

## **Behaviour of Concrete by Partial Replacement of Fine Aggregate with crusher sand and Cement by Glass Powder for M-25 Grades of Concrete**

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### **ABSTRACT**

The main objective of this research is to investigate the use of Glass Powder and other is crusher sand as partial replacement of cement and concrete production. In this research we analyze the strength of concrete made with using these waste materials one is Glass Powder and other is crusher sand. The Glass Powder is used as 20% replace by weight of cement and crusher sand as the partial replacement of Fine Aggregate from 0%, 10%, 20%, 30% and 40%. The grade of the concrete here is M-25 grade. It has been used as a replacement of fine aggregates in many literature works but this paper presents the feasibility of the substitution of glass powder for cement to achieve economy and environment saving. Slump Test was carried out for the fresh concrete whereas Compressive Strength, Flexure Strength and Split Tensile Tests were carried for the Hardened concrete. All tests are done at 7- day, 14 - day, and 28 days with 0 to 40% replacement of sand at an interval of 10%. Again above tests are carried out with 20% replacement of cement by glass powder. It is observed that the glass powder improve the strength and crusher sand can be used as sand. Experiment such as specific gravity test of crusher sand sand by pycnometer method, moisture content of sand and crusher sand by oven drying method, normal consistency of cement, and initial setting time of cement, were performed to determine the physical property of concrete. On fresh concrete slump test was preformed to check workability of concrete and after then compressive strength was checked. Thus crusher sand is appropriate substitute of fine aggregates in concrete mix for construction. This is great saving in costly material.

**Keywords:-** Glass Powder, crusher sand, Mix Design, Compressive Strength Test, Flexure Test, Split Tensile Test.

### **INTRODUCTION**

The concrete is useful materials in the construction industry. It is not only used in building construction but also in other areas like bridges, roads, harbors, dam, Railways and many more. It is comparatively economical, easy to make offers continuity solidity and indeed it lays the role of developing and improving or modern life. It is a composite material which is made up of sand, cement, aggregate and water. The fresh concrete can be mould into any desire shape. The life of the concrete is very high so it can be used as versatile material. In the concrete the cement is used as the binder material which has the binding tendency. Due to increase in activities for different regions and utilities scaring of the naturally available resources is being forced due to it's over exploitation. This is the threat to the environment. Also the use of conventional material becomes costly day by day. Hence conservation of the naturally available material is great challenge for the civil engineers. By using the alternative materials which reduced partially, there is only way to search materials which can fully or partially replaced naturally available material in the construction field. The various alternative materials are used as partial for fully replacement of conventional material e.g. Rice husk ash, fly-ash, sugarcane bagasses ash, coconut shell, crushed sand, recycled aggregate etc. Here we use the two waste materials which is easily available.

The crusher sand produced from stone crushing zones appears as a problem for effective disposal. Which is used here as partially replacement as fine aggregate. Also the glass powder produced from industries is also a waste material which can be used as partial replacement as cement. Sand is a material used in concrete as fine aggregate.

### LITERATURE REVIEW

Many works have been carry out to explore the benefits of using various waste materials such as granite dust, crusher sand, stone dust and glass powder in making and enhancing the properties of concrete. The following works have done by the authors as describe below-

Use of crusher sand as a fine aggregate in concrete draws serious attention of researchers and investigators. The maximum compressive and flexural strengths were observed for specimens containing a 6% waste sludge when compared with control and it was also found that waste sludge up to 9% could effectively be used as an additive material in cement could effectively be used as an additive material in cement. With the inclusion of glass powder the strength of concrete gradually increases up to a certain limit but the gradually decreases. With the inclusion of glass powder upto 10% the initial strength gain in concrete is high. At 10% there is 27.4% increase in initial Split Tensile strength for 7 days. At 10% there is 11.5% increase in initial Split Tensile strength for 28 days. The initial strength gradually decreases from 15%. It was found out that the optimum percentage for replacement of glass powder with cement and it is almost 10% cement for both cubes and cylinders, P. Aggarwal et al [5] carried out the experimental investigations on the effect of use of that material of ash as a replacement of fine aggregates. The strength progress for a variety of percentages (0-50%) replacement of fine aggregates with bottom ash can easily be equated the strength development of nominal concrete at a number of ages. Dr. Lalit Kumar, Er. Arvinder Singh. have investigate the possibility of using crushed stone dust as fine aggregate partially or fully with different grades of concrete composites. The suitability of crushed

