ABSTRACT

Concrete is a widely used material in the world. More than ten billion tonnes of concrete are consumed annually. Conventional concrete is a versatile material and it is a mixture of cement, sand, aggregate and water. Aggregates occupy 65 to 80% of the total volume of concrete and affect the fresh and hardened properties of concrete. Out of the total composition of aggregate, the fine aggregate consumes around 20 to 30% of the volume.

Sand is the most widely used fine aggregate in the process of manufacturing concrete. The river beds are the main sources for the natural sand. These natural resources are getting depleted very fast, due to over exploitation and contamination by chemicals and waste from nearby industries. The natural sand is transported from its available places to the construction sites. Transporting river sand to the construction sites increases its sale price significantly. The primary use of sand is in the manufacture of concrete and concrete products. The natural sand is deficient in many aspects to be used directly for concrete production, due to some of the following reasons: It contains an organic and soluble compound that affects the durability of concrete and therefore it shortens the life of the concrete product and the extraction of the sand from river bed in excess quantity is hazardous to the environment. To protect the river beds against the erosion and to ascertain the importance of having natural sand as a filter for ground water, periodic restrictions are being introduced by governmental authorities against
the collection of river sand. Due to short supply of natural sand and the increased activity in the construction sector, there is an acute need for a product that matches the properties of natural sand in concrete.

The manufactured sand which is available in abundance in various quarries is one of the major alternative material that can be used instead of natural sand in concrete. The manufactured sand is a by-product of the crushing and screening process in the quarries. Production of aggregates from crushed rocks generates a large proportion of fines. Quarry fines consist of a graded mix of coarse, medium sand and fine sand sized particles, plus clay/silt fraction known as the ‘filler’ grade. Filler grade material is defined by the industry as the material less than 0.075mm (75 microns) in size. The filler grade content of these fine material is reduced by washing it with water that produces a clean, saleable ‘sand’ product.

The scope of the present study is to investigate the effect of the physical and chemical properties of manufactured sand towards the performance of M 20, M 30 and M 40 grade concrete. An effort has been made to focus on the replacement of natural sand with manufactured sand from 0% to 100% on concrete properties.

The physical and chemical properties of manufactured sand such as specific gravity, fineness modulus, water absorption, surface moisture, size, shape, chemical composition and minerals present in it were experimentally determined and compared with those properties of natural sand. Mix design has been prepared by incorporating the specific gravity, fineness modulus,
water absorption and surface moisture values of various proportions of manufactured sand.

For various replacement levels of manufactured sand, the fresh and hardened properties of concrete such as workability, compressive strength, splitting tensile strength, flexural strength, modulus of elasticity and Poisson’s ratio were investigated at different curing periods and the optimum replacement level was determined. Based on these, the relationship between the mechanical properties of concrete was arrived at.

The durability properties such as alkali aggregate reaction, drying shrinkage, impact strength, abrasion, rapid chloride ion penetration, corrosion, acid attack, water absorption, sorptivity and water permeability tests were carried out on mortar and concrete specimens with 100% natural sand, 100% manufactured sand and for the optimum replacement level.

The micro structural properties of concrete with natural sand and manufactured sand were determined by Scanning Electron Microscopy (SEM) coupled with Energy Dispersive Spectroscopy (EDS) and X – Ray Diffraction (XRD) analysis. Those results were confirmed with the shape of the particles and the elements present in it.

The structural behaviour like load carrying capacity, ductility factor, energy absorption capacity, toughness indices and stiffness of Reinforced Cement Concrete (R.C) beam with manufactured sand were experimentally determined and compared with those of the conventional concrete specimens.
An analytical model was developed using finite element analysis software (ANSYS) from the experimental investigations, so as to arrive at the structural properties of any concrete mix just by giving its Young’s modulus and Poisson’s ratio values.

From the studies conducted, it was concluded that the manufactured sand can be used for the preparation of the concrete as far as the mechanical properties, durability properties and structural behaviour of the concrete are considered. It was noticed that the mechanical, durability and structural properties of concrete with manufactured sand increased when the replacement level of manufactured sand content also increased. However, these properties of the concrete with manufactured sand are higher for the proportion of 70% manufactured sand blending with 30% natural sand. Hence it is recommended that the manufactured sand can be used as fine aggregate in concrete.