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A STUDY ON PARTIAL REPLACEMENT OF CEMENT BY FLY ASH AND FULLY REPLACEMENT OF SAND BY STONE DUST IN CONCRETE

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ABSTRACT

High Performance Concrete (HPC) now a days used widely in the creation industry international. High performance concrete appears to be a better desire for a strong and durable shape. Normal and special materials are used to make these especially designed concrete that should meet a combination of overall performance requirements. In this venture, investigations were finished on electricity residences along with compressive energy, split tensile power and flexural power of M45 grade of HPC mixes with different replacement ranges consisting of 25%,30%,35% & 50% of cement by fly ash and 60%,65%,70%,75& 100% of stone dirt with sand by adopting water-binder ratio of zero.35. Super plasticizer (BASF) is used for better workability for high overall performance concrete. The HPC mix, grade M45 concrete is designed as according to IS: 10262-1982 IS: 456-2 hundred, that's traditional. Mechanical characteristics like Compressive electricity, Split-tensile electricity, Flexural energy had been examined. The result of those investigations demonstrates the power characteristics of stone dirt and the houses of fly ash based totally concrete mixes. Stone dust is sort of a darker, coarser version of sand. It is a with the aid of made from walking stones thru a crushing device to make overwhelmed stone. Its actual composition will glaringly rely upon what sort of stone become run thru the device. For example, sometimes granite is administered thru any such system; in different instances, it may be limestone, for instance. The gadget has a screen that traps the bigger cloth (that is, the beaten stone). The smaller fabric or "screenings" falls thru the screen. Depending on the scale of the holes within the screen used, it can be so first-rate in texture that it is basically a powder. Based at the outcomes acquired, the alternative of one hundred% stone and 25% fly ash with 1.2% of high-quality plasticizer which advanced traits changed into arrived .The information of the investigations alongside the effects are supplied in this record.

INTRODUCTION

High performance concrete (HPC) can be a concrete that meets unique combinations of overall performance and uniformity requirements that can't forever be completed habitually mistreatment preferred components and traditional mixture and placing and natural movement practices. To offer excessive overall performance concrete it's generally important to apply chemical and mineral admixtures moreover to equal elements, that area unit normally used for traditional concrete. In current instances, numerous researches location unit taking place for up the homes of concrete with relevancy energy, Durability and overall performance as a structural material.

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

1.1 Would like for top Performance Concrete

The big scale production of cement has compulsory numerous environmental problems on one hand and unrestricted depletion of natural resources on the opposite land. This danger to our ecology has junction rectifier to several investigations inside the utilization of commercial by using- products as supplementary cementations material in growing concrete. Another disadvantage throughout this quick developing world is to recognise the durability and also the strength of the concrete systems. High overall performance concrete (HPC) partakes been evolved over the last twenty years, and became generally added via personal region look at fashion and creation like excessive rises and parking garages. By mistreatment by way of- products like ash and stone dust with wonderful plasticizers we're able to achieve high performance concrete, that own excessive workability, excessive strength, and excessive modulus of snap, high density, high dimensional balance, low piousness and resistance to chemical assault.

Objectives of this Project

To through an experiment investigate the result of exchange 25%,30%,35% &40% replacement of cement by ash and replacement by65%,70%,75%&100% of sand by stone dust on strength characteristics particularly compressive strength, flexural strength and split strength

1.3 General Fly ash

Fly ash could be a terribly fine powder and tends to travel so much within the air. once not properly disposed, it's notable to contaminate air and water, and causes metabolism issues once indrawn. Once it settles on leaves and crops in fields round the station, it lowers the yield. The standard technique wont to get rid of each fly ash and bottom ash is to convert them into suspension for seizure in ash ponds round the thermal plants. This technique entails semi-permanent issues. The severe issues that arise from such selling are:

(i). the development of ash ponds needs huge tracts of land and this depletes land out there for agriculture over a amount of your time,

(ii). once one ash lake fills up, another should be designed, at nice price and additional loss of agricultural land, and

