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Structural Dynamics
Week 12: Module 03

Base Isolation

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Welcome to structural dynamics class so in this class we will study about base isolation systems so first of all what is base isolation so the name is itself is a self explanatory one that is we are isolating the base say this is a structure and it is placed on the ground and then it is vibrating so when it is vibrating because of the input ground motion and the structures displacement sare very large.

So we need to first find out the safety and the second one is comfort of the equipment's so what we do is say there are technique different techniques one is called active control method passive control method in passive control method we have say a tuned mass damper tuned liquid damper there are other techniques but there is a very popular technique which is called base isolation techniques so this base isolation technique is it will not allow the vibration energy to enter inside the building.

So that means what we are isolating the building so ground is here building easier so in between we placed some material such that the frequencies which are relevant to the structures vibration will be filtered out and other frequencies will enter which will anyway not cause harm to the structure so that is what is a concept of base isolation technique.

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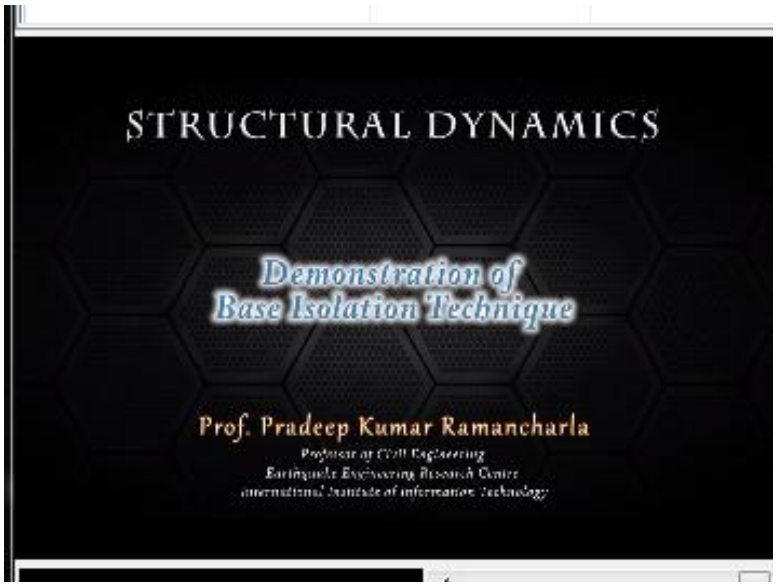

So in this demonstration we are discussing about base isolation technique so what is base isolation so for example if structures are founded or located on the ground which is imparting acceleration to the buildings so if this ground vibrates there is a possibility that buildings on the ground standing on the ground might collapse so now what we do in the base isolation concept is we try to put the buildings on the ground but with an isolation in between so what is isolation if you look at closely the isolation.

In this one as you can see it is resting on say for rubber bearings so what these rubber bearings do is even if the ground is shaking it will not transfer the frequencies which will affect the building through these rubber bearings so we have to understand the natural frequencies of the building or evaluate natural occurrences of the building and then design the bearings in such a manner that those frequencies are eliminated from the ground motion which is entering into the building so this is called base isolation technique.

So we are isolating the frequencies which will harm the structure so those frequencies will not enter the structure and that technique is called base isolation technique so if you can look at this closely so it depends on how many here in this case we have a full plat form resting on this

rubber bearings but in some special cases these rubber bearings can be designed for individual columns so this base isolation is a slowly becoming popular and it is used for short period buildings.

