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COMPARISION OF CONCRETE MADE THROUGH TSMA USING METAKAOLIN AND GGBS Vs NORMAL CONCRETE MADE THROUGH NMA

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Abstract - *The manufacture and use of sustainable materials, via disposal or reuse/recycling, can be done in a way that preserves the environment, creates no ecological imbalances, has no negative effect on human health, and can be done for a long time without sacrificing productivity. The use of recycled aggregate in concrete may help to preserve the environment. By separating the mixing process into two phases, a novel concrete mixing technique was developed to improve the quality of recycled aggregate concrete.*

This article presents two modified mixing techniques that differ from the two-stage mixing strategy in that they balance cement components with the amount of RA added in the second mix, which is referred as the two-stage mixing approach. Metakaolin and GGBS were also utilized to enhance concrete characteristics such as compressive strength, flexural strength, and permeability in a two-stage mixing process. After that, the results of concrete produced using the Two Stage Mixing Approach and concrete prepared with the Normal Mixing Approach were compared.

Key Words: Recycled Aggregate, Ground Granulated Blast Furnace Slag, Metakaolin, Two Stage Mixing Approach, Normal Mixing Approach

1. INTRODUCTION

Construction is the backbone of infrastructure development. Concrete, which is an essential building element, is the world's second-most-used item after water. Natural resources, such as stone, aggregate, sand, and water, are the basic ingredients of concrete, implying that this sector degrades these environmental assets. Moreover, aggregate quarrying and transportation contribute to environmental imbalance and pollution. Since World War II, recycled aggregates (RAs) from waste (CDW) have been utilized.

High recycling rates have been reached in a number of nations, especially in Europe, including the Netherlands, Denmark, and Germany, among others. This has been aided by those countries' comparatively low natural resource reserves, which have been converted to construction materials, or by the development of strict environmental legislation. These variables have allowed RA to be used in real construction applications, albeit with significant constraints, such as in-road pavement layers, embankments, and earth-filling activities.

Limits on the replacement ratio reflect empirically established impacts of recycled aggregate on concrete in previous research projects. Indeed, the quality of the aggregates determines the primary technical issues that arise when recycled aggregates are used. The compressive strength, flexural strength, and water permeability of concrete prepared with NMA and TSMA are compared in this research. The idea of the use of recycled material in concrete is not new; worldwide research has been carried out on recycled aggregates. However, recycled aggregates in India have failed to acquire momentum in the production of high-strength concrete.

2. LITRATURE REVEIW

2.1

In this paper, Sandeep Uniyal (2014) will describe two criteria that have been used to measure the compressive and flexural strength of concrete prepared using the two-stage mixing approach (TSMA). These parametric parameters are compared to traditional concrete with a percentage of recycled coarse aggregates (RCA) and fly ash variation. The results of this study show that concrete manufactured with 25% and 50% RCA substitution and 10% fly ash addition using TSMA has higher compressive and flexural strength for both 7 and 28 day strength than the comparable nominal concrete specimen made by NMA.

2.2

This experimental work, credited to Santosh Kumar and Sonu Pal (2017), focuses on the pre-soaked slurry two-stage mixing approach (PSTSMA) for getting the greatest mechanical properties. In the M40 concrete grade, recycled aggregate was employed as a 30 percent, 50 percent, and 100 percent replacement for natural aggregate. When compared to the Normal Mixing Approach, the PSTSMA approach improves the strength of recycled aggregate concrete by up to 6.35 percent at 28 days (NMA).

2.3

By a two-stage mixing approach Dr. Vanita Aggarwal (2014) did a modified mixture involving recycled coarse aggregates (RCA) and fly ash to increase the proportioning of the ingredients. Results from the experimental analysis were presented which showed changes in compressive strength. As a result of the porous nature of RA and the premixing process, TSMA has improved the strength of RAC. This can be attributed to the porous nature of RA and the fact that the aggregate and concrete were significantly denser.

2.4

This research paper has been experimentally studied by Asif Husain and Majid Matouq Assas (2013) and its feasibility and recycling in the new construction of dismantled waste concrete are being investigated. Current research is focused on the recycling of dismantled waste to reduce construction costs and solve the housing problems facing the world's low-income communities. This study shows that recycled aggregate obtained in the field produces high quality concrete. As a result of the compressive strength test of the replacement of parts and the complete recirculation aggregate concrete, it was found that the compressive strength was higher than that of general concrete using new aggregate.

