EXPERIMENTAL STUDY OF M35 GRADE OF CONCRETE ADOPTING ACI , DOE, USBR AND BIS METHOD OF MIX DESIGN ON REPLACEMENT OF SAND BY STONE DUST AS FINE AGGREGATE

Shahid Bin Bashir[1], Shashnak Yadav[2]

[1]Masters in Construction Technology and Management, Department of Civil Engineering, Desh Bhagat University, Punjab India.
[1]Assistant Professor in the Department of Civil Engineering, Desh Bhagat University, Punjab India.

Abstract - *Concrete is a construction chemical compound composed primarily of water, aggregate, and cement. Often, added constituents and reinforcements are incorporated in the mixture to accomplish the wanted functional characteristics properties) of the completed material. At point when these fix-ups are mixed together, they frame a liquid mass that is formed into shape. After some time, the concrete structures a hard grid which ties whatever remains of the fixings together into a solid stone-like material with numerous uses . Concrete is a to a great degree adaptable building material in light of the fact that, it can be designed for compressive strengths running from M 10, to 140 MPa or higher and workability going from 0 mm slump to 150mm slump or more. Concrete with a compressive strength under 50 MPa is viewed as ordinary strength. The basic elements of concrete in both of these occurrences are the same. However, the conclusion is its nearly equivalent proportioning. The exploratory system comprised of experimental work on concrete developed by ACI, DOE, USBR and BIS method mix design method to portray & think concerning its properties, for example, compressive strength, flexure strength, split tensile, abrasion strength. For this objective, the M35 examination of concrete cubes, frames and cylinder designed by ACI, BIS, USBR and BRITISH mix design processes or methods were thrown & tried for individual property after they've been cured for 7,28 and 56 days. For every stage curing an arrangement of different three specimens of every sort had been thrown. The effect of varying fine aggregates i.e. stone dust and sand on strength parameter discussed above, were studied and cost analysis was done on the basis of aggregates used as the cement constituents & water to cement ratio was kept constant.*

Key Words: **Stone Dust, Mix Design, Split Tensile Strength, Compressive Strength. Flexural Strength.**

1. INTRODUCTION

CONCRETE

Concrete is a composite material made for the most part out of water, aggregate, and cement. Often, added constituents and reinforcements are incorporated in the mixture to accomplish the wanted physical properties of the completed material. At the point when these fixings are mixed together, they frame a liquid mass that is formed into shape. After some time, the concrete structures a hard grid which ties whatever remains of the fixings together into a solid stone-like material with numerous uses . Concrete is a to a great degree adaptable building material in light of the fact that, it can be designed for compressive strengths running from M10 to 140MPa or higher and workability going from 0 mm slump to 150mm slump or more. Concrete with a compressive strength under 50 MPa is viewed as ordinary strength. In every one of these cases the fundamental elements of concrete are the same; however it is their relative proportioning that has the effect.

IMPORTANCE OF MIX DESIGN

Mix design is a procedure of determining the blend of constituents needed to meet expected properties of fresh and solidified concrete. Concrete mix design is the method of right proportioning of elements of concrete according to the site prerequisites, keeping in mind the end goal to get attractive properties of concrete in plastic as well as in solidified stage The prime target of proportioning a concrete mix is to get relative amounts of elements for the most practical mix that meets the base criteria of quality, workability, sturdiness, total attributes and economy. Reasonable proportioning of the elements of concrete is the fundamental nature of concrete mix design and its motivation is to guarantee most ideal extents of the constituent materials to meet the necessities of the structure being fabricated. Mix design is vital in different ways. Basic concrete must oppose external forces & internal stresses because of different sorts of loads. So concrete must show certain base property, for example, quality, consistency, sturdiness and so on.

Consequently some suitable materials ought to be chosen & their relative amounts ought to be resolved. Again concrete ought to be cleaning specialist in the most financial procedure.

It should be made certain in mix design that, the concrete:

- Agrees to the particular of structural strength set down, which is typically expressed regarding the compressive strength of standard test samples.
- Be capable for being blended, transported, compacted and put as productively as would be prudent.

- Maximum cement content to maintain a strategic distance from shrinkage cracking because of temperature cycle in mass
- Greatest water-cement ratio and/or greatest cement content to give satisfactory strength for the specific site conditions.

Various standard mix proportioning methods are accessible for routine normal strength concrete (NSC). Numerous methods have been created to touch base at these extents in an investigative way. There are four entrenched mix plan techniques for planning normal strength concrete (NSC) mixes to be specific Indian, American, US Bureau of Reclamation (USBR) and British Standard methods. These methods have some consistent ideas in touching base at extents however their strategy for computation is diverse

2. EXPERIMENTAL PROGRAM.

This section gives an itemized portrayal of the materials utilized as a part of the exploratory program and testing strategies utilized as a part of this study. The exploratory system comprised of research centre test on concrete designed by ACI, USBR, BIS and BRITISH mix design method to portray and think about the properties, for example, compressive strength, flexure strength, split tensile strength, abrasion. For this reason cubes, beams and cylinders of M35 and M40 evaluations of concrete designed by ACI, USBR, BIS and BRITISH mix design methods were thrown and tried for the individual properties after a curing time of 7,28 and 56 days. For every stage curing an arrangement of three specimens of every sort was thrown.

3. SPECIFICATIONS OF MATERIALS AND MIX DESIGN.

3.1 WATER:

The water utilized for mixing and curing was spotless and free from damaging amounts of organic and non-organic harmful substances and different substances that may be injurious to totals or concrete. Consumable water was utilized as a part of concrete brick work. The pH estimation of water ought to be at least 6.

Fine and Coarse Aggregates:

The provincially accessible stone dust and sand were utilized independently in this analysis. Its various physical properties were tested as per IS: 383 – 1970. 20 mm and 12.5 mm graded aggregates were used in such a ratio that it combines to form 20mm graded aggregates. Various properties of fine and coarse aggregates are listed below:-

For Stone dust:

Fineness modulus = 2.8
Grading zone = zone 3
Specific gravity = 2.65

For Sand:

Specific gravity of coarse aggregates = 2.72
Grading ratio of 20 mm aggregates to 12.5 mm = 1.5:1 (60% 20mm & 40% 12.5mm)
Unit weight of Coarse aggregates = 1450

3.1.1 CEMENT:

The cement utilized as a part of this trial project is the Portland Pozolona bond of grade 43. It was tested according to the important procurements of IS code and results are given below in table 3.1

Table 1: - Properties of Cement

Property	VALUES	Procurements of IS 8112-1989
Standard consistency (using Vicat apparatus)	33	---
Initial setting time (min.)	65	>30 mins
Final setting time (min.)	435	<10 hrs
Specific gravity	3.0	3.0 – 3.15

Mix design for M35 grade of concrete

Concrete with a particular finished objective to get charming properties of concrete in plastic additionally in cemented stage the prime focus of proportioning a concrete mix is to secure relative measures of components for the mild mix that meets the base criteria of strength, workability, sturdiness, aggregate traits and economy.

