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Effect of Aggregate Gradation on Performance of Concrete.

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Abstract: *Concrete is a versatile material, it has been used widely for the construction and for the rapid development of the country. We are very familiar about the physical and chemical properties of concrete i.e strength, durability and composition. and, with the various material used for making it with their physical and chemical properties. The properties of concrete easily get effected with the various factor that are workability, water cement ratio, exposure condition and types and size of aggregate and most importantly the gradation of aggregate. In concrete 70 to 80% of volume is occupied by the aggregate and the impact of aggregate are considered on the various characteristic along with the gradation.The aggregate gradation widely effects the properties of concrete such as compressive strength, durability, workability, shrinkage, density etc. The grading curves were studied in detail and its effect on performance of concrete were studied.*

I. Introduction

Aggregate are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect the economy. Earlier aggregates were consider as chemically inert material but now it has been recognised that some of the aggregates are chemically active and also that certain active bond at the interface of aggregates and paste. To know more about the concrete it is very essential that one should know more about the concrete, without the study of the aggregates depth and range the study of concrete is incomplete. The cement is the only factory made ingredient where as the sand and aggregates are the naturally occurring or may be artificially obtained, and thus the physical and chemical properties plays an important role in the strength or overall performance of concrete. The important properties which are needed to be study of aggregates of the best concrete are strength, durability, shape, water absorption, sieve analysis i.e. gradation of aggregates and durability and workability. The aggregate gradation plays an important role in the overall performance of concrete because the size of aggregates may varries in a concrete which will increase the volume of void in the concrete which will ultimately effects the performance of concrete. Gradation is also the one major factor which influence the overall performance of concrete due tothe presences of void content in the concrete oraggregate.Grade of concrete denotes its strength required for construction.Thestrength is measured with concrete cube or cylinders by civil engineers at construction site or at laboratory. Cube or cylinders are made during casting of structural member and after hardening it is cured for 28 days. Then compressive strength test is conducted to find the strength. The cubes are being made as a sample of the concrete used in a construction site.The proper gradation and selection of aggregate result into an economy of concrete and increases the properties and strength of concrete. An optimized gradation based on aggregate availability and project requirements will result in an economical concrete with good workability and finish. The proportions between coarse and fine aggregates will change based on the unique characteristics of each aggregate

fig : Normal aggregate

fig : Sandstone aggregate

fig : Marble aggregate

II. Material And Method

Gradation of aggregate is the process where the aggregate are distributed according to the shape and size so as to achieve.Making a concrete usinggraged aggregates based on studying their different properties and their gradation on basic of performing the different test, and on the basic of gradation of different type of aggregate by deciding their proportion based on gradation according to the mix design ratio, thus selecting the percentage of gradation of aggregates and adding all the ingredient according to the Indian standard of mixing the concrete and making mould.Aggregates influence, to a great extent, the load transfer capability of pavements. Hence it is essential that they should be thoroughly tested before using for construction. Not only that aggregates should be strong and durable, they should also possess proper shape and size By these studies we can easily assure the best type of aggregate and its gradation for any type of concrete work based on high strength requirement and economy of project.Aggregatesare tested for strength, toughness, hardness, shape, and water absorption. In this particular study we had deal with the three type of aggregate that are normal aggregate, marble aggregate and sand stone aggregate as shown above. All the three aggregate are first studied for the properties and then they are graded by passing through IS sieve of retained and passed by 20mm seive.

Properties Of Material

Point of comparison	Aggregate	Marble aggregate	Sand stone aggregate
Specific gravity	2.5-3	2.4-2.7	2.2-2.8
Water absorption	o.6/unit by weight	<0.1%	Not more than 1%
Texture	Rough, smooth	Non foliated	Medium grained
Hardness	3 on mohs scale	3-5 on mohs scale	6-7 on mohs scale
Porosity	Impermeable	Porous	impermeable
Compressive strength	25-97mpa	12.45mpa-131mpa	365-460 kg/m^2
Colour	Black ,grey, whitish yellow	Bluish , green, yellow, black, white	Red, pink, green, yellow, grey, white
Occurrence	Natural rock bed	Metamorphic rock	Sedimentary rock
Density	1520-1620kg/m^3	2.6-2.8 kg/m^3	2.0-2.6 gm/cm^3