2.5

Gumma Soumya (2018) aims to investigate the impact of concrete by replacing cement with silica fume partially and fine aggregate with quartz sand. This is done by running the compressive strength, split tensile strength and flexural strength of M35 grade concrete. The optimum ratios of silica fume and quartz sand were found at 15% and 60%. It can be seen that the addition of 60% quartz sand and 15% silica-fume increased the compressive strength by 19.16%, the split tensile strength by 7.2% from the nominal concrete, and the be flexural strength by 6.64% from the nominal concrete. Evaluation of M35 on the 28th.

3. MATERIALS USED AND METHODOLOGY

3.1 Cement

Ordinary Portland cement, grade 53, meeting IS: 8112-1989 standards. Cement's specific gravity was discovered to be 3.15.

Table – 3.1

Fineness M2/kg	Soundness	Initial setting time (min)	Final setting time (min)
260	1.0	140	260

3.2 Sand

Sand confined to zone 2 of IS: 383-1970 locally available sand.

Table – 3.2

SNO.1	FINE AGGREGATE (SILT CONTENT)	1.4

3.3 Coarse Aggregate and Recycled Coarsed Aggregate

Aggregate is a granular substance that is used to create any construction material such as cement or mortar etc. such as sand, gravel, pulled stones, recycled concrete etc., and that is combined with other binding elements. Aggregation is used as a filler to enhance the volume of a building material since it is cheaper than cement, reducing total cost of construction and increasing strength, durability and hardness.
The ecological nature of construction materials is increasingly being assessed. Concrete recycling is becoming more significant since it preserves natural resources and avoids the need for disposal utilizing the readily accessible concrete for new or other uses as an aggregate source. Recycling concrete is a simple process. Concrete is fractured, removed and crushed in a certain size and quality material.

Table – 3.3

S.NO.	AGGREGATE	AIV %
1.	100 % FRESH AGGREGATE	18.27
2.	15 % RECYCLED AGGREGATE	23.49
3.	30 % RECYCLED AGGREGATE	27.34
4.	45 % RECYCLED AGGREGATE	36.11

Table – 3.4

S.NO.	AGGREGATE	CRUSING VALUE %
1.	100 % FRESH AGGREGATE	17.34
2.	15 % RECYCLED AGGREGATE	20.84
3.	30 % RECYCLED AGGREGATE	25.56
4.	45 % RECYCLED AGGREGATE	35.23

Table – 3.5

S.NO.	% AGGREGATE	SPECIFIC GRAVITY
1.	100 % FRESH AGGREGATE	2.63
2.	15 % RECYCLED AGGREGATE	2.56

3.	30 % RECYCLED AGGREGATE	2.44
4.	45 % RECYCLED AGGREGATE	2.35

3.4 Metakaolin

Metakaolin is a form of kaolinite, a clay mineral, DE hydroxylated. Metakaolin is clay, which is frequently used in pottery but it is also utilized in concrete as a cement replacement. Meta-cooling has a lower particle size (1–2 m) and a greater surface area than Portland cement, but a larger particle size than SF. Metakaolin is subjected to a pozzolanic concrete reaction that refines the microstructure of the hydrated concrete paste. Compared to ordinary Portland cement, metakaolin reacts rapidly and lowers the diffusion coefficient. Research shows that SF and metakaolin have comparable effects on the chloride input resistance of the concrete. The usual metakaolin replacement levels range from 5% to 10% because to its tiny particle size and high surface area.

3.5 GGBS

Ground granulated slaughterhouses (GGBS, GGBFS) are produced from molten iron slaughter, which is then dried in water or steam and ground into a fine powder, in order to produce a glassy, granular product. GGBS includes high levels of CSH (calcium silicate hydrates), a strength boosting component to increase concrete strength, durability and aesthetics. GGBS is highly cementitious.
The production of enhanced slag cement such as PBFC (Portland Blast furnace Cement) and High- Slag Furnace (HSBFC) cement with a GGBS content of 30 to 70 percent and the development of ready-mixed and site-backed durable concrete are two of GGBS's most frequent applications.
Use of GGBS reduces the danger of alkali-silica reaction (ASR), improves chloride intrusion resistance, and reduces the risk of corrosion strengthening, and increases sulphate resistance and other chemical assaults.