stone dust waste as a fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. Two basic mixes were chosen for natural sand to achieve M25 grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. The test results indicate the crushed stone dust can be used effectively to replace natural sand in concrete. In the experimental study of strength characteristics of concrete using crushed stone dust as fine aggregate it is found that there is increase in compressive strength, flexure strength and tensile strength.

### III MATERIALS USES

#### Cement

In the present work locally available Portland Pozzolana Cement (fly ash based) brand name Birla Gold confirming to IS: 1489 (Part 1) -1991 was used. Having specific gravity 3.12 and normal consistency 33%

#### Fine Aggregate

The fine aggregate in this research work are used from locally available and confirms to zone II of IS 383:1970. Having specific gravity 2.67 and fineness modulus 2.87.

**Table 1. Sieve Analysis of Fine aggregate.**

Sieve Size	Weight retained (gm)	Cumulative weight retained (gm)	Cumulative Percentage weight retained	% Passing
4.75 mm	-	-	-	100
2.36 mm	55	55	5.5	94.5
1.18 mm	228	283	28.3	71.7
600 μ	348	631	63.1	36.9
300 μ	285	916	91.6	8.4
150 μ	75	991	99.1	0.9
Pan	5	996	100	0
Total 1 Kg	Fineness Modulus = $287.6/100 = 2.87$			

### Coarse Aggregate

Two aggregate of sizes 20 mm and 10 mm were used from local available from Bhopal in this work. The specific gravity of coarse aggregate was 2.72 for both the fractions. The sieve analysis of 10 mm and 20 mm coarse aggregate is given in table below. The 20 mm and 10 mm aggregate were mixed in the ratio of 60:40. The coarse aggregates are confirmed to IS 383:1970 and having specific gravity 2.84 and fineness modulus 6.026.

**Table 2. Sieve analysis for coarse aggregate of 20 mm size.**

Sieve size	Weight retained (gm)	Cumulative weight retained (gm)	Cumulative Percentage weight retained	% passing
40 mm	-	-	-	100
20 mm	484	484	9.68	90.32
10 mm	4165	4649	92.98	7.02
4.75 mm	345	4994	100	-
1.18 mm	0	4994	100	-
600 μ	0	4994	100	-
300 μ	0	4994	100	-
150 μ	0	4994	100	-
Total = 5 Kg	Fineness modulus = 602.66/100 = 6.026			

**Table 3. Sieve analysis for coarse aggregate of 10 mm size.**

Sieve size	Weight retained (gm)	Cumulative weight retained (gm)	Cumulative % weight retained	% passing
20 mm	-	-	-	100
10 mm	2856	2856	57.12	42.88
4.75 mm	1394	4250	85	15

2.36 mm	744	4992	100	-
1.18 mm	0	4992	100	-
600 μ	0	4992	100	-
300 μ	0	4992	100	-
150 μ	0		100	-
Total = 5 Kg	Fineness modulus = 642.12/100 = 6.42			

### Crusher sand

Crusher sand produced from stone crushing zones appears as a problem for effective disposal. Hence in this work crusher sand is used in the concrete as partial replacement of the sand. The main purpose of this work is to waste minimization. The study focuses to determine the relative performance of concrete by using crusher sand. Crusher sand was collected from local stone crushing units.

