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Ref. No. YBP/2021-22/230 Date: 27-10-2021

To,
Prof. Eknath P. Salokhe
Associate Professor
Department of Civil Engineering,
Sanjeevan Engineering & Technology,
Institute, Panhala

Sub: **Thank you note & Appreciation** for your Webinar on **"Concrete Mix Design"** at our Institute on 21-10 2021.

Respected Sir,

It's a pleasure for us that you delivered webinar for our diploma students and Faculties of Civil Group on 21th October 2021.

Webinar was interesting and informative. Your valuable session will not only motivate our students in academic career but also in real life and corporate life. You started with some basic and technical features of the Dams with practical examples. You further elaborated the session by explaining the classification of dams, their working and significance of Spillways in Water Resource Engineering.

We would like to thank you for conducting such an outstanding session We would be delighted to have you again as guest speaker on another occasion.

We once again thank you for your valuable time and consideration.

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AICTE Training and Learning (ATAL) Academy

Certificate

This is certified that **EKNATH PANDURANG SALOKHE**, **Associate Professor** of **SANJEEVAN ENGINEERING AND TECHNOLOGY INSTITUTE, PANHALA** participated & completed successfully AICTE Training And Learning (ATAL) Academy **Online Elementary** FDP on "**Strategic Civil Infrastructure**" from **25/10/2021** to **29/10/2021** at **KOLHAPUR INSTITUTE OF TECHNOLOGY's COLLEGE OF ENGINEERING(AUTONOMOUS)KOLHAPUR**.

Advisor-I, ATAL Academy
Mamta Rani Agarwal

Coordinator

D Y PATIL COLLEGE & ENGINEERING & TECHNOLOGY (AN AUTONOMOUS INSTITUTE) KASABA BAWADA, KOLHAPUR

Ref No: DYPCET / EXAM /308 **Date: 16/08/2023**

CONFIDENTIAL

To,
Mr. Eknath Salokhe ,
Sanjivani COE Panhala,
Kolhapur.

Subject: Appointment as Examiner / Moderator/ Re-valuator T. Y. B. Tech/ B. Arch (SEM-V) May – 2023

It gives me great pleasure to appoint you as **Examiner / Moderator/ Re-valuator for end semester examination T. Y. B. Tech/ B. Arch / MTech (SEM-V) May - 2023.** You are requested to confirm the same.

Name of programme & Sem.	Name of course	Course code
T. Y. B. Tech	Irrigation Engineering –I	201CEL304

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on

" INTRODUCTION TO NBA "

Certificate of Participation

This is certify that Prof. Ekanath P. Salokhe

form S.E.T.I. Panhala

has participated in one day Faculty Development Programme on "Introduction to NBA" organized by IQAC Sanjeevan Engineering & Technology Institute, Panhala under lead college activity on 15/03/2022.

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Date - 17th February, 2022.

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Prof. K. B. Narke
Co-ordinator

Prof. A. S. Shelake
Principal

Flexural Strengthening of Light Weight Reinforced Concrete Beams by Using Glass Fiber Reinforced Polymer

AKSHAY MAHADEV SHINDE[1], MUSKAN SHAKIL DESAI[2], ABHIJIT SARJERAO DAKAVE[3], PROF. A. C. THOKE[4]

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Abstract- The use of Lightweight concretes has gained acceptance and popularity worldwide in the recent years in the construction and development of both the infrastructure and residential buildings. Light weight aggregate concrete has become more popular in recent advancements owing to the tremendous advantages it offers over the conventional concrete but at the same time light in weight and strong enough to be used for structural purposes. Replacement of natural aggregate with concrete such as light weight concrete by using sintered fly ash aggregate (natural aggregate), The main disadvantage of conventional concrete it is high self -weight. This heavy self-weight will make it to some extent an uneconomical structural material. Light weight concrete having low density facilitates reduction of dead load and to increase thermal insulation.

I. INTRODUCTION

- DATA ANALYSIS (MATERIAL USED)

A. Cement

Ordinary Portland Cement Birla Shakti (M43 Grade) confirming to IS 269-1976 was used throughout the investigation. Different test was performed on the cement to ensure that it confirms to the requirement of the IS specification. The physical properties of the cement were determined as per IS 4031-1968 and are presented in the following table 1.

TABLE 1
Physical analysis of Birla Shakti (M43 Grade) Cement

Sr. No	Properties	Value	Requirements of IS:8112 1989
1	Specific Gravity	3.15	-
2	Standard Consistency	31%	-
3	Initial Setting Time	104 min	Min 30 min
4	Final Setting Time	205 min	Max 600 min
5	Soundness	3.5	Less than 10%
6	Fineness	5.5	Less than 10%
7	Compressive strength (N/mm^2)		
	3 Days	28.35	Not less than 22 N/mm^2
	7 Days	35.48	Not less than 33 N/mm^2
	28 Days	52.68	Not less than 43 N/mm^2

B. Sand

TABLE 2
Properties of Fine Aggregate

Sr. No.	Properties	Value
1	Specific Gravity	2.72
2	Fineness modulus	3.342
3	Silt content	4%
4	Water absorption (after 24hr)	2.6%

C. Sintered Fly Ash Aggregate

TABLE 3
Properties of sintered fly ash Aggregate

Sr. No.	Properties	Value
1	Specific Gravity	1.50
2	Fineness modulus	6.24
3	Water Absorption (after 24hr)	14.20%

D. Admixtures

Admixture Used for Project: - Algisuperplast N

E. Water:

Water is an important ingredient to make concrete. The purpose of adding water to concrete is, to distribute the cement evenly, react with cement chemically to produce calcium silicate hydrate gel and provide workable one. Small amount of water is needed to hydrate cement. Additional water is required to lubricate the mix. Excess water leads to bleeding stage ultimately creation of pores. Quantity of water is controlled by the w/c ratio. The water used must be free from oil, acid and alkali, salts and organic material. It should be potable.

