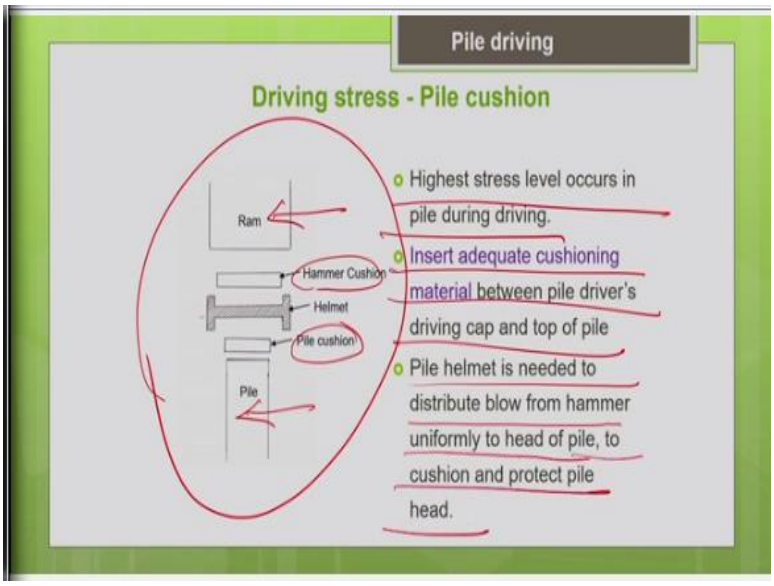

So, everyone knows particularly the precast piles or likely to be subjected to more amount of stress while driving it**.** They are subjected to more amount of handling stresses as well as when you drive the pile into the ground they are subjected to more amount of driving stresses. That is why all the stresses should be taken into account when you design your pile**.** So, highest stress across in the pile mainly during it is driving than when compare to during it is service life.

So, mainly during the driving it is being subjected to more amount of stress. So, how to control the driving stress? So, the commonly adopted method is, we have to introduce some cushioning material between the pile and the bile hammer so that is a basic thing we can do it. Particularly for the concrete piles as you know, concrete piles are weak in tension and they are more brittle.

They are likely to be shattered very easily when you subject it to a very high impact, that is why we have to protect the concrete pile from the driving stress by using adequate cushioning material. So, commonly used cushion is wood timber cushion so you have to choose a sufficient thickness depending upon the length of the pile needed, so we should never go below 10-centimeter thickness**.**

And we should replace the cushion at regular intervals as gets worn out. So, insert adequate cushioning material between the pile driver cap and the top of the pile. So, this is a common setup

which you can see to control the driving stress, so why we can see this is your pile and this is your hammer. So, you have two cushions, one is your pile cushion, other one is your hammer cushion.

And there is also a H shaped helmet which helps you to distribute the load uniformly over the head of the pile. So, that there is no stress concentration at a particular point on the pile head, so we can distribute the stresses uniformly using this arrangement. So, the pile helmet is needed to distribute the blow from the hammer uniformly to the head of the pile to cushion and protect the pile head. So, this is what is a common arrangement we follow for the now protection of a concrete piles.

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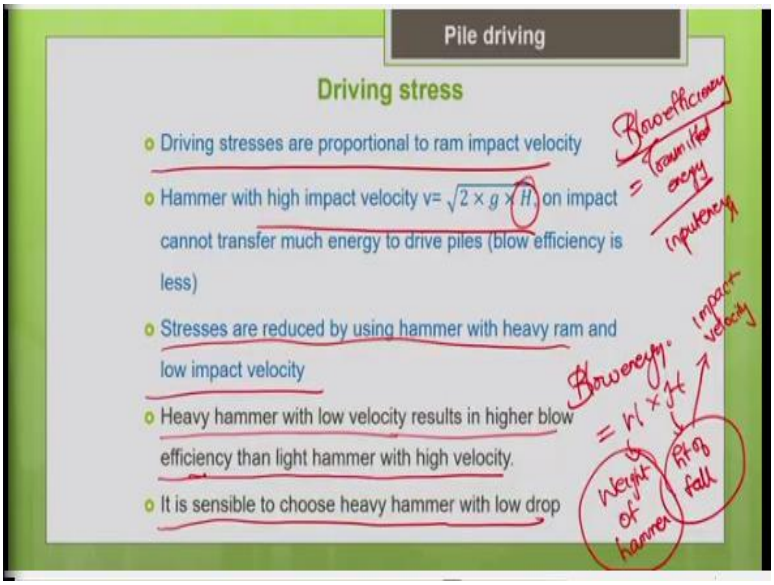

So, another important guideline which you should keep in mind to control the driving stress is, the driving stress is will be very high when the impact velocity is high, that depends upon your height of fall. So, as everyone knows the blow energy is nothing but your product of W into H, W is your weight of hammer and H is your height of fall or the stroke.

So, if you want to increase the blow energy of your pile, it is preferable to increase the weight of hammer but do not increase the height of fall. Because if you increase the height of fall this will increase your impact velocity and your pile head is subjected to lot of stresses**.** This may result in damage of your pile, if you increase it impact velocity, that is why it is preferable to go for heavier hammer and shorter stroke, so that is what is discussed in this slide.

So, the driving stresses are proportional to the ram impact velocity and your impact velocity depends upon your height of fall v = $\sqrt{2gH}$, H is your height of fall. So, that is why and the studies of found that your blow efficiency already we have discussed what is blow efficiency. Blow efficiency is nothing but the ratio of transmitted energy to input energy, so this will be high if the height of fall is this.