(iii). Brobdingnagain amounts of water zone unit expected to change over cinder into suspension. All through downpours, differed salts and tinny substance inside the suspension will filter directly down to the groundwater and pollute it. Consequently, it's required to use the abundantly out there fly fiery remains for the designing science development exercises especially inside the asphalt development in this way on defeat the issues uncover by the fly slag

Fly Ash Production and its Nature

The combustion of pulverised coal in thermal power plants produces fly ash. The warmth of burning coal turns the clay minerals gift within the coal powder into united fine particles principally comprising aluminium salt. Fly ash made therefore possesses each ceramic and pozzolanas property. Once powdered coal is burnt to get heat, the residue contains eighty per cent fly ash and twenty per cent bottom ash. The ash is anxious by flue gas collected at economizer, air pre-heater and clairvoyance hoppers.

General about Stone Dust

Stone dirt is a waste cloth acquired from crusher plants. It has capacity to be used as partial replacement of natural river sand in concrete. Use of stone dirt in concrete no longer handiest improves the fine of concrete however additionally preserve the herbal river sand for destiny generations. In the existing research, an experimental program turned into achieved to study the workability and compressive strength of concrete made using stone dust as partial replacement of satisfactory mixture in the variety of 10%-a hundred%. M25 grade of concrete was designed using Portland pozzolana cement (PPC) for referral concrete.

Fig No: 1.1 Stone Dust

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

Characteristics of Stone Dust:

- A sedimentary rock which include sheets of sand, mineral debris, and binding matrix deposited one atop in water environments and desolate tract formations.
- Very porous and water will penetrate it effortlessly.
- Brown, red, red, and purple Stone dust are generally known as brownstone.
- Available in a selection of floor textures and earth-toned shades.
- Weathers nice when its end-grain faces the weather (certainly bedded).(Face-bedded) stone is situation to extra deterioration. Water damages a face-bedded stone through spelling or flaking off whole sheets of sandstone. Also, freeze/thaw cycles permit water to get into the stone after which freeze and amplify inflicting a number of the pinnacle layer to cut up off.

NOTE: In many 19th century programs, the grain changed into located parallel to the climate facet (face-bedded) for cultured reasons. This changed into particularly common round doorways.

1.7 Use of Stone Dust

When building with herbal substances – stone, in addition to brick, metal, timber, or every other basic fabric – you continually get exactly what you pay for. Any structure, regardless of how nicely designed or grand in idea will instantly appearance cheap and disposable if it lacks excessive great exterior materials. Proportion, detailing and accurate usual design can best succeeds when embodied in a advanced grade of stone.

REVIEW OF LITERATURE

A variety of compaction instrumentation is often wont to increase the relative compaction of fly ash soil mixtures, dependent on soil kind. Because of its self-cementing properties, fly ash is often a good stabilizer for granular and fine grained materials. Fly ash by itself has very little cementations price however within the presence of wet it reacts with chemicals and forms cementations compounds and attributes to the development of strength and sponginess characteristics of soils. It a protracted history of use as AN engineering material and has been with success utilized in geotechnical applications. Fly ash consists of usually hollow spheres of element, metallic element and iron oxides and unoxidized carbon.

MATERIALS AND PROPERTIES

3.1 General

Several strategies area unit out there for stabilising the weak and compressible sub grade soils. But, the studies relevant to utilization of fly ash towards pavement construction in conjunction with gravelly sand haven't been disbursed extensively. During this study the fly ash is as an extra material in conjunction with the gravelly sand principally to grasp the behaviour of soil properties equivalent to strength, cosmic background radiation and compaction characteristics. Also, to grasp the penetration behaviour, the materials used and therefore the tests conducted on the materials area unit conferred within the following sections.