3.2 MIX DESIGNS OF M35 GRADE CONCRETE DESIGNED BY BIS, ACI, DOE, USBR METHODS USING STONE DUST.

3.2.1 MIX DESIGN OF M35 BY BIS METHOD.

- Target mean strength = 43.25
- Water cement ratio =0. 40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 Lt
- Volume of coarse aggregate corresponding to unit volume of total aggregate for different zones of fine aggregate = 0.66
- Volume of fine aggregates = (1-0.66) = 0.34

- Absolute volume of cement = 415/3.0*1/1000 =0.138
  Water = 164/1000 = 0.166
  Plasticizer = 4.15/1.1*1/1000 = 0.0037
- Total aggregates = 1-(0.138+0.166+0.0037) = 0.692
- Mass of coarse aggregate = 0.692*0.66*2.72*1000 = 1242.27 kg/m³
- Mass of fine aggregate = 0.692*2.54*1000*0.32 = 623.49 kg/m³
- Final ratio

Table 2: Ratio of constituents of M35 grade concrete for BIS method

	Cement	F. A	C. A	Water	Plasticizer
For 1 m³	415	623.49	1242.27	166	4.15

3.2.2 MIX DESIGN OF M35 BY ACI METHOD.

Test data required

Specific gravity of coarse aggregates = 2.72
Specific gravity of fine aggregates = 2.65
Grading ratio of 12.5mm and 20 mm aggregates = 1:1.5
Specific gravity of cement (PPC) = 3.0
Fineness modulus of fine aggregates = 2.8
Unit weight of C. A = 1450

Mix design:

- Target mean strength = 43.25
- Water cement ratio =0. 40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 Lt
- Fineness modulus of F. A = 2.8
- Bulk volume of C. A = 0.62
- Mass of C. A = 0.62*1450 = 899 kg
- Absolute volume of cement = 415/3.0*1/1000 =0.138
  Water = 166/1000 = 0.166 .
  Plasticizer = 4.15/1.1*1/1000 = 0.0038
  C.A = 899/2.72*1/1000 = 0.330
- Fine aggregates = (1- 0.330 – 0.166 – 0.138 -0.0038) = 0.362
- Mass of fine aggregates = 0.362 * 2.65 * 1000 = 959.3
- Final ratio in kg

Table 3: Ratio of constituents of M35 grade concrete for ACI method

	Cement	**F.A**	**C.A**	**Water**	**Plasticizer**
For 1 m³	415	959.3	899	166	4.15

3.2.3 DESIGN OF M35 BY USBR METHOD.

Test data required

Specific gravity of coarse aggregates = 2.72
Specific gravity of fine aggregates = 2.65
Grading ratio of 12.5mm and 20 mm aggregates = 1:1.5
Specific gravity of cement (PPC) = 3.0
Fineness modulus of fine aggregates = 2.4

Mix design

- Target mean strength = 48.25
- Water cement ratio =0.40
- Cement = 430 kg
- Water content according to the table 4.

Table 4. Water content

Max size of Aggregate	Air content	Fine Aggregates	C.A	Water
20 mm	6%	42 %	62%	156 ltr.

Amount of plasticizer added 1% of cement content = 1*430/100 = 4.3 ltr.

Table 5. Adjustments for water content

	Water	Sand	C.A
Fineness modulus (2.75 -2.4)	-------	- 3.1 %	+ 6.2%
Slump (25 – 50 mm)	-6%	-----	-------
Air content 6%	+18%	+4.5%	------
Water cement ratio 0.38	------	-0.4%	-------
Sand +1%	+0.4%	-------	-0.8%

So water content = +12.4%= 175.34 kg
- F.A = +0.4% = 42.4%

- C.A = +5.4% = 67.4 %
- Volume of F.A
  (1000- 430/3 -175.34) *0.424 =290.79.
  Weight of stone dust = 290.79 *2.65 = 290.79Kg
- Volume of C.A = 685.83-290.29=395.54
- Weight of C.A = 395.54*2.72= 1052 kg
- Final ratio in kg

Table 6. mix proportions of M35 as per USBR method

	Cement	F.A	C.A	Water	Plasticizer
For 1 m^3	430	290.79	1052	175.34	4.3

3.2.4 DESIGN OF M35 BY DOE METHOD.

Test data required

Specific gravity of coarse aggregates = 2.72
Specific gravity of fine aggregates = 2.65
Grading ratio of 12.5mm and 20 mm aggregates = 1:1.5
Specific gravity of cement (PPC) = 3.0
Fineness modulus of fine aggregates = 2.8
Wet density of concrete = 2400

Mix design:

- Target mean strength = 43.25
- Water cement ratio =0.40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 Lt
- Total aggregate content = 2400 (1- 415/3000 -0.166 – 0.0030) = 1662.4 kg
  Percentage of fine aggregates = 22% by 1662.4 = 22*1662.4/100 = 365 kg
- Mass of coarse aggregates = 1297 kg
- Final ratio in kg

Table 7:- Ratio of constituents of M35 grade concrete for DOE method

	Cement	F.A	C.A	Water	Plasticizer
For 1 m^3	415	365	1297	166	4.15

3.3 MIX DESIGNS OF M35 GRADE CONCRETE DESIGNED BY BIS, ACI, DOE, USBR METHODS USING SAND.

3.3.1 MIX DESIGN OF M35 BY BIS METHOD

- Target mean strength = 43.25
- Water cement ratio =0. 40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 0.8% of cement content = 0.8*415/100 = 3.32 Lt
- Volume of coarse aggregate corresponding to unit volume of total aggregate for different zones of fine aggregate = 0.66+0.02 = 0.68
- Volume of fine aggregates = (1-0.68) = 0.32
- Absolute volume of cement = 415/3.0*1/1000 =0.138
  Water = 164/1000 = 0.166
  Plasticizer = 3.32/1.1*1/1000 = 0.0033
- Total aggregates = 1-(0.138+0.166+0.0033) = 0.692
- Mass of coarse aggregate = 0.692*0.68*2.72*1000 = 1281.21 kg/m^3
- Mass of fine aggregate = 0.692*2.54*1000*0.32 = 562.45 kg/m^3
- Final ratio

Table 8: - Mix proportions of M35 as per BIS method

	Cement	F. A	C. A	Water	Plasticizer
For 1 m^3	415	562.45	1281.21	166	3.32

3.3.2 DESIGN OF M35 BY ACI METHOD

Test data required:

Specific gravity of coarse aggregates = 2.72
Specific gravity of fine aggregates = 2.54
Grading ratio of 12.5mm and 20 mm aggregates = 1:2
Specific gravity of cement (PPC) = 3.0
Fineness modulus of fine aggregates = 2.4
Unit weight of C. A = 1450

Mix design:

