Admixtures And Special Concretes

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Lecture -68

Special concretes - Lightweight concrete - Introduction, classifications

Concrete- weight-based classification:

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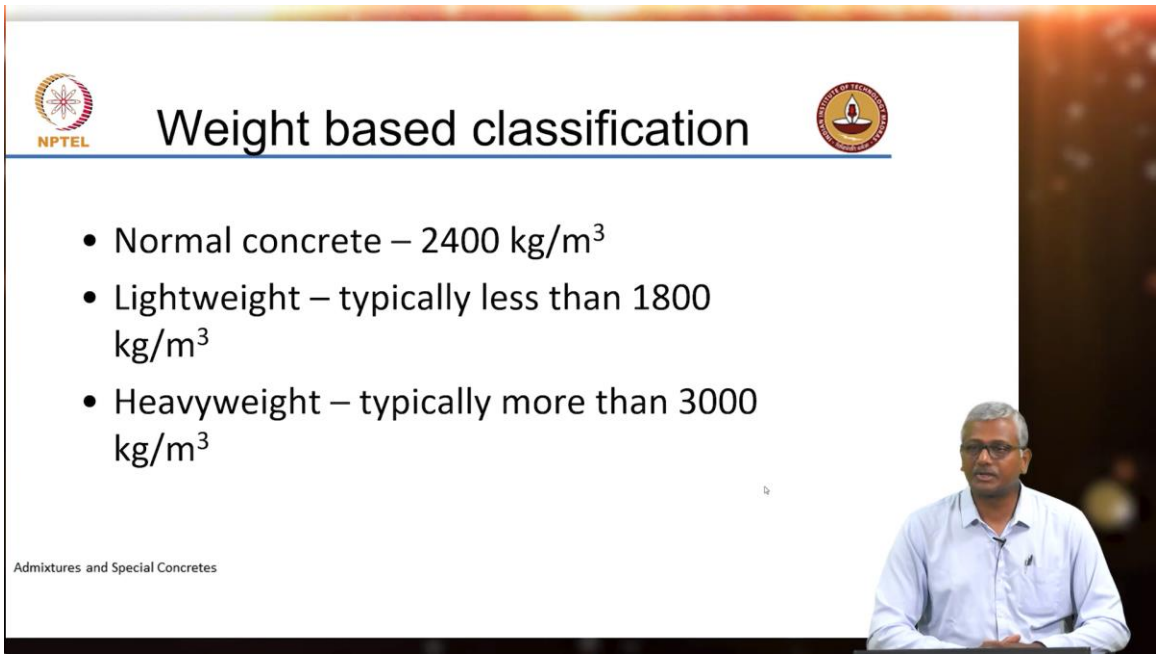

Right, so in several applications we demand concrete to have weights that are not normal that is not 2400 because we need specific properties like insulation with lightweight concrete or radiation shielding with heavy-weight concrete. So, in such applications, we must deal with densities that are not exactly at 2400. So normal concrete we typically say 2400 is the density, lightweight is typically less than 1800 kilograms per cubic meter density and heavy weight is generally more than 3000 kilograms per cubic meter although technically anything more than 2500-2600 could be termed as heavy weight, in most instances this is more than 3000 kilogram per cubic meter.

Ways to change concrete weight:

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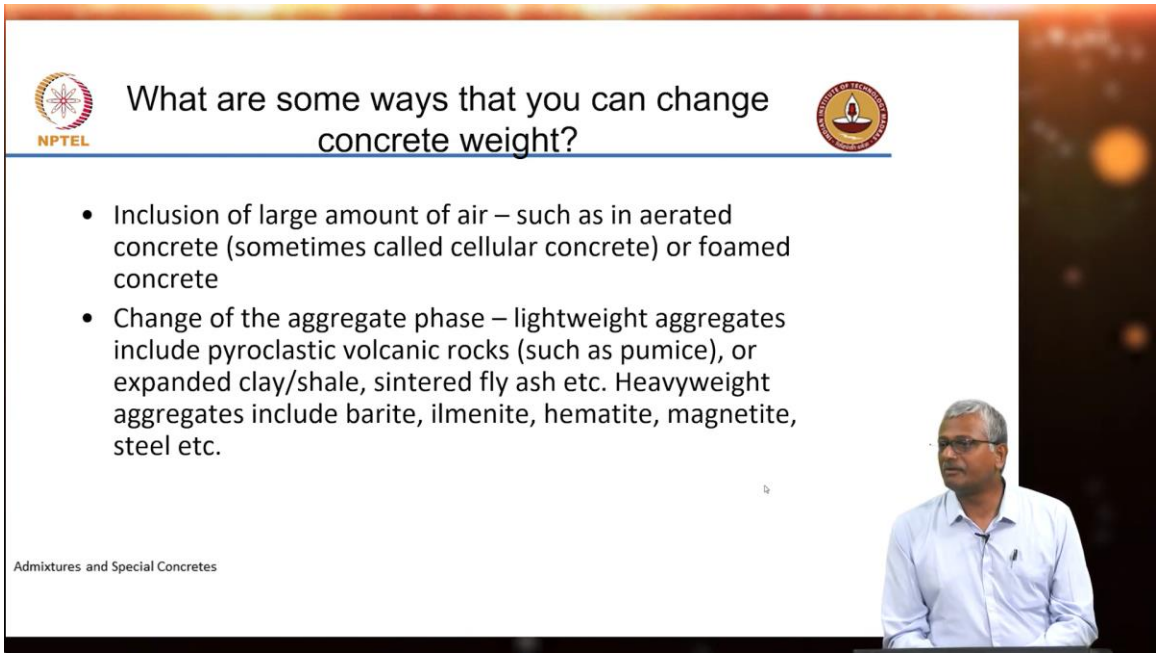

Now how do you make concrete change weight? The maximum proportion of material inside the concrete belongs to aggregate. So, by making aggregates lightweight or heavy weight is the easiest way that you can change the density of the concrete. Alternatively, if you want to make concrete lightweight you can also introduce more air in the system.

