STUDY ON STRENGTH AND DURABILITY OF CONCRETE BY USING GLASS POWDER (GP) AND MUNICIPAL SOLID WASTE (MSW)

Rupesh Kumar[1] Dr Priyank Gupta[2]

[1]M. Tech Student, Department of Civil Engineering, Vivekananda College of Engineering and Technolog, Mathura Bypass, Near Khair Road, Koil, Aligarh District, Uttar Pradesh, 202002

[2]Professor , Department of Civil Engineering, Vivekananda College of Engineering and Technolog, Mathura Bypass, Near Khair Road, Koil, Aligarh District, Uttar Pradesh, 202002

Abstract- Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. The appropriate utilization of Municipal Solid Waste Incineration (MSWI) residues is a worldwide studied topic over the last decades. One of the possibilities is to use MSWI ashes in concrete production, as it is done with coal combustion products M Sand and municipal solid waste finer than 600 µ is reported to have pozzolanic behaviour. An attempt is made to investigate the possibility of using the M Sand, municipal solid waste are the partial replacement of ordinary Portland cement in concrete.

The study has been made to evaluate the effect on mechanical and durability properties of M40 grade concrete made with replacement of cement with M Sand, (0%, 5%, 10%, 15%, 20% and 25%) and Municipal solid waste, (0%, 2.5%, 5%, 7.5%, 10% and 12.5%) by weight. For each set mechanical properties were studied by performing Compression test for Cubes, Flexural test for beams and Split Tensile test for cylinders and durability properties were studied by performing acid attack, alkaline attack and Sulphate attack test for cubes.

Key words: M Sand, Municipal Solid Waste, mechanical, durability, acid attack, alkaline attack, Sulphate attack

1. Introduction

In developing countries, with the increasing population, both economy and pollution free environment in construction industry are of principal importance in order to meet the inevitable human needs of multifarious forms. Thus, use of waste aggregates in the production of new type of concrete, which plays an essential role in the construction activity, is necessary for fulfilling the demand of aggregates. Most of the waste materials are generated from industrial waste and demolishing waste. Normally the above said waste can be dumped into low laying areas but limited area is available for dumping due to land cost in urban region. Other than the land cost, lead charges are also influencing the disposal of waste and it causes pollution to the nearby and surrounding areas.

There is an interest mounting up to the usage of waste materials as an alternative aggregates and significant research was performed on the use of many different materials as aggregate substitute such

as coal ash, fibre glass waste materials, waste plastics, rubber waste and blast furnace slag. The waste aggregates can be used as well as in mortar and concrete. These waste materials can solve few problems like lack of aggregates in construction sites and environmental problems. Hence, recycling, reuse and substitution of this waste appears to be an effective solution and most appropriate decision. By substitution of waste material in the preparation of concrete, a new concept for diminution of waste is proposed.

From the last decade, Construction industry conducted research on the effective utilization of waste products of concrete, from the last decade. Some of waste products are fly ash, rice husk ash, discarded tyre, plastic, glass rock, stone dust and ceramic waste. Each waste product has its own specific properties and it will be affected on properties of fresh and hard concrete. The use of products in concrete not only makes it economical but also solves few problems like land fill and disposal cost. Coarse aggregate is replaced with discarded waste materials and the crushed rock flour can be used to replace the natural sand in concrete composition.

In India, ceramic production is 100 million ton per year and about 15-30% of ceramic waste is generating from the total production. Ceramic industrial waste is developing day by day and it causes serious environmental problems to the human health. Disposable cost is also increased for these industries, due to the ceramic nature. In various parts of India, exhaustion of coarse aggregate is happening, hence to preserve natural coarse aggregate for future needs; crushed ceramic aggregate can be used to produce a new type of concrete without affecting strength. Mechanical properties of concrete are greatly influenced by the ingredient properties.