**Table 4. Sieve analysis for Stone Dust.**

Sieve size	Weight retained (gm)	Cumulative weight retained	Cumulative percentage weight retained	% passing
4.75 mm	-	-	-	100
2.36 mm	24	24	2.4	97.6
1.18 mm	158	182	18.2	81.8
600 μ	185	367	36.7	63.3
300 μ	385	752	75.2	24.8
150 μ	197	949	94.9	5.1
Pan	46	995	100	0
Total = 1	Fineness modulus = 227.40/100 = 2.27			

### Glass Powder

Waste glass powder in this study was used from locally available market. Glass waste is very hard material. The glass powder is ball pulverized and particles size are less than 150 μm and sieved through 75 μm.

### Water

The clean portable water is used in this experimental work without any visible impurities.

#### IV EXPERIMENTAL DETAILS

##### Mix design

In this experiment we select the grades of concrete M-25. The mix design was carried out as per IS: 10262-2009. The trials have been prepared and finally we find for M-25 grade was design for this experiment having the mix proportion 1:1.40:3.05 and the water cement ratio are 0.43. All locally available materials are used during the preparation of the mix proportion.

##### Mixing and casting of samples

The mixing and casting were done with proper care and all materials were weighted properly and mixed in laboratory concrete mixer. The water is added after all materials are feed into in mixer in proper order. The cubes were filled and compacted by using table vibrating machine and the cylinder and beams were compacted using the tamping rod for

around 25 times. The moulds were leveled properly. The specimens were kept for 24 hours and then it is removed from mould and kept in curing tank till the testing days. All specimens are tested at 7, 14, 28, and 28 days.

##### Compressive Strength Tests

The compressive strength tests were done by using the cubic specimen of sizes 150x150x150 mm. The moulds are confirming to the IS specification. For each test three specimens were taken and their average value is considered. The load should be applied gradually at the rate of 140 kg/cm<sup>2</sup> per minute till the specimens fails. The load at the failure divided by area of specimen gives the compressive strength of concrete. The cubes were tested at 7, 14, 28, and 56 days of curing.

##### Flexure Strength Tests

The flexure strength also known as modulus of rupture, bends strength, or fracture strength. The value of modulus of rupture depends on the dimensions of the beam and manner of loading. The value of the flexural strength is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. In these tests the beams were casted having the size 150x150x700 mm. For this the moulds

of the same sizes are taken which are confirming to the IS specification. During the casting it is compacted by using the tamping rod of around 25 times the diameter of the tamping rod is 16 mm. The flexure strength was tested at the age of 7, 14, and 28 days curing.

##### Split Tensile Tests

We know that the concrete is weak in tension. The tensile strength is one of the important properties of the concrete. The tensile strength tests the cylinders were casted having the size 150 mm diameter and 300 mm lengths. This is the indirect method of the testing the tensile strength of the concrete. For this the moulds of the same sizes are taken which are confirming to the IS specification. It is also casted by using the 16 mm tamping rod of around 25 times. The split tensile tests were carried out at 7, 14 and 28 days curing.

**Table 5. Details of Specimen Designation.**

Designation	Grade	Type	Cement %	Sand %	CA %	C.S %	G.P. %
A1 - 0	M - 25	Cube	100	100	100	0	Nil
A1 - 10	M - 25	Cube	100	90	100	10	Nil
A1 - 20	M - 25	Cube	100	80	100	20	Nil
A1 - 30	M - 25	Cube	100	70	100	30	Nil
A1 - 40	M - 25	Cube	100	60	100	40	Nil
A2 - 0	M - 25	Beam	100	100	100	0	Nil
A2 - 10	M - 25	Beam	100	90	100	10	Nil
A2 - 20	M - 25	Beam	100	80	100	20	Nil
A2 - 30	M - 25	Beam	100	70	100	30	Nil
A2 - 40	M - 25	Beam	100	60	100	40	Nil
A3 - 0	M - 25	Cylinder	100	100	100	0	Nil
A3 - 10	M - 25	Cylinder	100	90	100	10	Nil
A3 - 20	M - 25	Cylinder	100	80	100	20	Nil
A3 - 30	M - 25	Cylinder	100	70	100	30	Nil

