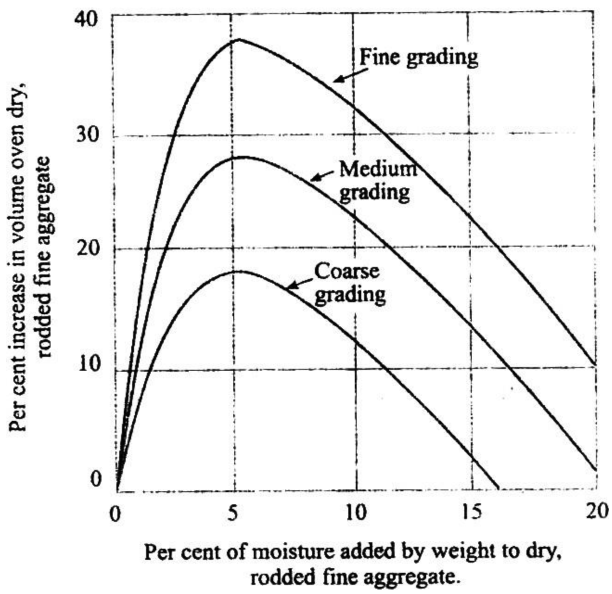
CALCULATIONS: -

W_1=Wt. of 1m^3 of compacted dry sand.

W_2=Wt. of dry sand contained in 1m^3 of wet loose sand.W_3=Wt. of 1m^3 of wet sand
X = Percentage of water added W_3=Wt. of dry sand + Wt. of water

$$\% \text{ of bulking} = \frac{W_1 - W_2}{W_1} x100$$

$$\text{Bulking factor} = \frac{W_1}{W_2}$$



% OF WATER BY WEIGHT OF CEMENT	VOLUME OF SAND (ML)	INCREASE IN VOLUME (ML)	% INCREASE IN VOLUME (ML)
0	350	0	0
2	360	10	3.2
4	375	25	4.28
8	360	10	3.2
12	350	0	0

RESULT:

Bulking of given Sand =25%

Percentage of water =4.28%

3.1.5 Specific Gravity of Fine Aggregate-Test on Aggregates

Aim: To Determine Specific gravity of fine aggregates

Theory:

Fine aggregate is used in many fields in sites for many purposes. So the determination of specific gravity of fine aggregate is very essential.

Specific gravity of fine aggregate can be defined as the ratio of the weight of given volume of coarse aggregate to the weight of given volume of distilled water.

Apparatus for determination of specific gravity of fine aggregate

1. Pycnometer
2. Balance weight

Procedure for the determination of specific gravity of fine aggregate

1. Clean the Pycnometer, dry it, Find the weight of the Pycnometer.
2. Take about 200gm of coarse aggregate sample in the pycnometer.Weight the Pycnometer, Note the weight W2
3. Fill the remaining part of Pycnometer with distilled water and weight W3
4. Empty the Pycnometer and clean it and fill it with distilled water. Note the weight W4

Calculations

1. Empty weight of Pycnometer = W1
2. Weight of Pycnometer+ sample= W2
3. Weight of Pycnometer+ sample+water = W3
4. Weight of Pycnometer+ water = W4

The specific gravity of fine aggregate = G = (W2-W1) / ((W2-W1) – (W3-W4))

Pycnometer

Sl.no	Description(gms)	Trail-1	Trail-2	Trail-3
1	Weight of empty Pycnometer(W_1)	681	681	681
2	W_1+Weight of fine aggregates(W_2)	1385	1395	1393
3	W_2+Water(W_3)	1961	1973	1968
4	Weight of pycnometer+water(W_4)	1534	1534	1534
5	Specific gravity of FA	2.56	2.59	2.56

Result : The average specific gravity of fine aggregates is 2.58

SPECIFIC GRAVITY OF COARSE AGGREGATE

Aim: To determine the specific gravity of coarse aggregate of a given sample.

Apparatus: The apparatus used in this test are aggregate sample**,** pycnometer**,** water and weighing balance.

Test Procedure

a. Find the weight of empty pycnometer (W1).
b. Fill up the pycnometer with coarse aggregate (W2).
c. Now fill the pycnometer with coarse aggregate and water (W3).
d. Now fill the pycnometer with only water (W4).
e. Finally the specific gravity of the aggregates is calculated as Specific gravity= $(W_2\text{-}W_1)/\ [(W_4\text{-}W_1)\text{-}(W_3\text{-}W_2)]$.

Observations

Following observations are obtained for coarse aggregate

Weight of empty Pycnometer = W_1 = 650gm

Weight of Pycnometer + 1/3rd of coarse aggregate = W_2 =1320gm

Weight of Pycnometer + coarse aggregate + water = W_3 = 1940gm

Weight of Pycnometer + water = W_4 = 1500gm

Specific gravity of coarse aggregate = $w_2\text{-}w_1\backslash(w_2\text{-}w_1)\text{-}(w_3\text{-}w_4)$

= (1320-650\(1320-650)-(1940-1500)

= 2.52

Result: The specific gravity of a coarse aggregate is 2.52

3.7.2 WATER ABSORPTION TEST ON COARSE AGGREGATE

Aim: The main objective of this test is to determine the water absorption of the coarse aggregate.

Apparatus : The apparatus are used in coarse aggregate sample and weighing balance and pyconmeter.

Test procedure

a. Find the weight of pycnometer (W1).
b. Fill up the with pycnometer 1/3 rd of coarse aggregate and then weight is calculated (W2).
c. Fill up of the pynconmeter with coarse aggregate and water and weight is calculated (W3).
d. fill up of the pynconmeter with only water(W4).

Observations

Following observations are obtained for coarse aggregate

Weight saturated coarse aggregate W_1 = 640gms

Weight of dry coarse aggregate W_2 = 630gms

Water absorption = $W_1\text{-}W_2/W_{2*100}$

= 640-630/630*100

= 1.58%

Result

The water absorptions of a coarse aggregate value is =1.58%.

3.7.3 AGGREGATE CRUSHING TEST

Aim: To determine the aggregate crushing value of the given specimen.

Apparatus

The apparatus for the standard crushing test consists of the following:

1. Steel cylinder with open ends, and internal diameter 25.2 cm, square base plate plunger having a piston of diameter 15 cm, with a hole provided across the stem of the plunger so that a rod could be inserted for lifting or placing the plunger in the cylinder.
2. Cylindrical measure having internal diameter of 11.5 cm and height 18 cm.

3. Steel tamping rod with one rounded end, having a diameter of 1.6 cm and length 45 cm to 60 cm.
4. Balance of capacity 3 kg with accuracy up to 1 g.
5. Compression testing machine capable of applying load of 40 tonnes, at a uniform rate of loading of 4 tonnes per minute.