II. M20 GRADE CONCRETE MIX DESIGN

M20 Grade Concrete mix design was done by using trial and error method with 100% Replacement of Natural Aggregate by Sintered Fly Ash Aggregate)

TABLE 4
FINAL MIX PROPORTION USING 100% REPLACEMENT OF NATURAL AGGREGATE BY SINTERED FLY ASH AGGREGATE

Cement	Sand	Sintered Fly Ash Aggregate	Water	Chemical
365	868.727	584.865	175.20	1% of Cement by Weight
1	2.377	1.602	0.48	

TABLE 5
QUANTITY OF INGREDIENT NEEDED FOR CASTING

Items	For 1 Cube	For 1 Beam	For 1 Cylinder
Cement (Kg)	1.232	1.825	0.573
Sand (Kg)	2.929	4.339	1.362
Coarse Aggregate (Kg)	0.000	0.000	0.000
Sintered Fly Ash Aggregate (kg)	1.974	2.924	0.918
Water (Kg)	0.591	0.876	0.275
Chemical (gm.)	12.32	18.250	5.730

III. STRENGTHENING OF BEAMS

Before bonding the composite fabric on to the concrete surface, the required region of concrete surface was made rough using a coarse sand paper texture and cleaned with an air blower to remove all dirt and debris. Once the surface was prepared to the required standard, the polyester resin was mixed in accordance with manufacturer's instructions. Mixing was carried out in a plastic container (Accelerator Cobalt 3% (Intense blue liquid) and Hardener 1.5%) and continued until the mixture in uniform colour. When this was completed and the fabrics had been cut to size, the resin mixture was applied to the concrete surface. The composite fabric was then placed on top of polyester resin coating and the resin was squeezed through the roving of the fabric with the roller. Air bubbles entrapped at the epoxy/concrete or epoxy/fabric interface were to be eliminated. Then the second layer of the resin was applied and GFRP sheet was then placed on top of resin coating and the resin was squeezed through the roving of the fabric with the roller and the above process was repeated. During hardening of the resin, a constant uniform pressure was applied on the composite fabric surface in order to extrude the excess resin and to ensure good contact between the resin, the concrete and the fabric. This operation was carried out at room temperature. Concrete beams strengthened with glass fiber fabric were cured for 24 hours at room temperature before testing.

The experimental work consists of casting of four sets of reinforced concrete (RC) beams having grade M20, cross-sectional dimensions of 100mm x 200mm and 1100mm length. We provided 2-10mm Ø bottom reinforcement and 2-10mm Ø top with 6mm Ø vertical stirrups @ 300 mm c/c. The strengthening of the beams using GFRP sheet is done on bottom side wrap with three different length configurations namely Central 1/3 length of Testing (300 mm Length), Central 2/3 length of Testing (600 mm Length) & Full length of Testing (900 mm Length).

The experimental study consists of casting of four sets of reinforced concrete (RC) beams of grade M20, with 100% Replacement of Natural Aggregate with Sintered Fly Ash Aggregate. Total 12 no. of RC beam are cast and curing for 28 days.

1. First set of (3 no.) Light Weight RC beams designated as control beams (SET I).
2. Second set of (3 no.) Light Weight RC beams (SET II); all are strengthened using single GFRP mat wrap, (for Central 1/3 length of Testing [300 mm]).
3. Third set of (3 no.) Light Weight RC beams (SET III); all are strengthened using single GFRP mat wrap, (for Central 2/3 length of Testing [600 mm]).
4. Fourth set of (3 no.) Light Weight RC beams (SET III); all are strengthened using single GFRP mat wrap, (for Full length of Testing [900 mm]).

IV. TESTING SETUP

All the specimens are tested in Universal testing machine (UTM). The testing procedures for the all specimens are same. After the curing period of 28 days is over, control beams (SET I) are washed and its surface is cleaned for clear visibility of cracks. Where other set of Light Weight RC beams (SET II, SET III, SET IV) are strengthened by GFRP sheets. The load arrangements for testing of all sets of beam is consist of two-point loading as shown in Figure 1A and 1B.,

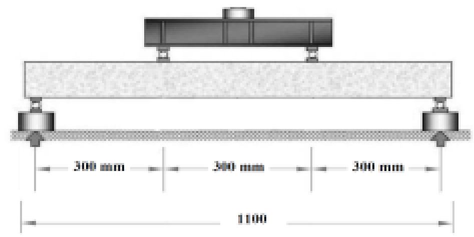


Figure 1 B: Experimental setup for testing of beams

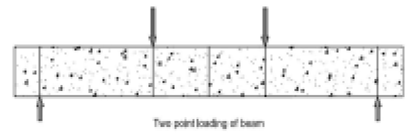


Figure 1 B: Experimental setup for testing of beams

A. Testing procedure

All the specimens were tested in the loading frame .The testing procedure for the entire specimen was same. After the curing period of 28 days was over, the beam as washed and its surface was cleaned for clear visibility of cracks. The most commonly used load arrangement for testing of beams will consist of two-point loading. This has the advantage of a substantial region of nearly uniform moment coupled with very small shears, enabling the bending capacity of the central portion to be assessed.

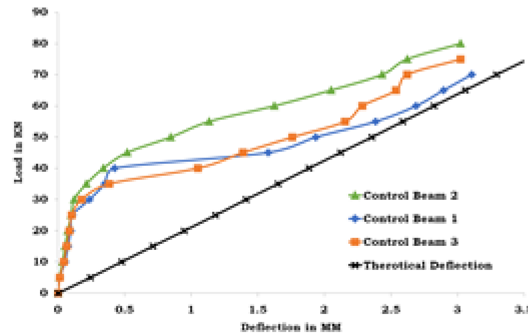
V. RESULTS ANALYSIS WITH RESPECT TO DEFLECTION

A. Introduction

This chapter describes the experimental results of all SETS beam (SET I, SET II, SET III, SET IV). Their behavior throughout the static test to failure is described using recorded data on deflection behavior, and the ultimate load carrying capacity. The mid-span deflection of each beam was compared with that of their respective control beams(as a practical deflection) and actual theoretical deflection . Also the load-deflection behavior was compared between three wrapping schemes having the same reinforcement (Central 1/3 length of Testing, Central 2/3 length of Testing and Full length of Testing). The mid-span deflections were much lower when bonded externally with GFRP sheets.

B. Load Deflection History

The two point static loading is applied on the beams and at the each increment of the load (1KN/sec). Deflections at the middle in beams are noted down and load Vs deflection curve of all the sets of beams is plotted. The Load- deflection of each strengthened beam is compared with that of their respective control beams (as a practical deflection) and actual theoretical deflection.



