

Title of Thesis: Behaviour of Concrete Incorporating Recycled Aggregates and Nanosilica

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ABSTRACT

Environmental protection, shortage of land for waste disposal, and increasing costs of waste treatment prior to disposal are main reasons for increasing interest for the recycling of construction and demolition waste materials throughout the world. The use of recycled concrete aggregates is encouraged due to following three reasons: conservation of natural resources, minimization of overall construction cost, and reduction of pollution. The concrete produced from the demolition of the concrete elements of buildings, roads and other infrastructure are termed as waste concrete. Aggregates are produced by crushing and sieving of the waste concrete is known as recycled aggregates and basically, recycled aggregates are of two types: recycled coarse aggregate and recycled fine aggregate.

The present work addresses the behavior of concrete using recycled coarse aggregates and nano-silica to develop sustainable construction material. The recycled coarse aggregates are retrieved from the construction and demolition waste collected from the demolition site of Jhargram city (a city of Eastern India). Furthermore, colloidal Nano-Silica has been utilized to study properties of concrete mixes. In addition to above, the behaviour of cement paste and mortar containing nano-silica has been studied.

The entire study is divided into five phases:

- **Phase I:** The physical and mechanical characteristics of recycled coarse aggregates obtained from field sources are determined as per procedures of IS: 2386 (1963) and compared with those values with natural coarse aggregates. Furthermore, characterization of cement and nano-silica has been done by performing standard tests.
- **Phase II:** The influence of water/cement ratio and addition of nano-silica as partial replacement of cement on the compressive strength and water absorption of mortar mixes is addressed in this phase using 3^2 factorial design of experiments.
- **Phase III:** In depth investigation of designed concrete mixes incorporating various percentages of Nano-silica accordance with the procedures of Bureau of Indian standards is carried out to study the various properties of concrete in the third Phase.
- **Phase IV:** In this phase, the influence of factors recycled coarse aggregate (%) and nano-silica (%) of various properties of concrete has been analyzed using general factorial design.
- **Phase V:** A detailed investigation is conducted on the microstructural characteristics (porosity, unhydrated cement and microhardness) of interfacial transition zone for better understanding the difference between various concrete mixes.

The study illustrates that behaviour of concrete mixes made with 100% recycled aggregates are inferior to that of concrete with natural aggregates. Furthermore, addition of colloidal Nano-Silica compensates the degradation in properties due to the substitution of natural coarse aggregates by recycled coarse aggregates.

Keywords: *Cement paste and mortar; Colloidal nano-silica; Factorial designs; Interfacial transition zone; Recycled aggregate concrete; Strength; Microhardness.*