Procedure

1. The aggregate passing 12.5 mm sieve and retained on 10 mm IS sieve is selected for standard test.
2. The aggregate should be surface dry condition before testing.
3. The aggregate may be dried by heating at a temperature 100^0C to 110^0C for a period of 4 hours and is tested after being cooled to room temperature.
4. The cylindrical measure is filled by the test sample of aggregate in three layers of approximately equal depth, each layer is being tamped 25 times by the rounded end of the tamping rod.
5. After the third layer is tamped, the aggregate at the top of the cylindrical measure is leveled off by using the tamping rod as a straight edge. About 6.5 kg of aggregate is required for preparing two test samples. The test samples thus taken is then weighed. The same weight of the sample is taken in the repeat test.
6. The cylinder of the test apparatus is placed in position on the base plate, 1/3 of the test sample is placed in the cylinder and tamped 25 times by the tamping rod. Similarly, the other two parts of the test specimen are added, each layer being subjected to 25 blows.
7. The total depth of the material in the cylinder after tamping shall however be 10cm.
8. The surface of the aggregates is leveled and the plunger inserted so that it rests on this surface in level position.
9. The cylinder with the test sample and plunger at a uniform rate of 4 tonnes per minute until the load is 40 tonnes, and then the load is released.
10. Aggregates including the crushed portion are removed from the cylinder and sieved on 2.36mm IS sieve. The material which passes this sieve is collected.

Observations

Table 3.6 Aggregate crushing test

Sample Number	Total wt. of dry Sample (W_1g)	Wt. Of sample retained on 2.36 IS sieve (W_2 g)	Weight of fines Passing 2.36 IS sieve, (W_3 g)	Aggregate crushing value = $\frac{W3}{W1}$%	Average aggregate crushing value
(1)	(2)	(3)	(4)	(5)	(6)
1	2560	1690	200	7.81	
2	2500	1670	200	8	7.90

Calculation

Total weight of dry sample taken = W_1 gm.

Weight of the portion of crushed material retained on 2.36mm IS sieve = W_2 g.

Weight of the portion of crushed material passing 2.36mm IS sieve = W_3 g.

The aggregate crushing value is defined as the ratio of the weight of fines passing the specified IS sieve to the total weight of sample expressed as a percentage. The value is usually recorded up to the first decimal place.

$$\text{Aggregate crushing value} = \frac{100\ W_3}{W_1}$$

Result

The mean of the crushing value obtained in the two tests is reported as aggregate crushing value.

IV MIX DESIGN

MIX DESIGN OF CONCRETE:-

Concrete mix design is a procedure of selecting the suitable ingredients of concrete and their relative proportions with an objective to prepare concrete of certain minimum strength, desired workability and durability as economically (value engineered) as possible.

As we decide to go for a concrete mix design, collect the following data before hand as few design stipulation are freezed on the basis of these data.

4.5.1 PRELIMINARY DATA REQUIRED FOR MIX DESIGN:

Purely governed on the local conditions, were the concrete need to be applied

Exposure Condition: Exposure Conditions of the structure: The general environment, to which the concrete will be exposed during its service life, is categorized into five classes to severity, as per IS 456.

Table 3 Environmental Exposure Conditions
(*Clauses* 8.2.2.1 *and* 35.3.2)

Sl No. (1)	Environment (2)	Exposure Conditions (3)
i)	Mild	Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
ii)	Moderate	Concrete surfaces sheltered from severe rain or freezing whilst wet
		Concrete exposed to condensation and rain
		Concrete continuously under water
		Concrete in contact or buried under non-aggressive soil/ground water
		Concrete surfaces sheltered from saturated salt air in coastal area
iii)	Severe	Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation.
		Concrete completely immersed in sea water
		Concrete exposed to coastal environment
iv)	Very severe	Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet
		Concrete in contact with or buried under aggressive sub-soil/ground water
v)	Extreme	Surface of members in tidal zone
		Members in direct contact with liquid/ solid aggressive chemicals

The exposure condition limits the minimum cement content, maximum water – cement ratio and minimum grade of concrete.

As per exposure condition, you have the above data for working the first trial and arriving its mix proportion.

If you are getting desired result at lower cement content, you need to put extra as mentioned by IS 456.

Minimum thickness of member: Size of aggregate should not be more than one-fourth of the minimum thickness of member, mostly 20 mm nominal size aggregate is suitable for most works. It is always suggested to go the maximum nominal size of aggregate to save on quantity of cement per unit of concrete.

Cement Grade: Cement type/grade locally available that can be made available throughout construction period

Workability: Placing condition of concrete governs its workability, low – slump of 25-75 mm (lightly reinforced sections in slab, beam, and column) to high – slump of 100-150 mm (slip form, pumped concrete).

Stipulation for Proportioning Concrete Ingredients

(a) Characteristic compressive strength required in the field at 28 days grade designation -

M 20

(b) Type of Cement : OPC 53 Grade confirming to IS 12269

(b) Maximum Nominal size of aggregate — 20 mm

(c) Shape of CA — Angular

(d) Workability required at site — 100 mm (slump)

(e) Type of exposure the structure will be subjected to (as defined in IS: 456) — Moderate

(h) Method of concrete placing: pump able concrete

(ii) Test data of material

The following materials are to be tested in the laboratory and results are to be ascertained for the design mix

(a) Cement Used : OPC 53 Grade Confirming to IS 12269

(b) Specific Gravity of Cement : 3.13

(c) Chemical admixture : -

(d) Specific gravity

Specific gravity of Fine Aggregate (sand) : 2.65

Specific gravity of Coarse Aggregate : 2.75

(e) Water Absorption

Coarse Aggregate : 0.4%

Fine Aggregate : 1.0%

(f) Free (surface) moisture

Coarse Aggregate : Nil

Fine Aggregate : Nil

Aggregate are assumed to be in saturated surface dry condition usually while preparing design mix.

(g) Sieve Analysis

Fine aggregates : Confirming to Zone I of Table 4 IS – 383

Mix Design of M20 Grade Concrete

Step 1: Determining the Target Strength for Mix Proportioning

Fck = fck + 1.65 x S

Where,

F’ck = Target average compressive strength at 28 days

Fck = Characteristic compressive strength at 28 days

S = Assumed standard deviation in N/mm2 = 5 (as per table -1 of IS 10262- 2009)

= 20 + 1.65 x 5.0 = 28.25 N/mm^2

Table 1 Assumed Standard Deviation
(*Clauses* 3.2.1.2, A-3 *and* B-3)

Sl No. (1)	Grade of Concrete (2)	Assumed Standard Deviation N/mm² (3)
i)	M 10	3.5
ii)	M 15	
iii)	M 20	4.0
iv)	M 25	
v)	M 30	5.0
vi)	M 35	
vii)	M 40	
viii)	M 45	
ix)	M 50	
x)	M 55	

Step 2 Selection of water-cement ratio:-
From Table 5 of IS 456, Maximum water-cement ratio = 0.50

Note: Do not start with w/c ratio above 0.50, even though the other desired results like Strength, workability could be achieved.