Objectives of the study

The following are the main objectives of the study

1. To determine the workability, the compressive strength, split tensile strength and flexural strength of concrete containing M sand and municipal solid waste.
1 Compare the results of the M Sand and municipal solid waste concrete to a conventional mix.
2 To study the compressive strength, split tensile strength, flexural strength of concrete by using M sand and municipal solid waste (MSW).
3 To study the durability of concrete by using M Sand and municipal solid waste (MSW).

2. Literature review

Wissam Elias Touma (2000) examined the alkali – silica reaction in Portland cement concrete. He found that using 10% silica fume to replace the cement by weight was effective in decreasing the 14-day expansion below 0.10% for slowly reactive aggregates. This level of replacement was not effective with highly reactive aggregates even though it caused a decrease in 14-day expansion. Replacing the cement with 55% of granulated slag and 25% of calcined clay became effective in decreasing the 14-day expansion below 0.10% for slowly and highly reactive aggregates.

Kome Shomglin et al (2001) considered the alkali aggregate reaction test on five different types of cement. Type I/II Portland cement, Type III Portland cement, two Calcium Sulfoaluminate cements (CSA I, and CSA II), and Calcium Aluminate cement (CA) with two types of aggregates like granitic and phyllonitic. The results indicated that CA cement showed high resistance to alkali silicate reaction and the other four types of cements pointed out that the

expansion was greater than 0.20 percent, 16 days after casting.

Pacheco-Torgal et al (2002) dealt with the durability properties of concrete with different types of aggregates. They found that there was not much difference on concrete durability parameters when produced either with granite, gabbro or calcareous coarse aggregate. The results obtained for vacuum water absorption, oxygen and water permeability of all concrete mixes showed the same order of magnitude. This indicated that the quality of concrete mixes produced with different aggregates looked approximately same, in all cases.

3. Materials and mix design

Cement

In this study Ordinary Portland cement of 53 grade (ACC cement) has been procured and has been used.

OPC 53 grade cement

Coarse aggregate

In this study coarse aggregate of nominal sizes of 20mm, 12mm are used

20mm coarse aggregates

12mm coarse aggregates

Fine aggregate

The fine aggregate used in this study is river sand which is obtained from local company and shown in figure with normal size of 2.36mm

Fine aggregates

M Snad

Made sand (M-Sand) is a substitute of stream sand for concrete turn of events. Fabricated sand is conveyed from hard rock stone by beating. The Manufactured sand is of cubical shape with grounded edges, washed and audited to as an advancement material. The range of delivered sand (M-Sand) is under 4.75mm. M sand is a possibility for stream sand. Due to rapidly creating advancement industry, the enthusiasm for sand has extended massively, causing absence of sensible waterway sand in most bit of the word.

Manufactured sand

Municipal Solid waste

For this study municipal solid waste collected from dumping yard at GWMC office.

Municipal solid waste

Superplasticizers

The use of superplasticizer is practiced for production of flowing, self levelling, self compacting and for the production of high strength concrete.

In this study, CONPLAST SP430 has been used in concrete mix to have high workability.

Mix design of m40 grade concrete

Final trial mix for M40 grade concrete is 1:1.63:2.54 at w/c of 0.45

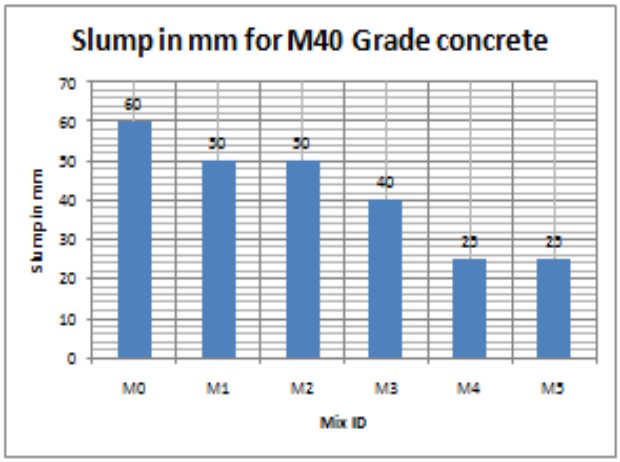
Mix Trials Used in this study

1. M0 - 0%MSW +0%M SAND
2. M1 - 5%MSW +2.5%M SAND
3. M2 - 10%MSW +5%M SAND
4. M3 -15%MSW +7.5%M SAND
5. M4 - 20%MSW +10%M SAND
6. M5 - 25%MSW +12.5%M SAND