- Target mean strength = 43.25
- Water cement ratio =0. 40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 Lt
- Fineness modulus of F. A = 2.4
- Bulk volume of C. A = 0.66
- Mass of C. A = 0.66*1450 = 957 kg
- Absolute volume of cement = 415/3.0*1/1000 =0.138.
  Water = 166/1000 = 0.166.
  Plasticizer = 4.15/1.1*1/1000 = 0.0038.
  C.A = 957/2.72*1/1000 = 0.351
- Fine aggregates = (1- 0.351 – 0.166 – 0.138 -0.0038) = 0.341
- Mass of fine aggregates = 0.341 * 2.54 * 1000 = 866.65
- Final ratio in kg

Table 9: - Mix proportions of M35 as per ACI method

	Cement	F.A	C.A	Water	Plasticizer
For 1 m^3	415	866.65	957	166	4.15

3.3.3 DESIGN OF M35 BY USBR METHOD

Mix design:

- Target mean strength = 43.25
- Water cement ratio =0.45
- Cement = 415 kg
- Water content according to the table below:

Table 10. Water content table

Max size of Aggregate	Air content	Fine aggregates	C.A	Water
20 mm	6%	42%	62%	156 lt

Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 lt

Table 11. Adjustments for water content

	Water	Sand	C.A
Fineness modulus (2.75 -2.4)	-------	-3.10%	6.20%
Slump (25 – 50 mm)	-6%	-----	-------
Air content 6%	18%	4.50%	------
Water cement ratio 0.4	------	-1%	-------
Sand 0.40%	0.40%	-------	-0.80%

- F.A = +0.4% = 42.4 %
- C.A = +5.4% = 67.4 %
- Volume of F.A
  (1000- 415/3 - 175.34) *0.424
  (685.83) *.43 =290.79
- Weight of sand = 290.79 *2.54 = 738.6
- Volume of C.A = 685.83 – 290.79 = 395.54
- Weight of C.A = 395.54*2.72= 1075.86 kg
- Final ratio in kg

Table12: - Mix proportions of M35 as per USBR method

	Cement	F.A	C.A	Water	Plasticizer
For 1 m^3	415	738.6	1075.86	175.34	4.15

3.3.4 DESIGN OF M35 BY DOE METHOD

Test data required

Specific gravity of coarse aggregates = 2.72
Specific gravity of fine aggregates = 2.54
Grading ratio of 12.5mm and 20 mm aggregates = 1:2
Specific gravity of cement (PPC) = 3.0
Fineness modulus of fine aggregates = 2.4
Wet density of concrete = 2400.

Mix design:

- Target mean strength = 43.25
- Water cement ratio =0.40
- Cement = 415 kg
- Water content = 415*0.40 =166 Lt
- Amount of plasticizer added 1% of cement content = 1*415/100 = 4.15 Lt
- Total aggregate content = 2400 (1- 415/3000 -0.166 – 0.0030) = 1662.4 kg
- Percentage of fine aggregates = 25% by 1662.4
  = 25*1662.4/1 = 415.6 kg
- Mass of coarse aggregates = 1246.8 kg
- Final ratio in kg

Table 13: - mix proportions of M35 as per DOE method

	Cement	F.A	C.A	Water	Plasticizer
For 1 m^3	415	415.6	1246.8	166	4.15

4. CASTING AND CURING OF SPECIMEN

Pan mixer was utilized for mixing constituents. All cubes, beams and cylinders were thrown in the standard metallic forms and vibrated to get obliged example size. The moulds were tidied up dust and oil was applied on all sides of moulds before cementing the specimen.

Fig.1: Beam moulds on vibrating table

Altogether mixed concrete was filled the moulds in three equivalent layers and the moulds were put on vibrating table for a little period. Over-abundance concrete is uprooted with a trowel and the top surface is done with a smooth surface

Fig. 2: Curing Tank

The moulds were demoulded after 24hrs and put in curing tank for the respective periods of 7, 28 and 56 days. A set of 3 samples was prepared for each stage curing. The temperature of curing tank was kept at 25° ± 2° c for 56 days.

4. TESTING

The accompanying test strategies were led so as to analyze the sought properties of concrete designed by distinctive methods.

4.1 TEST FOR COMPRESSIVE STRENGTH.

The test specimens were cubical in shape (150 * 150 * 150 mm). Moulds were filled for testing at 7, 28, 56 days curing.

Fig. 3: Specimen being tested on a compression testing machine

Procedure:

- Expelled the sample from water after the predetermined curing time and wipe out abundance water from the surface.
- Cleaned the bearing surface of the testing machine
- Put the sample in the machine in such a way, to the point that the load shall be connected to the opposite sides of the cube cast.
- Aligned the specimen centrally on the base plate of the machine.
- Rotated the movable portion gently by hand so that it touches the top surface of the specimen.
- Apply the load gradually, without shock and continuously at the rate of 140kg/cm2/minute till the specimen fails
- Recorded the maximum load and noted any unusual features in the type of failure.

4.2. TEST FOR SPLIT TENSILE STRENGTH.

The cylinder mould shell is of metal, 3mm thick. The cylinders used to be with dimensions 20 cm length and 10 cm DIA. Each mould was capable of being opened longitudinally to facilitate the removal of the specimen

Concrete cylinder were filled for testing at 7, 28, 56 days. At least 3 moulds were filled for testing at each stage curing

Fig. 4: Gear for split tensile testing of cylindrical specimen

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 06 | Jun 2022 www.irjet.net p-ISSN: 2395-0072

Procedure:

- Took the wet specimen from water after curing
- Wipe out water from the surface of the specimen.
- Noted the weight and dimension of the specimen.
- Set the compression testing machine for the required range.
- Placed the sample in the split tensile testing assembly.
- Placed the assembly in the compression testing machine.
- Bring down the upper plate to touch the assembly.
- Apply the load continuously without shock at a rate of approximately 14 MPa/min.
- Note down the breaking load (P)

CALCULATIONS:

As per IS456, split tensile strength of concrete. =0.7Fck
The splitting tensile strength is calculated using the formula

$$Tsp = 2P/\pi DL$$

Where P = applied load
D = diameter of the specimen
L = length of the specimen

4.3 TEST FOR FLEXURAL STRENGTH.

- Test specimens were prepared by moldings concrete to a beam section, curing and storing in accordance with standard procedure. The section of the beam shall be (100*100*500)mm.
- Moulds will be filled for testing at 7, 28, 56 days. At least 3 moulds were filled for testing at each stage curing.
- A four point bending test was conducted to measure the flexural strength of concrete beams. Circular rollers manufactured out of steel having cross section with diameter 38mm were used for providing support and loading points to the specimens. The length of the rollers was at least 10 mm more than the width of the test specimen. A total of four rollers was used, three out of which were capable of rotating along their own axes. The distance between the outer rollers (i.e. Span) was **3d** and the distance between the inner rollers was **d**. The inner rollers were equally spaced between the outer rollers, such that the entire system is systematic.
- The specimens stored in water were tested immediately on removal from water; while they were still wet. The test specimens were placed in the machine correctly centered with the longitudinal axis of the specimen at right angles to the rollers. The mould filling direction was normal to the direction of loading.
- The load shall be applied slowly without shock at the rate 1.0 MPa/min in all cases.