Table 5 Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal Maximum Size
(*Clauses* 6.1.2, 8.2.4.1 *and* 9.1.2)

Sl No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Mild	220	0.60	–	300	0.55	M 20
iii)	Moderate	240	0.60	M 15	300	0.50	M 25
iii)	Severe	250	0.50	M 20	320	0.45	M 30
iv)	Very severe	260	0.45	M 20	340	0.45	M 35
v)	Extreme	280	0.40	M 25	360	0.40	M 40

NOTES

1 Cement content prescribed in this table is irrespective of the grades of cement and it is inclusive of additions mentioned in 5.2. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS 1489 (Part 1) and IS 455 respectively.

2 Minimum grade for plain concrete under mild exposure condition is not specified.

Step 3 Selection of Water Content

Maximum water content for 20 mm aggregate = 186 Kg (for 25 to 50 slump)

Table 2 Maximum Water Content per Cubic Metre of Concrete for Nominal Maximum Size of Aggregate
(*Clauses* 4.2, A-5 *and* B-5)

Sl No.	Nominal Maximum Size of Aggregate mm	Maximum Water Content [1] kg
(1)	(2)	(3)
i)	10	208
ii)	20	186
iii)	40	165

NOTE — These quantities of mixing water are for use in computing cementitious material contents for trial batches.

[1] Water}content corresponding to saturated surface dry aggregate.

We are targeting a slump of 100mm, we need to increase water content by 3% for every 25mm above 50 mm i.e. increase 6% for 100mm slump

I.e. Estimated water content for 100 Slump = 186+ (6/100) X 186 = 197litres

Water content = 197 liters

STEP 4 – Calculation of Cement Content
Water-Cement Ratio = 0.50

Water content from Step – 3 i.e. 197 liters

Cement Content = Water content / “w-c ratio” = (197/0.50) = 394 kgs

From Table 5 of IS 456,

Minimum cement Content for moderate exposure condition = 300 kg/m3

394 kg/m3 > 300 kg/m3, hence, OK.

As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m3, hence ok too.

STEP 5: Proportion of Volume of Coarse Aggregate and Fine aggregate Content
From Table 3 of IS 10262- 2009, Volume of coarse aggregate corresponding to 20 mm size and fine aggregate (Zone I) = 0.60

Table 3 Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate
(*Clauses* 4.4, A-7 *and* B-7)

Sl No.	Nominal Maximum Size of Aggregate mm	Volume of Coarse Aggregate[1] per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate			
		Zone IV	Zone III	Zone II	Zone I
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	0.50	0.48	0.46	0.44
ii)	20	0.66	0.64	0.62	0.60
iii)	40	0.75	0.73	0.71	0.69

[1] Volumes are based on aggregates in saturated surface dry condition.

Note 1: In the present case water-cement ratio is 0.5.So there will be no change in coarse aggregate volume i.e. 0.60.

Note 2: Incase the coarse aggregate is not angular one, then also volume of coarse aggregate may be required to be increased suitably based on experience.

STEP 6: Estimation of Concrete Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

1. Volume of concrete = 1 m3
2. Volume of cement = (Mass of cement / Specific gravity of cement) x (1/100)

= (39/3.15) x (1/1000) = 0.125 m3

3. Volume of water = (Mass of water / Specific gravity of water) x (1/1000)
   = (197/1) x (1/1000) = 0.197 m3
4. Total Volume of Aggregates = 1- (b+c) =1- (0.125+0.197) = 0.678 m3
5. Mass of coarse aggregates = d X Volume of Coarse Aggregate X Specific Gravity of Coarse Aggregate X 1000
   = 0.678 X 0.60 X 2.80 X 1000
   = 1139 kgs/m3
6. Mass of fine aggregates

   = d X Volume of Fine Aggregate X Specific Gravity of Coarse Aggregate X 1000

   = 0.678 X 0.40 X 2.70 X 1000 = 732 kgs/m3

STEP-7: Concrete Mix proportions for Trial Number 1
Cement = 394 kg/m3

Water = 197 kg/m3

Fine aggregates = 732 kg/m3

Coarse aggregate = 1139 kg/m3

Water-cement ratio = 0.50

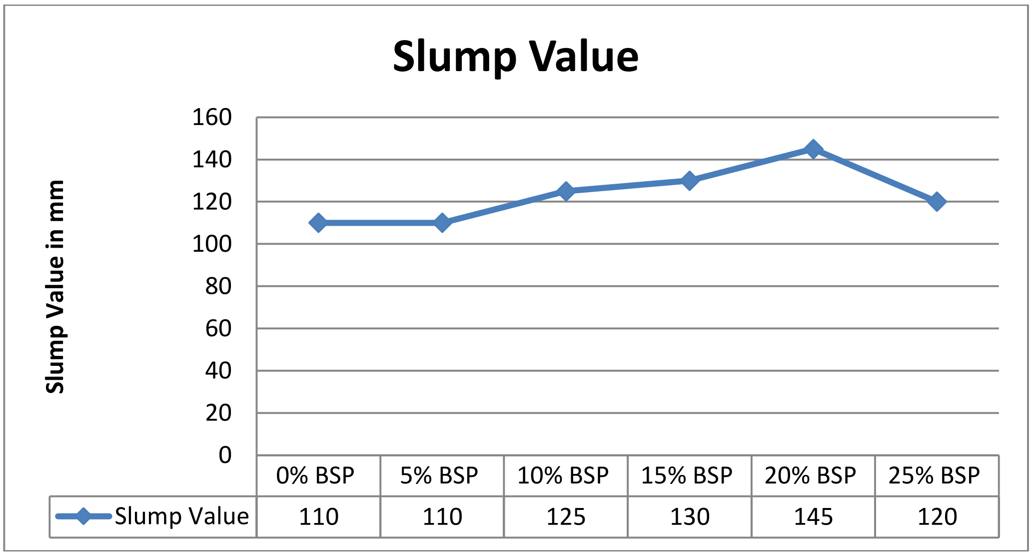
Final trial mix for M20 grade concrete is 1:1.85:2.89 at w/c of 0.50

MATERIAL	CEMENT	FINE AGGREGATES	COARSE AGGREGATES	WATER
Density	394 kg/m3	732 kg/m3	1139 kg/m3	197 kg/m3
Proportions	1	1.85	2.89	0.45

Chapter-5
Experimental Investigation
5.1 Workability Test
5.1.1 Slump Cone Test

Table 5.1 Showing the values of Slump Cone Test

S.No	Mix	Slump Value
1	0% BSP	110
2	5% BSP	110
3	10% BSP	125
4	15% BSP	130
5	20% BSP	145
6	25% BSP	120

