Building Materials and Composites

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Lecture No - 22

CMU, AAC and Pavement Blocks

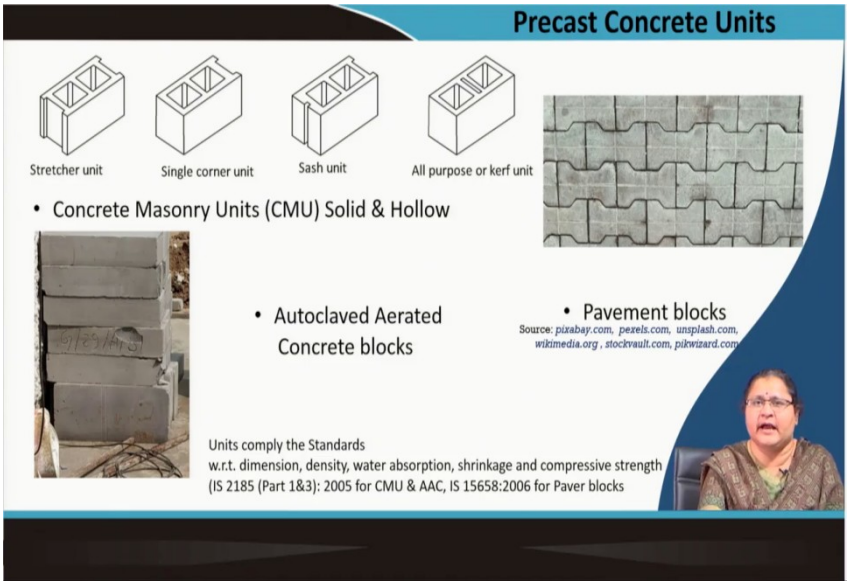
So, today we will be continuing with the second lecture of module 5 which was on prefabricated concrete construction. So, what we had learned in the first lecture is it was a dry construction which was more or less not much involving labour, considering the skill of the labour. So, we only required skilled labour but yes all these materials are being made in the in the way as a cast concrete and it is cast in a very controlled environment.

So, today we will try to cover the three units which are more or less similar to building blocks but larger in size which are mostly for walling purpose. One is the concrete masonry unit or the CMU which are of two types. One is a solid one and the other is a hollow one other is the aerated autoclave concrete block. So, these two blocks are extensively used in building industry as an alternative to brick because when we will go into the next lecture which is on precast wall panel you will see how labour skill is important over there.

So if we do not have a trained skill set it is very difficult to move on or move forward with the precast walling system in our country context. However, these CMU and AAC blocks have penetrated into the building industry we need to know both of these as a walling material.

The other that will be covered here is also another unit which is very much handy similar to very less in weight also not per se which is again another precast block where we are not using clay or burning process rather we are using concrete and we are calling it as pavement blocks which also you more or less see it when you are walking in a city like area. So you can see it in parking areas, walking areas, marketplaces, footpaths. So, these are called pavement blocks which are also precast items or precast concrete units. (refer time: 03:24)

So, let us move forward with knowing these items how they look, where are they used, what are their characteristics and what are the ingredients they are made of and gradually we move to their use and advantages and disadvantages. (refer time: 03:35)



So here comes the concrete masonry units. They are solid when they are solid it will be full now you are seeing the pictures which are all of units which are hollow. You can see a central piece which is called the web. This is the web and you can see some small projections at these ends. You can see here also there is two projections. In the next one you see this is a corner unit where only the projection is one end and this side is flat.

In this unit you see there is a very thin groove cut which is to receive any glass piece that is sash. So, you can receive a glass piece through it. So, you are having this kind of groove and this is a all-purpose brick which does not have all the 4 faces or the verticals are flat. So, this helps in interlocking maybe this is a corner unit, this is a sash unit. And you can see even Jamb units where one of these edges will have a profile of this kind and it will have hollows.

So, whatever is the requirement you can actually select your piece from the lot and use it. But what is the difficulty can you cut it. It is not possible so you have to move for a modular plan. So, everything should be given to you in advance where this kind of window will come and will bear this sash unit or where a door will come and you have a Jamb unit or where you are going to finish, there you will have a flat end.

So, this is how you can have multiple options and you can carry forward the construction process. But these are much bigger in size as compared to brick which we had seen. So, this makes the entire process faster. So, let us let us see the next which is already displayed, which is autoclaved aerated concrete block. As you can see, it is having a very neat finish, on one side and you can see that these are not having any kind of hollow inside it.

