International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
"International Conference on Modern Trends in Civil Engineering"(ICMTCE-2019)
(Towards Sustainable Development Goals)
Volume 5, Special Issue 02, Feb.-2019

Replacement of fine aggregate and coarse aggregate with crushed concrete and expanded polystyrene in M25 Grade Concrete

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ABSTRACT- This paper deals with the possibility of using fine aggregate and coarse aggregate as crushed concrete and expanded polystyrene. An experimental program based on one variable (proportion of fine aggregates and expanded polystyrene replacement) was implemented. The proportions of replacement were 5%, 10%, 15%, and 25% by mass of aggregates. Several mechanical properties were tested as compressive and tensile strengths. The results show a good correlation between aggregates replacement percentage and concrete properties. Concerning mechanical properties, a gradual decrease in compressive, splitting, and flexural strength with the increase in recycled aggregate percentage is shown

Keywords- flexural strength, compressive strength, aggregates

INTRODUCTION

Concrete:

Concrete is mostly known as a grey material with good mechanical strength, but heavy and cold. It is generally understood that concrete is not necessarily just heavy, sharp-edged grey blocks. It can acquire any shape, color, density and strength. It could be defined as a composite material that consists of a cement paste within which various sizes of fine and course aggregates are embedded. It contains some amount of entrapped air and may contain purposely-entrained air by the use of air-entraining admixtures. Various types of chemical admixtures and/or finely divided mineral admixtures are frequently used in die production of concrete to improve or alter its properties or to obtain a more economical concrete.

Since the cement paste is a plastic material when the cement and water are first mixed, the concrete is also plastic when first mixed. As, cement paste gains the rigidity and hardness (due to chemical reactions taking between the cement and the water) as time passes, the plastic concrete mixture also gains rigidity and hardness with time. Therefore, by placing die plastic concrete mixture into a mold having the desired shape and dimensions, a rock like material having the desired shape and dimensions is obtained when dimensions concrete hardness.

1.1.1 Classification of Concrete:

Concretes are grouped in to three according to their unit weights:

I. Heavy concrete**:** Unit weight is in the range of 3200kg/m3-4000kg/m3 and his kind of concrete used in nuclear reactors.

II. Normal concrete**:** Unit weight is in the range of 2400 kg/ni3-2600 kg/m3.
III. Lightweight concrete: Unit weight is less than 2000 kg/m3.

1*.1.2 Advantages:*

The popularity and wide use of concrete as a construction material derives from its advantages over other construction materials. Some of these advantages can be listed as follows:

- Concrete has the ability to be cast in any desired shape since it is in a plastic condition when the materials are mixed and hardens as time passes.

- Concrete is durable because it does not easily lose its quality as steel, does corrode, and as timber, does decay with time.
- Concrete is economical
- Because of the abundance and relatively low price of the aggregates which constitute about three fourths of its volume.
- Because of the low maintenance cost.

1.2 Concrete Making Materials:

1.2.1 Cement**:** Cement is a general term that can apply to all binders. There is a wide variety of cements that are used in the construction and building industries. The chemical composition of these cements can be quite diverse, but by far the greatest amount of concrete used today is made with Portland cements.

1.2.2 Aggregates: Aggregates generally occupy 70 to 80 percent of the volume of concrete and can therefore be expected to have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone or natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent, mostly in lightweight concretes. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance.

1.3 Expanded Polystyrene Beads (EPS):

Expanded polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. Therefore, it has a good sound and thermal insulation characteristics as well as impact resistance.

EPS is an inert material which is quite resistant to alkalis, methanol, ethanol silicon oils, halide acids, oxidizing and reducing agents. However, it has limited resistance to paraffin oil, vegetable oils, diesel fuel and Vaseline, which can attack the polystyrene foam after long term contact.

Polystyrene material undergo deterioration slightly of their mechanical properties when temperature is increased to its 'glass transition temperature' (Tg) which is ranging from 71°C to 77°C **(Ravindrarajah et al.,1994).** But, the level of toxicity of EPS when it is burnt is no greater than those from wood; similar toxic gas, carbon monoxide and carbon dioxide are produced.

1.3.1 Production Techniques of Expanded Polystyrene:

Unexpanded polystyrene beads' sizes usually range from 0.25 to 2.5 mm in diameter and dry density from 550 to 800 kg/ m^. For use in concrete, the polystyrene beads have to be expanded. The expanded polystyrene beads are produced using a chemical process called 'Chain polymerization'. Styrene monomer which made from benzene and ethylene is converted to linear polymer polystyrene in this process. During polymerization process, the double covalent bond between the carbon atoms is broken and redistributed to the end of the monomer to allow another styrene monomer to join. This process is continued until a long chain molecule is formed.

***1.4.1 Advantages of Expanded Polystyrene Concrete*:**

The structural use of is of much interest to engineers since it is possible that structural members made with polystyrene aggregate concrete could have the following advantages over those made weight normal weight concrete **(Tengku** et **al.2006),** such as:

- The lighter weight precast polystyrene aggregate concrete members would be easier to handle.
- The formwork would need to withstand a lower pressure.
- The size of the foundation can be reduced.
- The lower thermal conductivity of polystyrene aggregate concrete would improve the fire rating of the building.

1.4.3 Application of Expanded Polystyrene Concrete:

The properties of EPS lightweight concrete can be exploited in a number of ways from its use as a primarily material in wide different applications such as:

Generally, it is used in combination with other materials like steel (to make sandwich panels) which usually used for cold store construction, as the expanded polystyrene is good as a thermal insulation.