A3 - 40M - 25	Cylinder	100	60	100	40	Nil
A'1 - 10M - 25	Cube	80	90	100	10	20
A'1 - 20M - 25	Cube	80	80	100	20	20
A'1 - 30M - 25	Cube	80	70	100	30	20
A'1 - 40M - 25	Cube	80	60	100	40	20
A'2 - 10M - 25	Beam	80	90	100	10	20
A'2 - 20M - 25	Beam	80	80	100	20	20
A'2 - 30M - 25	Beam	80	70	100	30	20
A'2 - 40M - 25	Beam	80	60	100	40	20
A'3 - 10M - 25	Cylinder	80	90	100	10	20
A'3 - 20M - 25	Cylinder	80	80	100	20	20
A'3 - 30M - 25	Cylinder	80	70	100	30	20
A'3 - 40M - 25	Cylinder	80	60	100	40	20

CA= Course Aggregate, C.S = crusher sand, G.P = Glass Prouder

### V RESULTS AND DISCUSSION

**Compressive Strength:** The result of the compressive strength with partial replacement of crusher sand and without using glass powder for 7, 14 and 28 days are shown in the Table 6 for M-25 concrete and their graphical representation in the Fig. 1 for M-25 concrete. And by replacing 20% cement with glass powder along with crusher sand is shown in the Table 12 for M-25 concrete and their graphical representation is shown in the fig.

**Table 6. Compressive Strength of Different Mix of M-25 Concrete (without Glass Powder).**

Designation	Compressive Strength in N/mm <sup>2</sup>			% C.S.
	7 Days	14 Days	28 Days	
A1 - 0	21.15	24.39	32.56	0
A1 - 10	21.60	24.76	32.30	10
A1 - 20	21.96	25.01	34.80	20
A1 - 30	22.50	25.08	35.40	30
A1 - 40	23.18	25.70	37.02	40

**Flexure Strength:** The result of the flexure strength with partial replacement of crusher sand and without using glass powder for 7, 14 and 28 days are shown in the Table 8 for M-25 concrete and their graphical representation in the Fig. 3 for M-25 concrete. And by replacing 20% cement with glass powder along with crusher sand is shown in the Table 14 for M-25 concrete and their graphical representation is shown in the fig.

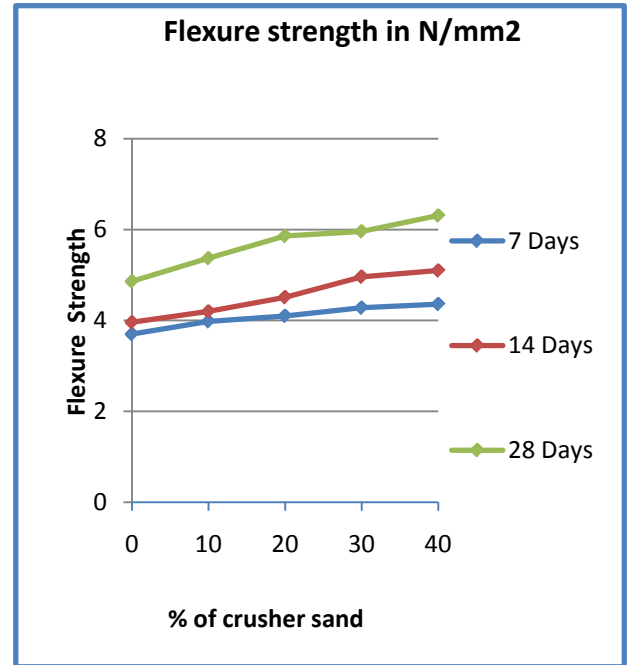
**Table 7. Flexure Strength of Different Mix of M-25 Concrete (without Glass Powder).**