These are solid in core but as the word is autoclaved aerated means it is full of air or pores. We will see further details but let us see the other unit which we will discuss in this particular lecture are the pavement blocks. This is a plan view of the pavement block where these pavements are actually one set beside the other. And you can see it is locked so this is totally a dry way of doing it and it is mostly done in parking areas on footpaths etc.

So, all these are maintaining or complying the standards with respect to its dimension, density water absorption, shrinkage and compressive strength. I am not going into detail parameters of each of these. But as a comparison, they are not that much absorbent towards water they do not have defect similar to brick like they do not have a efflorescence etc, they have compressive strength a considerable amount, those I will be reporting you.

And these are the IS codes which are IS code numbers, which you can always refer to if you want to get more input on these. Other than the hollow blocks concrete naturally unique units come as solid blocks also which are used for load-bearing structures. (refer time: 08:30)

Now coming to the dimension whatever it may be hollow core or solid core it will have more or less or typically 400 millimeter X 200 millimeter X 200 millimeter in dimension. That is replacing almost six bricks but yes you can have instead of 400 millimeter, you can have 600 millimeter in dimension, that is two feet size in length, you can have 175 thick, you can have 100 millimeter thick units for the internal partition walls.

So these units regularly typically they are of this dimension however you can change the dimension when you are ordering the moulds will be accordingly used. So, these are moulded out. So, brick was a moulded unit but after that you will it went in for burning. But here, these are made of mostly it has cement in it and it requires the hydration part and for its gaining strength and it is to be cured for 28 days.

Whereas AAC block you see two AA's are there one is for the air as I told you aerated and one is for autoclaved. So, this autoclaved aerated block, concrete blocks they are cured under heat and pressure in an autoclave. So, this is the major difference and we will come into the composition also where you will find it is quite different from the CMU. Unit weight of CMU hollows are 12.7 kg is solid it is 17 to 26 kgs depending on the compaction it is done, depending on the materials, the density of the materials.

And the strengths are also given which is more or less replacing brick when it is brick or more when it is solid and when it is hollow you can see it is 4 Newton per millimetre square. So, it is acting as a non load-bearing wall. So, it is standing between the structure. Coming to the AAC block, 80 percent of it can be air. So, these are much lighter in weight compared to the CMU's.

And it also has approximately low compression strength, compression strength of maximum strength of a plate is 8 Newton per millimetre square. So, you can well understand it is at par with brick, but having larger coverage, lesser joints, larger faster construction, less water absorption. Even you can avoid the plaster impart if it is a dry area. You can avoid the plaster inside you can aerated autoclaved blocks are very smooth as we had seen in the picture.

So, what is happening is you can avoid the plaster component. There is a savings because it is having air inside it. It is acting as a good insulator. (refer time: 11:58)

So, hollow core of CMU can be connected by reinforcement rod to keep it in position and it can face impact load. As I told you hollow blocks are not experiencing taking the load. So, they may be experiencing some impact force lateral impact. So, you can actually connect the

hollow blocks through reinforcement bar. So, you can have a set of hollow blocks placed with their webs etc and you can have a wall being made of it.

So, again you can have a half smaller dimension you can have continuous walls, vertical lines also unlike brick and you can actually push in a different rod, through and through at intervals that will pass and then you fill it with concrete. So, this concrete will be inside so you are pouring concrete. So, you are reinforcing with some rods at intervals when you are making the hollow block wall.

So, this is how you can strengthen your hollow block, when it is in a wall system. The hollow block advantages as you saw the units are much lesser in weight compared to the solid blocks they provide thermal insulation because of the air interrupted within it. Similarly the AAC, pores are acting as though the pores in the AAC block are providing thermal insulation. They also help in fire resistance.