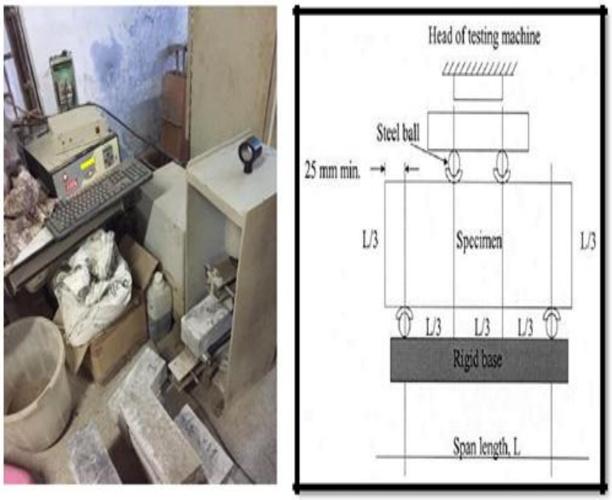

Fig. 5: four point bending test assembly

Calculation:

The Flexural Strength is given by
$f_b = pl/bd^2$
a> 200.0mm for 15.0cm specimen or > 13.0cm for 100.0 mm specimen.
$f_b = 3pa/bd^2$
a <20.0cm but >17.0 for 15.0cm specimen or <133 mm but >11.0cm for 100.0mm specimen.
b = width of specimen
d = failure point depth
l = supported length
p =max. Load

4.4 TEST FOR ABRASION.

The abrasion testing machine was utilized for this test as determined in IS 1237. Test size: - square molded sample (71.0 mm) was utilized as test for testing. The sample dried to consistent mass at a temperature of 105 degree c. The sample was tried following 7 and 28 days curing. 3 samples were tried at every curing stage.

Procedure:-

- The weight of specimen was noted nearest to 0.1 gm before test and after every four cycles.
- The grinding path was evenly strewn with 20 gm of abrasive powder. The specimen was fixed in holding device such that the test surface faces the grinding disc. The specimen was centrally loaded with 294 N.
- The grinding disc runs at a speed of 30 RPM. The disc was stopped after a cycle of 22 revolutions.

The test cycle was repeated 16 times, the specimen being turned 90· in the clockwise direction and spreading 20 gm of abrasive powder on testing track after each cycle.

Calculation:

The abrasive wear of specimen after 16 cycles will be calculated as the mean loss in the thickness.

Δt = W − W ▯ V/W ▯ A
Δt = loss in thickness after 16 cycles
W1 = initial mass of the sample
W2 = final mass of the sample

Fig. 6: Abrasion testing of concrete specimen

A = area of sample in mm^2
V = volume of sample.
The abrasive wear shall be reported to the nearest whole number of 1000 mm per 5000mm3.

5. RESULTS

5.1 COMPRESSION TEST

The compressive strength of distinctive specimens was tried following 7, 28 and 56 days of curing. The 150 mm cubes were tried on compression testing machine under monotonic load @ 14Mpa/min. The crucial compressive load of the cubes obtained from diverse mix design methods is said in the table underneath

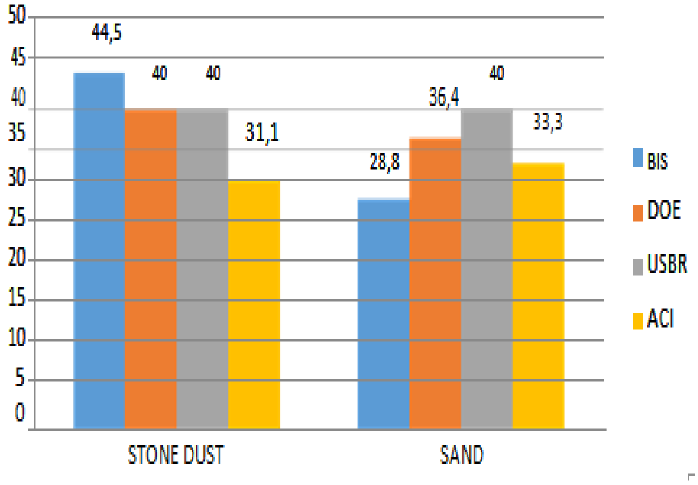

Chart 1: Compressive strength of M35 grade of concrete at 7 Days

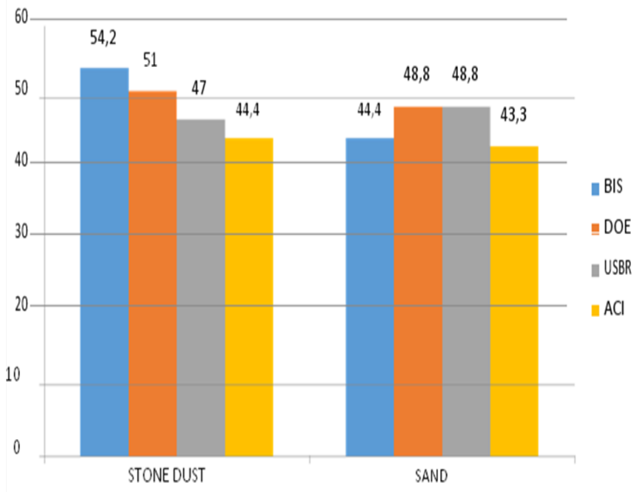

Chart 2: Compressive strength of M35 grade of concrete at 28 Days.

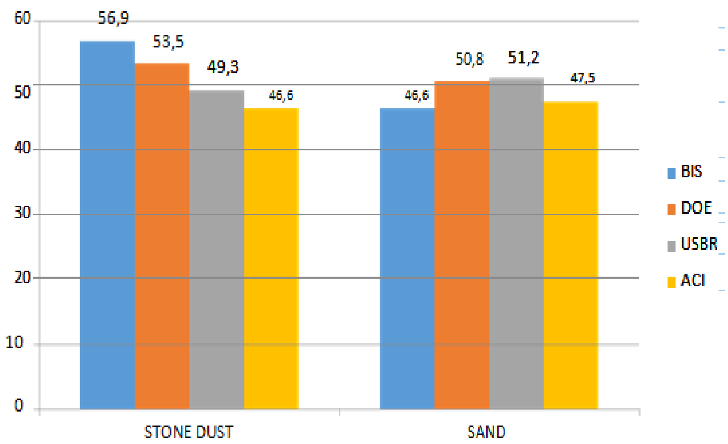

Chart 3: Compressive strength of M35 grade of concrete at 56 Days.