Due to its good energy absorbing characteristics, polystyrene concrete can also be used as a protective layer of a structure for impact resistance, especially for the protection of buried military structures and fenders in offshore oil platforms. Principally, expanded polystyrene concrete is used for prefabricated non-load bearing panels, hollow and solid block, lightweight sandwich panels.

1.5 Crushed concrete (Recycled Aggregate):

The protection of the environment is a basic factor, which is directly connected with the survival of the human race. Parameters like environmental consciousness, protection of natural recourses, sustainable development play an important role in modern requirements construction works.

Construction materials are very significant in our lives, because we spend 90% of our time in buildings or infrastructures (roads, highways, bridges, etc.). The section of construction materials corresponds to 3–4% of the total product in Europe, and the construction industry, as well as construction works, occupies millions of people. However [1], in a parallel manner the construction section is responsible because it:

1.*5.2 Advantages of re-use crushed concrete:*

1-***Environmental considerations*.** In this time of increasing attention to the environmental impact of construction and sustainable development, Portland cement concrete has much to offer:

2-***Economic factors.*** Recycling concrete is an attractive option for governmental agencies and contractors alike. Most municipalities impose tight environmental controls over opening of new aggregate sources. In many areas, increase of the cost of starting new quarries is increased. For demolition contractors, landfill space is limited and can be far away, especially in urban areas. Hence, the disposal of old concrete and masonry is costly. Also, dumping fees will most likely rise as construction debris increases and the number of accessible landfills decreases. Furthermore, the cost and transport distances of conventional aggregates could continue to increase as sources grow scarce.

3-***Other uses*:** Unprocessed RCA is useful to be applied as many types of general bulk fill, bank protection, sub-basement, road construction, noise barriers and embankments. Processed RCA can be applied to new concrete for pavements, shoulders, median barriers, sidewalks, curbs and gutters, and bridge foundations. It also can be applied to structural grade concrete, soil-cement pavement bases, lean concrete and bituminous concrete (PCA 2008). Also, it has been used to produce high strength concrete (Nelson et al 2004).

LITERATURE REVIEW

2.*1 GENERAL*:
Concrete is a composite material that consists of cement, fine aggregate, coarse aggregate and water. The strength and fire resistance of concrete mainly depends on coarse aggregate, which is facing a severe problem of scarcity due to several reasons. Many investigations by researchers have been reported on the replacement of coarse aggregate with EXPANDED POLYSTYRENE & fine aggregate with CRUSHED CONCRETE (RE-CYCLED CONCRETE).

1. Ben Sabaa and Sri Ravindrarajah: They examined the building properties of expanded polystyrene aggregate (EPS) concrete with somewhat substituting normal coarse aggregate with chemically treated approximate volume of EPS at the stages of 30, 50. and 70%. Finally observe that unit weight, compressive strength, drying shrinkage and creep increases by increasing EPS substitution in concrete.

2. Miled, K., K. Sab and R. Le Roy: They were explored the Particle size impact of the polystyrene beads on the compressive strength of EPS Crete. It was watched that smaller the size of EPS beads, increases .The concrete compressive quality. for a similar concrete porosity.

3. Abdulkadir Kana and Ramazan Demirbodaba: They have done an exploratory examination on the impact of the proportion of EPS beads to cement in concrete. By this trial and study they carried out EPS concrete. It has been discovered that the density of EPS concrete has been altogether affected by the Portland Cement/EPS proportion. Slump value than the w/c ratio are affected by Higher Densities.

4- Rakesh Sakale et. al (2015):

studied the replacement of fine aggregate by crushed concrete in steps of 5%, 10%, 20%, 30% and 40% respectively by volume of cement and its effects on compressive strength, split tensile strength, workability and flexural strength are determined. It is found that the compressive, flexural and split tensile strengths of concrete increase initially as crushed concrete increases and become maximum at about 20% and later decrease. The workability of concrete reduces monotonically as the replacement percentage increases.

7-**Chikhalikar S.M. and Tande S.N(2012):**

There is a need to replace a part of fine aggregate by re-use concrete to reduce the consumption of fine aggregate and the environmental pollution can be checked to some extent. Recently the research has shown that the waste glass can be effectively used in concrete as fine aggregate. Crushed concrete when grounded to a very fine powder shows some cementations properties because of silica content. Therefore the crushed concrete to some extent can replace the cement and fine aggregate, contributes for the strength development and also enhances durability of the concrete.

4. CONCLUSIONS

The following conclusions were drawn from the study.

1. Increase in the EPS beads content in concrete mixes reduces the compressive and tensile strength of concrete.

2. All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.

3. Workability increases with increase in EPS beads content.

4. The replacement by using EPS has shown a positive application as an alternate material in building nonstructural members, and it also serves as a solution for EPS disposal.

5.Obtained results suggest that expanded polystyrene concrete has scope for nonstructural applications, like wall panels,partition walls, etc.

6-The rate of gain of early compressive strength is less compare to that of control concrete. 7-The rate of gain of 7days and 28 days compressive strength had increased.

8-The split tensile strength shows alternate increase and decrease in early strength for various percentages of replacement, whereas the 7days strength 50%and 100% replacement of fine aggregate with crushed concrete has shown increment in strength than that of control concrete

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