METHODOLOGY

NORMAL MIXIXNG APPROACH

In the beginning, ground and fine aggregates are combined. In the second stage, water and cement ingredients are added and mixed.

TWO STAGE MIXING APPROACH

The TSMA process coats the RA surface with a thin layer of cement slurry, which is expected to penetrate the porous old mortar and fill in fractures and crevices. The use of reclaimed concrete as a roadway base material reduces pollution from trucks.

Fine Aggregate + RA + FA

⇓

50 Sec Mixing

⇓

Pour Half Water

⇓

60 Sec Mixing

⇓

Cement + GGBS + Metakaolin

⇓

60 Sec Mixing

⇓

Pour Half Water

⇓

150 Sec Mixing

⇓

Concrete

4. EXPERIMENTAL OBSEVATION

The test observations of the TSMA and the nominal NMA mix are given in the table below.

- M-40 (0-0-100) denotes a specimen mix containing 0% Metakaolin, 0% GGBS, and 100% FA.
- M-40 (10-30-15) denotes a specimen mix containing 10% Metakaolin, 30% GGBS, and 15% RA.
- M-40 (10-30-30) denotes a specimen mix containing 10% Metakaolin, 30% GGBS, and 30% RA.
- M-40 (10-30-45) denotes a specimen mix containing 10% Metakaolin, 30% GGBS, and 45% RA.

4.1 COMPRESSIVE STRENGTH RESULT

Table – 4.1 Compressive Strength at 7 and 28 days

SL. No.	Mix Code	Mix Design	7 Days (MPa)	28 Days (MPa)
1	C452M0GGBS0	Nominal Mix	36.72	51.00
2	C272M45GGBS135	M40 (10-30-15)	40.05	54.86
3	C272M45GGBS135	M40 (10-30-30)	45.57	60.76
4	C272M45GGBS135	M40 (10-30-45)	43.38	60.25