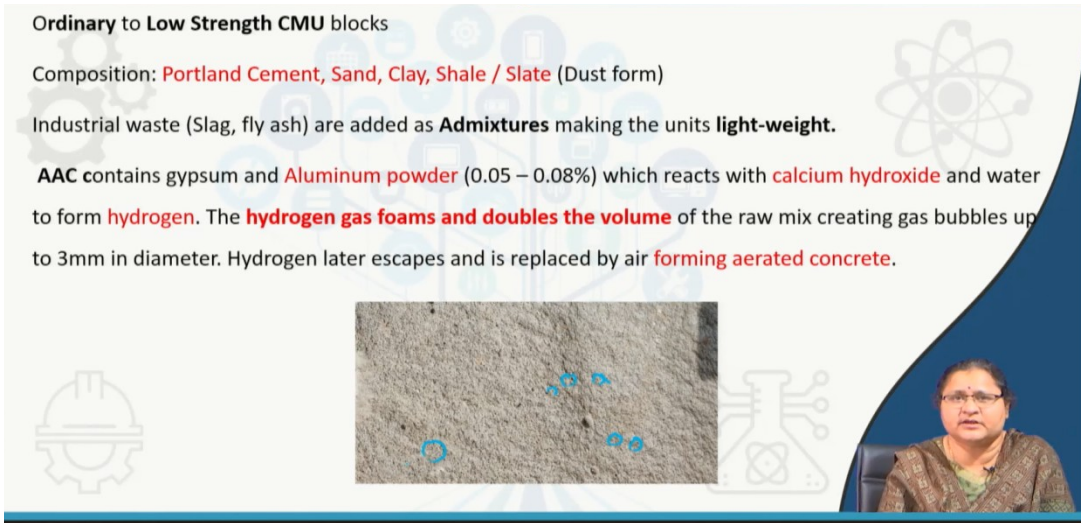
I had already explained special Jamb blocks, sash blocks are designed to receive door window frames. So unless and until you have a plan you cannot move forward with these kinds of blocks. Now, coming to how to stick each other, as I told, it is not completely dry. Yes, it has application of mortars similar to that of brick and it is mix one is to six is the cement, sand ratio of the mortar and they are very thin in high temperature to avoid shrinkage.

And lime may be added. So then, the proportion becomes 1:2:9 and it is mostly used for desert area, hilly area where further shrinkage can be controlled by using calcium chloride, 1/2 kg of calcium chloride per bag of cement. So, these are some typical mortar mix to be used and as the number of joints are very less, as the number of number of units are less, so joints are much less in number. And they are thin too.

Now, coming to the ingredients, what makes the concrete masonry unit or the AAC blocks? First, we will discuss the concrete masonry units you see it is Portland cement, sand, clay and shell or slate in dust form which are the basic ingredients. And you can add the admixtures which help to make it little lightweight, that is slag, fly ash, which are coming from the industry.

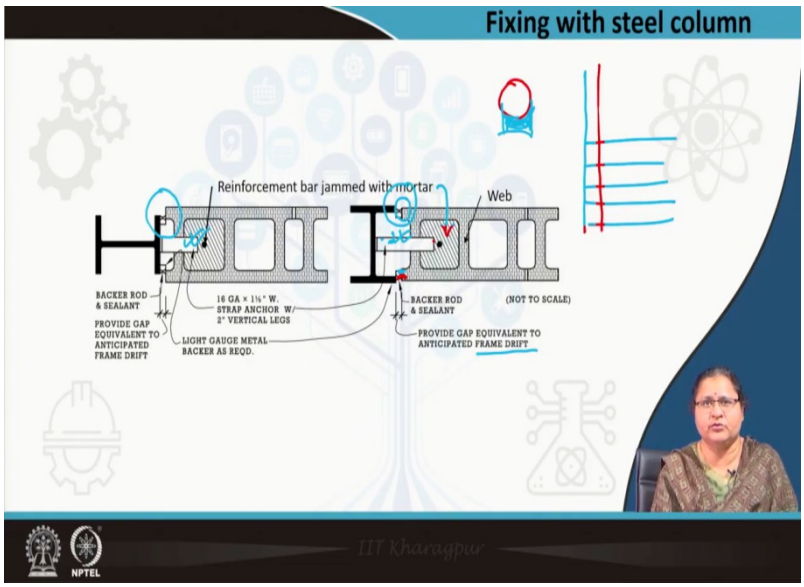
But unlike CMU blocks you see the composition of autoclaved aerated concrete is quite different. It contains gypsum and aluminium powder very little 0.05 to 0.08 percent but which actually reacts with calcium hydroxide and water which you are mixing while preparing and hydrogen is liberated. This hydrogen gas actually folds and doubles the volume of concrete itself.