Graph 1 Load vs Deflection Results of control RC beams (SET I)

C. Load vs Deflection Results of Light Weight RC beams designated as control RC beams (SET I)

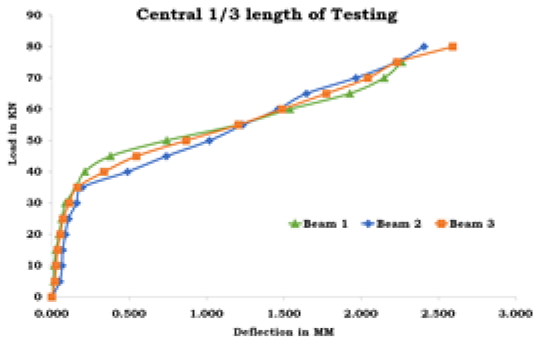
TABLE 6
LOAD VS DEFLECTION RESULTS OF CONTROL RC BEAMS (SET I)

Load In KN	Deflection in MM			
	Theoretical	Control Beam 1	Control Beam 2	Control Beam 3
0	0	0	0	0
5	0.243	0.014	0.0124	0.0132
10	0.478	0.053	0.035	0.044
15	0.712	0.076	0.053	0.0645
20	0.947	0.096	0.0721	0.08405
25	1.182	0.108	0.0984	0.1032
30	1.412	0.235	0.12	0.1775
35	1.651	0.351	0.212	0.383
40	1.885	0.425	0.341	1.049
45	2.12	1.578	0.52	1.39
50	2.355	1.935	0.845	1.76
55	2.589	2.385	1.135	2.1555
60	2.824	2.687	1.624	2.284
65	3.058	2.894	2.05	2.538
70	3.293	3.105	2.432	2.621
75	3.527		2.621	3.021
80	3.762		3.021	

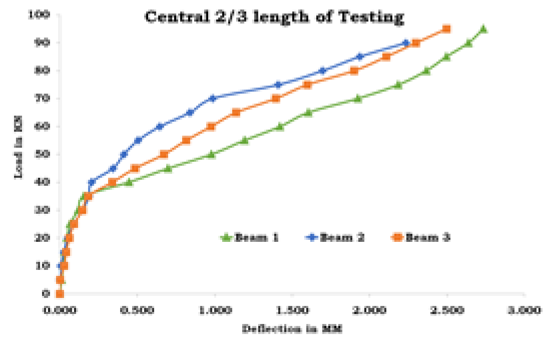
D. Load vs Deflection Results of Light Weight RC beams (SET II); all are strengthened using single GFRP wrap for Central 1/3 length of Testing (Length = 300mm).

TABLE 7
LOAD VS DEFLECTION RESULTS OF LIGHT WEIGHT RC BEAMS (SET II) (GFRP WRAP LENGTH = 300MM)

Load In KN	GFRP Wrap for Central 1/3 length of Testing		
	Beam 1	Beam 2	Beam 3
0	0.000	0.000	0.000
5	0.012	0.051	0.019
10	0.014	0.065	0.027
15	0.027	0.070	0.036
20	0.046	0.087	0.054
25	0.064	0.107	0.073
30	0.089	0.160	0.112
35	0.157	0.196	0.164
40	0.213	0.488	0.338
45	0.379	0.740	0.547
50	0.742	1.019	0.868
55	1.201	1.235	1.205
60	1.539	1.462	1.488
65	1.926	1.646	1.773
70	2.148	1.965	2.044
75	2.264	2.226	2.233
80		2.407	2.591



Graph 2 Load vs Deflection Results of Light Weight RC beams (SET II)(GFRP Wrap for Central 1/3 length of Testing, i.e.Wrap Length = 300mm)



Graph 3 Load vs Deflection Results of RC beams (SET II) (GFRP Wrap for Central 2/3 length of Testing, i.e.Wrap Length = 600mm)

E. Load vs Deflection Results of Light Weight RC beams (SET III); all are strengthened using single GFRP wrap for Central 2/3 length of Testing (Length = 600mm).

TABLE 8
Load vs Deflection Results of Light Weight RC beams (SET III)(GFRP Wrap Length = 600mm)

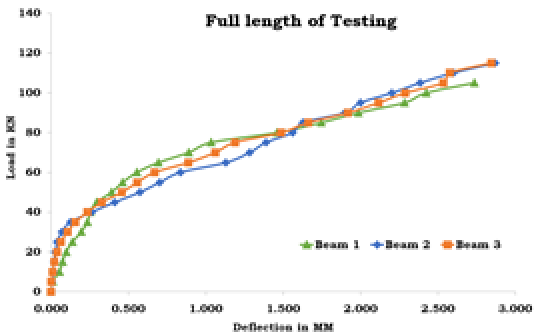
Load In KN	GFRP Wrap for Central 1/3 length of Testing		
	Beam 1	Beam 2	Beam 3
0	0.000	0.000	0.000
5	0.010	0.000	0.001
10	0.024	0.006	0.028
15	0.029	0.027	0.040
20	0.046	0.050	0.060
25	0.066	0.090	0.090
30	0.118	0.147	0.145
35	0.155	0.187	0.183
40	0.447	0.206	0.339
45	0.698	0.343	0.484
50	0.978	0.414	0.673
55	1.194	0.506	0.816
60	1.421	0.646	0.976
65	1.605	0.840	1.138
70	1.924	0.987	1.394
75	2.185	1.411	1.598
80	2.366	1.698	1.901
85	2.496	1.937	2.109
90	2.638	2.236	2.300
95	2.735		2.498

F. Load vs Deflection Results of Light Weight RC beams (SET IV); all are strengthened using single GFRP wrap for Full length of Testing (Length = 900mm).

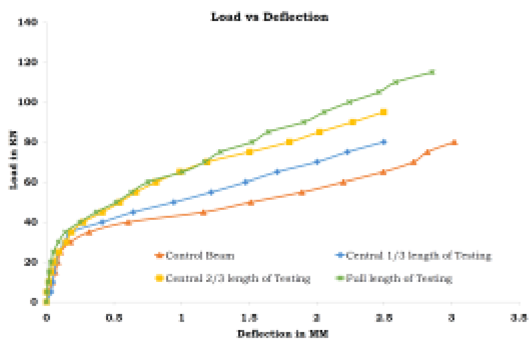
TABLE 9
LOAD VS DEFLECTION RESULTS OF LIGHT WEIGHT RC BEAMS (SET IV) (GFRP WRAP LENGTH = 900MM)

