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An Experimental Research Based on Compressive Strength with Portland Cement M15 and M20 Grade Aggregate

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Abstract: *This study examined the feasibility of replacing sand and coarse material in concrete with expanded polystyrene (EPS) and crumb rubber. For Grade M20 and M15 concrete samples, crumb rubber and EPS were used in place of sand and coarse aggregate to varying degrees (0%, 10%, 20%, and 30%). For the test, a 240 × 115 × 57 mm concrete sample for the M15 and M20 grades was created. The prepared concrete brick's bulk density, compressive strength, and water absorption were among the several characteristics that were identified. Before the experiment was conducted, the normal consistency, initial and final setting times, and compressive strength of the cement employed were found to be 27%, 120 minutes, 290 minutes, and 40.34 N/mm2, respectively*

Keywords: Expanded Polystyrene, Crumb Rubber, Grade M20, M15 Concrete Samples, Concrete Brick's Bulk Density, Compressive Strength, Water Absorption

I. INTRODUCTION

Bricks are currently the most commonly used building material. In order to prepare bricks, clay is moulded into identically sized rectangular blocks, which are then dried and burned. Common burnt clay bricks, fly ash clay bricks, engineering bricks, concrete bricks, and sand lime bricks (calcium silicate bricks) are the primary types of bricks used in brickwork. Concrete is a multipurpose, composite material. The components of concrete are in high demand since it is one of the most often used building materials worldwide. Concrete's primary ingredients are aggregate, sand, and cement. Since river sand is readily available in the natural world, it has been a key component of concrete in Nepal. Using river sand is common. The usage of river sand has skyrocketed in tandem with the rise in building activity. Over-excavation of river sand is turning into a major environmental problem. Furthermore, the majority of aggregates come from the environment, and a great deal of environmental issues and natural disasters are caused by the excessive exploitation of sand and aggregate. To lessen the usage of these fundamental component materials, it is consequently vital to investigate alternative solutions. As a result, it will take time to replace the natural river sand and aggregate in concrete. Crumb rubber, a recycled rubber made from used car and truck tires, is one of the possible marginal materials appropriate for substituting sand in concrete. Tyre trash has grown to be a significant ecological and environmental issue. Rubber waste from tires can take over 50 years to decompose, and the quantity of tires thrown away increases each year. As a result, recycling garbage becomes increasingly important. Natural sand extracted from riverbeds is the most commonly used fine aggregate in concrete. Yet, the excessively nonscientific way of mining from riverbeds, lowering of the water table, sinking of bridge piers, etc., is creating a need for river sand availability for the preparation of concrete. Finding alternatives to river sand for use in concrete manufacturing is therefore in great demand. The selection of substitute materials for sand a number of variables, including their availability, chemical composition, and physical characteristics, go into making concrete. Nowadays, finding alternatives to river sand for concrete production is necessary. The use of crumb rubber as a new brick material supplement has been the subject of a recent, fruitful study that suggests it may be a viable solution to both the environmental issue and the issue of economical building design. Currently, a significant amount of the waste used in this study is disposed of in sanitary landfills or openly dumped into waste pits and open spaces. In a similar vein, coarse aggregate can be substituted with expanded polystyrene (EPS). An

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EPS product is a thermoplastic that is robust, lightweight, and long-lasting. EPS is composed of expanded polystyrene beads and is typically white in colour. The packaging and construction industries might benefit from EPS because of its low weight, high robustness and superior qualities for thermal insulation. EPS has a strong defence against biological deterioration. As an insulating substance, it also lessens the impacts of moisture and water vapour. Both waste management and garbage disposal are under risk from EPS. Environmentalists are concerned about this material.

II. LITERATURE REVIEW

Oyedepo et al.,(2014) investigated the properties of concrete using sawdust as partial replacement for sand. The concrete mix ratio of 1:2:4 was prepared using water/cement of 0.65 with 0%, 25%, 50%, 75% and 100% sawdust as partial replacement for fine sand. Using sawdust in a proportion greater than 25% replacement of sand is detrimental to strength and density properties of concrete.

Cammille A Issa, et al conducted research on recycled crumb rubber as a substitute for fine aggregate in concrete at 0% to 100% replacement to crushed sand in concrete mix. The result of research showed that 25% Replacement of crushed sand gives good compressive strength and by using crumb rubber up to 25% results in 8% decrease in density of concrete and ductility of concrete increases therefore it is useful in shock resisting element , highway barrier etc. And also damping properties improves.