Similar to the other materials of CMU, you are adding gypsum and aluminium powder which reacts with calcium hydroxide, increases in volume and creates a lot of bubbles inside the material. The hydrogen eventually escapes and it is replaced by air forming aerated concrete. And as I told you around 80 percent may be here. So, this has led it to be light in weight. So, working with aerated concrete is much easier than working with the CMU blocks which are quite heavier.



And you can see this is a picture which I have taken which was a broken AAC piece from site and you can find out the pores inside. Hope it is visible to all of you. You can see the pores, these are the pores which have formed inside it and if you happen to come across some AAC blocks, you will see they are very light in weight. And with that you can differentiate between a CMU block and AAC block if it is not hollow. (refer time: 18:33)

So, coming to the high strength CMU blocks, they will be added with further gravels, that is coarse segregates. And they also require some curing for three to four weeks; water is sprinkled on the blocks, whereas as I told you, AAC products are cured under heat and pressure. (refer time: 18:56)



So, now coming to the fixing, if it is concrete machinery, solid, it can take the load, if it is a beam column structure with concrete or a framed structure with concrete you can keep on placing your units and get the desired wall. But if it is fixed against steel columns, here are the details. Why do I say steel columns, because these units can be used for high-rise structures.

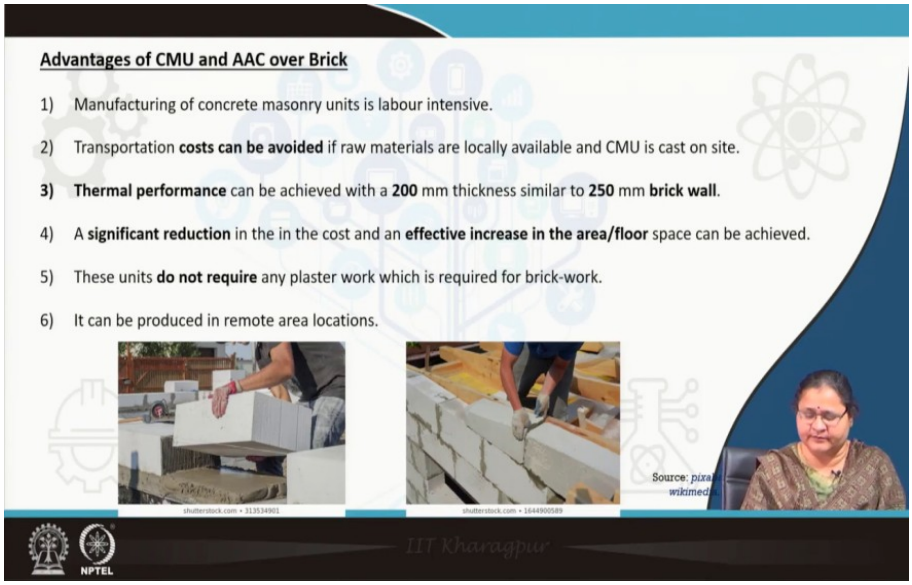
The structure may not necessarily be a beam column structure made of concrete. It may be a steel column beam structure. So, what you see here the joints which is important and which I will explain. See the joint here one side will be the inside one is the outside here also the same thing the joint here the I section is in the direction of the wall. Here the I Section is bit rotated at 90 degrees.

So, here there is a chance it will come and match it can even get into it, depending on the structural design. But if it is not setting inside, you have to see in this point. So, this is the sealing point. And you see here, there is a backer rod, one is the backer rod and right in front of it is the sealant. In front of it is the sealant so the backer rod is a flexible pipe and the sealant which actually holds it, seals it will actually come out, come like this.

So, sealant will, cannot enter inside completely so this backer rod is giving the flexibility. You see the frame drift it will allow any kind of movement, expansion, thermal movement sway, this sealant and this backer rod will be the cushion and at the same time it is giving water seal. So, no water can enter inside. How are they tied up? you see here is a fastener, this is the steel strap, this member.

This steel strap is bolted on this face, on the other side it is embedded on this concrete. So, this is rich this is mortar. As you see this is mortar and you can see the rod reinforcement which is keeping it stable continuous. So, all the blocks here are tired by this rod, one after the other. So, if you see the section it will be like this where you have the steel column and the rod is actually passing all these blocks and this is finally jammed with the mortar.

