CHAPTER 1

INTRODUCTION

1.1 GENERAL

Concrete is a commonly used building material in the world. Conventional concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Compare to all other ingredients, aggregates occupy 75 to 80% of the total volume of concrete and affect the fresh and hardened properties of concrete. In the total composition of concrete, 25 to 30% was engaged by the fine aggregate in volume.

The quality of concrete is persistent by its mechanical properties. The mechanical properties mainly divided into short-term and long-term properties. Compressive strength, Split tensile strength, Modulus of Elasticity and Flexural strength are short term properties. Porosity and impermeability are the long term properties.

1.2 HIGH STRENGTH CONCRETE

American concrete Institute defines a high-strength concrete / high performance concrete as concrete that has a specified compressive strength to design of 6,000 psi (41 MPa) or greater. Under the ACI definition durability is optional and this has led to number of High Performance Concrete structures, which should theoretically have had very long services lives, exhibiting durability associated distress early in their lives.

High strength Concrete (HSC) / High performance concrete (HPC) is a concrete made with appropriate materials combined according to a
selected mix design; properly mixed, transported, placed, consolidated and
cured so that the resulting concrete will give excellent performance in the
structure in which it is placed, in the environment to which it is exposed and
with the loads to which it will be subject for its design life. Mix proportions
for high-strength concrete are influenced by many factors, including specified
performance properties, locally available materials, local experience, personal
preferences, and cost. With today’s technology, there are many products
available for use in concrete to enhance its properties.

The strength development with time is a function of the constituent
materials and curing techniques. An adequate amount of moisture is necessary
to ensure that hydration is sufficient to reduce the porosity to a level
necessary to attain the desired strength. Although cement paste in practice
will never completely hydrate, the aim of curing is to ensure sufficient
hydration. In general, a higher rate of strength gain is observed for higher
strength concrete at early ages. At later ages the difference is not significant.

1.2.1 Advantages of HSC / HPC

- Reduction in size of the columns
- Speed of construction
- Workability and pumpability
- Improved durability in aggressive environment
- Durability against chloride attack
- Low shrinkage and high strength
- Service life more than 100 years
- High tensile strength
- Reduced maintenance cost
1.3 MANUFACTURED SAND

The manufactured sand (M-Sand) is prepared either by washing quarry dust, dried and then sieved through 4.75 mm sieve or by using secondary jaw crusher. The M – sand can be manufactured in different zones as Zone II, Zone III as per IS 383-1970. Manufactured sand consists of more angular shaped particles compared to river sand. Thus, the manufactured sand as angular particles produces a better bonding in concrete. Manufactured sand is used in concrete to minimize the waste in stone quarry and to reduce the removal of natural sand.

1.4 INDUSTRIAL WASTES AS FINE AGGREGATE

Manufactured sand is used as an alternative to natural river sand in producing concrete with less porosity. The parent rock for the production of M-sand is a traditional source, which is less available due to more usage of resources. To minimize the use of resource, the alternative waste materials from Thermal Power Plant and Granite Stone processing industry are used as marginal replacement for M-sand in concrete.

1.5 ENVIRONMENTAL PROBLEMS

1.5.1 Granite Powder and its Disposal

Granite is an igneous rock, which is widely used as construction material in different forms. Granite industries produce a lot of dust and waste materials. Granite quarry sludge is the waste from rock processing in quarries and crusher units. Indian granite stone industry produces around 17.8 million tons every year.

There are many granite stone cutting and polishing industries in Tamil Nadu. These industries produce significant amounts of waste in the
form of slurry consisting of lime, granite powder and bon fringes as residues. Presently, the dried slurry is disposed of by filling it in the low lying areas. This leads to changes in soil fertility, pollution of the groundwater and that of the surrounding environment. And also all the processing units are disposing this industrial waste by dumping it in open yards, occupying about 25% of total area of the industry. Presently, the fines are at present disposed by filling in barren land causing serious environmental issues. If this material is possible to be used for partial replacement in building materials, it is of benefit both economically and environmentally. After a detailed investigation of all these factors, it is found that the utilisation of slurry in building blocks and in special concrete was the best methods of disposal. Utilization of granite powder will avoid the disposal problems and related environmental issues. Utilization of granite powder will reduce the usage of M-sand and conserve natural resources.

### 1.5.2 Bottom Ash and its Disposal

Bottom ash is part of the non-combustible residue of combustion in a furnace or incinerator. In industrial context, it usually refers to coal combustion and comprises traces of combustibles embedded in forming clinkers and sticking to hot side walls of a coal-burning furnace during its operation. The portion of the ash that escapes up the chimney or stack is, however, referred to as fly ash. The clinkers fall by themselves into the bottom hopper of a coal-burning furnace and are cooled. The above portion of the ash is referred to as bottom ash too. Coal bottom ash (CBA) is formed in coal furnaces. It is made from agglomerated ash particles that are too large to be carried in flue gases and fall through open grates to an ash hopper at the bottom of the furnace. Bottom ash forms up to 25% of the total ash while the fly ash forms the remaining 75%. It is mainly composed of
silica, alumina and iron with a small amount of calcium, magnesium and sulphate.

Nowadays bottom ash is extracted, cooled and conveyed using dry ash technology from various companies. Dry ash handling has much benefit. When left dry, the ash is used to make concrete and other useful materials.

Bottom ash may be used as raw alternative material, replacing earth or sand, for example in road construction and in cement kilns (clinker production). A pioneer use of bottom ash was in the production of concrete blocks used to construct many high-rise flats in London in the 1960s.

Large quantity (35 million tons) of coal bottom ash is produced by thermal power plants in India. The present method of disposal of coal bottom ash on open land is the main cause of an environment hazard for the surrounding community.

As utilization of coal bottom ash can help in alleviating environmental problems, thus the present work was done to explore the possibility of its use as M-sand replacement in concrete manufacturing.

1.6 ORGANISATION OF THE THESIS

This thesis has been arranged in seven chapters. Brief descriptions of chapters are discussed below.

Chapter 1: Introduction: The first chapter deals with the use of manufactured sand in concrete as fine aggregate. This chapter also comprises the possibility of replacing the M-sand by Industrial waste materials as fine aggregate. It also defines the objectives of the research work.
Chapter 2: Literature Review: This chapter presents the review of literature about the influence of granite powder and Bottom ash on the fresh concrete and its effects on mechanical, durability and structural properties of hardened concrete.

Chapter 3: Experimental Investigation: The third chapter presents the material properties, mix proportions for High strength concrete, strength and durability test procedures and dimension, casting and test procedure of RC beam.

Chapter 4: Strength and durability characteristics: This chapter summarizes the results of strength and long term performance of concrete. This chapter also presents the micro structure analysis of Granite powder and Bottom ash using Scanning Electron Microscopy (SEM) analysis of concrete, Energy Dispersive Spectroscopy (EDS) analysis and X-ray Diffraction (XRD) analysis of elements in Granite powder and Bottom ash.

Chapter 5: Behaviour of RC beam under monotonic loading: The fifth chapter describes the flexural behaviour of RC beam without waste and with waste subjected to monotonic loading under two point loading system.

Chapter 6: Behaviour of RC beam under cyclic loading: This chapter represents the flexural behaviour of RC beam without waste and with waste subjected to cyclic loading.

Chapter 7: Conclusions and suggestion for future research: The seventh chapter presents the conclusions arrived based on the test results and also the suggestion for the further usage of waste in higher percentage.