Load In KN	GFRP Wrap for Central 1/3 length of Testing		
	Beam 1	Beam 2	Beam 3
0	0.000	0.000	0.000
5	0.010	0.006	0.001
10	0.055	0.015	0.010
15	0.075	0.018	0.022
20	0.098	0.028	0.038
25	0.138	0.039	0.064
30	0.195	0.070	0.108
35	0.235	0.125	0.155
40	0.254	0.263	0.234
45	0.294	0.411	0.328
50	0.391	0.575	0.458
55	0.462	0.701	0.557
60	0.554	0.835	0.670
65	0.694	1.130	0.887
70	0.888	1.283	1.061
75	1.035	1.390	1.188
80	1.459	1.560	1.485
85	1.746	1.626	1.661
90	1.985	1.898	1.917
95	2.284	1.998	2.116

Load In KN	GFRP Wrap for Central 1/3 length of Testing		
	Beam 1	Beam 2	Beam 3
100	2.425	2.201	2.288
105	2.735	2.385	2.535
110		2.600	2.575
115		2.870	2.845



Graph 4 Load vs Deflection Results of Light Weight RC beams (SET II) (GFRP Wrap for full length of Testing, i.e.Wrap Length = 900mm)



Graph 5 Load vs Deflection Results of Light Weight RC beams (All SETS)

VI. DISCUSSION ON DEFLECTION

It is observed from Graph 8.15, Graph 8.19, Graph 8.23, that the deflection of beams (SET II, III and IV) when bonded with GFRP sheets with bottom side wrap is lesser than the control beams (SET I).

With reference to graph 5,

1. Maximum deflection of Control Beam (SET I) is 3.02 mm @ Load 80 KN
2. Maximum deflection of SET II is 2.499 mm @ Load 80 KN
3. Maximum deflection of SET III is 2.49 mm @ Load 95 KN
4. Maximum deflection of SET IV is 2.80 mm @ Load 115 KN

With reference to Tables and Graphs it is observed that for load of 80 KN the deflection of Light Weight Light Weight RC Beams designated as control Light Weight RC Beams (SET I) is 3.021 mm similarly for the same load the deflection of Light Weight RC Beams strengthened using single GFRP mat wrap for Central 1/3 length of Testing [300 mm] (SET II) is 2.4993 mm, Light Weight RC Beams strengthened using single GFRP mat wrap for Central 2/3 length of Testing [600 mm] (SET III) is 1.7991 mm and Light Weight RC Beams strengthened using single GFRP mat wrap for Full length of Testing [900 mm] (SET IV) is 1.5226 mm.

CONCLUSION

Successfully achieved reduction in deflection for Strengthening of Light Weight RC Beams with GFRP warp for Full length of Testing (i.e. 900mm length) by 40.44 %.

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FLEXURAL STRENGTHENING OF LIGHT WEIGHT REINFORCED CONCRETE BEAMS BY USING GLASS FIBER REINFORCED POLYMER

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Experimental Study on Structural Light Weight Concrete for Partial Replacement to Coarse Aggregate by Sintered Fly Ash Aggregate

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Abstract: *The use of Lightweight concretes has gained acceptance and popularity worldwide in the recent years in the construction and development of both the infrastructure and residential buildings. Light weight aggregate concrete has become more popular in recent advancements owing to the tremendous advantages it offers over the conventional concrete but at the same time light in weight and strong enough to be used for structural purposes. Replacement of natural aggregate with concrete such as light weight concrete by using sintered fly ash aggregate (natural aggregate), The main disadvantage of conventional concrete it is high self -weight. This heavy self-weight will make it to some extent an uneconomical structural material. Light weight concrete having low density facilitates reduction of dead load and to increase thermal insulation.*

Keywords: Structural Light Weight Concrete

I. Introduction

1.1 Review Stage Importance of Aggregate

Aggregate in concrete is structural filler, but its role is more important than what that simple statement implies. Aggregate occupies most of the volume of the concrete. It is the stuff that the cement paste coats and binds together.

The composition, shape, and size of the aggregate all have significant impact on the workability, durability, strength, weight, and shrinkage of the concrete. Aggregate can also influence the appearance of the cast surface, which is an especially important consideration in concrete countertop mixes. Aggregates contribute to overall strength of concrete. Aggregate is inexpensive and it does not enter into the complex chemical reactions with water. To get better results with concrete, it is necessary the gradation of aggregates. Good gradation of aggregates can increase the workability of concrete. Good gradation can also reduce the air voids. Economy is another reason for thoughtful aggregate selection. You can often save money by selecting the maximum allowable aggregate size.

Using larger coarse aggregate typically lowers the cost of a concrete mix by reducing cement requirements, the costliest ingredient. Less cement (within reasonable limits for durability) will mean less water if the water-cement (w/c) ratio is kept constant. A lower water content will reduce the potential for shrinkage and for cracking associated with restrained volume change

1.2 Problems of Natural Aggregates with Respect to Environment

The problem we face with natural aggregate is Silica alkali reaction due to reactive aggregates. In this the reactive aggregates in presence of moisture and alkaline medium produce an expansive gel which exerts bursting pressure on concrete and cracks the matrix of concrete. Nearly every community in nearly every industrialized or industrializing country is dependent on aggregate resources (sand, gravel, and stone) to build and maintain their infrastructure. Unfortunately, aggregate resources necessary to meet societal needs cannot be developed without causing environmental impacts.

The most obvious environmental impact of aggregate mining is the conversion of land use, most likely from undeveloped or agricultural land use, to a (temporary) hole in the ground. This major impact is accompanied by loss of habitat, noise, dust, blasting effects, erosion, sedimentation, and changes to the visual scene. Mining aggregate can lead to serious environmental impacts. Societal pressures can exacerbate the environmental impacts of aggregate development.

In areas of high population density, resource availability, combined with conflicting land use, severely limits areas where aggregate can be developed, which can force large numbers of aggregate operations to be concentrated into small areas. Doing so can compound impacts, thus transforming what might be an innocuous nuisance under other circumstances into severe consequences. In other areas, the rush to build or update infrastructure may encourage relaxed environmental or operational controls. Under looser controls, aggregate operators may fail to follow responsible operational practices, which can result in severe environmental consequences. The geologic characteristics of aggregate deposits (geomorphology, geometry, physical and chemical quality) play a major role in the intensity of environmental impacts generated as a result of mining.