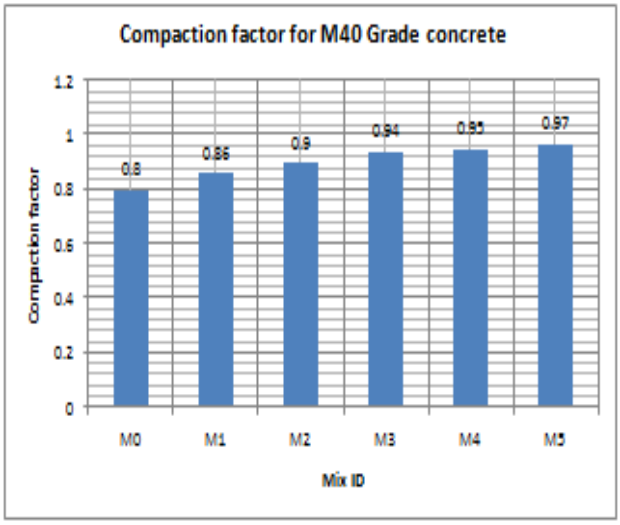
4. Results and analysis

Workability:

Slump cone test:

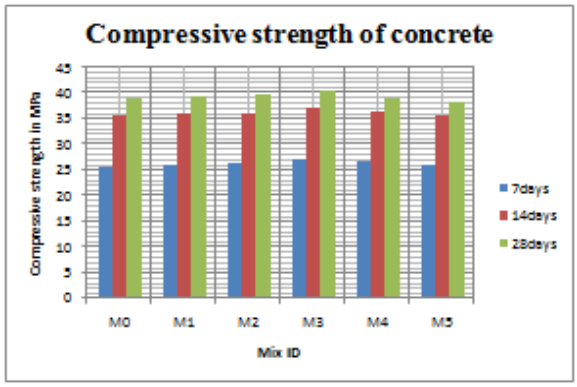


Compaction factor test

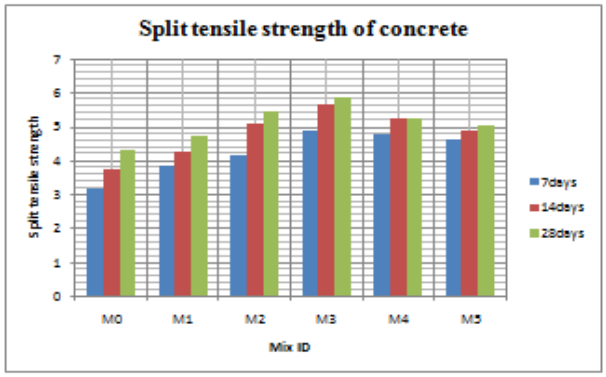


STRENGTH OF CONCRETE:

