CHAPTER 2
RESEARCH PLAN

2.1 Statement of the Problem

The construction industry is not sustainable due to various reasons. Primarily it consumes huge quantities of virgin materials. Secondly, the principal binder in concrete is Portland cement, the production of which is not only highly energy intensive but also a significant contributor to greenhouse gas emissions that are implicated in global warming and climate change. Thirdly many concrete structures suffer from lack of durability which has an adverse effect on the resource productivity of the industry. Since the fly ash concrete system addresses all these three sustainability issues, its adoption will enable the construction industry to become more sustainable. Fly ash in concrete reduces the water demand, improves the workability, minimizes cracking due to thermal and drying shrinkage and enhances durability to reinforcement corrosion, sulphate and sea water attack. The countries like China and India, this technology can play an important role in meeting the huge demand for infrastructure in a sustainable manner.

Meet the housing and infrastructural needs of society in a sustainable manner are, unquestionably, the most important challenge confronting the concrete industry today. Among the sustainability issues, the three major ones that are widely discussed may be summarized below:

2.1.1 Climate Change

In many parts of the world, extreme weather patterns are occurring with greater frequency. Most of the scientists believe that this phenomenon is associated with the high emission rates of green-house gases, primarily carbon dioxide, the environmental concentrations of which has increased from 280 to 370 parts per million volumes mainly during the industrial age. The transportation industry and the cement industry happen to be the two largest producers of carbon dioxide. The latter is responsible for approximately 7% of the world’s carbon dioxide emissions.

2.1.2 Resource Productivity

The construction industry is the largest consumer of virgin materials such as sand, gravel, crushed rock, fresh water, etc. It is consuming Portland and modified Portland
cements at an annual rate of about 1.6 billion metric tons. The cement production consumes vast amounts of limestone and clay besides being energy-intensive. Obviously, large amounts of energy and materials, in addition to financial resources, are wasted when structures deteriorate or fail prematurely which, in fact, has been the case with many recently built reinforced concrete bridge decks, parking garages, and marine structures throughout the world. Traditionally, most concrete structures are designed for a service life of 50 years. With the advent of high performance concrete mixtures, some structures are now being designed and built for a service life of 100 years. In the long run, sustainable development of the concrete industry will not take place until it is able to make even more dramatic improvements in the resource productivity. In this context, it should be noted that the Factor Ten Club, a group of scientists, economists and business people have made a declaration that, within one generation, nations can achieve a tenfold increase in their resource productivity through a 90% reduction in the use of energy and natural resource materials.

2.1.3 Industrial Ecology

Achieving a dramatic improvement in resource productivity through durability enhancement of products is a long-term solution for sustainable development. A short-term strategy that must be pursued simultaneously is to practice industrial ecology at a larger scale than is the case today. Simply defined, the practice of industrial ecology by a manufacturing industry involves the reclamation and re-use of its own waste products and, to the extent possible, the waste products of other industries which are unable to recycle them in their own manufacturing process. Reportedly, over 1 billion tons of construction and demolition waste is generated every year. Cost-effective technologies are available to recycle most of the waste as a partial replacement for the coarse aggregate in fresh concrete mixtures. Similarly, industrial wastewaters and non-potable waters can substitute for municipal water for mixing concrete unless proven harmful by testing. Blended cements containing fly ash from coal-fired power plants and ground-granulated slag from the blast-furnace iron industry provide excellent examples of industrial ecology because they offer a holistic solution for reducing the environmental impact of several industries. The construction industry already uses concrete mixtures containing cement replacement materials, such as 15% to 30% fly ash or 30% to 50%
slag by mass. With conventional materials and technology, it is now possible to produce high-performance concrete mixtures containing 50% to 60% fly ash by mass of the blended cementitious material. The fly ash is readily available in most parts of the world. China and India, the two countries that consume large amounts of cement, together produce over 300 million tons of fly ash per year. The technology of fly ash concrete is especially significant for countries like China and India, where, given the limited amount of financial and natural resources, the huge demand for concrete needed for infrastructure and housing can be easily met in a cost-effective and ecological manner.

Because of the incessant generation of solid waste materials, more and more is necessary to develop new technologies that help us to exploit them. In cement and concrete industry the use of waste materials is widely practiced whenever they maintain, (or) more of the goal properties of final products.

2.2 Scope of the work

The scope of the present investigation is to study the different parameters such as physical properties of four types of cement, workability, strength, durability, mineralogy and microstructure behaviour of concrete produced with the four types of cement. An attempt has been made to compare between the above said cements. This study may help us to encourage the increased use of blended cement or use of SCM’s in making concrete for suitable development, harmony and to maintain ecology without compromising with the performance characteristics of concrete including durability.

The structures in coastal region are exposed to severe marine environment. In this context, the present investigation has been taken up for durability studies also to ascertain the type; whether OPC or blended cement concrete that is less susceptible to deterioration under marine environment. This will help in deciding the type of cement best suited for coastal regions.

2.3 Research Objective

The main objective of the investigation is an attempt to compare the properties of fresh concrete, strength and durability properties of hardened concrete, microstructure and mineralogical studies relating to the concrete produced from four different types of cement namely, Portland Pozzolana Cement & Portland Slag Cement (blended cements)
and 43 Grade & 53 Grade OPC. Investigations are carried out on M20, M25 and M30 grade of concrete with a water-cement ratio of 0.55, 0.50 and 0.45 respectively.

The effect of sea water attack, acid attack, chloride penetration and drying shrinkage of concrete containing blended cement particular to Indian environment are proposed to study.

2.4 Research Plan

The research plan has been made as follows to study the following parameters.

- The physical properties of four types of cements.
- Fresh concrete properties such as slump, compaction factor and Vee-Bee tests.
- Hardened concrete properties such as compressive strength, split tensile strength, and flexural strength.
- The resistance to permeability of chloride ions for concrete in accordance with ASTM C1202-94.
- The drying shrinkage of concrete in accordance with ASTM C 157.
- The effect of seawater attack on concrete (M30 grade of concrete) by direct immersion in sea water (back water) for at Kadekar, Udupi.
- The effect of Sulphate attack on concrete by immersing in sulphuric acid (for M30 Grade of concrete).
- Capillary measurement (to determine the water absorption rate) on concrete cylinders (for M30 grade of concrete).
- Mineralogy and microstructure of concrete using XRD and SEM technique (for M25 grade of concrete at 90 days of curing and for M30 grade of concrete at 150, 180 and 210 days of curing).