Table: Properties of material

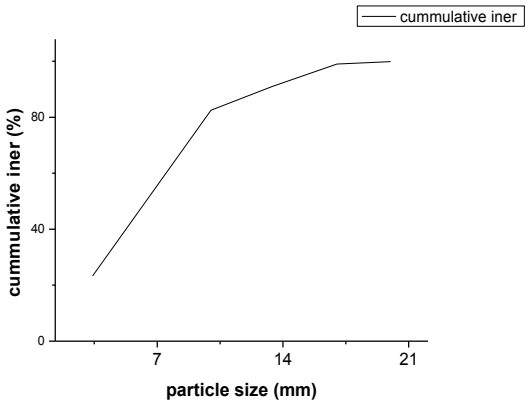
Properties Of Cement

Initial setting time	30-45 minutes
Final setting time	10-12 hours
Specific gravity	3.15
Colour	Greenish grey

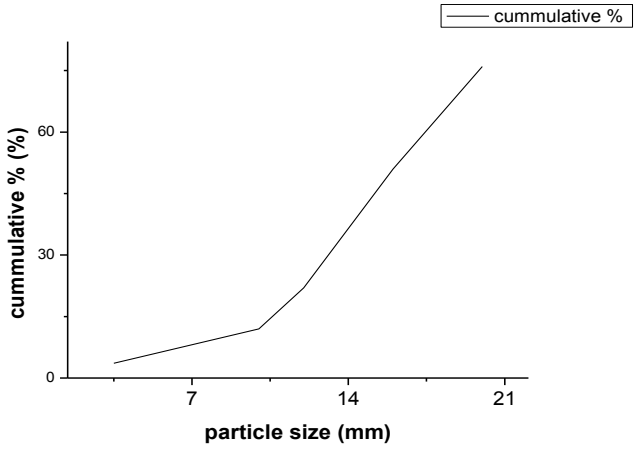
After the study of aggregate gradation the very next step is the mix proportion of the material. The mix design ratio for the particular study is selected from the excel sheet developed by us as per IS 10262 – 2009, the mix ratio of 1:1.9:2.3 is used throughout the study and was kept constant.The water cement ratio in this study was kept constant as 0.45 and was used throughout the study. The cement to sand ratio was also kept as constant. The aggregate was taken as 820.22kg, whereas the quantity as cement was taken throughout the study was 438.13kg.The process of aggregate gradation has a large impact on the overall performance of aggregates

due to the size and shape of aggregates. The aggregates size and shape are responsible for the void content in the concrete, as earlier discuss the various impact and effect of aggregates size and shape on the overall performance of concrete.

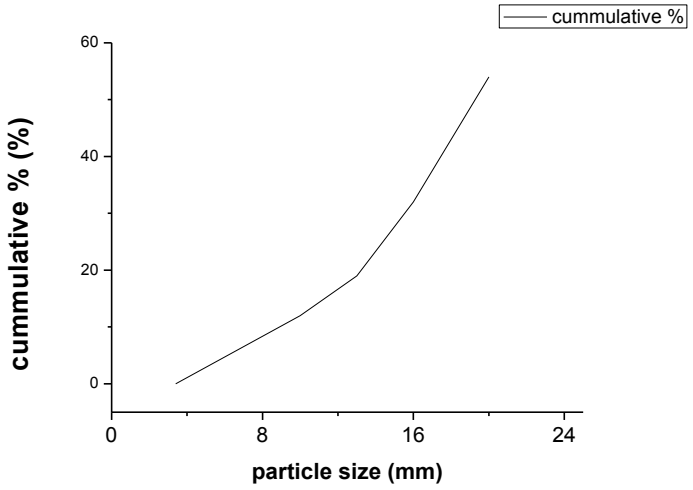
Sr.no	Name of aggregate	Gradation name	Size of aggregate with the %of finer /gradation				
			4.75 Mm	10 mm	12.5 Mm	16 mm	20 Mm
1	Stone aggregates	A11	-	40%	-	60%	-
		A12	-	60%	-	40%	-
		A13	-	50%	-	50%	-
2		A21	-	40%	-	60%	-
		A22	-	60%5	-	40%5	-
		A23	-	0%	-	0%	-
3		A31	-	40%	-	60%	-
		A32	-	60%5	-	40%5	-
		A33	-	0%	-	0%	-
4	Sand stone aggregate	S11	-	40%	-	60%	-
		S12	-	60%5	-	40%5	-
		S13	-	0%	-	0%	-
5		S21	-	40%	-	60%	-
		S22	-	60%5	-	40%5	-
		S23	-	0%	-	0%	-
6		S31	-	40%	-	60%	-
		S32	-	60%5	-	40%5	-
		S33	-	0%	-	0%	-
7	Marble aggregate	M11	40%	60%	-	-	-
		M12	60%5	40%5	-	-	-
		M13	0%	0%	-	-	-
8		M21	40%	60%	-	-	-
		M22	60%5	40%5	-	-	-
		M23	0%	0%	-	-	-
9		M31	40%	60%	-	-	-
		M32	60%5	0%50	-	-	-
		M33	0%	%	-	-	-