Table no 3.1 Properties of cement

S.NO	PROPERTY OF CEMENT	VALUES	As per IS:4031 part(I-V)-1996
1	Specific gravity	3.15	3.15
3	Normal Consistency	30%	30%-35%
4	Initial setting time	90min	>30
5	Final setting time	350min	<600
6	Fineness	1.6%	<10%

Fig No: 3.2 Physical Properties of Ordinary Portland cement

S.No.	PROPERTY		Test Results
1	Normal Consistency		29%
2	Specific Gravity		3.12
3	Setting time		
	A)	Initial Setting time	110Min
	B)	Final Setting time	180Min
4	Fineness of Cement(IS Sieve no. 9)		2.76%
5	Compressive Strength		
	At 7 days		37Mpa
	At 28 days		54Mpa

Procedure:

I. Heat 1Kg of sand on stove to get rid of all of the moisture. This will make the debris free from brotherly love brought on due to surface tension of unfastened water ins and.

Ii. Arrange all the sieves so as of size, with biggest sieve length at the pinnacle.

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

S.No	Property	Result
1	Fineness Modulus	7.176
2	Specific Gravity	2.645
3	Bulk Density	
	Loose State	1.181gm/cc
	Compacted State	1.498 gm/cc

Iii. Place weighted material at the pinnacle most sieves and shake each sieve. Shaking shall be completed with a varied movement from side to side, left to right, circular –clockwise, anti- clockwise with frequent jerking, so that the fabric is kept moving over the sieve surface. Shaking must be finished until all the particles are given a threat to skip via the sieve.

Iv. Weigh the fabric retained on every sieve on a weighing stability. The cloth retained on each sieve after shaking represents the fraction of mixture coarser than the sieve size in question and finer than the sieve length above.

V. Calculate % retained and the cumulative % retained on every sieve. The summation of the % cumulative wt retained on all of the sieve sizes up to 150micron, divided by way of 100 gives the fineness modulus.

Vi. The sieve evaluation is recorded in following table

Set of sieves ranging 40 mm, 25 mm, 20 mm, 16 mm, 12.5 mm, 10 mm, 6.Three mm, 4.75mm, 2.36 mm, 1.18mm, 600 µ, three hundred µ, 150µ weighing stability, heating pan and stove.

Table no 3.3 Physical Properties of fine mixture

Table no 3.4 Sieve analyses for Fine Aggregate

Sieve Size	Weight retained in Sieve (grams)	% retained	Cumulative % retained	% passing
10 mm	-	-	-	100
4.75 mm	55	5.5	5.5	94.50
2.36 mm	90	9.0	14.5	85.50
1.18 mm	143	14.3	28.8	71.2
600 microns	204	20.4	49.2	50.80
300 microns	312	31.2	80.4	19.60
150 microns	178	17.8	98.2	1.80
Pan	18	1.8	100	0

Tensile strengths may be very sensitive to differences in combination floor texture and floor place in keeping with unit volume.

Table no 3.5 Properties of Coarse Aggregate

Classification of Fly ash

According to IS 3812-1981, there are two grades of Fly Ash

I, Grade I fly ash, which are derived from bituminous coal having fractions SiO2+Al2O3+Fe2O3greater than 70 %.

II, Grade II Fly ash, that are derived from lignite coal having fractions SiO2+Al2O3+Fe2O3greater than 50 %.

ASTM C618 exact classes of fly ash, Class C and Class F depending on the form of coal and the ensuing chemical analysis.

Class C fly ash, usually produced from the combustion of lignite or sub bituminous coals, consists of CaO better than 10 percent and possesses cementations homes in addition to pozzolanas homes. Class F fly ash,

S.No	Property	Result
1	Fineness Modulus	2.696
2	Specific Gravity	2.615
3	Bulk Density	
	Loose State	1.660 gm/cc
	Compacted State	1.702 gm/cc

normally created from the combustion of bituminous or an anthracite coal incorporates CaO under 10 percentage and possesses pozzolanas properties.

Classification, primarily based on the boiler operations is labeled with awesome identities:

Low temperature(LT) fly ash, Generated out of combustion temperature underneath 9000

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

C : High temperature(HT) fly ash, Generated out of combustion temperature underneath ten thousand This threshold temperature demarcates the development of metakaolinite stages in the case of LT and the same constituents form as reactive glassy phases in the case of HT fly ash. LT fly ash therefore desired for precast constructing materials inclusive of bricks/blocks. However the better ignition loss, of the order of 4-8 percent makes the fly ash much less ideal for cement and urban programs. In comparison, the initial pozzolanas response is sluggish in HT fly ash, which is extended with age. This property collectively with a rather low ignition loss makes HT fly ash extra appropriate to be used in cement and urban industries.