1.3 Sintered Fly Ash Aggregate

Table 1: Properties of Sintered Fly Ash Aggregate

Product :	Sintered fly ash light weight aggregates.
Application:	As aggregate in concrete for lightweight construction works.
Features:	The fly ash nodules made with the help of water are fired at 1200 degree Celcius. The fine particles of fly ash melt at the surface and are welded together. The nodules crumble during the sintering process. Mixing 5, 10 & 20% plastic clay in fly ash produce good quality aggregate. The sintered fly ash aggregate concrete is spherical in shape, possessing 5-20 mm size and light grey color. Water absorption is 15-20% in uncrushed material and 40-50% in crushed material; bulk density: 640-750 kg/m3 , aggregate crushing strength: 5-8.5 t.
Economy:	50 tpd.
Equipment:	Sintering machine, ribbon mixer, conveyor, handling equipment.
Raw Materials:	Fly ash, plastic clay.

II. Concrete Mix Design

1. Cement : Birla Shakti Cement (M43 Grade)
2. Grade of concrete : M20
3. Target strength = fck + (1.65+S)
   = 20+ (1.65 x 4)
   = 26.60 N/MM^2
4. Specific Gravity
   a. Cement : 3.15
   b. Sand : 2.99
   c. Natural Aggregate : 3.12
   d. Sintered Fly Ash Aggregate : 2.02
5. Cement content : 335 kg/ m3
6. W/C ratio : 0.450
7. Cementitious material content : 335x 1.0 = 335 Kg/m^3
8. Water content : 335 x 0.450 = 150.75 Kg/m^3
9. Sand content[fa] : 892.595 Kg/m^3
10. Coarse aggregate[Ca] : 1274.81KG/M^3

Table 2: Final Mix Proportion using natural aggregate

Cement	Sand	Natural Aggregate	Water	Chemical
335	892.6	1273.063	150.75	0.8% of Cement by Weight
1	2.664	3.80	0.45	

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Table 3: Work done using Replacement of cement with Sintered Fly Ash Aggregate

Sr. No.	Design IDS	Natural Aggregate	Sintered Fly Ash Aggregate
1	A	100%	0%
2	B	90%	10%
3	C	80%	20%
4	D	70%	30%
5	E	60%	40%
6	F	50%	50%

Table 4: Material Required for Casting 6 Cubes of Each Replacement

Design ID	Cement (Kg)	Sand (Kg)	Coarse Agg. (Kg)	Sintered Fly Ash Agg. (Kg)	Water (Kg)
A	7.919	21.099	30.0923	-	4.088
B	7.4621	19.8824	25.5568	1.365	3.6079
C	7.4622	19.8822	22.7172	2.7304	0.0792
D	7.4620	19.8825	19.8772	4.096	3.8531
E	7.4620	19.8825	17.0379	5.7684	3.8531
F	7.4642	19.8884	14.1821	6.8284	3.3587

III. Result Analysis

3.1 With *Respect* to Density

A. 7 Days Cube Density Result using Sintered Fly Ash Aggregate

Table 5: 7 Days Cube Density Result using Sintered Fly Ash Aggregate

ID Mark	Weight of Cube Kg	Volume	Density	Average Density KN/m^3
A0	9.200	3441782.2	26.196	
A0	9.100	3430347.4	25.997	26.027
A0	8.960	3391675.7	25.889	
A10	8.680	3387344.0	25.112	
A10	8.660	3403145.0	24.938	24.920
A10	8.578	3402043.8	24.710	
A20	8.531	3397537.0	24.607	
A20	8.510	3415656.2	24.416	24.519
A20	8.610	3439481.5	24.532	
A30	8.210	3374736.0	23.841	
A30	8.167	3368250.0	23.762	23.735
A30	8.210	3408825.0	23.603	
A40	7.795	3287908.0	23.234	22.713

ID Mark	Weight of Cube Kg	Volume	Density	Average Density KN/m^3
A40	7.817	3407639.3	22.481	
A40	7.681	3356986.0	22.423	
A50	7.650	3415630.0	21.949	21.754
A50	7.680	3434753.4	21.912	
A50	7.518	3442722.0	21.401	

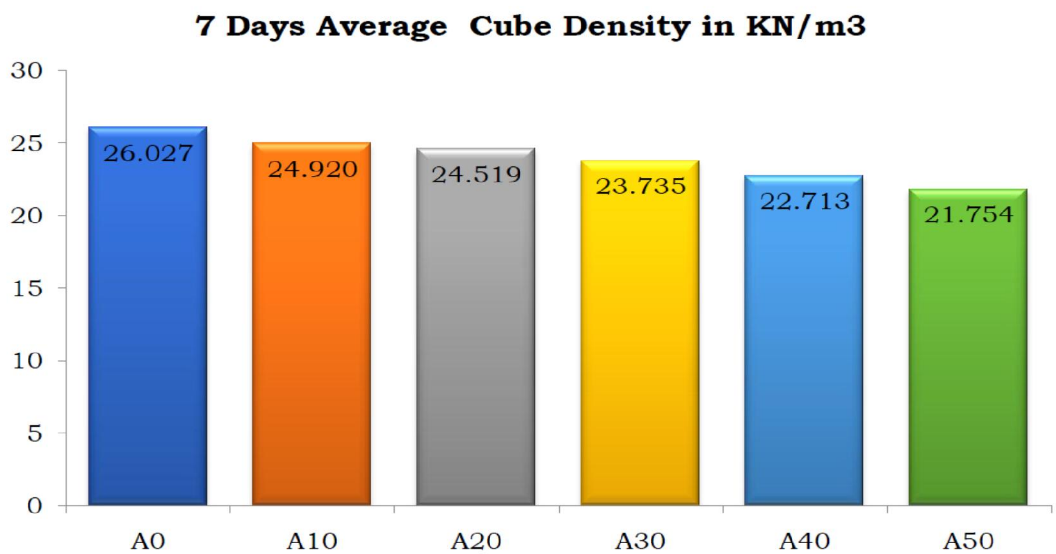

Figure 1: 7 Days Average Cube Density Result using Sintered Fly Ash Aggregate

B. 28 Days Cube Density Result using Sintered Fly Ash Aggregate

Table 6: 28 Days Cube Density Result using Sintered Fly Ash Aggregate

ID Mark	Weight of Cube Kg	Volume	Density	Average Density KN/m^3
A0	9.240	3456530.4	26.197	26.102
A0	9.205	3458827.1	26.081	
A0	9.120	3433832.1	26.028	
A10	8.750	3424583.3	25.040	25.110
A10	8.820	3447385.8	25.073	
A10	8.792	3416539.1	25.219	
A20	8.240	3413075.8	23.660	23.884
A20	8.350	3429101.7	23.863	
A20	8.315	3377199.0	24.129	
A30	8.105	3411029.6	23.286	23.214