Designation	Flexure Strength in N/mm <sup>2</sup>			% C.S.
	7 Days	14 Days	28 Days	
A2 - 0	3.70	3.96	4.86	0
A2 - 10	3.98	4.20	5.37	10
A2 - 20	4.10	4.51	5.86	20
A2 - 30	4.28	4.96	5.96	30
A2 - 40	4.36	5.10	6.31	40

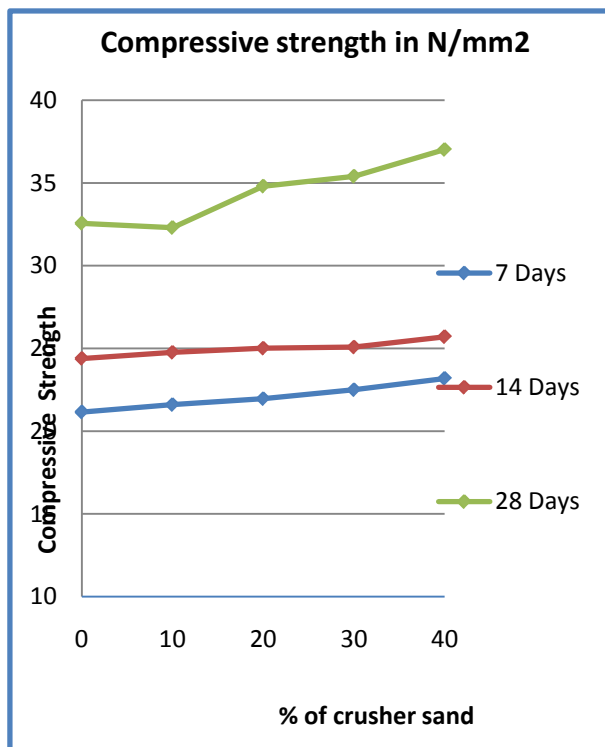
**Split Tensile Strength:** The result of the split tensile strength with partial replacement of stone dust and without using glass powder for 7, 14 and 28 days are shown in the Table for M-25 concrete and their graphical representation in the Fig. 5 for M-25 concrete and in the Fig. And by replacing 20% cement with glass powder along with crusher sand is shown in the Table 16 for M-25 concrete and their graphical representation is shown in the fig.

**Table 8. Split Tensile Strength of Different Mix of M-25 Concrete (without Glass Powder).**

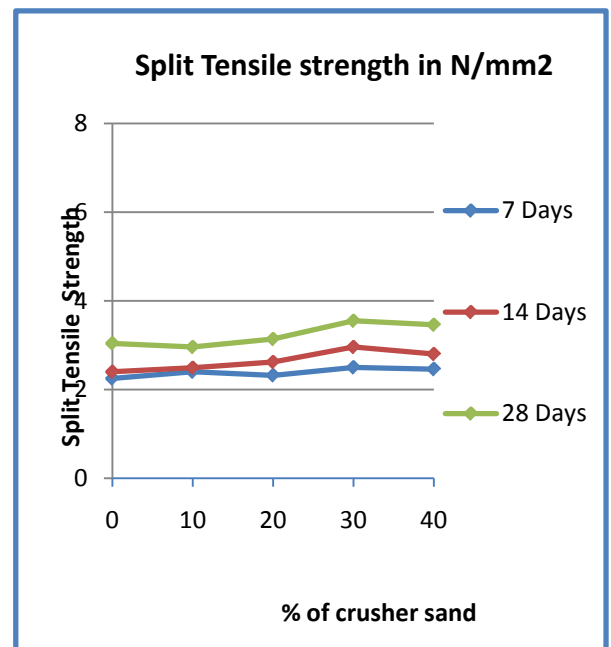
Designation	Split Tensile Strength in N/mm <sup>2</sup>			% C.S
	7 Days	14 Days	28 Days	
A3 - 0	2.25	2.40	3.04	0
A3 - 10	2.40	2.49	2.96	10
A3 - 20	2.32	2.62	3.14	20
A3 - 30	2.50	2.96	3.55	30
A3 - 40	2.46	2.80	3.46	40