Table 14: - Compressive strength of M35 grade of concrete at 7, 28 & 56 days for stone dust and sand

Types of mix design	BIS		DOE		USBR		ACI	
Fine Aggregate	Stone Dust	Sand	Stone Dust	Sand	Stone Dust	Sand	Stone Dust	Sand
Target Mean Strength	43.25		43.25		39.25		40	
Density of Concrete (kgm3)	2474	2474	2465	2476	2459	2424	2330	2310
Compressive Strength (N/mm2) at 7 days	44.5	28.9	40	36.4	40	40	31.1	33.3
Compressive Strength (N/mm2) at 28 days	54.2	44.4	51.2	48.4	47.13	48.8	44.4	45.3
Compressive Strength (N/mm2) at 56 days	56.9	46.6	50.8	49.3	49.31	51.2	46.2	47.5

5.1.1OBSERVATIONS

The comparison was carried out between compressive strength of concrete composed by IS, DOE, ACI and USBR methods for M35 evaluation utilizing stone dust and sand independently as fine aggregates.

For **M35** concrete designed by BIS method, there was huge 50% raise in 7 Days compressive strength, 22% increase in 28 days and 56 days compressive strength of cubes casted using stone dust as compared to cubes casted using sand. For M35 concrete designed by DOE method, there was 9% increase in 7 Days compressive strength, 4% increase in 28 Days and 56 days compressive strength of cubes casted using stone dust as compared to cubes casted using sand. Taking into account M35 concrete designed by USBR method, it was noted that the cubes casted with sand achieved same (i.e. 40 N/mm^2) compressive strength at 7 Days, whereas there was slight increase of 3% in compressive strength at both 28 and 56 days strength of cubes casted using sand as compared to compressive strength of cubes casted using stone dust. Similarly for M35 concrete designed by ACI method, it was the cubes casted sand which achieved a slight increase in compressive strength at 7, 28 and 56 days.

5.2 FLEXURE TEST.

The beams of dimensions (10*10*50 cm) were prepared and tested after 7, 28 and 56 days of curing. Beams were tested under monotonic increasing loading to determine the flexural tensile strength. The rate of load application was 1.0 MPa/min in all cases. The flexural strength can be determined as PL/BD^2, where P is the maximum node applied (N), L is the span length (mm) that is the distance between the line of fracture and the nearesqqt support measured from the center line of the tensile side of specimen, B is the width of the specimen (mm), d is the depth of specimen (mm)

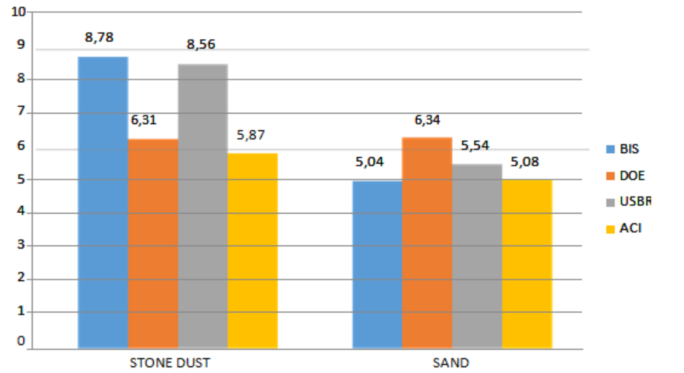

Chart4: Flexure strength of M35 grade of concrete at 7 days.

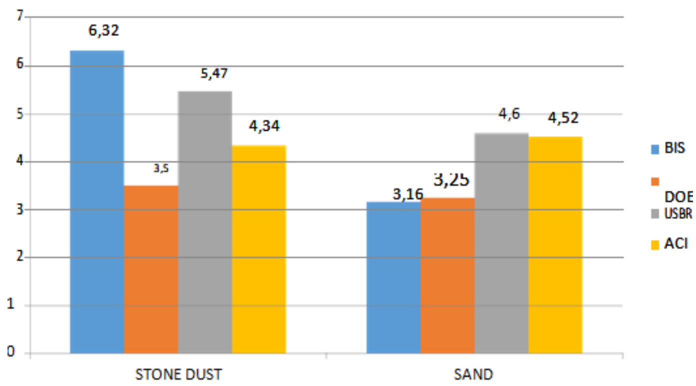

Chart5: Flexure strength of M35 grade of concrete at 28 days.

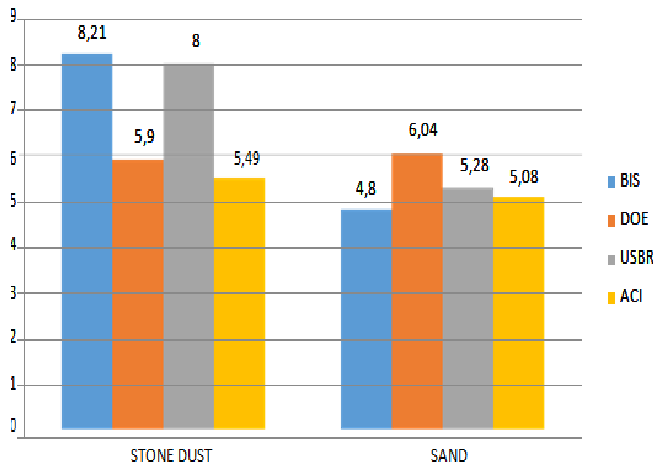

Chart 6: Flexure strength of M35 grade of concrete at 56 days.

Table 15: - Flexure strength of M35 grade of concrete at 7, 28 & 56 days for stone dust and sand

Types of mix Designs	BIS		DOE		USBR		ACI	
Fine aggregate	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand
Target mean Strength	4.60		4.60		4.60		4.60	
Density of concrete(Kg/m^3)	2500	2451	2460	2450	2550	2452	2360	2450
Flexural Strength (N/mm^2)At 7 Days	6.32	3.16	3.50	3.25	5.47	4.60	4.34	4.52
Flexural Strength (N/mm^2) 28 Days	8.21	4.80	5.9	6.04	8	5.28	5.49	5.08
Flexural Strength (N/mm^2) 56 Days	8.78	5.04	6.31	6.34	8.56	5.54	5.87	5.33

5.2.1 OBSERVATIONS

The comparison was carried out between compressive strength of concrete designed by IS, DOE, ACI and USBR methods for M35 grade using stone dust and sand independently as fine aggregates. **For M35** concrete designed by BIS method, there was huge 50% raise in 7 Days flexural strength, 71% increase in 28 days and 74% increase in 56 days flexural strength of cubes casted using stone dust as compared to cubes casted using sand. For M35 concrete designed by DOE method, there was 7% increase in 7 Days flexural strength, 2% decrease in 28 Days and similar 56 days flexural strength of cubes casted using stone dust as compared to cubes casted using sand. Taking into account M35 concrete designed by USBR method, it was noted that the cubes casted with stone dust achieved higher (i.e. 5.41 N/mm^2) flexural strength at 7 Days, where it was an increase of 51% in flexural strength at both 28 and 56 days strength of cubes casted using stone dust as compared to flexural strength of cubes casted using sand. Whereas, for M35 concrete designed by ACI method, it was the cubes casted sand which achieved a slight increase in flexural strength at 7, 28 and 56 days.