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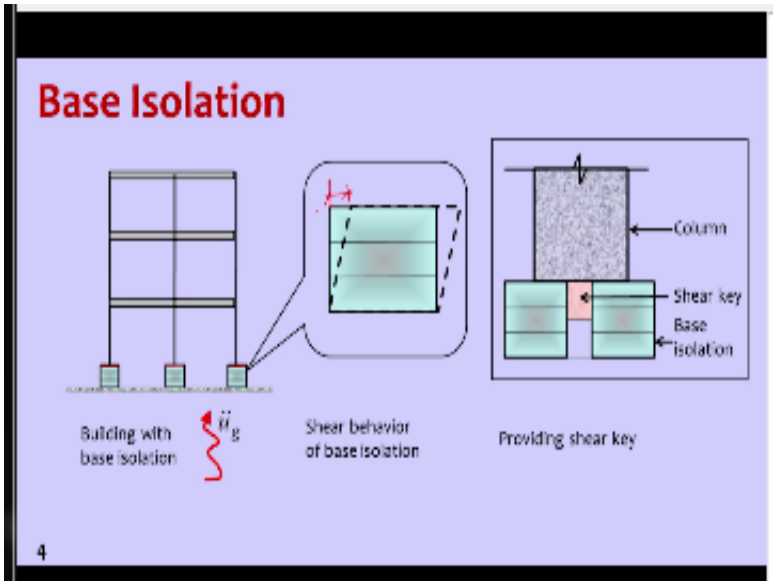

So base isolation technique is like explained in this figure something like say building which has to rest on the ground is now supported by using this like elastomeric rubber pads this pants and then so they will have a capacity to bear the complete load of the building vertically gravity loads and the moment when you shake the building when you shake the ground so they will take all the shear deformation so it is something like this okay, so as you can see this is a column and total load of the column is coming on to this base isolation system.

So this is elastomeric rubber pad there is a shear key and then you have layers of rubber and different materials ok so the shear key provides offered shear resistance that is number one and then if building is displacing so all the amount of the sheared formation will be taken into consideration.

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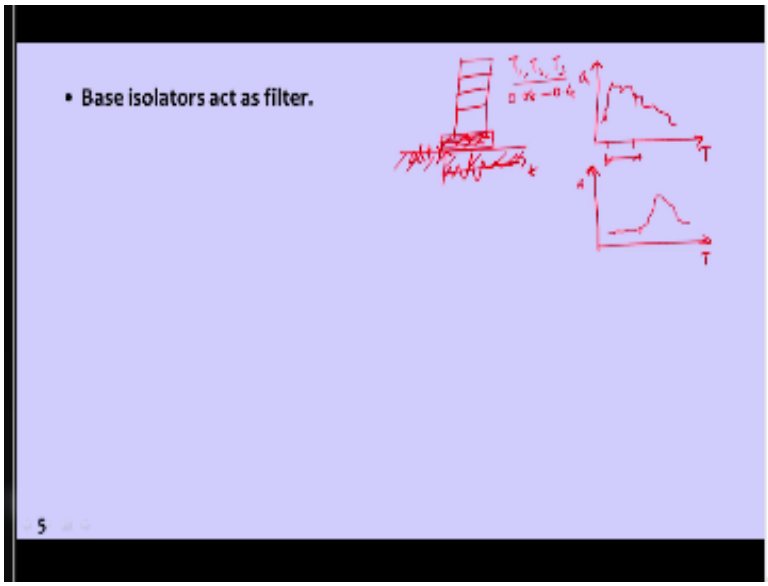

Then base Isolators act as a filter so what is the meaning of filter let's take a building so building has say natural frequency of natural period t1 t2 t3 so this is the range of building frequencies okay say natural periods say I would say that's a point zero eight up to say point four seconds okay so this is different ,different range of frequencies present in this one is building then what we do is we will filter it out so when we have say ground motion t so if you take say Four spectrum of this ground motion something like this t and amplitude.

So this is a range of periods and because of which there is a possibility of damage to the structure so what we do is we will remove filter out these frequencies and we will be left with the motions something like this so these frequencies are filtered out so this is a concept like explained in a simple manner that the energy present in the frequencies which might damage or which may damage the structure that energy is removed so this is a mathematical concept so how do we remove physically so physically what we do is so we will put a filter here filter kind of thing and ground easier so ground earthquake is entering first the filter and then unwanted frequencies are removed from that and then the remaining frequencies are entering.

The building which will not cause harm to the building so that is the concept of base isolation so base isolation technique is used for short story buildings so reason for that is if I take small building then it will have mainly share behavior but if i take tall building then it will have bending behavior so flexure behavior so because of flexure behavior what happens is the columns at the edges may get lifted up so base isomeric elastic bearings.