Tests Conducted: In the gift study it's aimed to bring out the impact and quality of the fly ash in conjunction with the gravelly sand that is usually in the pavement construction. In affiliation to the present, the subsequent tests area unit planned and conducted on fly ash gravelly sand mixtures. The fly ash proportions adopted within the study in conjunction with the gravelly sand area unit 1/3, 5%, 10%, 15%, two hundredth and twenty fifth by weight of dry soil. The tests equivalent to Grain Size Distribution, relative density, changed Compaction, Direct Shear tests, CA Bearing quantitative relation (CBR) and Dynamic Cone Penetrometer tests (DCPT) area unit conducted. The tests equivalent to direct shear, cosmic background radiation and DCPT area unit conducted on the specimens compacted at changed compaction. The changed compaction tests area unit adopted because; the bulk main road pavements area unit designed for additional traffic volumes.

Table No: 3.11.Chemical Properties of Fly ash

Content of the Component	Value
% SiO_2	60.5
% Al_2O_3	30.8
% Fe_2O_3	3.6
% CaO	1.4
% MgO	0.91
% SO_3	0.14
% K_2O+Na_2O	1.1
Loss of ignition (LOI)	0.8
Specific surface area, m^2/kg	338
Lime reactivity, N/mm^2	6.2

Experimental Investigation

4.1 Mix Design

This is the step wherein we acquire all the required statistics for designing a concrete mix from the patron. The data required for blend proportioning is as follows.

Grade designation (whether M10, M15, M20 and many others)

- Type of cement to be used
- Maximum nominal size of aggregates
- Minimum & maximum cement content
- Maximum water-cement ratio
- Workability
- Exposure situations (As consistent with IS-456-Table-4)
- Maximum temperature of concrete on the time of putting
- Method of transporting & placing
- Early age energy requirement (if any)
- Type of aggregate (angular, sub angular, rounded and many others)
- Type of admixture to be used (if any)

4.2Casting, curing and testing of Concrete Cubes

4.2.1 Casting

Cubes of concrete should be cast for every shift of concreting paintings to estimate the strength of concrete. Concrete for filling the cubes must be taken from the center discharge of concrete mixer. Concrete from starting or on the give up of discharge must be averted. Cubes should be crammed in three same layers. Each layer must be uniformly tamped at least 35timeswith a16mm blunt rod. The tamping have to be performed in this sort of way that the rod penetrates thru the layer up to the lower layer. Cubes ought to be well levelled and completed the use of hand trowel. Cubes ought to be kept in shadow properly blanketed with moist gunny bags.

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

Fig No: 4.1 Cubes moulding

4.2.2Curing

After finishing touch of casting all the specimens have been saved to maintain the ambient conditions viz., temperature of 27±2 C and ninety% relative humidity. The specimens had been removed from the mold and some cubes are kept in water for water curing and a few are saved in lab for indoor curing. Cubes should be de moulded after 24 hours and immersed in water for curing. It is vital to keep the cubes far away from the shocks or vibrations specially for initial 3 days of casting.

Fig No: 4.2Curing of concrete cubs in water

4.2.3 Testing

We recommend that minimum 6 cubes should be taken every day and the batch of 3cubes be tested for 7 days and 28 days respectively. As per IS 456 -2000 minimum frequency of sampling is as follows:-

Vol of concrete Number of samples
00 - 5 m3 1
06 - 15 m3 2
16 - 30 m3 3
31 - 50m3 4
51 & above 4 plus
one additional for each additional 50 m^3. Three test specimens shall be made for each sample for testing at 28 days .If 3 and 7day strengths are required, additional samples should be taken, over and above mentioned in the frequency of sampling.