Graph1: Gradation of marble aggregate



Graph2: Gradation of sand stone aggregate



Graph3: Gradation of normal aggregate

The casting is the process where the cement slurry or liquid material mixture is poured into the mould which contains the hollow cavity of the desired shape and size then it is allowed to solidify or hardened is known as casting. In this study we had casted different cubes of size 150mmx150mm by using different material or by using different size and type of aggregate, sand and cement as described above. In the casting process the very first step is of aggregate gradation of all the three types of aggregate that are stone, marble, sand stone aggregate.

The casting process of cube requires the various precaution and care so as to obtain the optimum result. The very first precaution to be taken is during the mixing of all the ingredient together to get a homogenous mixture or paste. While mixing it should remember the water is required to add gradually in the mix. After the mixing, the mixture should be placed in the mould with in the or before the initial setting time, and the cube moulded properly to as to manage the time for placing and should be oiled before. During placing the mixture in the mould, it should be tamped using iron rod after each layer so as to reduce the void present there, and to compact the mixture. After all this process the mould is kept for hardening for 24hrs and then is removed from cube and is left for curing under water and then the compressive strength test is done on 7 days or 21 days. The below table shoe the various detail of material and their percentage used in the casting process.

Conventional Casting

The conventional cubeswere casted so as to check whether the ratio decided or selected from the mix design is good or not or is desired to give the optimum test result. The following tables shows the 7days strength of the cube of different aggregates.

Sr no.	Material	Gradation name	Compressive in days	Avg. weight (kg)	Avg. density (kg/m2)	Avg. compressive strength (Nmm2)
1	Normal aggregate	A1 A2 A3	7days	8.03 8.25 8.14	2379.25 2444.44 2411.85	25.17
2	Sand aggregate	S1 S2 S3	7days	8.11 7.97 8.05	2402.96 2361.48 2385.18	27.12
3	Marble aggregate	M1 M2 M3	7 days	7.05 7.79 7.22	2222.22 2308.14 2139.25	23.08

Testing Of Specimen

The analysis of cube is done for the compressive strength of cube for the 7 days strength in N/mm^2. The test is performed in the laboratory under the lab assistant in the compression testing machine. During the test all the cube are placed in the machine to check the strength of the cube by applying the maximum load to the cube to check the strength of the concrete cube. The compressive test is calculated by the formula as load applied to the total area of the cube.

Compressive strength $= \frac{\text{Total load applied}}{\text{Total area of the cube}} \text{x}100$

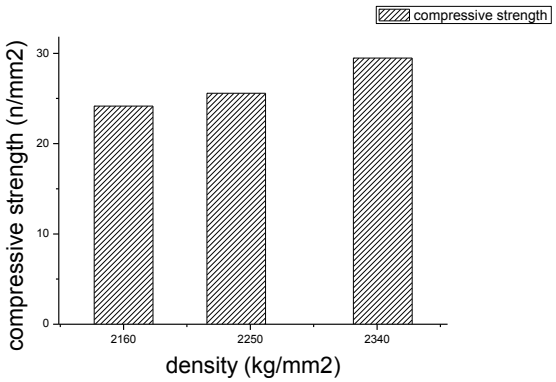
Unit = N/mm^2

The following table shows the various test result obtained for the different cube.