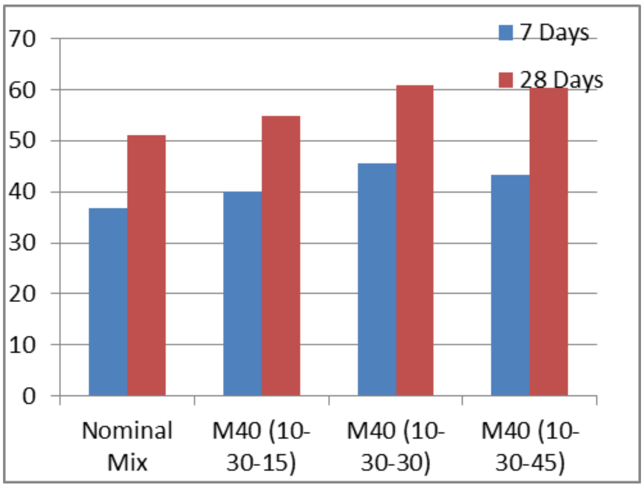

Chart – 4.1 Compressive Strength at 7 and 28 days

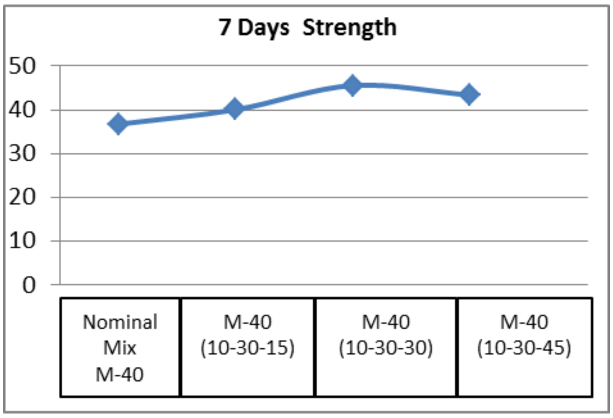

Chart – 4.2 Compressive Strength at 7 days

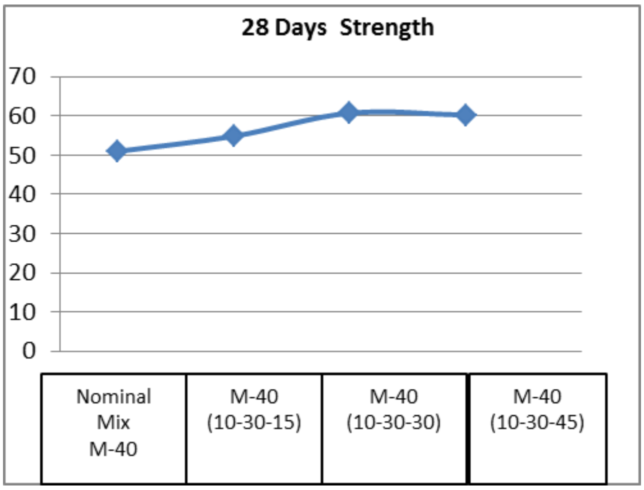

Chart – 4.3 Compressive Strength at 28 days

4.2 FLEXURAL STRENGTH RESULT

Table – 4.2 Flexural Strength at 28 days

SL. No.	Mix Code	Mix Design	28 Days (MPa)
1	C452M0GGBS0	Nominal Mix	5.56
2	C272M45GGBS135	M40 (10-30-15)	6.10
3	C272M45GGBS135	M40 (10-30-30)	7.24
4	C272M45GGBS135	M40 (10-30-45)	6.90

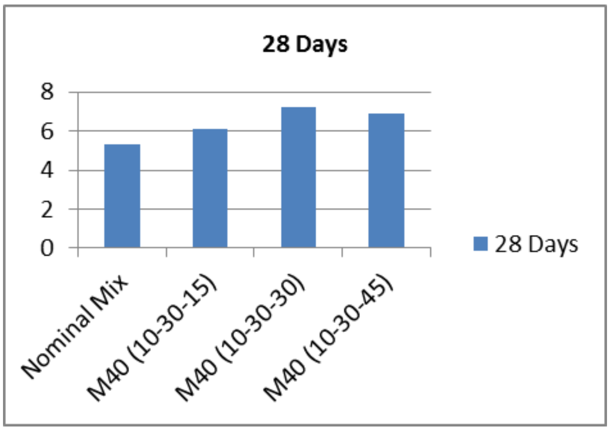

Chart – 4.4 Flexural Strength at 28 days

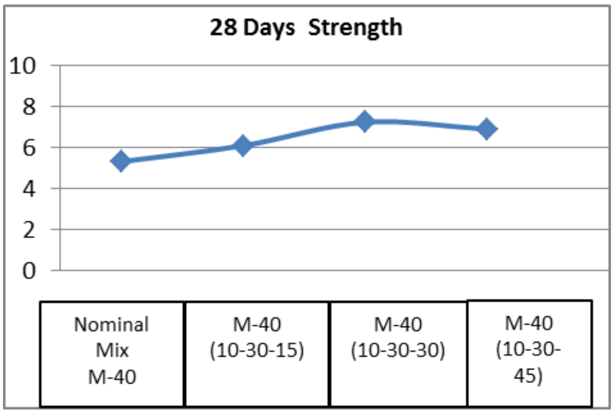

Chart – 4.5 Flexural Strength at 28 days

4.3 WATER PERMEABILITY RESULT

Table – 4.3 Water Permeability at 7 and 28 days

SL. No.	Mix Code	Mix Design	28 Days (Penetration MM)
1	C452M0GGBS0	M40 Nominal Mix	40
2	C272M45GGBS135	M40 (10-30-15)	36