F.pache co-Torgal et al studied the effect on fresh and hardened concrete properties by using polymeric waste like tyre rubber and PET bottles in concrete mix. The research result showed that with increase in rubber content workability (slump) increases, and the properties like compressive strength, split tensile strength, flexural strength and modulus of elasticity decreases. However, the toughness of concrete mix increases with the higher content of tyre rubber. In another similar research, Ghaly and Cahill carried out experiments with 5%, 10%, and 15% by volume of rubber aggregates in concrete with water and cement ratios of 0.47, 0.54, and 0.61. Around 180 samples were tested for compressive strength. Test results showed that compressive strength reduces for rubber mix concrete by 10-30%. The author suggests that such rubber mix concrete is not suitable for critical building components. However, this can have application in non-load bearing structures and road paving works. (Ghimire,2018) experiment on the properties of Concrete brick with partial replacement of Sand by Saw Dust and Partial Replacement of Coarse Aggregate by Expanded Polystyrene. The final result of experiment showed that water absorption of prepared M15 and M20 concrete brick samples increased with increase in percentage replacement of sand by saw dust and EPS by coarse aggregate. Compressive strength and Bulk density of prepared M15 and M20 concrete brick sample decreased with increase in percentage content of saw dust and EPS. The result of the experiment show that partial replacement of sand by saw dust and coarse aggregate by EPS in concrete brick sample had sufficient strength as compared to common bricks. (Bhatta,2019) experiment on properties of concrete brick with complete replacement of sand by Brick Dust Waste and Partial Replacement of Coarse Aggregate by EPS.

Sr no.	Author Name	Year	Results
1	Dr.M.A. Ismail et al.	2009	has studied the properties of ordinary Portland cement by adding different type natural fibres
2	Oyedepo et al.	2014	investigated the properties of concrete using sawdust as partial replacement for sand.
3	Jayaprada et al.	2015	has found there is an increase in compressive strength of concrete of grade M20 up to an addition of 1.25% of coir fibre in addition of sisal fibre
4	Shreeshail.B.H et al	2015	has studied the behaviour of concrete by adding coir fibre. As per his research he has found that there is increase in the compressive strength of concrete by adding coir fibre in it.
5	Cammille A Issa, et al.	2015	conducted research on recycled crumb rubber as a substitute for fine aggregate in concrete at 0% to 100% replacement to crushed sand in concrete mix.
6	F.pache co-Torgal et al.	2016	studied the effect on fresh and hardened concrete properties by

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			using polymeric waste like tyre rubber and PET bottles in concrete mix
7	Ghaly and Cahill,	2017	arried out experiments with 5%, 10%, and 15% by volume of rubber aggregates in concrete with water and cement ratios of 0.47, 0.54, and 0.61
8	Ghimire,	2018	experiment on the properties of Concrete brick with partial replacement of Sand by Saw Dust and Partial Replacement of Coarse Aggregate by Expanded Polystyrene
9	Bhatta,	2019	experiment on properties of concrete brick with complete replacement of sand by Brick Dust Waste and Partial Replacement of Coarse Aggregate by EPS

The final result show that with increased in percentage of EPS, compressive strength of the Brick sample decreased. The result showed that concrete brick made with replacement of sand by BDW and partial replacement of coarse aggregate by EPS had enough compressive strength as compare to common brick. The result obtained from research show that with whole replacement of sand by brick dust and upto 30% partial replacement of coarse aggregate by expanded polystyrene, the concrete brick so produced can be used for masonry unit in construction of building.

III. MATERIALS USED

Following materials were used in this research work:

- OPC cement
- Sand
- Coarse aggregates
- EPS
- Crumb rubber and
- Water

Following equipment/machines available in Central Material Testing Lab in Institute of Engineering, Pulchowk Campus were used for the experimental works:

- Sieve sets as per Indian Standard
- Sieve Shaking Machine
- Volumetric Flask
- Vicat Apparatus
- Buckets
- 240*115*57 mm brick moulds
- Curing tank
- Electronic Balance
- Compressive Strength Testing Machine
- Others

IV. SAMPLE PREPARATION

A typical ordinary brick in Nepal is 240 mm by 115 mm by 57 mm. Six identically sized moulds were thus produced for sample manufacturing so that their characteristics could be compared with those of bricks made in Nepal. Different M15 and M20 grade concrete brick samples were created by partially substituting coarse aggregate with EPS and crumb rubber for sand. For the mix, volume batching was employed. For M15 grade concrete brick, three samples of each sample type A, B, C, and D were created. As a result, twelve samples of M15 grade concrete brick were produced. Sample type A served as the M15 grade control sample, while samples types B, C, and D were created by substituting10%,20%, and 30% of the sand is made of crumb rubber, and the coarse aggregate is made of EPS.

