Chapter-1

INTRODUCTION

One of the basic infrastructural facilities that man needs for good living is shelter. The development of technology in materials and construction has made it possible to build even skyscrapers. However, the increasing cost of conventional construction materials has made it difficult to meet the shelter requirements of the teeming population of developing countries.

Fast expansion of the construction industry brought forth with it associated problems. The most widely used construction material is concrete, commonly made by mixing portland cement with sand, crushed rock and water. Man uses no material except water in such huge quantity. The conventional fine aggregate used in concrete is river sand. This is fast becoming a rare and expensive commodity. Uncontrolled sand mining from river beds leads to problems like bank erosion lowering of water table and other adverse effects to the environment. Similarly, quarrying of granite is the main source of coarse aggregate and that also causes environmental issues. It is high time to think about an alternative to the aggregates. The necessity of using locally available materials (marginal materials) for the production of concrete is the need of the hour, particularly in fast developing countries like India.

Laterite is one such marginal material abundantly available in many parts of the world, particularly in tropics and sub tropics. In India, there are large deposits of laterite in the peninsular region, which have not been fully utilised so far.
Laterite is the product of intensive and long lasting tropical rock weathering which is intensified by high rain falls and elevated temperature. Laterite consists mainly of the minerals kaolinite, goethite, hematite and gibbsite which form in the course of weathering. Moreover, many laterite deposits contain quartz as relatively stable relic mineral from the parent rock. The iron oxides goethite and hematite cause the red brown colour of the laterite.

Laterised Concrete (LC) can be defined as the concrete in which part or all the fine and course aggregates are replaced by laterite aggregate. The utilisation of laterised concrete as a construction material has not yet become popular due to lack of proper understanding about its behaviour. Even though studies on the use of lateritic soil in concrete has been carried out in countries like Australia, Nigeria, the U S and India, they are limited to either the replacement of sand in concrete or its use as sub grade material in road construction. No systematic study has been reported on the suitability of laterite concrete as an alternative to conventional concrete, especially with laterite coarse aggregate.

Industrial by-products, such as fly ash and slag, invariably contain small quantities of toxic metals. The practice of using these for land filling, dumping into streams and ponds or even stockpiling, presents serious health hazards. However, when utilised in blended portland cements or as mineral admixtures in concrete, the toxic metals become immobilised in the form of insoluble products of cement hydration and thus are rendered harmless. Also these industrial by-products which are generally pozzolanic or cementitious serve as supplementary cementing materials and enhance durability and other engineering properties of portland cement concrete products. Combined use of laterite aggregate and supplementary cementitious materials may lead to an economical concrete.
Self Compacting Concrete (SCC) is an innovative concrete made with same materials of normal concrete that does not require vibration for compaction. It flows under its own weight; completely filling formwork and achieves full compaction, even in the presence of congested reinforcement. The hardened concrete is dense homogeneous and has even better engineering properties and durability compared to traditional concrete.

The type of aggregate used has influence on spalling of concrete when exposed to fire (high temperature). Marginal materials like laterite might perform better because of their better thermal stability.

Hence a comprehensive study on the physical and mechanical properties of laterised concrete is required to confirm the suitability of laterised concrete for construction purpose.

In cases where compaction and placing are difficult, such as jacketing of structural steel element for fire protection, casting of ferrocement element etc., self compacting concrete is a better choice than conventional concrete. Most of the existing studies in this area are focused on the strength behaviour of concrete subjected to elevated temperature but not in line with it as a fire protection material. Apart from mechanical properties, formation of cracks, its pattern, spalling of cover concrete, colour changes etc., should also be considered while using concrete as a fire protection material. Only limited information is available with regard to the thermal properties of laterised concrete (LC) and Laterised Self Compacting Concrete (LSCC) which are subjected to elevated temperatures.

Ferrocement is a form of reinforced concrete using closely spaced multiple layers of mesh or small diameter rods completely infiltrated with and encapsulated in mortar. The most common type of reinforcement is steel mesh.
Other materials selected- organic, natural, or synthetic fibers may be combined with metallic mesh. Applications of ferrocement are numerous, especially in structures or structural components where self-help or low levels of skills are required. Besides boats and marine structures, ferrocement is used for housing units, water tanks, roofing sheets etc..

In the present investigation, it is proposed to conduct a systematic study to check the suitability of laterite aggregate for preparing concrete and self compacting concrete and the performance of such concrete when exposed to elevated temperatures. This investigation includes behavioral study of concrete with different types of cements, supplementary cementitious materials (fly ash and ground granulated blast furnace slag), development of mix design methodology for laterised self compacting concrete, shear strength parameters and behaviour of ferrocement element made with laterised self-compacting concrete.

The contents of various chapters of this thesis are briefly described below.

Chapter 1 is the introductory chapter and makes general observations on the need of the present research work and the highlights of the present study. A brief outline of each chapter is also presented here.

Chapter 2 presents a review of the investigations carried out by earlier workers. Details of laterite aggregates, influence of types of cements and supplementary cementitious materials in concrete, behaviour of concrete, self compacting concrete, ferrocement and influence of temperatures on concrete are the key areas of review. A critical discussion has been presented based on the review of literature specific to area of study. Scope and objectives of the
present study have been derived based on the above and the same is presented in this chapter.

Chapter 3 deals with details about various materials used for the present study and their test results. The methods of testing self compacting concrete, heating of specimen etc. are also mentioned briefly in this chapter. An experimental setup for the determination of shear strength (Mode II fracture) of concrete has been fabricated and its details along with test procedure have been presented in this chapter.

Chapter 4 deals with the preliminary study on the suitability of laterite aggregate in concrete. Laterised concrete has been developed either by replacing fine aggregate or by replacing both fine and coarse aggregates in conventional concrete. The properties of laterised concrete at fresh and hardened stages have been compared with the corresponding properties of conventional concrete. To study the influence of the source of laterite aggregate, concrete has been made using laterite aggregate collected from various sources and their properties were compared. The influence of type of cement and supplementary cementitious materials in concrete has also been discussed in this chapter.

Chapter 5 proposes a mix design methodology developed by this researcher for laterised self compacting normal strength concrete (M20 to M40 grade) and provides details about the experimental studies carried out to validate the proposed mix design methodology.

Chapter 6 discusses the influence of various parameters on the physical and mechanical properties of laterised concrete when exposed to high temperature. The laterised concrete specimens, both vibrated and self compacting type, were heated to different temperature levels (200ºC, 400ºC and
600°C). The specimens were then cooled to ambient temperature in two different ways, namely air cooling and water cooling. The shear strength (mode II), influence of temperatures on strengths of concrete, modulus of elasticity, cracking behaviour, colour variation have been discussed in this chapter. The self compacting laterised concrete flexural ferrocement elements at elevated temperatures have also been discussed in this chapter in detail.

Chapter 7 presents the summary of the work carried out and major conclusions derived based on the detailed study and its discussion. Suggestions for further study in the related area have also been given in this chapter.