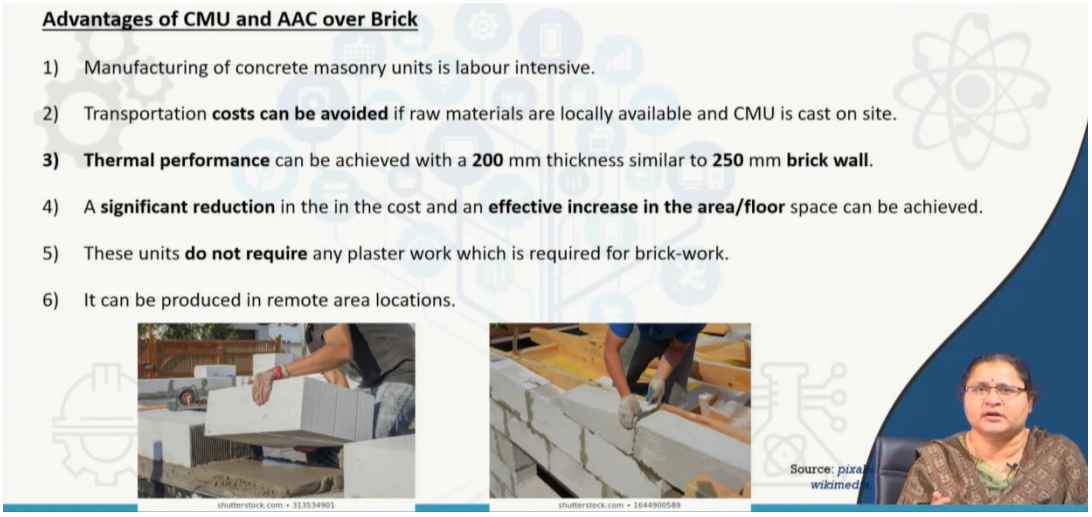
So, this behaves as a continuous wall connector. So, there are two details here, one is the connecting the I section with the CMU and the backer rod and the sealant which is giving it weather protection and any kind of expansion movement of the entire structure due to any reason. (refer time: 22:58)



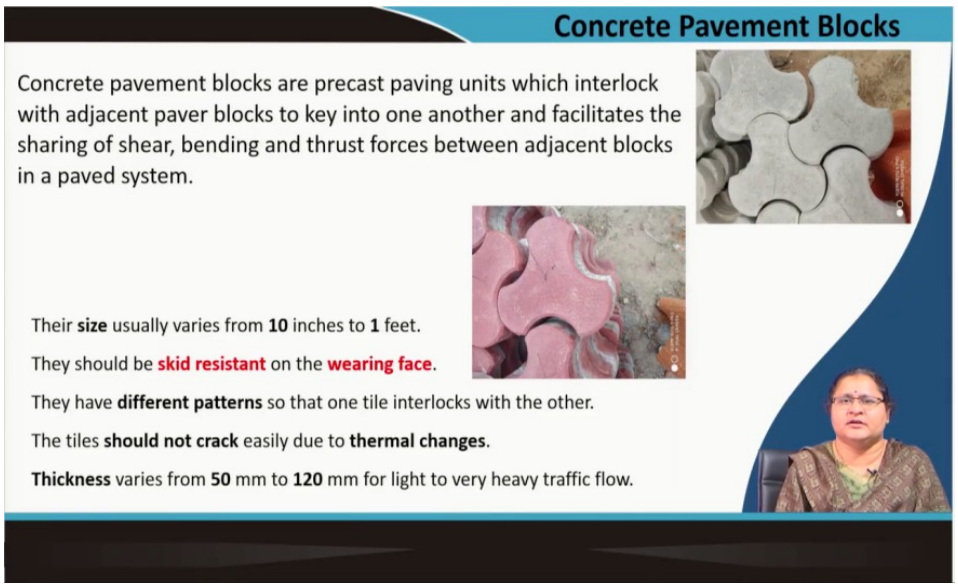
So, let us come to the advantages of CMU and AAC blocks. It is similarly constructed; it is to be made as cast in situ concrete. It is labour-intensive when it is made in the factory. But

transportation cost can be avoided if the raw materials are locally available. Thermal performance is better whatever you get with 250 thick wall to 50 thick brick wall. You can get the same with 200 thick walls which causes a significant reduction in cost and increase in floor space because you are trying to get same efficiency with 200 thick wall.