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V. RESEARCH METHODOLOGY

A structure developed to obtain answers to research questions is known as a research design. Since the focus of all of the research conducted here is laboratory experimentation, the research methodology used can be regarded as experimental study.

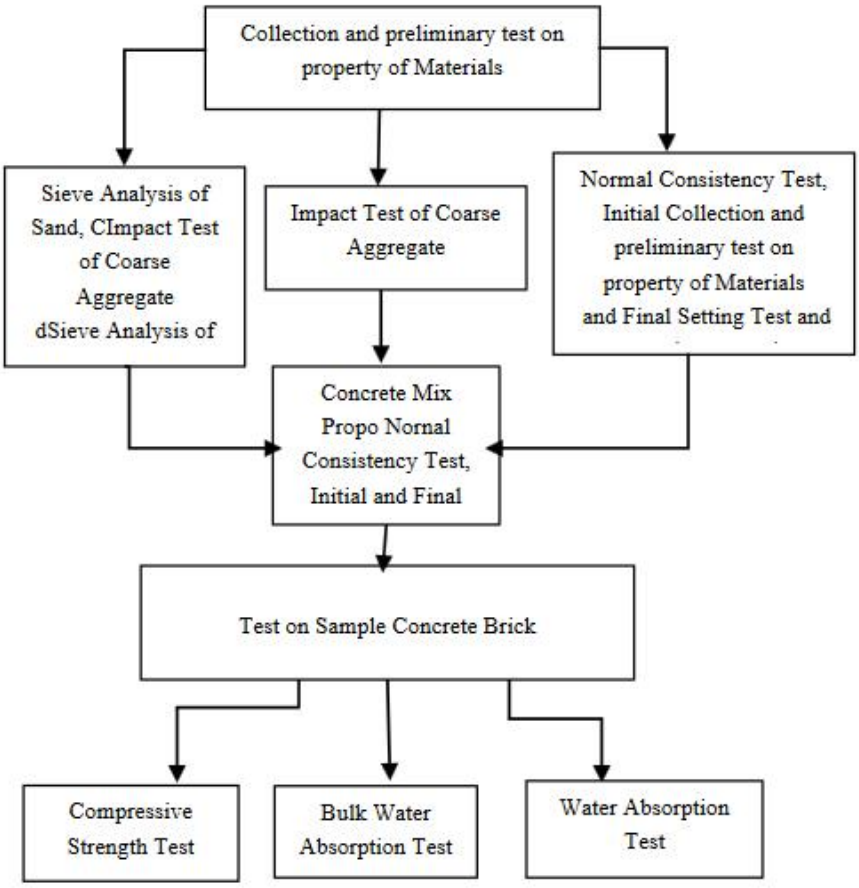

Figure 1- Flow chart of research methodology

VI. CONCLUSION

When the percentage content of crumb rubber and EPS was increased from 0% to 30% as a partial replacement of sand and coarse aggregate, respectively, the compressive strengths of M15 and M20 concrete brick reduced from 10.08 to 9.41 MPa and 26.08 to 13.76 MPa, respectively. Similarly, while increasing the percentage content of crumb rubber and EPS as partial replacement of sand and coarse aggregate, respectively, from 0 to 30%, the bulk densities of M15 and M20 concrete brick decreased from 24.36 to 20.3 KN/m3 and 24.23 to 21.21 KN/m3, respectively. This demonstrated that adding more EPS and crumb rubber to concrete brick makes it lighter. Similarly, M15 and M20 concrete brick's water absorption rose from 2.61 to While increasing the percentage content of EPS and crumb rubber to partially replace sand and coarse aggregate, respectively, from 0% to 30%, the corresponding percentages were 2.56% and 2.31 to 2.71%. The findings showed that as the fraction of sand replaced by crumb rubber and coarse aggregate by EPS increases, so does water absorption.

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