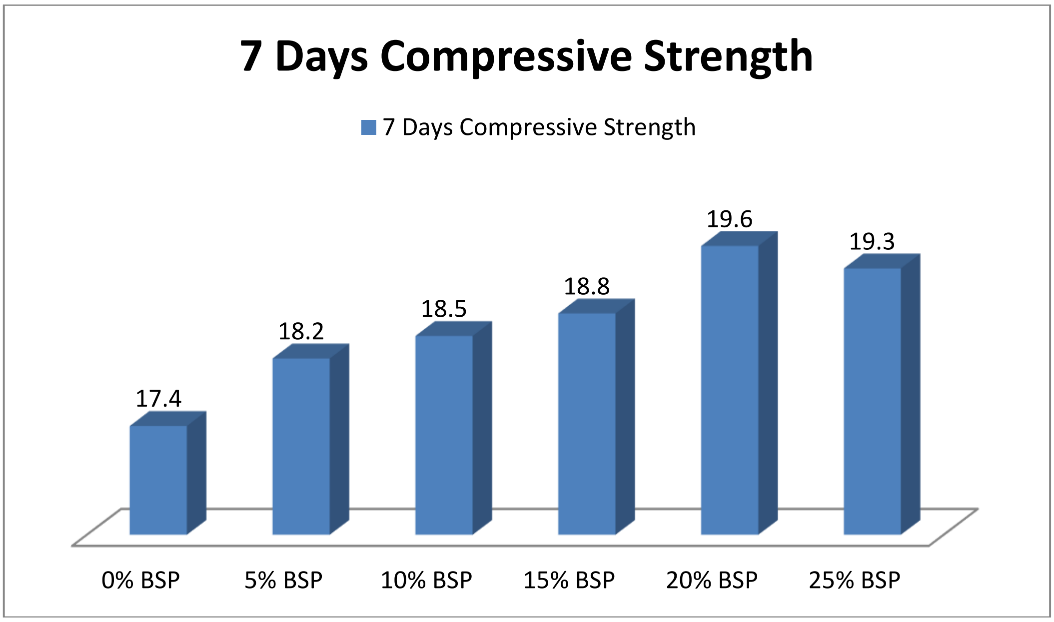


Graph 5.1 Showing the variation of slump for Bethemcherla Stone Powder Concrete

5.2 Compressive Strength Investigation

Table 5.2 Showing the values of Compressive Strength Test ofBethemcherla stone powder Concrete after curing 7 days

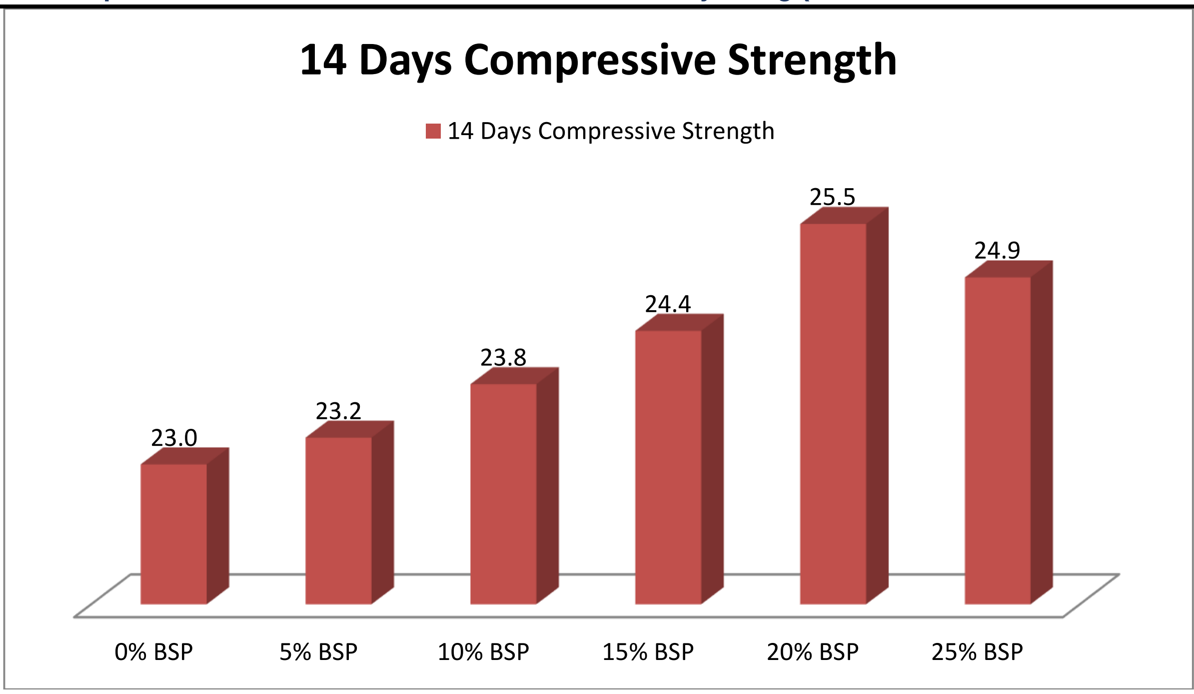
S.No	Mix	7 Days Compressive Strength
1	0% BSP	17.4
2	5% BSP	18.2
3	10% BSP	18.5
4	15% BSP	18.8
5	20% BSP	19.6
6	25% BSP	19.3



Graph 5.2 Showing the variation of Concrete after partial replacement of cement with Bethemcherla stone powder after curing 7 days

Table 5.3 Showing the values of Compressive Strength Test ofBethemcherla stone powder Concrete after curing 14 days

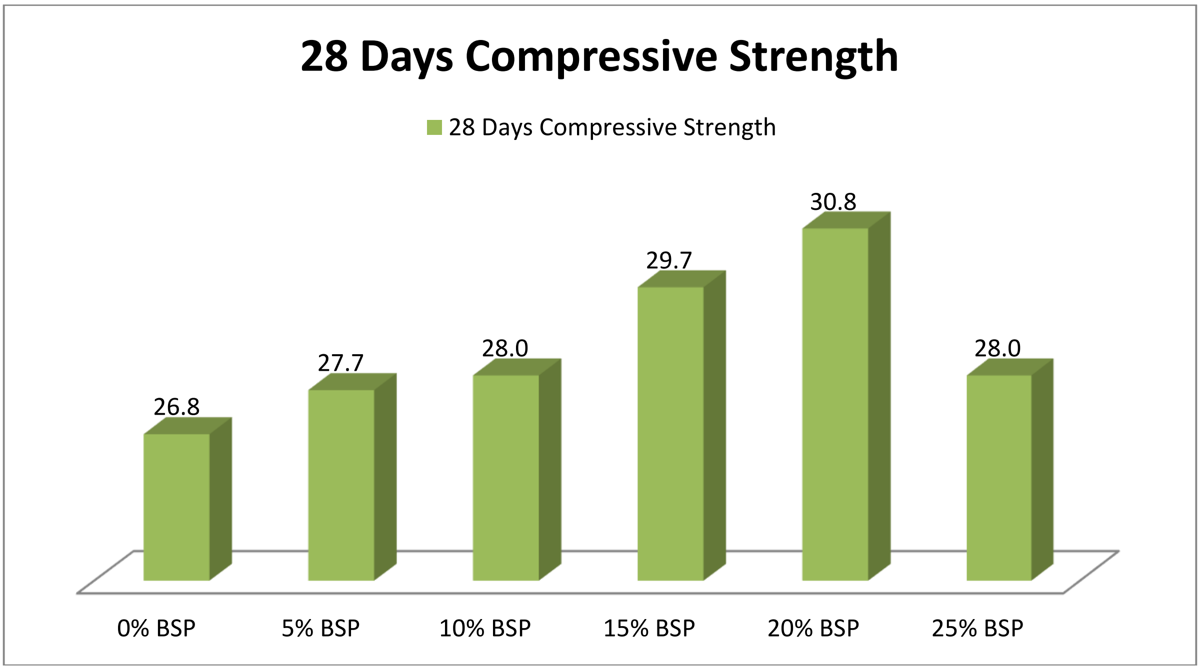
S.No	Mix	14 Days Compressive Strength
1	0% BSP	23.0
2	5% BSP	23.2
3	10% BSP	23.8
4	15% BSP	24.4
5	20% BSP	25.5
6	25% BSP	24.9