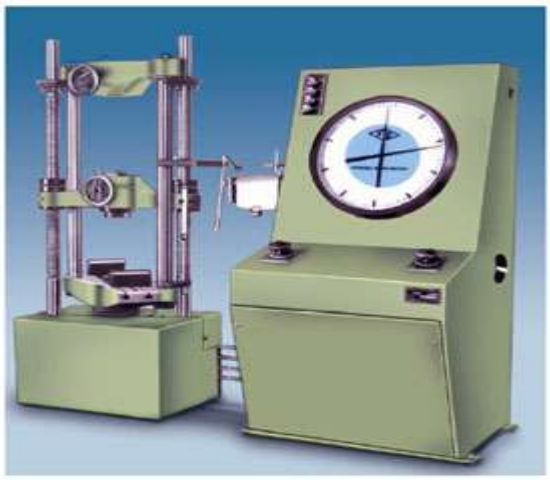

Fig No: 4.3 Testing machine

We recognise, compressive power is equal to remaining load divided with the aid of move sectional region of concrete specimen. We took the concrete specimen's dimension before beginning the trying out and calculated move sectional vicinity.

Now we got the final load. So we can now calculate the concrete compressive electricity.

Compressive electricity = Ultimate load (N) / go sectional area (mm2). = P/A

The unit of compressive strength could be N/mm2.

Normally 3 samples of concrete specimens are examined and common result is taken into consideration. If any of the specimen compressive electricity end result varies through extra than 15% of average result, that result is rejected

After 7 days, 14 days and 28 days of curing, 3 150mm cubes of a concrete aggregate had been tested the use of

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

the compression device. These cubes had been loaded on their facets throughout compression trying out such that the load was exerted perpendicularly to the route of casting. The average cost of the three cubes was taken because the compressive power. Table no 5.1 Compressive strength (n/mm^2) - fly ash

S.No	Specimen	7 Days	14 Days	28 Days
1	C	46.76	64.66	71.48
2	C1-25%	38.45	50.59	58.80
3	C2-30%	35.54	50.32	56.0
4	C3-35%	34.79	47.44	54.71
5	C4-40%	31.2	43.2	48.00

From the table it was observed that,

1. There was decrease of strength forspecimenC1-25%, when compared to the normal concrete.
2. There was decrease of strength forspecimenC2-30%, when compared to the normal concrete but there was a decrease when compared with C1-25%.
3. There was a decrease of strength for specimenC3-35%, when compared to the normal concrete.
4. There was a decrease of strength for specimenC4-40%, when compared to the normal concrete.

So from the above table specimen C1-25% is more effective

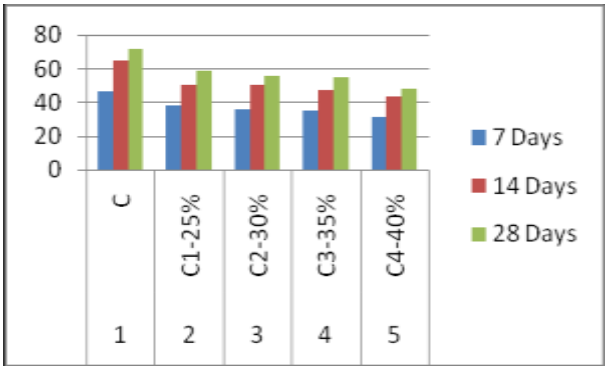

Fig no: 5.1 Variation of Compressive strength for fly ash

Fig no : 5.2 Compression testing machine

Table no 5.2 Compressive strength (n/mm^2) - stone dust

S.No	Specimen	7 Days	14 Days	28 Days
1	C	46.46	64.46	71.38
2	S1-60%	35.68	49.01	54.76
3	S2-65%	35.32	49.63	55.38
4	S3-70%	35.89	49.87	55.68
5	S4-75%	40.37	55.82	61.28
6	S5-100%	44.0	60.99	

From the table it was observed that,

1. There was a decrease of strength forspecimenS1-60%, when compared to the normal concrete.
2. There was a decrease of strength forspecimenS2-65%when compared to the normal concrete but there was an increase when compared with S1-60%.
3. There was a decrease of strength forspecimenS3-70%when compared to the normal concrete but there was an increase when compared with S1-60% and S2-70%.
4. There was a decrease of strength forspecimenS4-75%when compared to the normal concrete but there was an increase when compared with S1-60% , S2-70% and S3-75%
5. There was a decrease of strength for specimenS5-100%when compared to the normal concrete but there was an increase when compared with other specimens.