5.3 SPLIT TENSILE TEST

Cylinders of 10 cm diameter and 20 cm length were prepared and tested under increasing loading @14 MPa/min. Three cylinders were tested at 7, 28 and 56 days of curing for each type of mix design. The Split Tensile Strength is determined by **2P/πLD** Where P= Load at which sample fails, L= length of the specimen cylinder, D= diameter of the specimen cylinder.

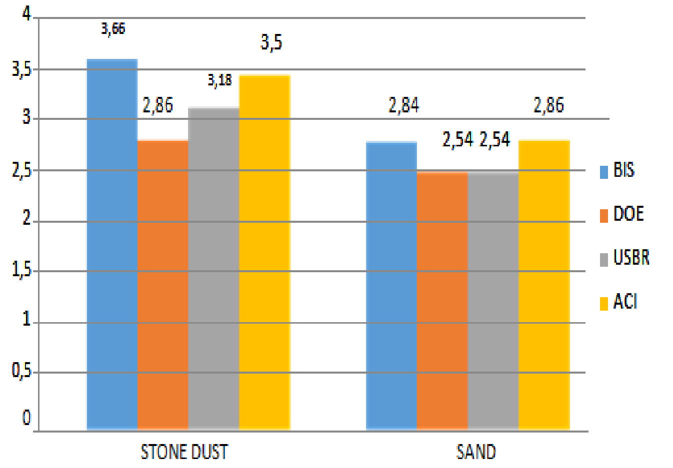

Chart 7: Split Tensile strength of M35 grade of concrete at 7 days.

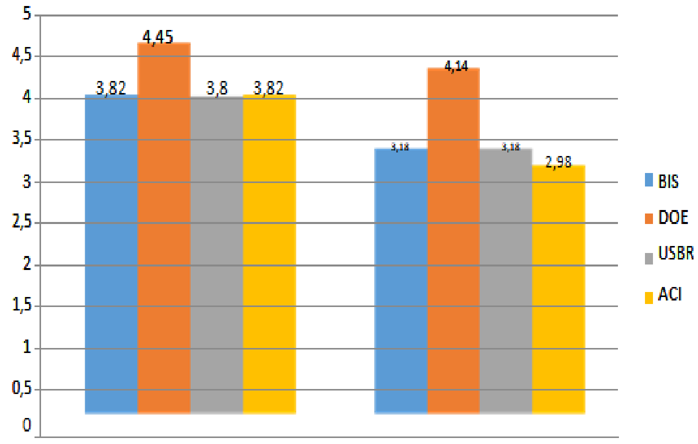

Chart 8: Split Tensile strength of M35 grade of concrete at 28 days.

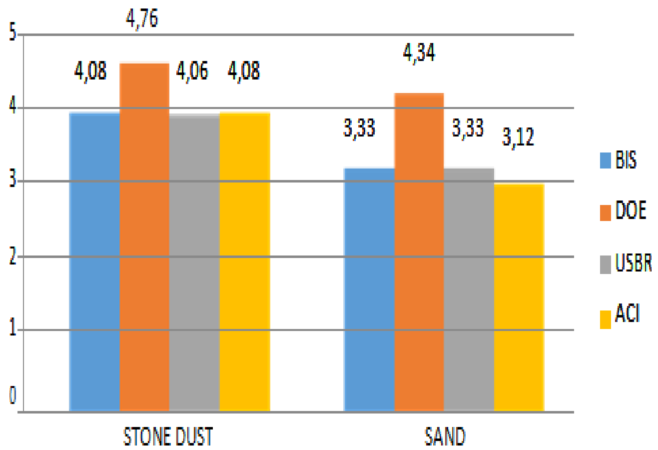

Chart 9: Split Tensile strength of M35 grade of concrete at 56 days.

Table 16: - Split tensile strength of M35 grade of concrete at 7, 28 & 56 days for stone dust and sand

Types of mix designs	BIS		DOE		USBR		ACI	
Fine aggregate	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand
Density of concrete (Kg/m^3)		2388		2446		2420		2357
Split Tensile strength (N/mm^2) At 7 days	3.66	2.84	2.86	2.54	3.18	2.54	3.50	2.86
Split Tensile strength (N/mm^2) At 28 days	3.82	3.18	4.45	4.14	3.80	3.18	3.82	2.98
Split Tensile strength (N/mm^2) At 56 days	4.08	3.33	4.76	4.34	4.06	3.33	4.08	3.12

5.3.1 OBSERVATIONS

Ensuing to examination of the information acquired from outlines for split tensile strength for M35 evaluation concrete composed by ACI, USBR, DOE and BIS methods utilizing stone dust and sand independently as fine aggregates, taking after certainties were watched.

For M35 concrete designed by BIS method, there was 10% raise in 7 Days split tensile strength,30% decrease in 28 days and 56 days split tensile strength of cubes casted using stone dust as compared to cubes casted using sand. For M35 concrete designed by DOE method, there was 55% decrease in 7 Days split tensile strength, 24% decrease in 28 Days and 56 days split tensile strength of cubes casted using stone dust as compared to cubes casted using sand. Taking into account M35 concrete designed by USBR method, it was noted that the cubes casted with stone dust achieved 25% more split tensile strength at 7 Days, also there was an increase of 19% in split tensile strength at both 28 and 56 days strength of cubes casted using stone dust as compared to flexural strength of cubes casted using sand. Whereas for M35 concrete designed by ACI method, it was again the cubes casted stone dust which achieved a 22% increase in split tensile strength at 7days, and 30% increase in 28 and 56 days split tensile strength.

5.4 ABRASION TEST

Abrasion test was performed on concrete samples measuring 70*70*25mm, to analyse the toughness of concrete designed with various mix design methods. The loss of thickness was observed in each case. The results obtained are put into a table below.