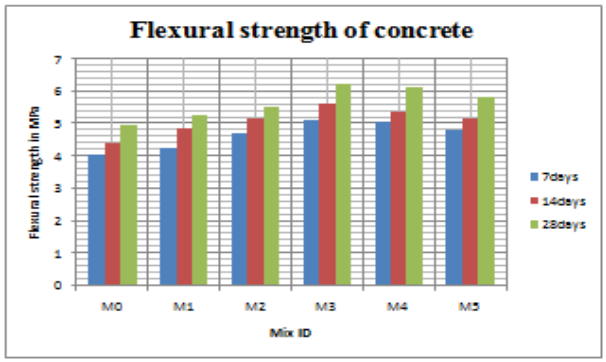
Compressive strength



Split tensile strength

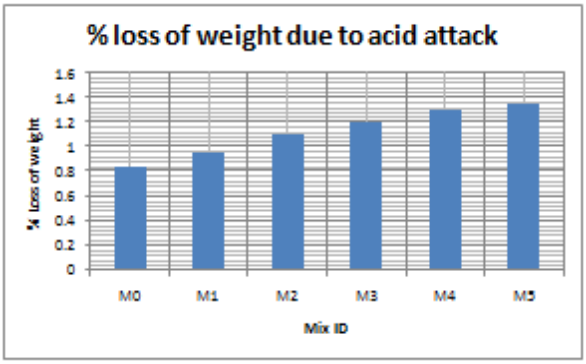


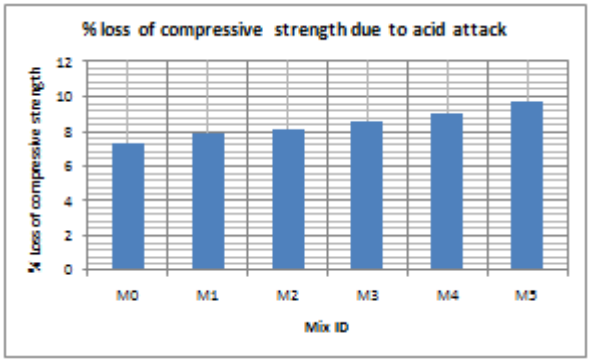
Flexural strength



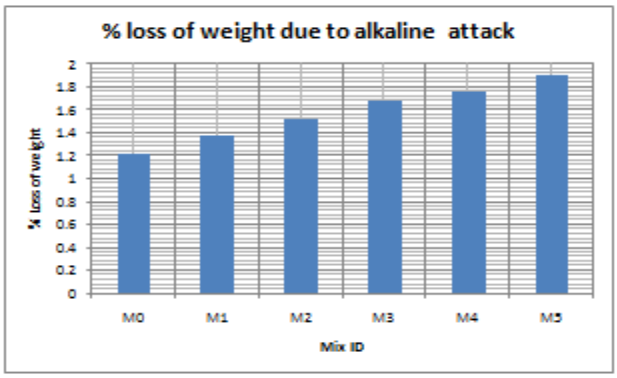
DURABILITY OF CONCRETE:

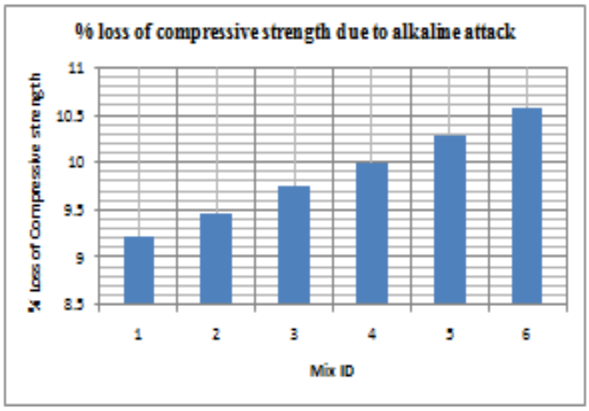
Acid attack



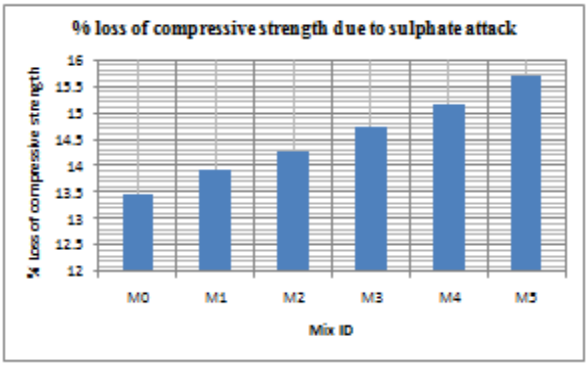


Alkaline attack:





Sulphate attack:



5. Conclusions

From this study the following conclusions were made

1. Considering, The Acute Shortage Of River Sand, Huge Short Coming On Quality Of River Sand, High Cost, And Environmental Effects, The Construction Industry Shall Start Using The Manufactured Sand To Full Extent As Alternative. Hence M-Sand is eco friendly.