Graph 5.3 Showing the variation of Concrete after partial replacement of cement with Bethemcherla stone powder after curing 14 days

Table 5.4 Showing the values of Compressive Strength Test ofBethemcherla stone powder Concrete after curing 28 days

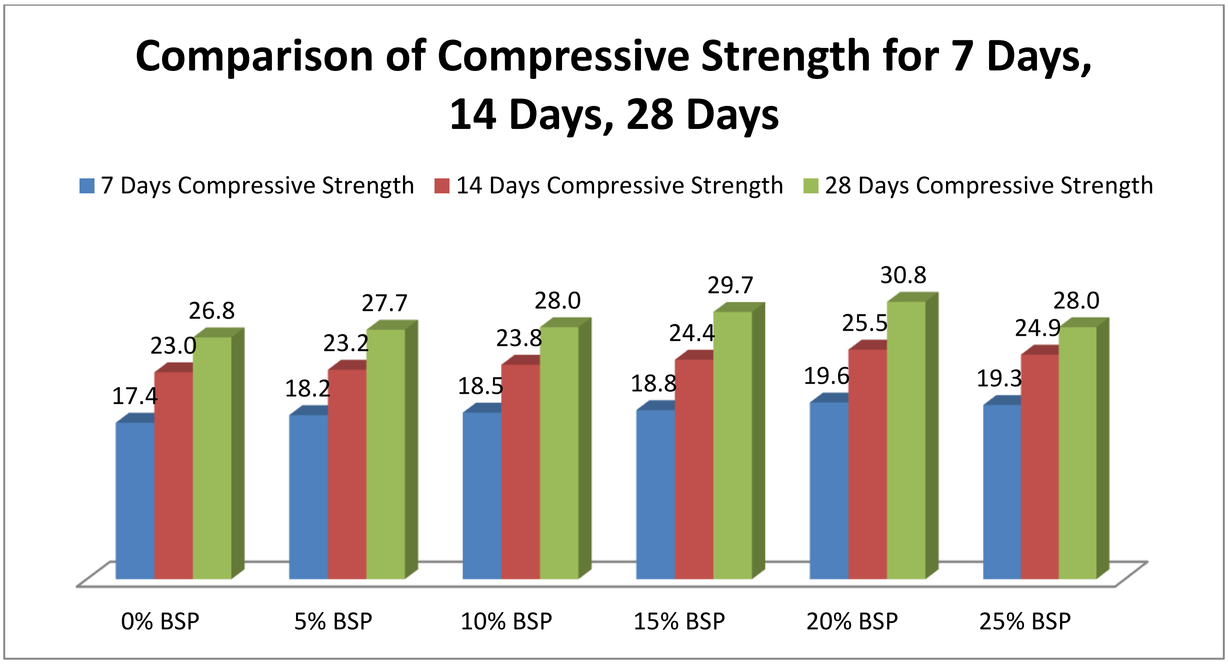
S.No	Mix	28 Days Compressive Strength
1	0% BSP	26.8
2	5% BSP	27.7
3	10% BSP	28.0
4	15% BSP	29.7
5	20% BSP	30.8
6	25% BSP	28.0



Graph 5.4 Showing the variation of Concrete after partial replacement of cement with Bethemcherla stone powder after curing 28 days

Table 5.5 Showing the values of Compressive Strength Test ofBethemcherla stone powder Concrete after curing 7,14,28 days

S.No	Mix	7 Days Compressive Strength	14 Days Compressive Strength	28 Days Compressive Strength
1	0% BSP	17.4	23.0	26.8
2	5% BSP	18.2	23.2	27.7
3	10% BSP	18.5	23.8	28.0
4	15% BSP	18.8	24.4	29.7
5	20% BSP	19.6	25.5	30.8
6	25% BSP	19.3	24.9	28.0

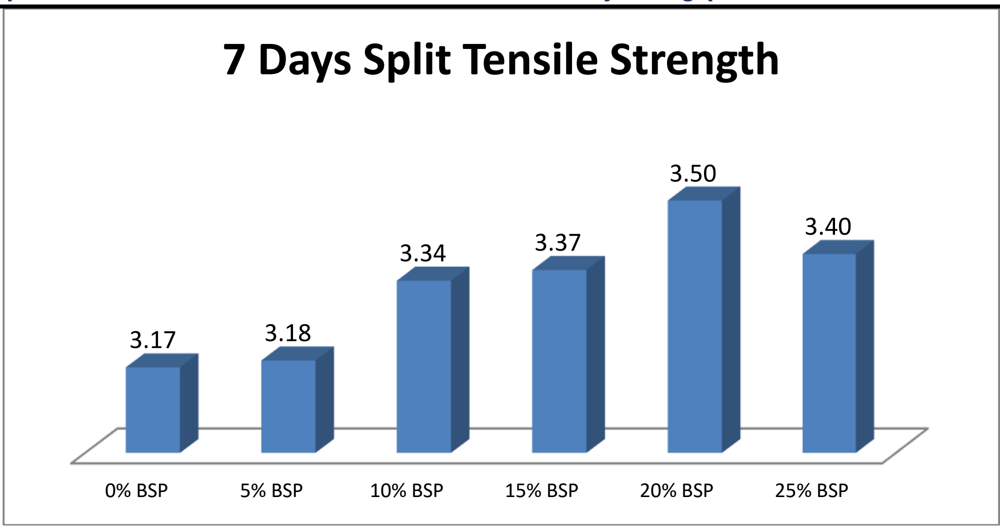


Graph 5.5 Showing the variation of Concrete after partial replacement of cement with Bethemcherla stone powder after curing 7,14, 28 days

5.3 Split Tensile Strength Investigation

Table 5.6 Showing the values of Split Tensile Strength Test ofBethemcherla stone powder Concrete after curing 7 days