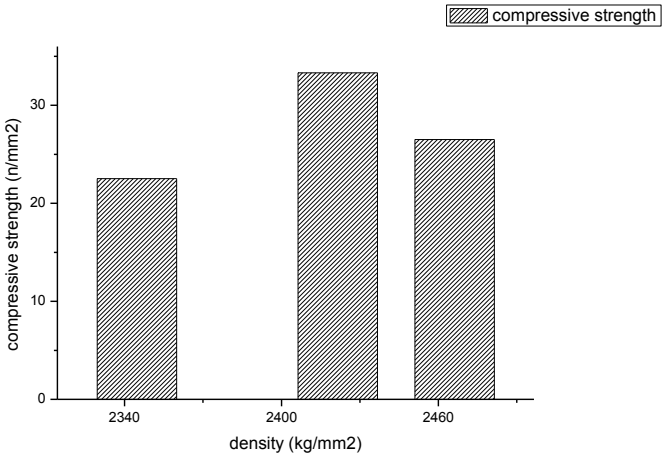
Sr. no	Material	Gradation name	Compressive strength (days)	Avg. density (kg/mm2)	Avg.weight(kg)	Avg. compressive strength (Mpa)
1	Normal aggregate	A11 A21 A31	7	2239.97	7.56	25.58
		A12 A22 A32	7	2159.99	7.29	24.15
		A13 A23 A33	7	2232.09	7.53	29.48
2		S11 S21 S31	7	2344.69	7.91	22.53

	Stand stone Aggregate	S12 S22 S32	7	2421.47	8,32	33.33
		S13 S23 S33	7	2466.17	8.15	26.51
3	**Marbal aggregate**	**M11** **M21** **M31**	**7**	**2144.19**	**7.24**	**22.66**
		M12 **M22** **M32**	**7**	**2155.05**	**7.28**	**30.22**
		M13 **M23** **M33**	**7**	**2241.86**	**8.09**	**25.92**

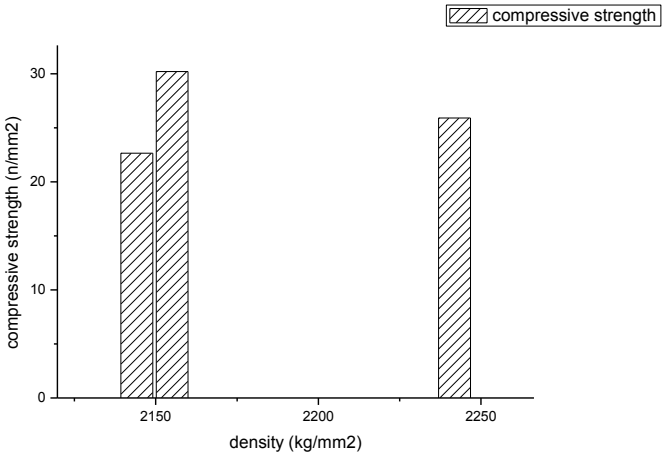
Table: Test result of cube



Graph4: density vs compressive strength of normal aggregate



Graph5 :density vs compressive strength of sand stone aggregate



Graph6: density vs compressive strength of marble aggregate

III. Conclusion

After doing an academic work of project report on **effects of aggregate gradation and types on performance of concrete** we concluded the following results: -

1) From the above result we concluded that the marble, sand stone aggregate and normal aggregate, sand stone aggregate had given the highest strength in comparison to both of them.

2) The highest value of compressive strength obtains by using sandstone aggregate is 33.33 N/mm^2.

3) The sandstone gradation of 60-40% gave the highest compressive strength.

5) From all the aggregate gradation the sand stone aggregate gradation gave the highest strength.

6) The result obtain is as we have expected at the initial stage of study.

7) The graph obtain by the gradation of aggregate is slightly S or S Curve.

8) The cost of sandstone is slightly uneconomical to use in every structure therefore it should be used at a big level project or where the structure is required of high strength.

9) The result obtained in this study satisfied the mix design of the initial stage.

10) Keeping w/c ratio, cement content and sand content constant as 0.45, 438.13 and 820.22 respectively we have achieved the highest strength of aggregates.

11) The study of aggregate gradation were done successfully.

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