So they will not have not much tension capacity so what happens is the sea seating or shear key from the column or below the column will come out so it will not offer any tension resistance so that is why base isolation technique is not suitable for tall buildings it is suitable for short building say five-story to ten storey buildings are suitable candidates for base isolation techniques.

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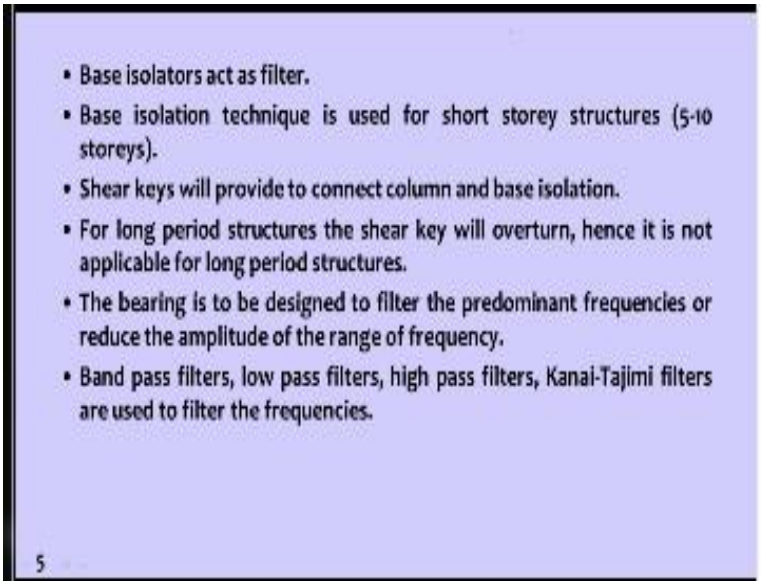

So shear keys will provide to connect column at the and base isolation system so for long periods structure shear key will overturn and then it is not applicable for long period structures so bearing is to be designed to filter the predominant frequencies or to reduce amplitude of the range of frequencies so band pass filters low pass filters high pass filters we use there are special

filters called can kanai-Tajimi filters are used to filter these frequencies so we will see a cartoon how this base isolation works.

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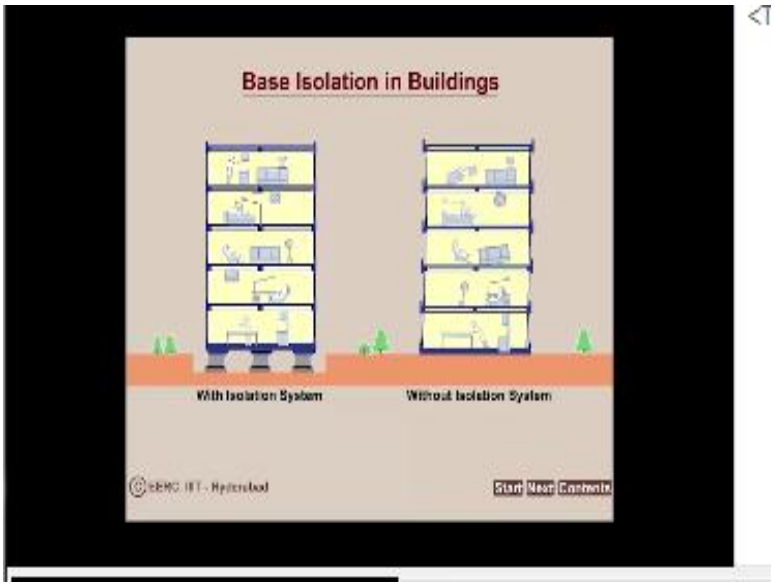

So in India.

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We have some applications of base isolation techniques as you all know that in 2001 January 26 we had a massive earthquake in Gujarat so 6.9 magnitude earthquake which damaged so many buildings and life loss was around14,000 people died during that earthquake so now a hospital building which was severely damaged was reconstructed and a base isolation technique was used in that so it is a four-story hospital building .

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So Bhuj hospital in Gujarat so where it is standing on isomeric rubber pads you can see in between the column and the structure so there is based Isolators in this one you can see so they have a capacity to deform laterally and they are very strong enough to carry the entire load building in that.

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