These units do not require plastering if it is on the internal face also because they are very smooth in nature and can be produced in remote areas also where there is no concept of brick. So, here are some collected images you can see free images where actually they are set.The construction process is much faster in nature. Coming to the disadvantages, (refer time: 24:10)



They cannot be cut into as many shapes you want as many sizes you want. They are to be planned, building are to be planned in a modular way, matching with the dimensions of the CMU. Accuracy is also very important because they will finally go and march with the main structure or if it is load-bearing it has to go and end at a certain point. So, for every 10 meters there should be a check. It is preferred that shapes are square, rectangle, angles are not much suitable and special pieces can be ordered or manufactured according to requirement. (refer time: 24:54)



Now, let us move to the third item which is the concrete pavement block. As I have already told these are mostly seen in footpaths, parkings, marketplace, public spaces, etc., it has a benefit or a reason for that. These units are interlocking in nature. If you remember the previous shape which was something like this. There also there was a pattern which was locking with another member and this was continued.

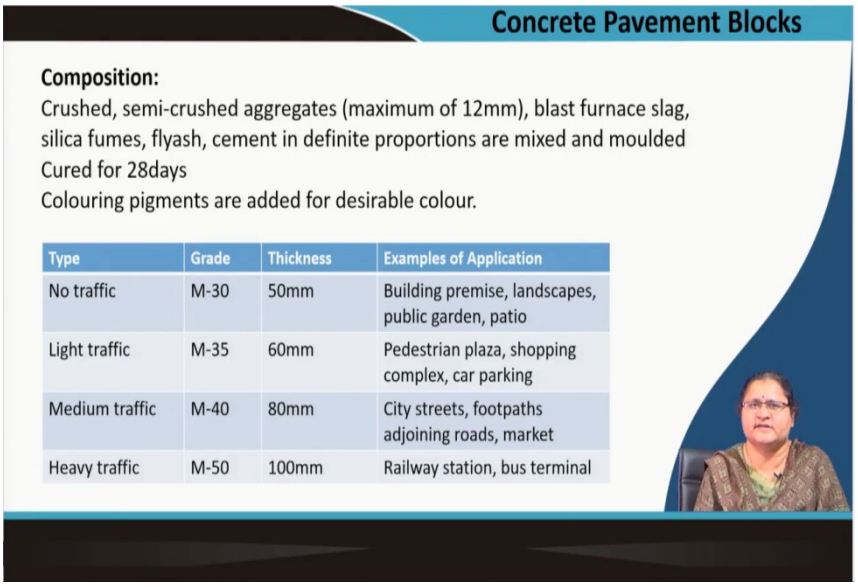
Here you see the pattern has changed to a more or less triangle with circles. So, you can generate various shapes. But you have to remember the principle is of interlocking. So, why interlocking so that you get a smooth finish and no gaps are there and there is no joints also and you can get a continuous surface. What are the advantages of that? Advantage is, you can always pick up with little effort to any one piece and you can open up the entire assembly.

So, it is important that you have to propose such units in areas where you need to access sometimes the city level infrastructure. It may be electrical line, it may be water line, it may be cables for Internet, so many lines are moving or passing underground the surface and wherever it is moving it is mostly following roads and whenever you are using it you can always access the ground beneath it. You do not have to break it.

So, these are recommended and this interlocking helps in sharing the shear bending thrust force between their adjacent blocks. And finally the load is shared to the ground. They are more or less within one feet dimension, but one feet cross one feet dimension with different shapes alternatives, which will have the interlocking arrangement. Here if you observe the pictures which are taken from site.

You can see there are lots of dots like structures or dots like impressions on top of it which makes it skid resistant and it is the wearing face because you are always walking on this face. So they may have different patterns to interlock and they usually do not crack due to thermal heat. They are continuously exposed under sunlight.