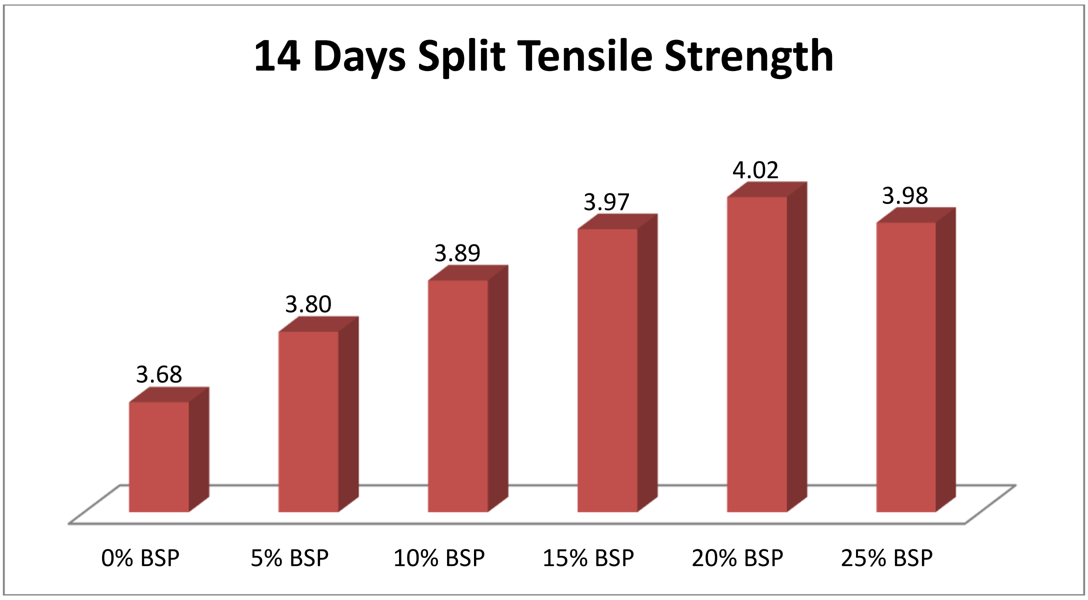
S.No	Mix	7 Days Split Tensile Strength
1	0% BSP	3.17
2	5% BSP	3.18
3	10% BSP	3.34
4	15% BSP	3.37
5	20% BSP	3.50
6	25% BSP	3.40



Graph 5.6 Showing the variation of Split Tensile Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 7 days

Table 5.7 Showing the values of Split Tensile Strength Test ofBethemcherla stone powder Concrete after curing 14 days

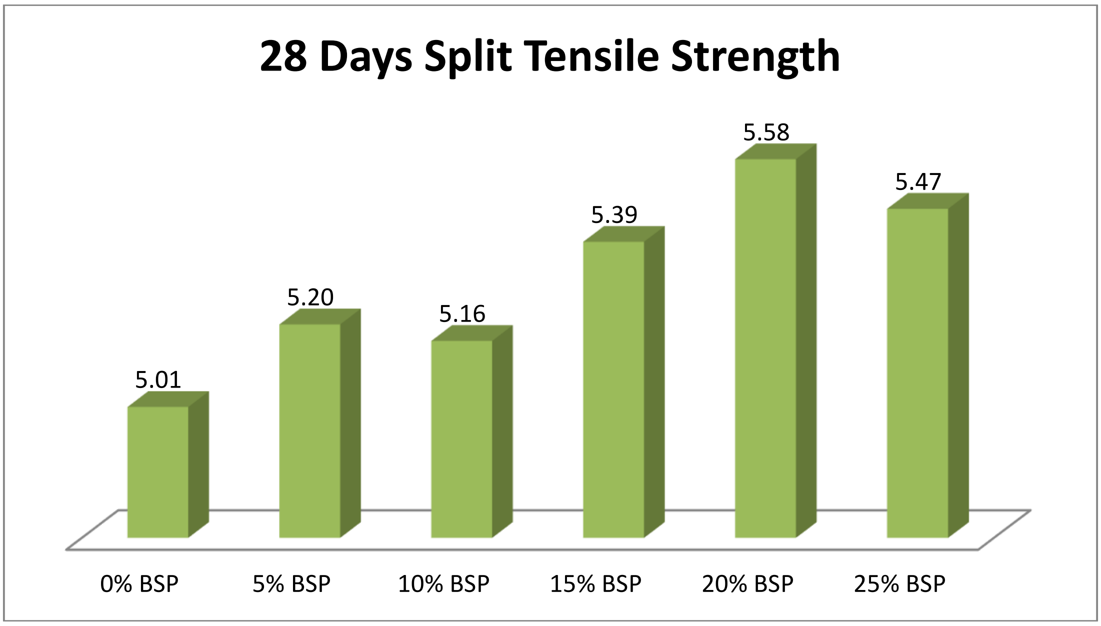
S.No	Mix	14 Days Split Tensile Strength
1	0% BSP	3.68
2	5% BSP	3.80
3	10% BSP	3.89
4	15% BSP	3.97
5	20% BSP	4.02
6	25% BSP	3.98



Graph 5.7 Showing the variation of Split Tensile Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 14 days

Table 5.8 Showing the values of Split Tensile Strength Test ofBethemcherla stone powder Concrete after curing 28 days

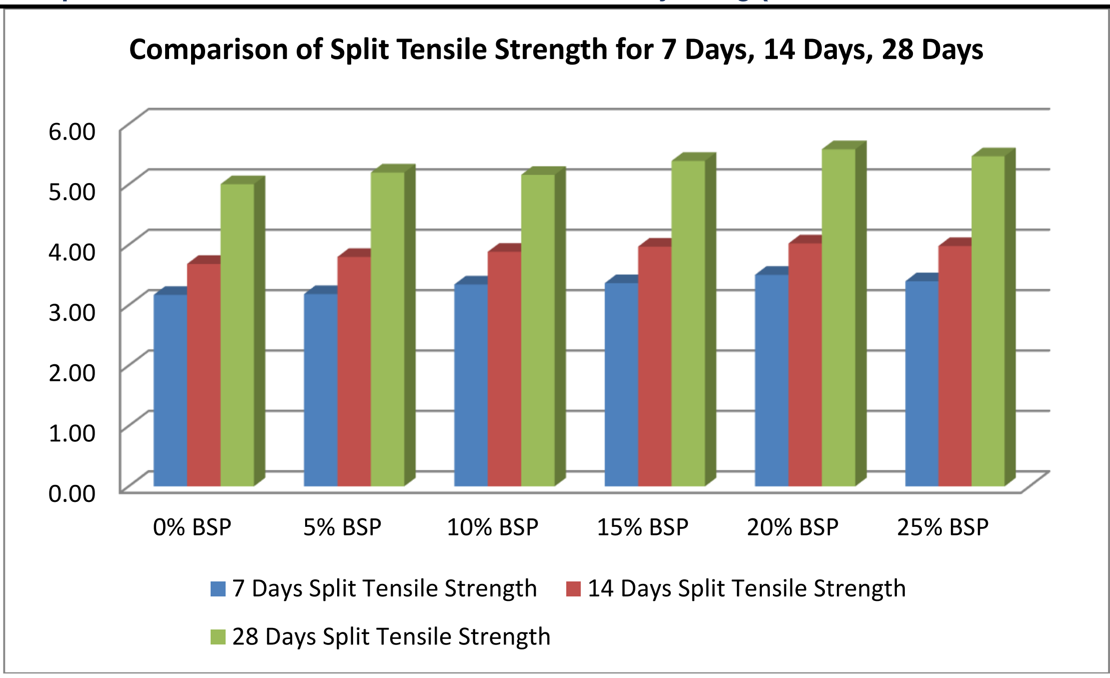
S.No	Mix	28 Days Split Tensile Strength
1	0% BSP	5.01
2	5% BSP	5.20
3	10% BSP	5.16
4	15% BSP	5.39
5	20% BSP	5.58
6	25% BSP	5.47