17: - Abrasion values of M35 grade

Types of mix Designs	BIS		DOE		USBR		ACI	
Fine aggregate	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand	Stone dust	Sand
Initial weight (gm)	302	306	278	312	315	285	285	302
Final weight (gm)	290	302	265	302	305	282	278	296
Loss of weight (gm)	12	4	13	10	10	3	8	6
Average loss of thickness (mm)	1.04	0.334	1.13	0.83	0.86	0.261	0.69	0.526

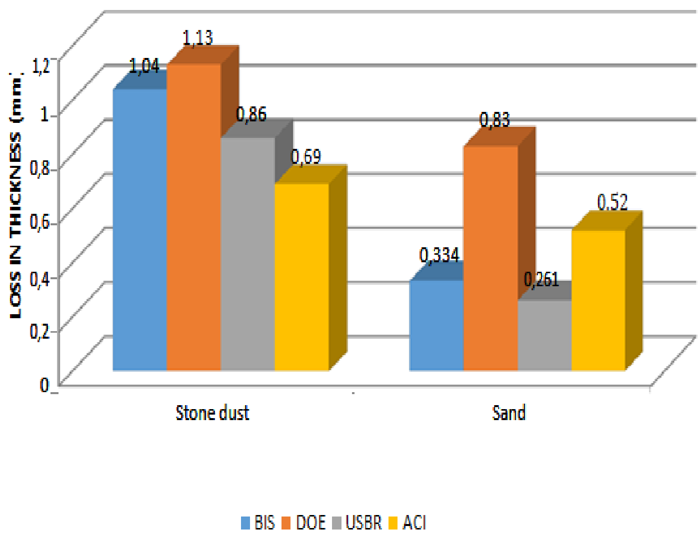

Chart 10: Abrasion values of M35 grade

5.4.1OBSERVATIONS

The examination between the cement planned by different configuration techniques presumed that for **M35** evaluation, tests of USBR method samples utilizing stone dust bestowed least misfortune in thickness, yet the higher strength was seen in samples of USBR method utilizing sand.

5.4.2 Analysis of proportioning as per different mix design methods

The M35 grade of concrete were designed by different methods of mix design for fulfillment of objectives in this research work. The cement content and water cement ratio was fixed in this analysis. The fine aggregates and coarse aggregates were varied according to mix designs .To compare the proportioning parameters of different mix design methods, the proportions obtained as per design from DOE, ACI, BIS and USBR are listed below:

Table 18: - Comparison of Mix proportions of M35 obtained as per different Mix Design Methods using stone dust

Type of mix design	W/C	Water Content	Cement content	Stone dust	Coarse aggregates	Plasticizer
BIS	0.4	166	415	**623.5**	**1242**	4.15
DOE	0.4	166	415	**365**	**1297**	4.15
USBR	0.4	176	415	**855**	**1008**	4.15
ACI	0.4	166	415	**959.3**	**899**	4.15

Table 19: - Comparison of Mix proportions of M35 obtained as per different Mix Design Methods using sand

Type of mix design	W/C	Water Content	Cement content	Stone dust	Coarse aggregates	Plasticizer
BIS	**0.4**	**166**	**415**	**562.5**	**1281**	**4.15**
DOE	**0.4**	**166**	**415**	**415.2**	**1246**	**4.15**
USBR	**0.42**	**174.3**	**415**	**738.6**	**1075.9**	**4.15**
ACI	**0.4**	**166**	**415**	**866.1**	**957**	**4.15**

5.4.3 OBSERVATIONS

In context with the tables above, following observations were made. The amount of cement and water cement ratio were kept similar for all the methods i.e. cement= 430 and W/C= 0.38 for M40 concrete and cement =415, W/C= 0.40 for M35 concrete. For M40 and M35 concrete, the minimum amount of sand was observed in DOE method whereas maximum amount of sand was found in ACI method. For both M35 and M40 if stone dust is taken into consideration, it was maximum in ACI method and it was minimum for DOE method.

5. COST ANALYSIS OF DIFFERENT MIX DESIGN METHOD

The expense correlation in this exploration is based upon the amount of aggregates fine and coarse utilized as a part of different blend plan method, as the concrete substance is settled for all the methods. The expense of aggregates used to bear on the examination is taking into account the expense of by regional standards accessible aggregates without the transportation cost. The examination is executed for one m3 of concrete composed.

Table 20: - cost evaluation for M35 concrete using stone dust

Type of mix design	Coarse aggregate (m^3)	Stone Dust Used (m^3)	Total aggregate Used (m^3)	Cost of Coarse aggregates (Rs1070/m^3)	Cost of stone dust (Rs535/m^3)	Total Cost of aggregates(Rs)
BIS	0.856	0.382	1.238	915/-	205/-	1120
DOE	0.894	0.223	1.117	956/-	120/-	1076
USBR	0.695	0.524	1.219	743/-	280/-	1023
ACI	0.62	0.588	1.208	663/-	315/-	978

Table 21: Cost Evaluation for M35 concrete using Sand

Type of mix design	Coarse Aggregate (m^3)	Sand used (m^3)	Total aggregates used	Cost of aggregates(Rs1070/m^3)
BIS	0.882	0.349	1.231	1317
DOE	0.859	0.258	1.117	1195
USBR	0.741	0.458	1.199	1283
ACI	0.66	0.538	1.198	1282

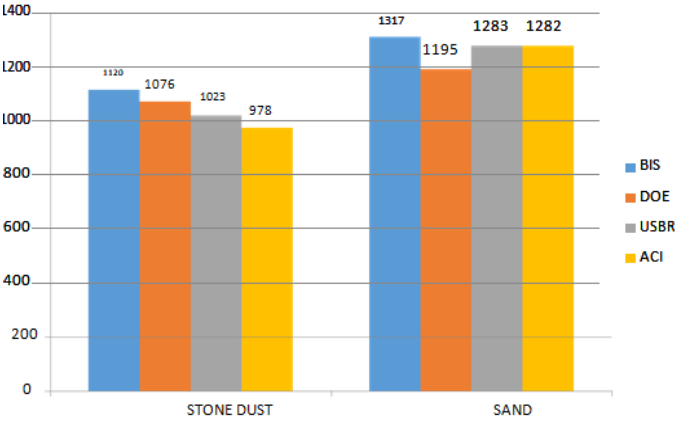

Chart 11: Cost analysis for M35 grades of concrete designed

5.4.4 OBSERVATIONS

In the wake of evaluating above tables and outlines, the accompanying things have been watched. The cement content was fixed for all the methods and price of aggregates is varying in each method. The rate of stone dust is Rs.535/- per cubic meter whereas the cost of sand and crushed coarse aggregate is Rs.1070/- per cubic meter. For M35 concrete, ACI method using stone dust proved to be most economic method, whereas BIS method with sand proved to be most expensive method.

6. CONCLUSION

The exploratory system comprised of laboratory test on concrete designed by ACI, USBR, BIS and BRITISH mix design method to portray and think about the properties, for example, compressive strength, flexure strength, split tensile strength, abrasion. For this reason cubes, beams and cylinders of M35 evaluations of concrete designed by ACI, USBR, BIS and BRITISH mix design methods were thrown and tried for the individual properties after a curing time of 7,28 and 56 days. For every stage curing an arrangement of three specimens of every sort was thrown. There were two arrangements of tests threw, one utilizing stone dust and another set involving sand , composed autonomously with ACI, USBR, BIS and BRITISH mix design methods for M35 grade. After evaluating the values of various strength parameters, loss due to abrasion, varying mix proportions and cost analysis , some conclusions discussed below were drawn for both M35 concrete designed by distinctive design methods like ACI, DOE, USBR , BIS further broadly differentiated with the type of aggregates i.e. sand and stone dust.