Coming to the thickness, which is important point is, it varies from 50 millimetres to 120 millimetres and that should be selected considering the flow of traffic over it. It may be a cycle track made with this kind of time. It may be a running track. (refer time: 28:41)

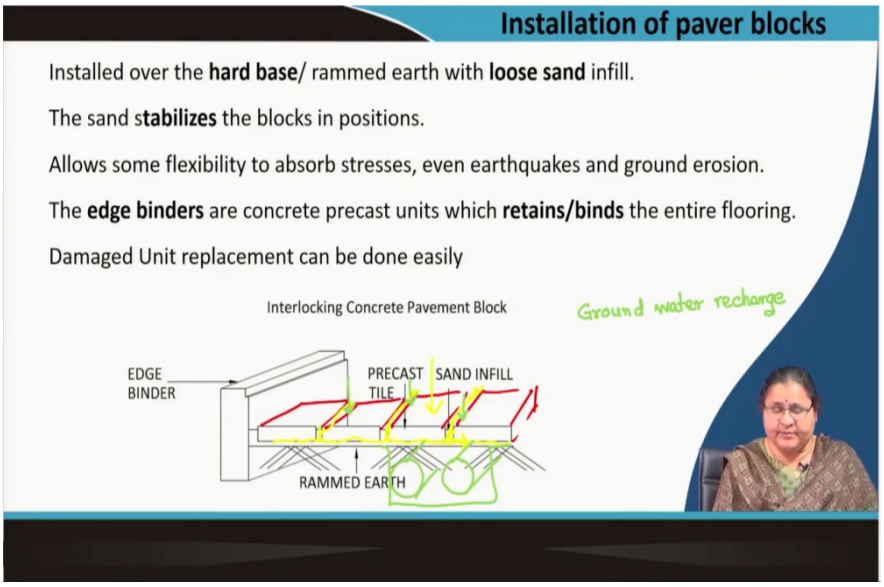


So, let us come to the composition and then the uses. It is crushed, semi crushed, segregate maximum size is 12 millimetre depending on the load it is going to carry. Blast furnace slag, silica, fumes, fly ash and cement, they are mixed in definite proportions and moulded out. I have already referred to the code, the standard which is to be followed and they are cured for 28 days.

As you had seen colouring maybe added but let us come to the main point, where are we going to use them and what is the type which we are referring to? So, when it is no traffic, that is only human traffic like building premises, some landscape, some public garden, patio's where people will be walking. As architects you all might have come across these spaces.

Like traffic, we call it pedestrian Plaza, shopping complex, car parking. See here the grid is varying from M30 concrete to M35 concrete. Medium traffic is streets, city streets, footpaths, adjoining roads, markets and see the thickness has changed from 50 to 60 to 80 and then for heavy traffic like railway station areas, bus terminals, where lot of porters, movements, luggage things, or heavy materials may be carried.

So that is heavy traffic. Yes, you have again another category the docks. Docks and yards they have very heavy traffic and those being 120 millimetre size coming to their placing. (refer time: 30:36)



As they are interlocking units and you are not putting any kind of mortar in between they can become loose at any point. They can just come out from the edge; one by one they can open. So, you have to have a edge binder so you are having an edge binder what you see it is it may be a concrete masonry unit holding the tiles in position. So, these are the tiles whatever be the interlocking pattern this is a simplified version and these are placed on stable earth that is Rammed earth.

And what is done is you are filling it with sand. These are all in with sand. Why sand? This sand will move down. This sand will actually give the stability of these blocks. So, whatever load is falling on this if it is not falling on this this can go down. But the sand will move that side and will stabilize the whole thing. So, this will not be damaged because of any soil erosion, neither will be disturbed by earthquake.

At no point it will be disturbed unless it is humanly picked up. It will stay in its position the other is you can always access the infrastructure which may be below this rammed earth. So, you can open a few and you can actually access the pipe or the cable tray or the trench which may be underground. Another important benefit of it is which is not pointed or noted is ground water recharge. So, in case of heavy rain also the water will percolate through these gaps and water will seep inside the earth any replacement of a damaged unit can always be done.

So it will always remain complete. And any kind of movement can happen on top of it. If you keep all these main points in mind, this is what precast item is done is, what is the purpose of this precast item is, to give coverage to many Bear, Bear locations where which can be dressed and made usable for various uses. This is a very fast process. You have to make that and keep on moving forward. (refer time: 34:01)

So, we can conclude that although these are very similar to brick. But they provide faster construction the CMU's and the AAC blocks the joining is also very simple easy and it is mostly used for walling purpose. There is no efflorescence no plastering required for dry areas when we are using this. Pavement blocks on the other hand helping groundwater recharge and does not affect any surface movement gives easy access to underground service lines;

Whereas at the same time gives at rest floating for parking, for movement, for cycling, for human movement, for public spaces, for landscape places and we now would like to move to the precast panels which have not been much into our use in our country context, thank you.