3	C272M45GGBS135	M40 (10-30-30)	30
4	C272M45GGBS135	M40 (10-30-45)	26

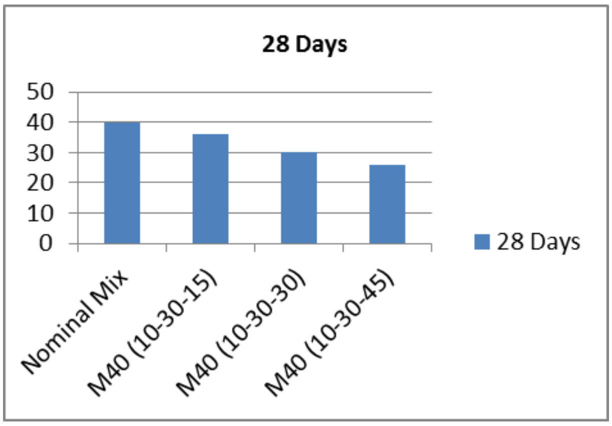

Chart – 4.6 Permeability at 28 days

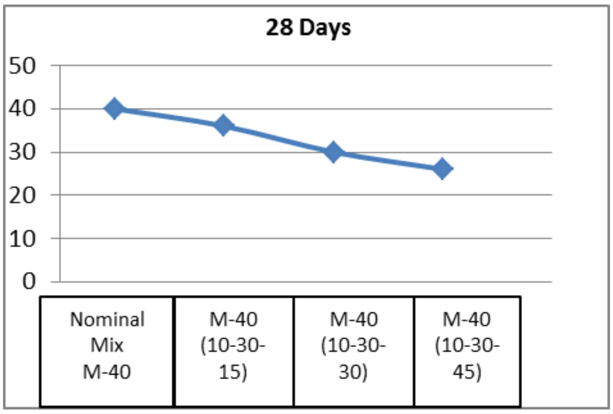

Chart – 4.7 Permeability at 28 days

5. RESULT AND CONCLUSION

The following are the outcomes of the aforesaid experimental analysis:

A. The NMA M-40 grade nominal concrete strengths for 7 days and 28 days are 36,72 MPa and 51,00 MPa, respectively.

B. 15 percent of the specimen The compressive strengths of RCA are 7 day and 28 day with 40,05 MPa and 54,86 MPa respectively using TSMA, 10% Metakaolin and 30% GGBS.

C. The compressive strength of the specimen formed by 30 percent RCA is 7 days and 28 days, respectively, 45.57 MPa and 60.76 MPa for TSMA, 10 percent Metakaolin and 30 percent GGB.

D. The compressive strengths of the 45 percent RCA specimen are 7 and 28 days, respectively, of 43,38 MPa and 60,25 MPa, employing TSMA, 10 percent metakaolin and 30 percent GGB.

E. The 28-day flexural strengths of NMA M-40 grade nominal concrete is found 5.56 MPa.

F. The specimen formed by 15 percent RCA has 28 day flexural strengths of 6.10 MPa using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

G. The specimen formed by 30 percent RCA has 28 day flexural strengths of 7.24 MPa using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

H. The specimen formed by 45 percent RCA has 28 day flexural strengths of 6.90 MPa using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

I. The specimen formed by 45 percent RCA has 28 day flexural strengths of 6.90 MPa using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

J. The specimen formed by 15 percent RCA has 28 day water permeability is 36 mm using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

K. The specimen formed by 30 percent RCA has 28 day water permeability is 30 mm using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

L. The specimen formed by 45 percent RCA has 28 day water permeability is 26 mm using TSMA, 10 percent Metakaolin, and 30 percent GGBS.

CONCLUSIONS

After casting, samples were examined, yielding the aforementioned results, which are represented by TABLES and CHARTS. The results of this study show that the compressive strength, flexure strength and water permeability of concrete produced with 15 percent, 30% and 45 percent RA replacement and addition of 10 percent Metakaolin, and of 30 percent GGBS TSMA are higher for 7 days and 28 days than the same nominal concrete specimen produced by NMA.

Compared to a mixing specimen, the specimen mix M-40 (10-30-15) showed an 8,31% increase in compressive strength for 7 days and a 7,03% increase in strength for 28 days. However, specimen mix M-40 (10-30-30) showed a 19,42% increase in strength of compression for 7 days and an increase of 16,06% in strength for 28 days. The compression specimen mix M-40 (10-30-45) shows an increase of 15.35% in compression strength of seven days and an increase of 15.35% in compressive strength of 28 days.

In 28 days, specimens M40 (10-30-15), M40 (10-30-30), and M40 (10-30-45) showed 8.85 percent, 23.02 percent, and 19.42 percent increase in flexural strength, respectively.

And for water permeability specimen M40 (10-30-15), M40 (10-30-30) and M40 (10-30-45) shows 10%, 25% and 35% decrease in water permeability in 28 days. Concrete built using TSMA, which includes the substitution of 30% RA and the addition of 10% Metakaolin and 30% GGBS, achieves the highest 28-day strength. This concrete will be both cost-effective and sturdy, and it can be adopted in place of nominal concrete in any construction project.

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