CHAPTER 1

INTRODUCTION

1.1 General

Concrete is the most widely used man made construction material in civil engineering world. It has specialty of being cast in any desirable shape but plain concrete however possesses very low tensile strength, limited ductility and little resistance to cracking. As a matter of fact, advancement in concrete technology has been generally on the strength of concrete. It is now recognized that strength of concrete alone is not sufficient, the degree of harshness of the environmental condition to which concrete is exposed over its entire life is very important. Therefore, both strength and durability have to be considered explicitly at the design stage. To do this, a durable structure needs to be produced. For concrete buildings, one of the major forms of environmental attack is chloride ingress, which leads to corrosion of the reinforcing steel and a subsequent reduction in the strength, serviceability and aesthetics of the structure. This may lead to early repair or premature replacement of the structure. A common method of preventing such deterioration is to prevent chlorides from penetrating the structure by using relatively impenetrable concrete. The ability of chloride ions to penetrate the concrete must then be known for design as well as quality control purposes. The penetrability of concrete is obviously related to the pore structure of the cement paste matrix. This will be influenced by the water–cement ratio of the concrete, the inclusion of supplementary cementing materials which serve to refine the pore structure and the degree of hydration of the concrete. The highly developed pore structure occurs due to greater amount of heat of hydration which intern depends on the age of concrete. This is especially true for concrete containing slower reacting supplementary cementing materials such as fly ash require a longer time to hydrate [1].

Concrete protects the steel bars for attacks from the environment and preventcorrosion to take place. However, the cracks in the concrete form a problem. Here theingress of water and ions take place and deterioration of the structure starts with the corrosion of the steel. To increase the durability of the structure either the cracks that are formed are repaired later or in the design phase extra reinforcement is placed in the structure to ensure that the crack width stays within a certain limit. This extra reinforcement is then only needed for durability reasons (to keep the crack width small) and not for structural capacity. Especially with current steel prices this extra steel is not desirable. Durability is one reason to prevent cracks or limit crack widths. Other reasons are water tightness of structures, loss of stiffness and aesthetic reasons.If in some way a reliable method could be developed that repairs cracks in concrete automatically, this would increase and ensure durability and functionality developed that repair cracks in concrete enormously. On the other hand it would save a lot of money. Of course repair cracks of cracks that develop in concrete structures would go down. But also the extra steel that is used to limit crack widths could probably be saved to a large extent. Cracks widths in concrete structure should be limited, mainly for durability reasons. If cracks widths are too large the cracks need to be repaired or extra reinforcement is needed already in the design. If a method could be developed to automatically repair cracks in concrete this would save an enormous amount of money, both on the costs of injection fluids fro cracks and also on the extra steel that is put in structures only to limit crack widths. For structural reasons thisextra steel has no meaning. A reliable self-healing method for concrete would lead toa new way of designing durable concrete structures, which is beneficial for national and global economy [2].

Therefore a novel technique has been developed by using a selective microbialplugging process, in which microbial metabolic activities promote calcium carbonate (calcite) precipitation. This technique is referred as Microbiologically Enhanced CrackRemediation (MECR). In this technique ureolytic bacteria are used hence the concrete is called Bacterial concrete.The “Bacterial concrete” can be prepared by adding spore forming bacteria in theconcrete that are able to continuously precipitate calcite, this process of production of calcite precipitation is called Microbiologically Induced Calcite Precipitation (MICP). B Sphaericus is used to induce calcite precipitation in concrete. The basic principle for this process is that the microbial urease hydrolyzes urea to produce ammonia and carbon dioxide and the ammonia released in surrounding subsequently increases pH, leading to accumulation of insoluble calcium carbonate. Bacterial cultures improve the strength of concrete and crack repairs in concrete structures.