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018

ISSN: 2320-1363

So from the above table specimen S5-100%is more effective

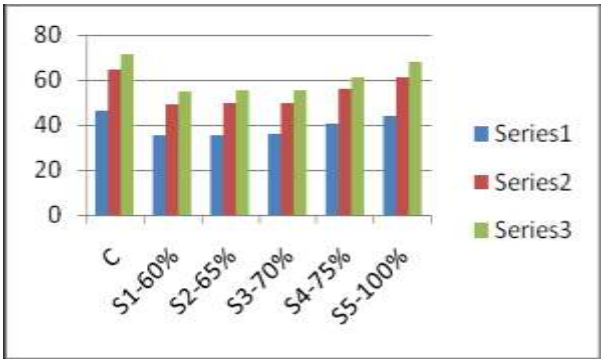

Fig no: 5.3 Variation of Compressive strength for stone dust

Fig no : 5.4 Compression test Sample

Table no 5.3 Split tensile strength (n/mm^2) - fly ash

S.No	Specimen	7 Days	14 Days	28 Days
1	C	2.92	4.0	4.8
2	C1-25%	2.92	4.0	4.8
3	C2-30%	2.86	3.83	4.4
4	C3-35%	2.77	3.62	4.0
5	C4-40%	2.64	3.54	4.1

From the table it was observed that,

1. There was no change in strength for specimen C1-25%, when compared to the normal concrete.
2. There was a decrease of strength for specimen C2-30%, when compared to the normal concrete but there was a decrease when compared with C1-25%.
3. There was a decrease of strength for specimenC3-35%, when compared to the normal concrete and C2-30%
4. There was a decrease of strength for specimenC4-40%, when compared to the normal concrete and other samples

So from the above table specimen C1-25% is more effective

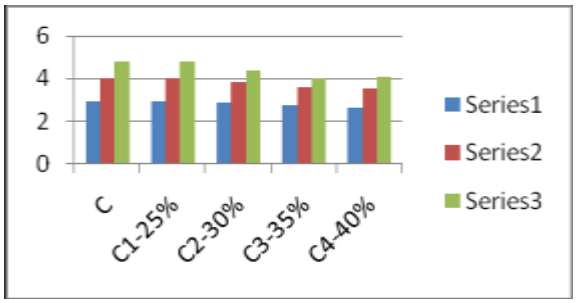

Fig no: 5.5 Variation of Split tensile strength for fly ash

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

Fig no 5.6 Split tensile strength test diagram

Table no 5.4 Split Tensile Strength (N/mm^2) - Stone Dust

S.No	Specimen	7 Days	14 Days	28 Days
1	C	2.9	4.0	4.8
2	S1-60%	2.67	3.52	3.93
3	S2-65%	2.58	3.63	3.96
4	S3-70%	2.67	3.39	3.86
5	S4-75%	2.82	3.83	4.34
6	S5-100%	3.30	4.35	4.83

From the table it was observed that,

1. There was a decrease of strength forspecimenS1-60%, when compared to the normal concrete.
2. There was a decrease of strength forspecimenS2-65%, when compared to the normal concrete, but there was an increase when compared with S1-60%.
3. There was a decrease of strength forspecimenS3-70%, when compared to the normal concrete, but there was an increase when compared with S1-60% and S2-70%.
4. There was a decrease of strength forspecimenS4-75%, when compared to the normal concrete, but there was an increase when compared with S1-60% , S2-70% and S3-75%
5. There was an increase of strength for specimenS5-100%when compared to the normal concrete another specimens.