ID Mark	Weight of Cube Kg	Volume	Density	Average Density KN/m³
A30	8.200	3466632.8	23.181	
A30	8.098	3424381.4	23.175	
A40	7.900	3372726.0	22.955	22.526
A40	7.865	3408453.4	22.613	
A40	7.762	3456277.6	22.009	
A50	7.650	3388323.7	22.126	21.796
A50	7.680	3441632.3	21.869	
A50	7.518	3443873.0	21.393	

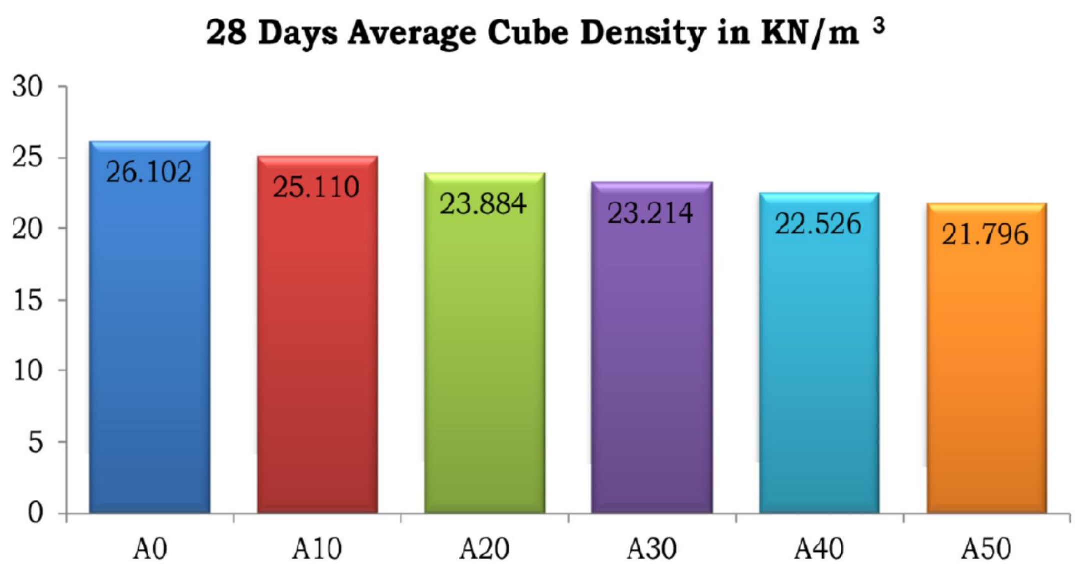

Figure 2: 28 Days Average Cube Density Result using Sintered Fly Ash Aggregate

C. 28 Days Beam Density Result using Sintered Fly Ash Aggregate

Table 7: 28 Days Beam Density Result using Sintered Fly Ash Aggregate

ID Mark	Weight of Beam Kg	Volume	Density	Average Density KN/m³
A0	13.310	5000000	26.088	26.447
A0	13.650	4970000	26.754	
A0	13.520	4980000	26.499	
A10	12.817	4955000	25.121	25.135
A10	12.805	5050000	25.098	
A10	12.850	5060000	25.186	
A20	12.168	5012500	23.849	23.823
A20	12.198	5028000	23.908	

ID Mark	Weight of Beam Kg	Volume	Density	Average Density KN/m³
A20	12.098	5032500	23.712	
A30	11.821	5005000	23.169	
A30	11.795	4990000	23.118	23.095
A30	11.733	4988000	22.997	
A40	11.528	4989000	22.595	
A40	11.586	4965000	22.709	22.646
A40	11.548	5012500	22.634	
A50	10.867	5035000	21.299	
A50	10.834	5050000	21.235	21.261
A50	10.842	5005000	21.25	

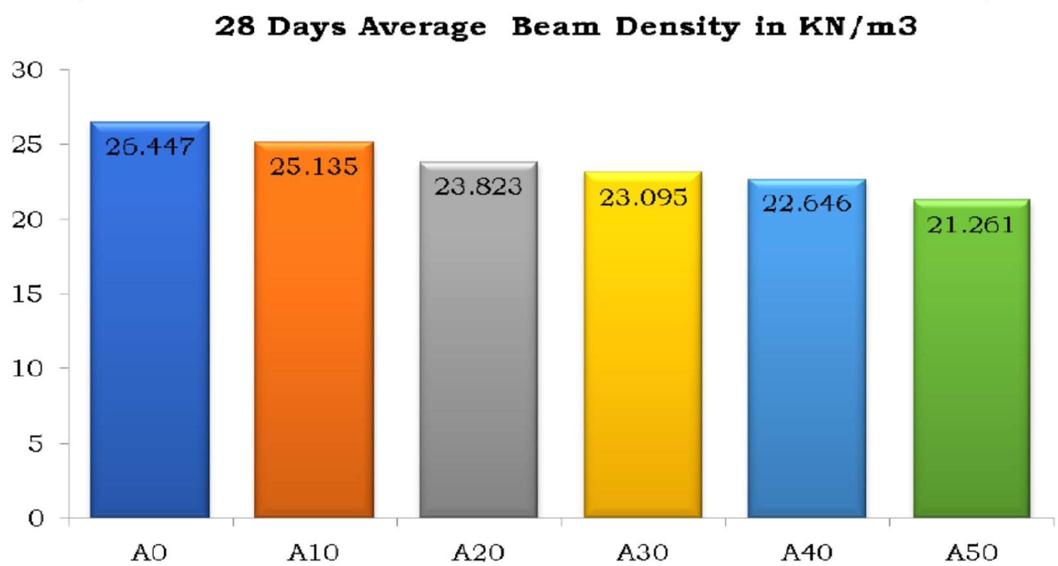

Fig 3. 28 Days Average Beam Density Result using Sintered Fly Ash Aggregate

D. 28 Days Cylinder Density Result using Sintered Fly Ash Aggregate

Table 8: 28 Days Cylinder Density Result using Sintered Fly Ash Aggregate

ID Mark	Weight of Cylinder Kg	Volume	Density	Average Density KN/m³
A0	4.205	1546457	26.224	
A0	4.197	1548016	26.174	26.147
A0	4.176	1550825	26.043	
A10	4.056	1566475	25.295	
A10	4.005	1543340	24.977	25.101
A10	4.014	1577792	25.033	
A20	3.864	1574645	24.097	23.885
A20	3.805	1547704	23.729	