Graph 5.8 Showing the variation of Split Tensile Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 28 days

Table 5.9 Showing the values of Split Tensile Strength Test ofBethemcherla stone powder Concrete after curing 7,14,28 days

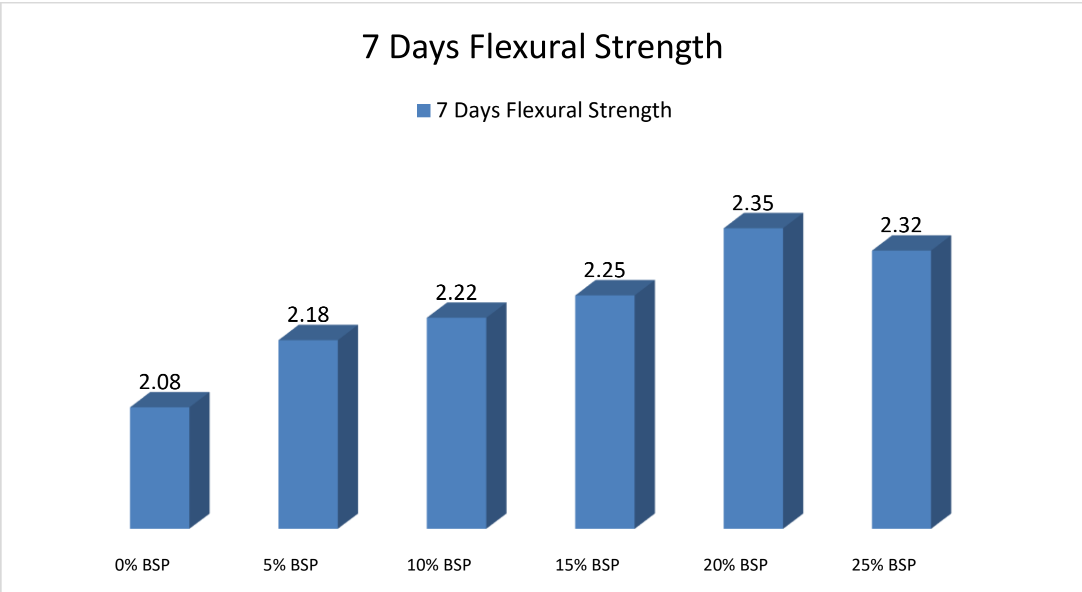
S.No	Mix	7 Days Split Tensile Strength	14 Days Split Tensile Strength	28 Days Split Tensile Strength
1	0% BSP	3.17	3.68	5.01
2	5% BSP	3.18	3.80	5.20
3	10% BSP	3.34	3.89	5.16
4	15% BSP	3.37	3.97	5.39
5	20% BSP	3.50	4.02	5.58
6	25% BSP	3.40	3.98	5.47



Graph 5.9 Showing the variation of Split Tensile Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 7,14,28 days

Table 5.10 Showing the values of Flexural Strength Test ofBethemcherla stone powder Concrete after curing 7 days

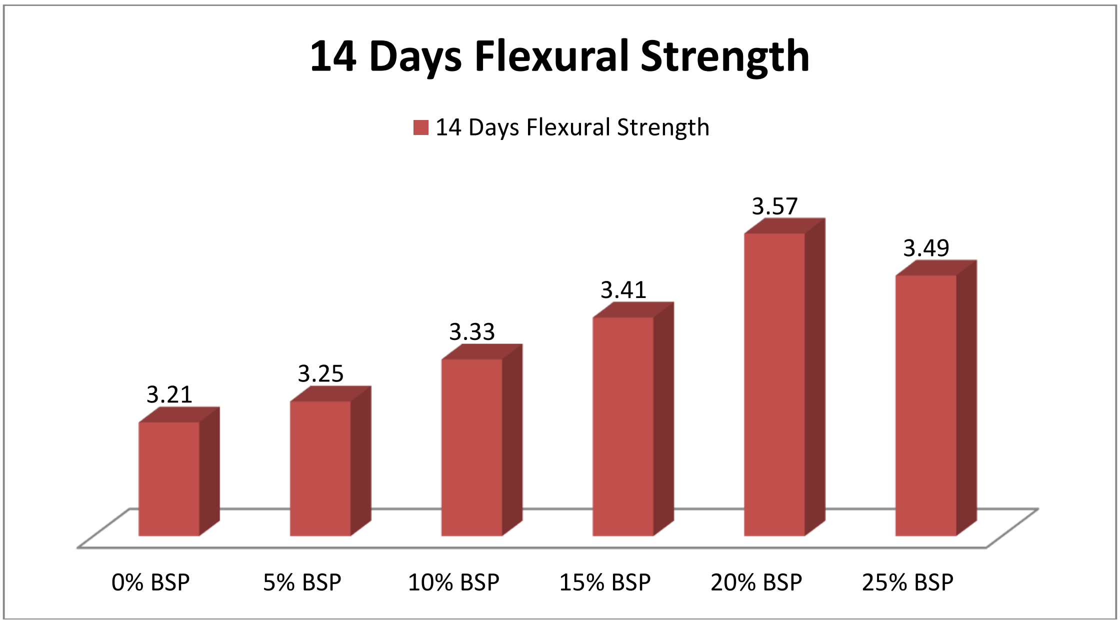
S.No	Mix	7 Days Flexural Strength
1	0% BSP	2.08
2	5% BSP	2.18
3	10% BSP	2.22
4	15% BSP	2.25
5	20% BSP	2.35
6	25% BSP	2.32



Graph 5.10 Showing the variation of Flexural Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 7 days

Table 5.11 Showing the values of Flexural Strength Test ofBethemcherla stone powder Concrete after curing 14 days