So from the above table specimen S5-100%is more effective

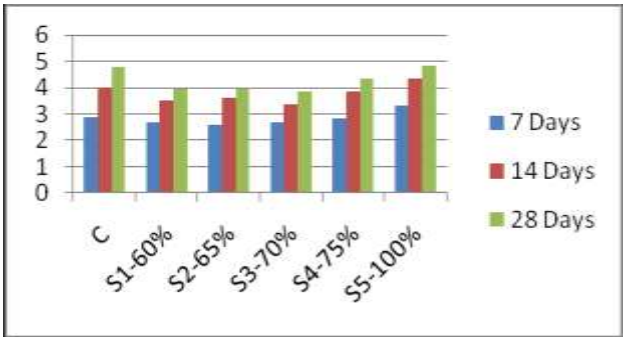

Fig no: 5.7 Variation of Split tensile strength for stone dust

5.3 Flexural Strength Test

This take a look at is performed on Universal Testing gadget. The beam detail is honestly supported on steel rollers of 38mm in diameter d these rollers should be so set up that the distance from centre to centre is 400 mm for 10.Zero cm specimens. The load is implemented through comparable rollers mounted at the 1/3 factors of the helping span, which is spaced thirteen.3cm centre to centre. The load is divided similarly among the two loading rollers, and all rollers are hooked up in such a way that the load is carried out axially and without subjecting specimen to any tensional stresses. The specimen is located in the device in such a way that the load is implemented to the uppermost floor as forged in the mildew, along two lines spaced thirteen.3 cm aside. The axis of the specimen is carefully aligned with the axis of the loading tool. No packing is used between the bearing surfaces of the specimen and the rollers. The load is carried out without surprise and increasing constantly are rate such that the excessive fibre stress increases at a price of one hundred eighty kg/min for the 10.0 cmspecimens. The load is accelerated till the specimen fails, and the most load implemented to the specimen at some point of the check is recorded. Also the distance among the line of fracture and the nearer assist is measured. In the gift research, this check has been carried out on beam specimens after 7 , 14 and 28 days of curing.

5.4Workability

Table no 5.5Slump for fly ash and stone dust

Workabili	Fly Ash		Stone Dust	
S.No	Specimen	Slump(mm	Specimen	Slump(m
1	C	30	C	30
2	C1-25%	50	S1-60%	45
3	C2-30%	51	S2-65%	43
4	C3-35%	53	S3-70%	40
5	C4-40%	55	S4-75%	37

IJMTARC – VOLUME – V – ISSUE – 23, JULY-SEP, 2018 ISSN: 2320-1363

6	---	----	S5-100%	35

From the table it was observed that,

1. There was a gradual increase in slump for the fly ash when compared with normal concrete.
2. There was a gradual increase in slump for the specimen S1-60%, S2-65% and there is gradual decrease for the samples S3-70%, S4-75% and S5-100%, but there was an increase with normal concrete.

So from the above table specimenC4-40% and S2-65%is more effective.

5.5 Strength Properties

Table no 5.6Strength Properties

Compressive Stre (N/mm^2)	Split Tensile Stre (N/mm^2)	Workabili (mm)
61.4	4.65	50

From the above results the Compressive Strength is 61.4 N/mm^2, Split Tensile Strength is 4.65 N/mm^2 and Workability is 50mm

CONCLUSIONS

- In this the Concrete Mix M45 has been designed as 1:2.43:0.78:0.35. The concrete with optimum replacement percentage of 25% replacement of cement by fly ash and 100% fully replacement of fine aggregate by Stone dusts in concrete mix quantities also arrived.
- The slump value for M45 grade using Stone dust and fly ash gets increased, when 100% replacement of Stone dust and 25% replacement of fly ash with 1.2% super plasticizer.
- Hence fly ash and stone dust replacement is effective for HPC in order to attain high strength. Compare to nominal concrete M45 grade concrete attain increase % strength by using lower water/binder ratio.
- Also reduce the segregation and bleeding. Utilization of fly ash in manufacturing building materials has increased significantly due to its increasing availability and massive environmental problems caused by disposal of fly ash.
- Two types of fly ash have been defined as class F and class C in which high lime content is identified. Physical properties of fly ash may vary depending on the nature of coal.
- Generally it is recommended to use around 25% of fly ash as replacement of cement in order to obtain effective resultant end products.

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