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ID Mark	Weight of Cylinder Kg	Volume	Density	Average Density KN/m^3
A20	3.821	1558953	23.829	
A30	3.715	1563652	23.168	23.116
A30	3.700	1576607	23.075	
A30	3.705	1543340	23.106	
A40	3.658	1577792	22.813	22.628
A40	3.622	1574645	22.588	
A40	3.605	1547704	22.482	
A50	3.429	1560519	21.384	21.542
A50	3.438	1555199	21.441	
A50	3.496	1580929	21.802	

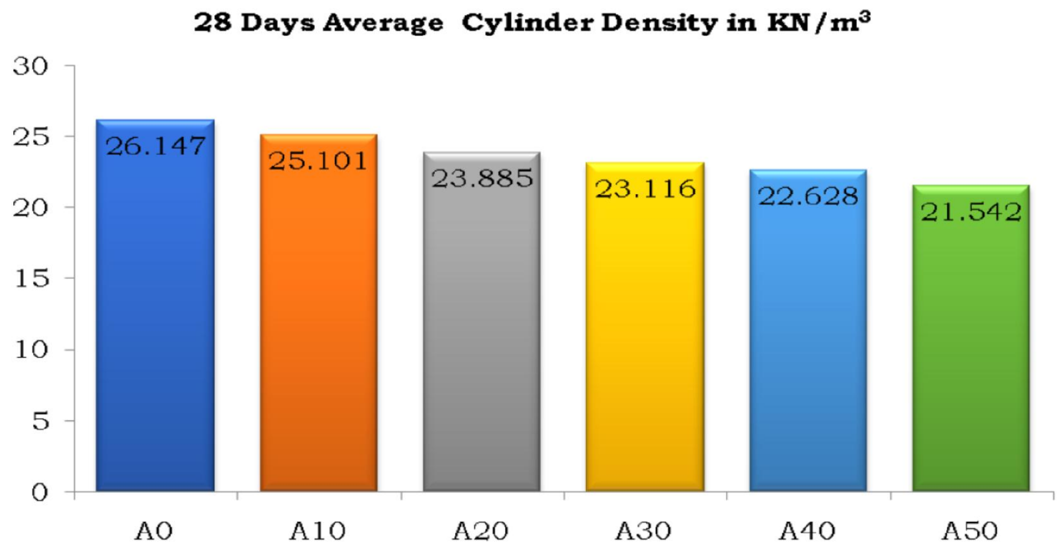

Figure 4: 28 Days Average Cylinder Density Result using Sintered Fly Ash Aggregate

3.2 With Respect to Strength

A. 28 Days Compressive Strength using Sintered Fly Ash Aggregate

TABLE 9: 28 Days Compressive Strength Result using Sintered Fly Ash Aggregate

Cube ID Mark	Compressive Strength in N/mm^2	Average Compressive Strength in N/mm^2
A0	37.445	36.677
A0	36.574	
A0	36.011	
A10	34.51	33.924
A10	33.871	
A10	33.389	
A20	32.544	32.257

Cube ID Mark	Compressive Strength in N/mm^2	Average Compressive Strength in N/mm^2
A20	31.89	
A20	32.337	
A30	30.7	
A30	29.796	30.247
A30	30.245	
A40	29.053	
A40	28.329	28.392
A40	27.794	
A50	24.609	
A50	25.296	25.181
A50	25.638	

B. 28 Days Flexural Strength using Sintered Fly Ash Aggregate

Table 10: 28 Days Flexural Strength Result using Sintered Fly Ash Aggregate

ID Mark	Flexural Strength in N/mm^2	Average Flexural Strength in N/mm^2
A0	4.4	
A0	4.4	4.467
A0	4.6	
A10	4.4	
A10	4.2	4.267
A10	4.2	
A20	3.6	
A20	3.8	3.667
A20	3.6	
A30	3.8	
A30	3.2	3.4
A30	3.2	
A40	3.4	
A40	3.2	3.267
A40	3.2	
A50	3	
A50	3	3.067
A50	3.2	

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C. 28 Days Split Tensile Strength using Sintered Fly Ash Aggregate

Table 11: 28 Days Flexural Strength Result using Sintered Fly Ash Aggregate

ID Mark	Split Tensile Strength in N/mm^2	Average Split Tensile Strength in N/mm^2
A0	6.682	
A0	6.491	6.576
A0	6.555	
A10	6.3	
A10	6.3	6.342
A10	6.427	
A20	5.855	
A20	5.918	5.855
A20	5.791	
A30	5.218	
A30	5.155	5.239
A30	5.345	
A40	4.836	
A40	4.964	4.858
A40	4.773	
A50	4.518	
A50	4.645	4.455
A50	4.2	

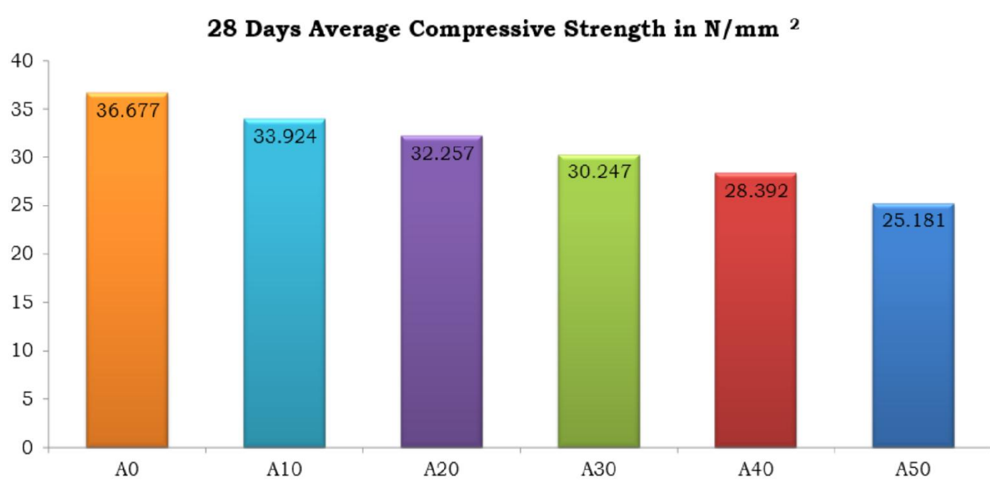

Figure 5:28 Days Average Compressive Strength Result using Sintered Fly Ash Aggregate