**Figure 2. Flexure Strength of Different Mix of M-25 Concrete (Without Glass Powder).**



**Figure: 1. Compressive Strength of Different Mix of M-25 Concrete (Without Glass Powder).**



**Figure 3. Split Tensile Strength of Different Mix of M-25 Concrete (Without Glass Powder).**

**Table 9. Compressive Strength Strength of Different Mix of M-25 Concrete (Without Glass Powder).**

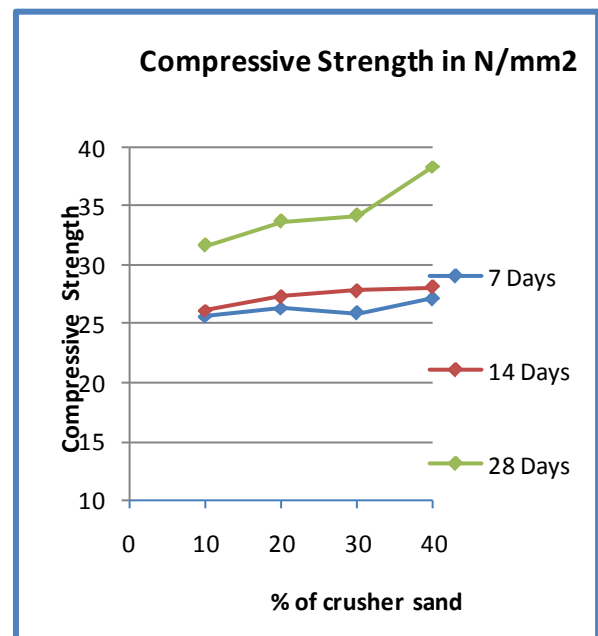
Designation	Compressive Strength in N/mm <sup>2</sup>			% C.S.
	7 Days	14 Days	28 Days	
A'1 - 10	25.62	26.15	31.70	10
A'1 - 20	26.32	27.30	33.72	20
A'1 - 30	25.90	27.80	34.20	30
A'1 - 40	27.12	28.12	38.40	40

**Table 11. Split Tensile Strength of Different Mix of M-25 Concrete (with Glass Powder 20% & Cement 80%).**

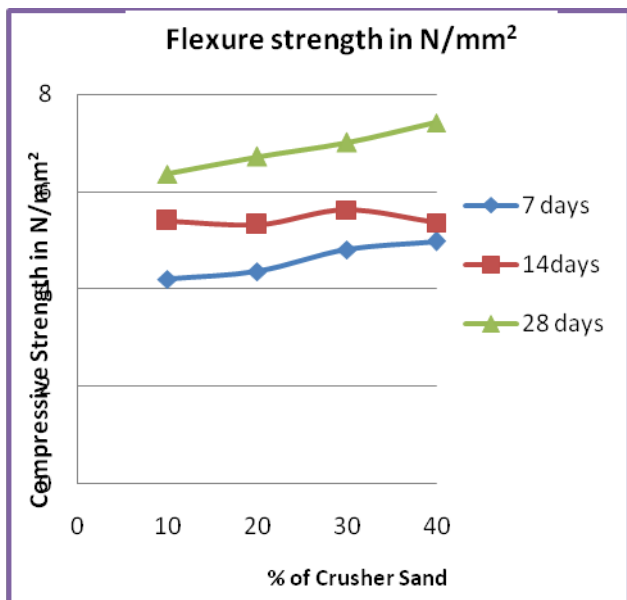
Designation	Split Tensile Strength in N/mm <sup>2</sup>			% C.S.
	7 Days	14 Days	28 Days	
A'3 - 10	2.32	2.48	3.10	10
A'3 - 20	2.38	2.56	3.16	20
A'3 - 30	2.60	2.68	3.30	30
A'3 - 40	2.80	2.98	3.46	40