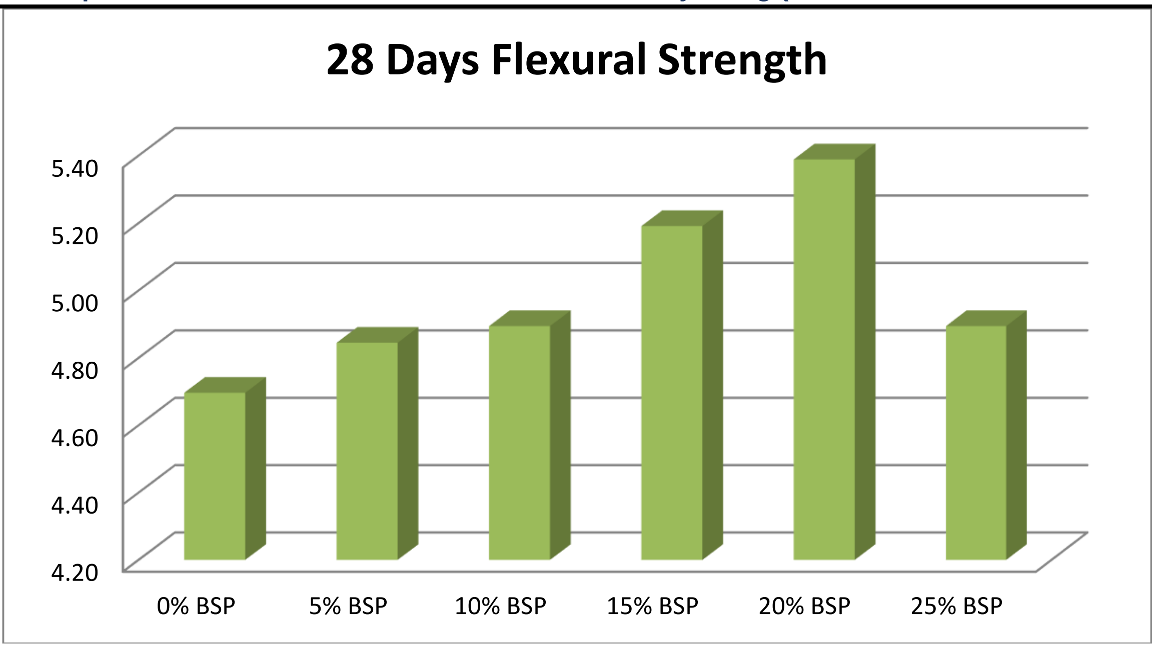
S.No	Mix	14 Days Flexural Strength
1	0% BSP	3.21
2	5% BSP	3.25
3	10% BSP	3.33
4	15% BSP	3.41
5	20% BSP	3.57
6	25% BSP	3.49



Graph 5.11 Showing the variation of Flexural Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 14 days

Table 5.12 Showing the values of Flexural Strength Test ofBethemcherla stone powder Concrete after curing 28 days

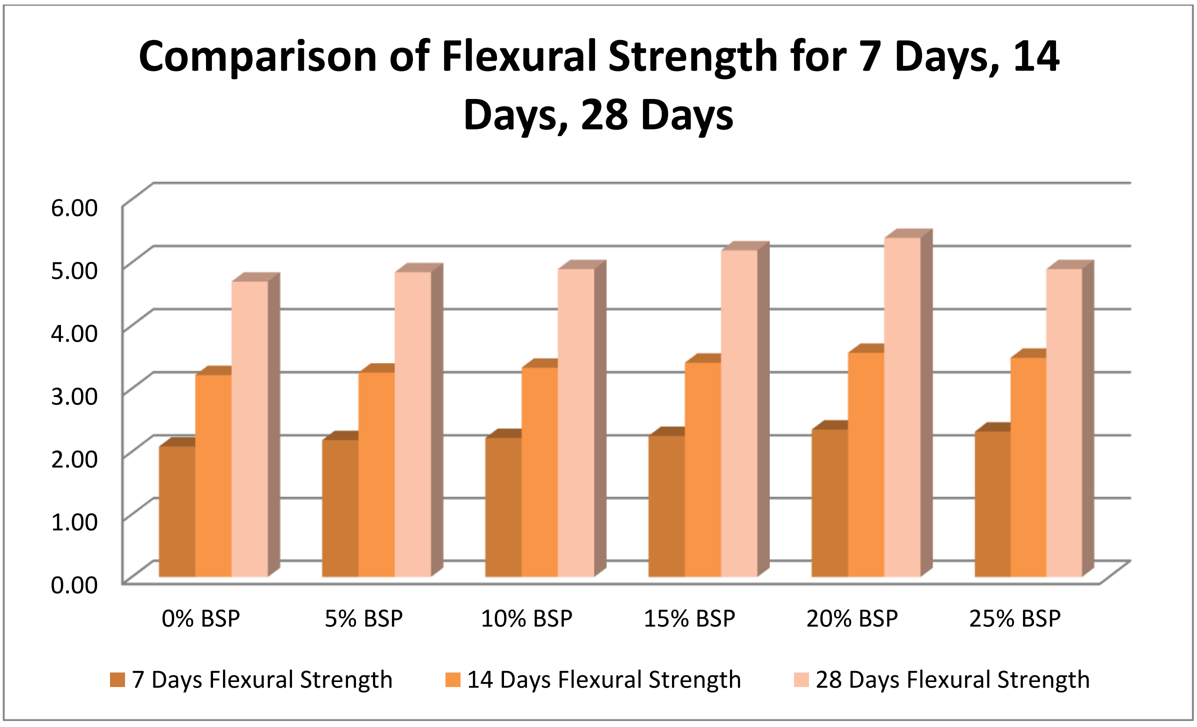
S.No	Mix	28 Days Flexural Strength
1	0% BSP	4.70
2	5% BSP	4.84
3	10% BSP	4.89
4	15% BSP	5.19
5	20% BSP	5.39
6	25% BSP	4.89



Graph 5.12 Showing the variation of Flexural Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 28 days

Table 5.13 Showing the values of Flexural Strength Test of Bethemcherla stone powder Concrete after curing 7,14, 28 days

S.No	Mix	7 Days Flexural Strength	14 Days Flexural Strength	28 Days Flexural Strength
1	0% BSP	2.08	3.21	4.70
2	5% BSP	2.18	3.25	4.84
3	10% BSP	2.22	3.33	4.89
4	15% BSP	2.25	3.41	5.19
5	20% BSP	2.35	3.57	5.39
6	25% BSP	2.32	3.49	4.89



Graph 5.13Showing the variation of Flexural Strength of Concrete with partial replacement of cement with Bethemcherla stone powder after curing 7,14, 28 days

Conclusions

From the above study the following conclusions were made

1. The use of Bethamcherla Stone Powder as a partial replacement of cement provides us an alternative source to use the waste into a useful material.

2. The value of slump decreases with increase in the percentage of Bethamcherla Stone Powder.
3. The optimal value (maximum value) of compressive strength was observed at 20% replacement of Cement with Bethamcherla Stone Powderfor 7days, 14 days and 28 days.After 20% the compressive strength of concrete decreases.
4. The optimal value (maximum value) of Split Tensile strength was observed at 20% replacement of Cement with Bethamcherla Stone Powder for 7days, 14 days and 28 days.After 20% the Split Tensilestrength of concrete decreases.
5. The optimal value (maximum value) of Flexural strength was observed at 20% replacement of Cement with Bethamcherla Stone Powder for 7days, 14 days and 28 days.After 20% the Flexural strength of concrete decreases.

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