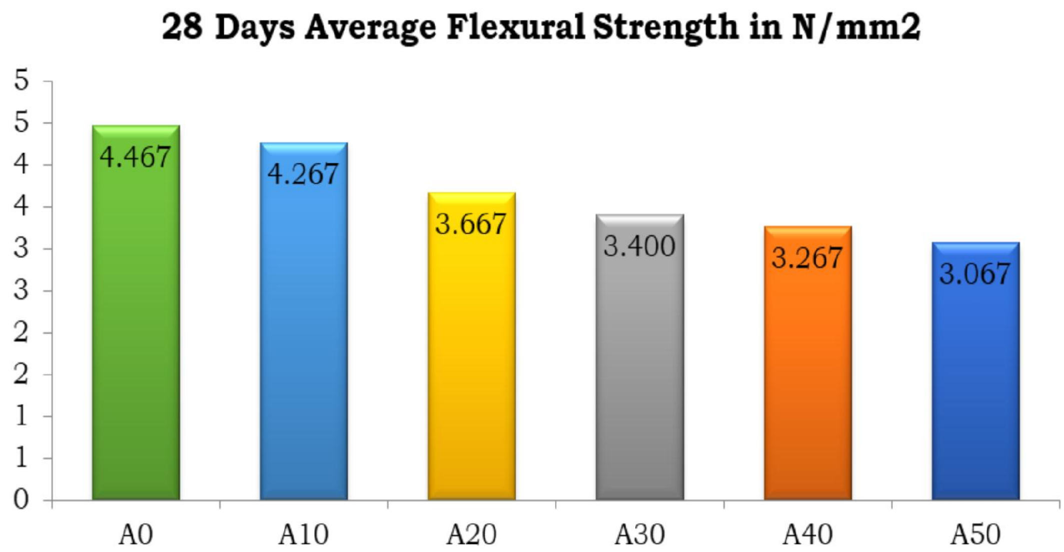

Figure 6: 28 Days Average Flexural Strength using Sintered Fly Ash Aggregate

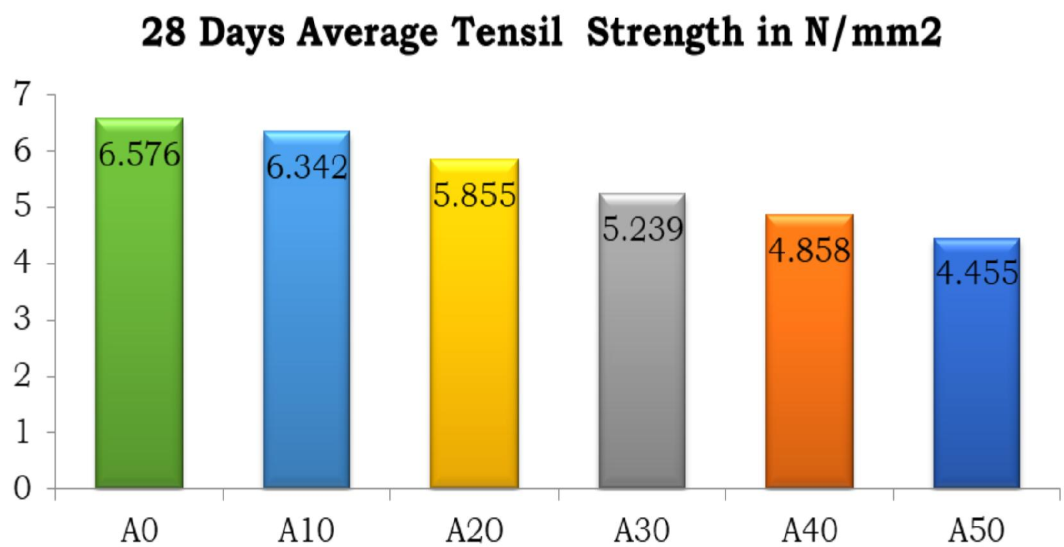

Figure 7: 28 Days Average Tensile Strength using Sintered Fly Ash Aggregate

IV. Conclusion

4.1 Density

For M20 grade of concrete design mix, it has been seen that density goes on decreasing with increase in the percentage of pumice. Density is maximum for conventional concrete. We achieved optimum density required for light weight concrete at 50% are 20.361 KN/m3 ,20.565 KN/m3 ,20.365 KN/m3 respectively. It has been observed that the density at 50% replacement is lowered by 16.12%, 15.29% &16.41% than conventional concrete in cube, beam and cylinder respectively.

Table 12: Density of concrete

Grade of concrete	**M20**
28 Days density of cube Conventional Concrete (N/mm^2) For concrete design mix	24.274

28 Days density of beam Conventional Concrete (N/mm^2) For concrete design mix	24.276
28 Days cylinder of Conventional Concrete (N/mm^2) For concrete design mix	24.365
28 Days density of Cube for 50% replacement sintered fly ash (N/mm^2)	20.361
28 Days density of beam for50% replacement sintered fly ash(N/mm^2)	20.565
28 Days density of cylinder for50% replacement sintered fly ash(N/mm^2)	20.365

4.2 Strength

For M20 grade of concrete design mix, it has been seen that compressive strength decreases with increase in pumice percentage. Compressive strength is maximum for 0 % i.e. for conventional concrete. We achieved optimum Compressive Strength for 50 % replacement of sintered fly ash . We achieved the optimum strength of respectively. It has been observed that the strength of concrete for 50% replacement is reduced by 40% (for cube), 27% (in beam) & 14.77% (in beam) respectively.

Table 13: Compressive, Flexural and Split Tensile Strength of concrete for 28 days

Grade of concrete	**M20**
28 Days Compressive Strength of Conventional Concrete (N/mm^2) For concrete design mix	32.24
28 Days Flexural Strength of Conventional Concrete (N/mm^2) For concrete design mix	3.933
28 Days split tensile Strength of Conventional Concrete (N/mm^2) For concrete design mix	5.748
28 Days Compressive Strength of Concrete of 50% replacement sintered fly ash(N/mm^2)	22.435
28 Days flexural Strength of Concrete of 50% replacement sintered fly ash(N/mm^2)	2.867
28 Days split tensile Strength of Concrete of 50% replacement sintered fly ash(N/mm^2)	3.352

Considering all above factors, it is interesting to say that we are slightly near to achieve lightweight concrete at 50 % replacement of natural aggregate by pumice stone in terms of density and strength. And further replacement of artificial aggregate can make difference in the results as per density and strength point of view to achieve light weight concrete.

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