2. M-Sand is more economical and cost effective in construction industry as it gives more workability, High strength and durability to the concrete with less pre and post concrete defects.
3. Municipal Solid Wastes Ash has been highly effective in increasing the workability of the fresh concrete easing the placement of concrete.
4. The value of slump for the concrete decreases with increasing the percentage of M Sand and municipal solid waste for M40 Grade concrete. The value of compaction factor for the concrete decreases with increasing the percentage of M Sand and municipal solid waste for M40 Grade concrete.
5. Compressive strength for 7days, 14days, 28days for the concrete increases initially up to 15% M Sand+7.5% Municipal solid waste than decreases with increasing the percentage of M Sand and municipal solid waste for M40 Grade concrete. The optimum value for the compressive strength was obtained at 15% M Sand+7.5% Municipal solid waste.
6. Split tensile strength and flexural strength for 7days,14 days and 28days for the concrete increases initially up to 15% M Sand+7.5% Municipal solid waste than decreases with increasing the percentage of Glass powder and municipal solid waste for M40 Grade concrete.
7. The addition of M Sand and municipal solid waste significantly increased the compressive, tensile and flexural strengths of concrete with maximum strengths in each case being achieved at 15% M Sand+7.5% Municipal solid waste.
8. The percentage loss of weight and percentage loss of compressive strength is increases with in increasing the percentages in all cases in durability studies in M Sand and municipal solid waste concrete. So, the concrete is durable up to 15% M Sand+7.5% Municipal solid waste.

So the replacement of 15% M Sand+7.5% Municipal solid waste is generally useful for better strength values in M40 grade of concrete.

References

1. Martin Keppert , Zbysek Pavlik , Robert Cerny, Pavel Reiterman, “Properties of Concrete with Municipal Solid Waste Incinerator Bottom Ash”, IPCSIT vol. 28 (2012) © (2012) IACSIT Press, Singapore.
2. Bhupendra Singh Shekhawat, Dr. Vanita Aggarwal, “Utilisation of Waste Glass Powder in Concrete – A Literature Review”, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 7, July 2014
3. Amit Kumar Gupta, Dr. Rajeev Chandak, “Effect on compressive strength of concrete with partial replacement of cement by municipal solid waste incinerator ash”, International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 02 | Feb -2017.
4. Gautam Singh , Ashish Kumar singh, Akhil Bhaskar, Ajit Singh Attree, “A Critical Study of Effectiveness Of Waste Glass Powder In Concrete”, International Archive of Applied Sciences and Technology.
5. Md. Safiuddin , Mohd Zamin Jumaat, M. A. Salam, M. S. Islam, R. Hashim, “Utilization of solid wastes in construction materials”, International Journal of the Physical Sciences Vol. 5(13), pp. 1952-1963, 18 October, 2010.
6. Hashim Mohammed Alhassan, Ahmed Musa Tanko, “Characterization of Solid Waste Incinerator Bottom Ash and the Potential for its Use”, International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 4, July-August 2012, pp.516-522.
7. Gunalaan Vasudevan, Seri Ganis Kanapathy pillay, “Performance of Using Waste Glass Powder In Concrete As Replacement Of Cement”, American Journal of Engineering Research (AJER), Volume-02, Issue-12, pp-175-181.
8. Veena V. Bhat, N. Bhavanishankar Rao, **“**Influence of Glass Powder on the Properties Of Concrete”, International Journal of Engineering Trends and Technology (IJETT) – Volume 16 Number 5 – Oct 2014
9. T.Subramani , S.B.Sankar Ram, “Experimental Study on Concrete Using Cement With Glass Powder”, IOSR Journal of Engineering (IOSRJEN), Vol. 05, Issue 05 (May. 2015), ||V3|| PP 43-53.