**Table 10. Flexure Strength of Different Mix of M-25 Concrete (with Glass Powder 20% & Cement 80%).**

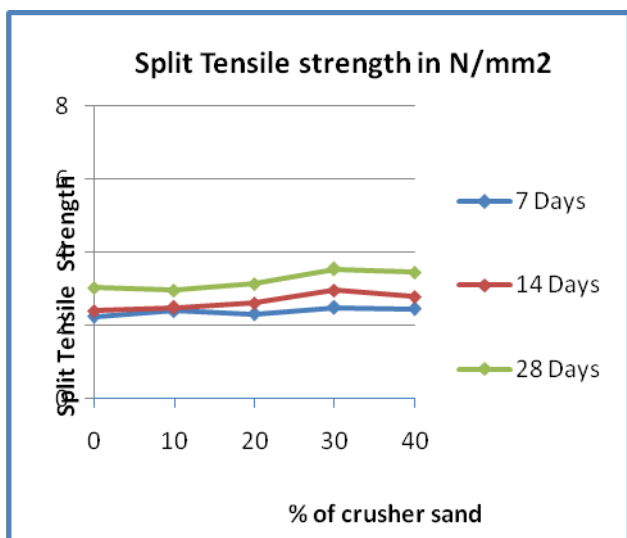
Designation	Flexure Strength in N/mm <sup>2</sup>			% C.S.
	7 Days	14 Days	28 Days	
A'2 - 10	4.48	5.10	6.40	10
A'2 - 20	4.70	5.60	6.76	20
A'2 - 30	4.96	5.21	6.96	30
A'2 - 40	5.10	5.36	7.01	40



**Figure 4. Compressive Strength of Different Mix of M-25 Concrete (with 20% Glass Powder & 80% Cement).**



**Figure 5. Flexure Strength of Different Mix of M-25 Concrete (With 20% Glass Powder & 80% Cement).**



**Figure 6. Flexure Strength of Different Mix of M-25 Concrete (With 20% Glass Powder & 80% Cement).**

#### VI RATE ANALYSIS OF MATERIALS

To know the cost of concrete mix prepared by using natural sand as well as crusher sand and Cement as well as waste glass powder, the rate analysis have been carried out. The cost is

calculated for 1 cum of concrete mix for M-25

**1.1.1.1 Table 12 Rate Analysis of M-25 Grade of Concrete.**

**1.1.1.2 (per cum)**

MATERIALS	QUANTITY (cum)	RATE (per cum)	COST (Rs)	TOTAL COST (Rs)
(A) Cement	0.126 cum	2460.00	Rs. 310	<b>(A+B+C+D)</b>  <i>1.1.1.3</i> Rs. 747.00
(B) Fine aggregate (Sand)	0.255 cum	600.00	Rs. 153	
(C) Coarse Aggregate	0.439 cum	640.00	Rs. 281	
(D) Water	0.180 cum	20.00	Rs. 3.60	
<b>Rate per cu m — Rs. 747.00</b>				
(E) Waste Glass Powder	0.126 cum	700.00	88.20	<b>(C+D+E+F)</b>  <b>Rs.475</b>
(F) Crusher Sand	0.255 cum	400.00	102.00	
<i>1.1.1.4</i> <b>1.1.1.5 Rate per cu m — Rs. 475.00</b>				

#### VII CONCLUSION

From the about experiments following conclusions are observes:

1. The compressive strength by replacing 40% sand by crusher sand the strength increases by 10, 5, 13 and 14% at 7, 14 and 28 days respectively in M-25 concrete. As compared to the conventional concrete. Thus crusher sand increases the



compressive strength of the concrete and reduce the cost of material and also its great use of waste materials.

2. The compressive strength of the concrete by replacing the 40% sand by crusher sand and 20% cement by the glass powder the strength increases by 28, 15, 18 and 24% at 7, 14 and 28 days respectively in M-25 concrete. As compared to the conventional concrete. Thus glass powder can also be used up to 20% which is also great saving in costly cement and use of waste material.

