

# UNDERSTANDING CONCRETE TECHNOLOGY

(For Civil Engineering Students)



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A MUST-READ BOOK TO STUDENTS PURSUING  
DIPLOMA IN CIVIL ENGINEERING



# Understanding Concrete Technology

(For Civil Engineering Students)

First Edition

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# 1. Introduction to Concrete Technology

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Concrete is one of the oldest and most common construction materials used in the world, mainly due to its low cost, easy availability, durability and its ability to sustain in extreme weather and other environmental conditions [55][90]. Concrete carries high compressive strength, but it is weak in tensile strength. Steel is used to reinforce the concrete [89][90]. Rapid advancements have been taken place in concrete technology during the past three decades. The strength of the concrete can be achieved through the use of steel reinforcement, and it is called as reinforced cement concrete (R. C. C.). If the tensile reinforcement in R. C. C. members are stressed during and after the casting it is termed as Pre Stressed Concrete (P. S. C.). The development works in concrete technology led to bring a variety of concrete forms such as: fibre reinforced concrete, polymer concrete, Sulphur concrete, lightweight aggregate concrete, high density concrete, ready-mix concrete, self-compacting concrete, high-strength concrete, high-performance concrete, high volume fly ash concrete, self-curing concrete, floating and smart concrete [76]. The worldwide production of concrete is 10 times of that of steel by tonnage [55]. Currently, the global production of concrete is 4.4 billion tons annually. This number is expected to rise to over 5.5 billion tons by year 2050 [38]. Production of concrete is indicated by the production of cement. Globally, China's estimated production of cement during the year 2020 is 2.2 billion metric tons. It is followed by India and the estimated cement production of which is 340 million metric tons [29]. However, one problem with concrete production is that it produces eight percent of the world's total carbon dioxide emissions [38].

## 1.1 What is concrete?

In its simplest form, concrete is a mixture of Portland cement, water and aggregates (both fine and coarse) [70]. The paste gets hardened and gains strength to form the rock-like mass called concrete through a series of chemical and physical changes called hydration [9][11].

## 1.2 Ingredients of Concrete

The materials used in manufacturing the concrete are known as ingredients of concrete. The word concrete usually mean cement concrete. Main ingredients that makeup the concrete mix is: cement, fine and coarse aggregates and water [6]. In addition to the main ingredients, chemical admixtures and mineral admixtures are also used to improve the specific properties. Aggregates generally occupy 60 to 80 percent of the volume of concrete [22]. The compositions of the concrete are given as follows:

### 1.2.1 Cement

Portland cement is the most common cement that is used in the concrete. It comprises of 7-14% of the concrete. The purpose of cement is to provide binding capability to the concrete [26]. In India, 23 types of cements are used. For example, Ordinary Portland cement has 33, 43, 53 (IS 12269:2013) grades of specification. Similarly other types of cements can be graded with specifications [73].

In India, the following 23 types of are used for different kinds of situations and conditions [73]:

#### (i) Ordinary Portland Cement

*Grade 33 (OPC33)* is more workable as compared to other grades of Portland cement. The main purpose of this grade of cement is to use it for plastering, flooring and for masonry works. It can be used for up to M20 grade of concrete. According to IS 4931(Part 5):1988, its initial setting time is minimum of 30 minutes and the maximum final setting time is 600 minutes. Attainment of its minimum compression strength is 16MPa (Mega Pascals) at 3 days; 22MPa in 7days and 33 Mpa at 28 days. It has low heat of hydration that leads to lesser cracks. It can be referred at Indian Standard Specifications IS: 269 [AD2].

#### (ii) OPC43 grade cement

Grade 43 is generally used in RCC works and for the construction of precast concrete members too. It is used in concrete grades up to M-30, precast elements. As per IS 4931 (Part 5):1988, the minimum initial setting time is 30 minutes and the maximum final setting time is 600 minutes.