In comparison with sand and stone dust as fine aggregates, it was the concrete casted using stone dust that substantiated itself better in compressive, flexural, split tensile strength and economy. However, the abrasion misfortunes were more in stone dust when contrasted with sand. Various parameters are discussed in detail as follows:-

- In case of compressive strength, the target mean strength was achieved by all the samples of M35 grade of concrete using stone dust. For M35 grade concrete while using stone dust, maximum compressive strength was achieved by BIS method (i.e. 54.2 N/mm^2 for M35), whereas the least compressive strength was imparted by ACI method for M35.

- Considering for M35 grade, maximum compressive strength was accomplished by DOE and USBR with similar values (i.e. 48.8 N/mm2), though least strength was accomplished by BIS method (i.e. 43.3 N/mm^2). Therefore it was reasoned that stone dust gave preferable compressive strength over that of compressive strength given by sand.

- Taking into account the flexural strength attained using stone dust as fine aggregate after 28 days curing, same pattern of strength was observed for M35 grade of concrete i.e. BIS method (8.21 N/mm^2 for M35) was at peak followed by USBR method (8 N/mm^2 for M35), whereas the minimum flexural strength was attained by ACI method (5.49 N/mm^2 for M35).

- The flexural strength achieved by samples using sand was less as compared to the strength achieved by samples casted using stone dust. For M35 grade using sand, the maximum flexural strength at 28 days was achieved by DOE (.i.e.6.04 N/mm^2), whereas the minimum flexural strength was given by BIS (i.e. 4.8 N/mm^2).

- The split tensile strength of the cylinders casted with stone dust and sand offered a marginal difference. For cylinders of M35 grade casted using stone dust, the maximum Split tensile after 28 days was achieved by BIS method (i.e. 3.66 N/mm^2) whereas the minimum was achieved by DOE method (i.e. 2.86 N/mm^2).

- In contrast with the cylinders casted using sand, the M40 grade cylinders designed by BIS(i.e.5.41 N/mm^2) achieved maximum split tensile strength, whereas the minimum was achieved by ACI method (i.e. 2.99). In this regard cylinders with stone dust achieved a slight higher spilt tensile strength than that of cylinders casted using sand.

- The concrete mix designed using stone dust gave more abrasion losses than the concrete mix designed using sand. For M35 grade of concrete maximum loss in thickness was observed in DOE method using stone dust and minimum loss in thickness was observed in USBR using sand.

- The analysis of proportions of aggregates was carried out for different mix design methods. In case of stone dust used as fine aggregate, minimum amount of coarse aggregate for M35 was used by ACI method and the maximum amount was used by DOE method .The maximum amount of stone dust and was used by ACI method and the minimum was used by DOE method for both M35. Whereas minimum amount of sand was used by DOE in M35, while the maximum amount of sand was used by ACI in both M35.

- Cost analysis of various design mixes was carried out taking into account the variation in aggregates as the cement content was fixed for every method. In terms of fine aggregates, stone dust was 50% cheaper than sand. So the same mix designs with same grades using stone dust proved to be economical as compared to sand to be used as fine aggregate. When stone dust was used the most economical method came out be ACI for both M35 concrete (Rs.883-Rs.978 per cubic meter of concrete), while the most expensive was BIS method (Rs.1120-Rs.1153). Whereas when Sand was used as fine aggregate the most economical was DOE method (Rs1195 per cubic meter of concrete).

- The overall conclusion of the study reveals that the concrete designed as per BIS method using stone dust achieved higher compressive flexural and split tensile strength for both the grades. As the BIS method is most expensive in comparison with other methods therefore DOE followed by USBR and then ACI should be favoured for economy, strength parameters and toughness.

5.3 FUTURE SCOPE

- In this study stone dust as a fine aggregate was used with crushed aggregate. In future , attempts can be made in using stone dust with rounded aggregate.

- The strengths achieved by present cement content gave a good rise in strengths, whereas it can be optimized to bring down the strength near to target strength for economy.

- The fine aggregate as stone dust can be used for higher compressive strengths more than 40 MPa.

ACKNOWLEDGEMENT

This study would not be complete, had it not been for a lot of assistance from a lot of sources. I take this as an opportunity to extend my gratitude to all of those who have contributed to the completion of this report in any manner large or small.
I am especially grateful to my guide **ER. SHASHNAK YADAV** whose remarkable enthusiasm and valuable words were instrumental in my perceiving things in a logical manner and formulating a direction for this study.

REFERENCES

[1] Amarjit Singh, Kamal Gautam, (University Of Hawaii At Manoa, USA; 30th Conference On OUR WORLD IN CONCRETE & STRUCTURES): 23 - 24 August 2005, Singapore On Comparison Of ISI And ACI Methods For Absolute Volume Concrete Mix Design

[2] **"Concrete Technology", Gambhir M.L. ,Tata Mcgraw Hill,fifth edition**-2013,

[3] **" Concrete mix proportioning as per IS 10262:2009 –** Comparison with IS 10262:1982 andACI 211.1**-91", M.C. Nataraja and Lelin Das**

[4] Code of practice for plain and reinforced concrete (fourth edition), IS 456:2000, Bureau of India Standard, New Delhi.

[5] Dr.Deepa A. Sinha(Indian Journal Of Applied Sciences) Studied The Compressive Strength Of Concrete Using Different Mix Design Methods. Volume : 4 | Issue : 7 | July 2014.

[6] H. S. Sureshchandra, G. Sarangapani, and B. G. Naresh Kumar ; "Experimental Investigation on the Effect of Replacement of Sand by Quarry Dust in Hollow Concrete.Block for Different Mix Proportions" ;International Journal of Environmental Science and Development, Vol. 5, No. 1, February 2014.

[7] Indian standard concrete mix proportioning - Guidelines (First revision) IS 10262:2009, Bureau of India Standard, New Delhi, India.

[8] **Nataraja, M.C, Lelin Das and N. Richard Sandeep "Comparison of Indian** Standard Draft **Method and ACI Method of Concrete Mix Proportioning",** Second national seminar onadvances in materials and structure, IIT, Chennai, India.

[9] R. Ilangovana, N. Mahendrana And K. Nagamanib (Vol. 3, No. 2, May 2014) Strength And Durability Properties Of Concrete Containing Quarry Rock Dust As Fine Aggregate.

[10] S. P. S. Rajput, M. S. Chauhan **(**International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (SSN 2250-2459, ISO 9001:2008 Certified Journal,), Suitability of Crushed Stone Dust as Fine Aggregate in Mortars. Volume 4, Issue 3, March 2014.

BIOGRAPHIES

[1]**Shahid Bin Bashir ,** Masters in Construction Technology and Management, Department of Civil Engineering, Desh Bhagat University, Punjab India.

[2]**Shashnak Yadav**
Assistant Professor in the Department of Civil Engineering, Desh Bhagat University, Punjab India.