We already know about air-entrained concrete but air-entrained concrete has an air content of only about 5 to 8 %, only about 5-8%. At that air content, your density is not going to reduce to much lower than 2200. So, it does not qualify as lightweight concrete. It is still a normal concrete, normal air-entrained concrete. But lightweight means you are less than 1800. So, you introduce much more air as compared to that.

Commonly today we are using products like aerated concrete. We also call aerated concrete as cellular concrete. Lot of large air pockets are put inside the system. We can also use foam like your shampoo generates foam. We can have foaming agents that generate similar foam.

This foam is mixed with cement paste or cement mortar and the structure of air is maintained once the hardening of the cement paste or mortar happens. So that is essentially to get lightweight systems. But as far as heavy-weight concrete is concerned the only option is to change the aggregate phase. You cannot really do anything to the cement paste to make it heavyweight. You can make it lightweight but you cannot make it heavy weight.

So as far as lightweight aggregates are concerned, we have pyroclastic volcanic rocks. Pyroclastic are those rocks that are formed by the fusion of the ashes that come out of the volcanic eruption. So, in a volcanic eruption, there are 3 types of rocks formed. One is called intrusive igneous rock which is formed under the surface of the Earth's crust where cooling happens very slowly and the rock forms crystal sizes which are quite large. Then cooling can happen on the surface of the Earth and we make what is known as extrusive igneous rocks.

In such cases like basalt, the particle sizes are small because the cooling is happening rather rapidly. The crystals do not get a long enough time to develop. So, particle sizes are small. And you have the ashes which are the lightweight components that get spewed out in the case of volcanic eruption. These ashes can get cemented together and form what we call pyroclastic.

So, like lightweight aggregates like pumice or breccia, several types of lightweight aggregate can form because of the fusion of these ashes. Again, ashes are silica. So, this silica, fusion of that silica leads to the formation of pyroclastic rocks. Now you can also have manufactured lightweight aggregate which we will talk about later like expanded clay or shale. That means you take advantage of the layered structure of these materials and sort of puff them up.

That is what you call expanded clay expanded shale or sintered fly ash. We talked about this previously. The particles of fly ash can be pelletized, made to stick together so that they form aggregate-size particles and then sintered or burnt at high temperatures just like what we do for bricks. The same thing happens with fly ash, the silica and alumina present. So sintering leads to the formation of a hard bond and that leads to the formation of lightweight aggregate, artificial lightweight aggregate.

Heavyweight aggregates are essentially those that contain iron mostly like barite, and ilmenite. Sorry barite is barium sulfate which is also heavyweight, but ilmenite, hematite, magnetite, and so on are actual iron-bearing heavyweight aggregates. Steel can also be used as an aggregate. How? You take a reinforcing bar cut into aggregate size, put it into concrete, it becomes a heavyweight aggregate. If you want extremely high densities in concrete that is what they do. They use steel.

We call it the use of steel punchings. You are cutting out reinforcement to the size of the aggregate.

Lightweight Concrete:

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So lightweight aggregate concrete can be used of course for several purposes or lightweight concrete can be used for several purposes. For structural purposes we have to use densities that are on the higher side otherwise we will not be able to make concrete that is strong enough. But for masonry units for lightweight blocks for instance you can make densities of 800 to 1400 and when you are trying to get only insulation as a function from lightweight materials, you can go for densities even lower than 800 kg per cubic meter.

So lightweight for concrete masonry units this is what we typically design with aerated blocks and foamed concrete blocks. What is the advantage of using these blocks over bricks? Why do I want to, why today's construction, why do we see more aerated blocks than bricks? Sorry, more uniformity compared to bricks, okay maybe because these are industry-processed. Bricks can come out of; I mean more economical from what perspective? The material may not be a more economical, larger size, you need fewer blocks but economy comes primarily from productivity, right? Here one block is almost equal to 8 bricks in volume. So, where you are spending time placing 8 bricks and putting mortar in between, you are putting one block. So, productivity increases tremendously and for the loads that are required for infill walls and partition walls, your aerated blocks or foam blocks are good enough.

You do not need high-quality bricks in this process. And secondly of course sustainability-wise also you can do a lot more with concrete than you can do with red brick. If you are using red soil, or topsoil for brick making, that is not really a good sustainable

practice because topsoil is useful for agriculture. Now depending upon what you do to attain light weight either aggregates or foaming or aeration, the densities will differ. Generally, when you are going towards these systems they are foamed or aerated.

But here primarily it is lightweight aggregate concrete LWAC, lightweight aggregate concrete which is on the higher density side. For insulation purposes, you will not really go with aggregates unless you have aggregates that have very low density. So that is possible, you can still do it, and you can still make concrete with less density than water. We had previously made concrete with 800 to 900 densities for the construction of a concrete canoe. In fact, even at a competition at IIT Madras in 2016, we had called teams from outside also to make their concrete canoes and race them.

Of course, we could not race more than one canoe at one time because we were using the towing tank in a hydraulics lab which had only a limited length and limited width. Now it is not there, it will be there in the new academic complex 2, NAC 2. Anyway, I do not know if they will permit us to use it for concrete canoe races again but this is a very popular competition in the US, it happens every year, concrete canoe competition. So regularly utilized material for this is lightweight concrete and they typically use lightweight aggregate in this competition.