3. The flexure strength of the concrete by replacing the 40% sand by crusher sand increase 18, 28, 29 and 30% at 7, 14 and 28 days respectively in M-25 concrete. As compared to the conventional concrete. Thus crusher sand also increase the flexure strength at the later ages of the concrete.

4. The flexure strength of the concrete by replacing 40% sand by crusher sand and 20% cement by the glass powder the strengths are increase by 37, 35, 44 and 43% at 7, 14 and 28 days respectively in M-25 concrete and 19, 18, 42 and 44% at 7, 14 and 28 days. As compared to the conventional concrete. Thus flexure strength is also increase by including the glass powder. It also reduces the consumption of the cement.

The split tensile strength of the concrete by replacing sand 40% by crusher sand the strengths increases 9, 17, 14 and 16% at 7, 14 and 28 days respectively in M-25. Hence crusher sand increases the tensile strength of the concrete which is also saving in fine aggregate.

5. The split tensile strength of the concrete by replacing 40% sand by crusher sand and 20% cement by glass powder the tensile strength is increase 24, 24, 14 and 13% at 7, 14 and 28 days respectively in M-25 concrete. Hence by adding the glass powder with crusher sand is also increase the tensile strength of the concrete. Hence saving in cost is two ways cost of sand and cement.

6. It is found that the cost of concrete mix prepared by adding waste glass powder and crusher sand for M-25 grade of concrete mix prepared by cement and natural sand. For the same, sample of concrete mix the cost becomes

747.00 to 475.00 Rs for M-25 grade of concrete Per cum using cement, sand, waste glass powder and crusher sand respectively.

#### **VIII FURTHER SCOPE OF WORK**

1. The study can be carry out by increasing the percentage of crusher sand up to 100% and fully replacement of the fine aggregate.

2. The study can also be carry out by increasing the percentage of glass powder up to maximum level with or without crusher sand.

3. The engineering properties like water absorption, reduction in weight of concrete and density of the concrete can be study by using the crusher sand and glass powder.

4. The effect temperature and humidity can also be study.

5. The study can also be carry out by using higher grade of concrete.

#### **REFERENCES:-**

[1] Dr. G. Vijayakumar, Ms H. Vishliny, Dr. D. Govindarajulu studies on glass powder as partial replacement of cement in concrete production. IJETAE: International journal of emerging technology and advanced engineering. Volume 3, Issue 2, Feb 2013.

[2] J.D. Chaitanya kumar, G.V.S. Abhilash, P.Khasim Khan, G.Mnikanta sai, V. Tarakh ram experimental studies on glass fiber concrete. AJER: American Journal of Engineering Research e-ISSN: 2320-0847 : p-2320-0936 volume-5, Issue-5, pp-100-104.

[3] Brajesh kumar Suman, Vikas Srivastava JMEST: Journal of Multidisciplinary Engineering Science and Technology ISSN: 3159-0040, vol. 2 Issue 4, April – 2015

[4] Er. Lalit Kumar , Er. Arvinder Singh A study on the strength of concrete using crushed stone dust as fine aggregate. IJRASET: International Journal for Research in Applied Science & Engineering Technology. ISSN: 2321-9653 vol. 3 Issue I, Jnauary 2015.

[5] A.K. Shau, Sunil Kumar and A.K. Sachan (2003) “crushed stone waste as fine aggregate for concrete” the Indian concrete Journal, pp 885848.

[6] Prakash Rao, D.s. & Giridhar Kumar, V.(2004) “Investigations on concrete with stone crusher dust as fine aggregate”. The Indian Concrete Journal, M.E. Thesis submitted to Osmania University, Hyderabad, India.

[7] IS: 383-1970. Specification for coarse and Fine Aggregates from natural sources for concrete.

[8] IS: 10262-2009: Guidelines for concrete mix design proportioning.

[9] IS: 456-2000. Specification for plain and reinforced concrete.