Advanced Topics in the Science and Technology of Concrete
Indian Institute of Technology, Madras
Colorimetric Test to Assess Carbonation Resistance in Concrete

Good afternoon to all. Today I am going to just explain how the colorimetric test can be useful in the assessment of carbonation resistance in concrete mixes. So here we are going to see with respect to natural carbonation and the accelerated carbonation, how the colorimetric test is useful in the assessment of carbonation. As you know carbonation is a natural process where the atmospheric carbon dioxide reacts with the hydrated cement products like amorphous calcium silicate hydrates and then crystalline (())(0:41).

So here these compounds will convert into calcium carbonate and then byproduct will be water. So here there will be reduction in alkalinity. This reduced alkalinity will start from the surface of the concrete and then it travels inside and reaches the steel-cementitious interface. So when the PH at the steel-cementitious interface reduced below certain level of 9 or 11, so there is possibility of depletion of this passivation layer and due to that the corrosion can initiate in the concrete. And also there are not enough performance based specifications which are available at the site to evaluate the carbonation distance of the mixes.

So since the process is very slow, we need to have some accelerated test methods to assess the performance of the prescribed concrete mixes for a particular project in the site level. So there are various accelerated carbonation test standards available. One among the standard is RILEM CPC-18 which is mostly used in the European countries where there will be different sizes of specimens will be useful. For example, the RILEM CPC-16 prescribes 150 mm cross, 150 mm cross, 700 mm specimen also. And here in our lab we are going to use this 100 mm cross, 100 mm cross, 500 mm specimen for the concrete test.

And also for motor test, we used to have this 40 mm cross 160 mm prism specimens for the continuous monitoring of carbonation depth. This kind of specimens are preferred over these cube specimens because we can continue the carbonation test in the same specimens over a period of time. For the calculation of this carbonation coefficient we need to have the carbonation depth measurement at various intervals. So these measurements can be taken in the same concrete prism over a period of time. For example, this accelerated test can be started after

28 days of exposure and we will have one more test at 56 days, then 90 days and then 112 days we will have carbonation depth measurements.

So for this the entire study we can use the same prism specimens for the carbonation depth measurement which could be useful in, which could be a standard way for measuring the carbonation depth. So here I am going to use two types of indicators for this carbonation test assessment. So one is phenolphthalein indicator which is a standard test method available in site also. So the other one is rainbow indicator which is having a working range of PH 5 to PH 13. So this phenolphthalein indicator will show colorless when the PH goes below 9.

This rainbow indicator will turn into green when the PH goes below 9. So normally in our concretes whenever the PH is reducing below 9, we will say that the corrosion is initiated. So the carbonation depth measured is also an indication of the portions which are having PH lesser than 9. So here we are going to just show how we will do the measurement of carbonation depth using these two indicators. So now I will just show you how these small motor prisms can be broken into segments and then which can be useful in the continuous monitoring of this carbonation depth over a period of time.

So we will just use this fractural test setup where we can break the motor prism into two and then we will spray the phenolphthalein indicator and then rainbow indicator on the freshly broken surfaces on the two different pieces and then we will measure the carbonation depth.

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So after the prism is broken, so we are just going to spray the phenolphthalein indicator over this. So this is the freshly broken surface. This kind of breaking is preferable than socket just to avoid the calcium leaching which could possibly occur during the saw cutting, the carbonation front will get disturbed when there is saw cut has been done. And the spraying of the indicator should be done at once to avoid any other external carbonation which could possibly occur.

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So now I am going to spray the phenolphthalein indicator over the freshly broken surface. So that should be just kept slightly away from the fractured surface and then just we should spray that over the broken surfaces. So you could see the carbonated portions are staying colorless and then the non-carbonated portion will be in pink color as expected. So this is how we could find the colorless and then, so the colorless zone will be the carbonated zone and then the central pink zone will be the non-carbonated zone.

Then we have to make the measurements using these vernier calipers to determine this carbonation depth on all four faces of the motor prism. So normally we used to have the measurements like at least three measurements on each faces. So I will use the vernier caliper and then measure the carbonation depth from the surface of this motor prism and I will just take the measurements until where I am going to see the pink color of the concrete. So I will just explain that measurement method.

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So using the vernier calipers I just took the measurements like now I am just taking the measurements on each faces. So similarly on the all four faces of the motor prism. So from all four faces I am getting a carbonation depth of 9.5. So the mean value will be calculated based on the measurements using these four different, all four faces of the concrete. So while using phenolphthalein indicator it is recommended to have a mask and then gloves always. Since it can be a carcinogenic agent, so it is always recommended to have a mask while doing this phenolphthalein indicator test.

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So similarly I will just show how the rainbow indicator performs for measuring the carbonation depth. So this is rainbow indicator where you can see the working range will be 5 to 13. So here the non-carbonated zone will be the violet one. So the carbonation zone which will be expected to have a green color over this surface, so we will just spray this as we did for phenolphthalein indicator and then we will measure the carbonation depth as similar to what we did for phenolphthalein indicator.

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I am going to use another freshly broken surface. Here you could see that the portion which is non-carbonated and deep violet and then portions which are partially carbonated and then fully carbonated has a mixture of green color and then pink color which is evident. So this color change of green represents that system is completely carbonated. So again here we can measure using the vernier caliper as we did for phenolphthalein indicator. So similarly this was, this measurement was taken at 28 days of exposure. Similarly the subsequent measurements will be taken at 56 days, 90 days, and then 120 days.

So using the tutis model, we will just fit this mean carbonation depth at these three or four different edges and then we will just calculate the carbonation coefficient of this accelerated carbonation test. So based upon the relationship between the natural and then accelerated carbonation test we will derive the natural carbonation coefficient and then we can substitute that natural carbonation coefficient in this tutis model to calculate the service life of the concrete system using carbonation induced corrosion.

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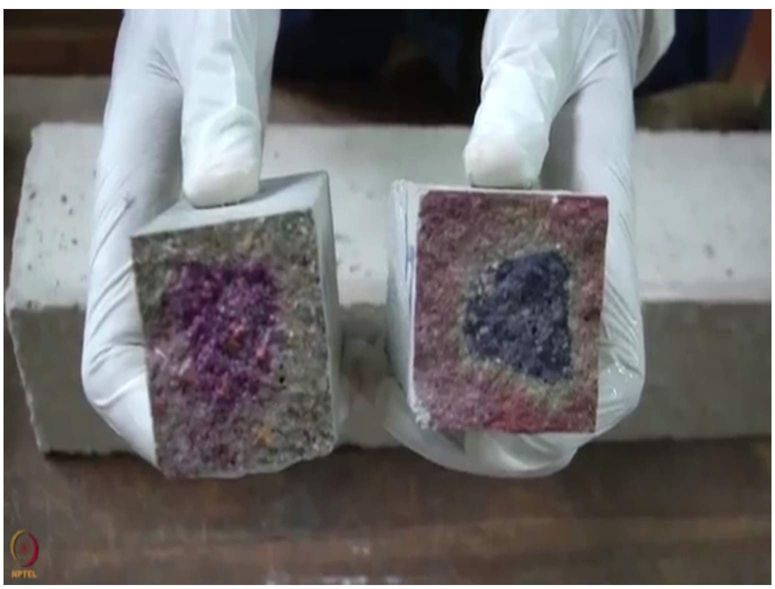

So similarly for concrete specimens we can take slices at each time interval using share cutters and then do the measurements as I did for motor specimens.