Strength of Concrete using Clay as a Partial Replacement of Binder Content with and Without Lime

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Abstract: Materials are the most important component of building construction.}The demands of construction material are increasing day by day significantly. This demand is increasing the material prices and scarcity of material in construction industry. To achieve economical and eco-friendly criteria naturally occurring material is selected. Clay is a natural material and it can be available easily. This paper interprets the experimental investigation on strength of concrete using clay as a partial replacement to binder content (cement) in concrete. The replacement percentages are grouped as 0%, 10%, 20%, 30%, 40% of clay and 5% of hydrated lime with cement in each series in M25 grade of concrete. To achieve the pozzolanic property of clay hydrated lime was added. Different tests are performed to determine the optimum percentage of clay as a replacement for binder content (cement) in concrete. The Compressive strength test, split tensile strength test and flexural strength test were performed on the specimens. Total 90 cubes of size 150 mm were prepared for compressive strength test, 30 cylinders of 150 mm diameter and 300 mm height were prepared for split tensile strength test and 30 beams of size 150 mm x 150 mm x 1000 mm were prepared to carry out the flexural strength test. The results are compared to find the ideal proportion of clay as a replacement for cement. It is found that 10% replacement with 5% hydrated lime gives satisfactory results.

Keywords: Clay, Concrete, Hydrated lime, Partial replacement, Pozzolanic property, Replacement percentage.

I. INTRODUCTION

In construction industry concrete is used very widely. It provides good strength, durability, impermeability, resistance to fire and abrasion, etc. Cement is the main component for making concrete. The environmental degradation took place by the use of various materials in the building construction. These materials are cement, sand, bricks, steel, wood, glass, tiles, etc. Sometimes harmful pollutants are released by building materials damaging the environment [1]. In the production of cement, there is a large magnitude of creation of CO2 gas which is hazardous to our environment [2]. Today, the rise in demand for materials in building construction has resulted in significant degradation of natural resources. For this, it is beneficial to choose eco-friendly materials to achieve the structural economy. The mud concrete can be prepared by taking into account strength and durability parameters [3]. Clayey soil performs a vital role in increasing the strength and ductility of stabilized soil [4]. In some cases, calcined material is used to improve the initial and final strength of Portland cement. But it is required to find its long-term durability effect [5], [6].

Marine clay stabilization can be done by replacing cement with wood – ash. The parameters considered are unconfined compressive strength, shear modulus at the initial stage and shear strength [7]. The termite clay as a replacement to cement in roofing tile is investigated and optimum 10% replacement in cement is found appropriate [8]. Cement can be replaced by fly ash and lime sludge (as a water softening sludge) in the preparation of mortar [9]. In some cases, Indian calcium bentonite is used as a replacement for cement [10]. The industry-produced quicklime can be used for activation of clay as a cementitious material [7]. Such replacement will decrease the production of greenhouse gases and cement production costs [11]. The construction industry is using clay as a natural abundantly available material. It is a natural pozzolana available on earth [12]. Soil efficiency can be improved using clay minerals formulating epoxy resin cement clay mixtures [4].

Clay is an economical and effective alternative for the construction of low-cost housing units. It is widely used in tropical regions where very limited resources are available [3]. Clay is used as a binder in construction for many years and still worked well. The particle size of clay is less than 2 microns which exhibits plasticity characteristics by absorbing water and shrinks after removing the water. The three main clay minerals are Kaolinite, illite, and montmorillonite. Kalins pozzolanic reactivity with calcareous montmorillonite can be used [2]. Kaolinite clay can be used as an admixture in concrete to improve strength, workability and chloride diffusion coefficient [13]. The cement paste is verified for its porosity characteristics and microstructure is assessed. The most stable clay is Kaolinite. Montmorillonite soils are quite expansive and swelling in nature whereas illite clay comes in between. An optimum dose of 20% bagasse ash with soft clay is found suitable for the replacement of Ordinary Portland Cement [14]. To activate the clay as a cementitious material, industry-produced quicklime is required [11].

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