So, the blow efficiency is going to be maximum when the height of fall is less. So, we have to reduce the stress by using hammer with heavier ram and low impact velocity. So, heavy hammer with low velocity results in higher blow efficiency than light hammer with high velocity. Hence it is sensible to use with heavy hammer with low drop, so basically if you want to increase your blow energy better go for heavier hammer**.**

But do not increase a height of fall, particularly for the concrete piles which are weak in tension they are easily likely to get shattered if we increase the height of fall. So, there is a restriction on the height of fall for the concrete pile, so we have to follow that. And reduce a height of fall and increase weight of hammer to get to your desired blow energy, that is a right strategy. And that will also increase your blow efficiency, that is what is proved in earlier studies that the transmitted energy is more if you reduce the height of fall and increase your weight of hammer.

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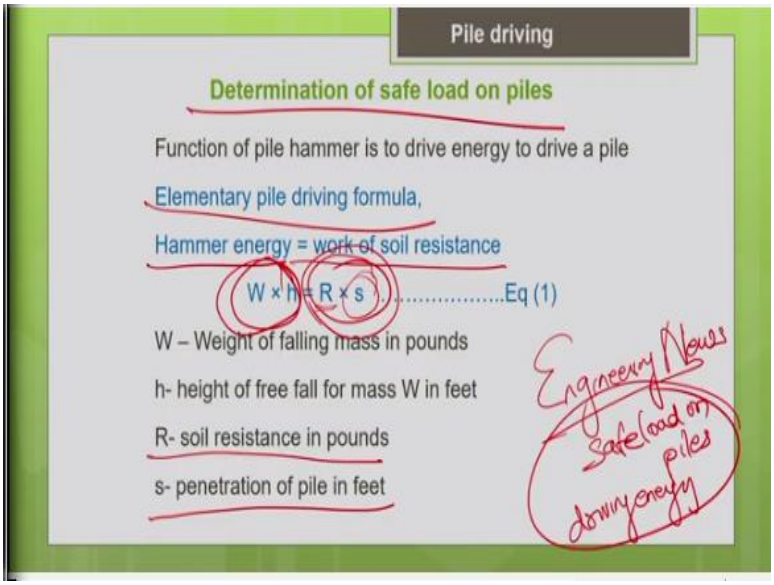

So, now let us see with how to determine the safe load on the piles? As a piles are likely to be subjected to more amount of stress during driving. We need to determine what is the safe load allowable on the pile that is very important. There are very many popular relationships of formulae which have been derived already in this context. We just go into discuss one such formula called as engineering news formula, it is very formula, engineering news.

To determine what is a safe load on the piles and also you can find what is the driving energy needed for the pile, both these since I can determine from this engineering news formula. And this is basically derived from the elementary pile driving formula which is nothing but your hammer energy equal to the work of soil resistance. That means what is the function of a pile hammer, it is going to offer you the required blow energy to drive the pile into the ground**.**

So, when you drive the pile into the ground, the pile has to overcome this oil resistance and make the desire depth of penetration, that is a work done**.** So, hammer energy is nothing but W into h and the resisting energy is nothing but R into s, what is R? R is a soil resistance in the pounds and s is the penetration of the pile in feet. So, basically you have to blow the hammer on the top of the pile so you offer the blow energy and get the work done.

Hammer energy = work of soil resistance

$$W \times h = R \times s$$

So, what is the work done, you have to overcome the soil resistance and do the desire penetration for the pile so that is what is the work done. So, hammer energy is equal to the work of soil resistance, that is nothing but the product of the soil resistance and the product of the penetration of the pile in the feet. So, from this elementary formula driving a formula.

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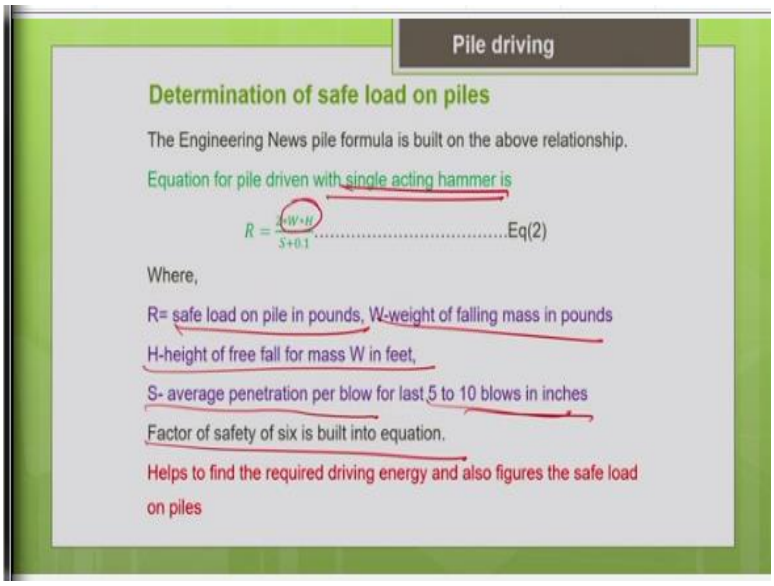

The engineering news formula have been derived which is commonly accepted formula to determine the safe load on the pile. This is nothing but 2 w H by S + 0.1 and this is for single acting hammer, if it is going to be a double acting hammer where the mechanism is different, the formula has to be modified**.** So, the main objective is introduce to you that there are many relationships available to help you to find what is the safe mode available on the pile for different types of hammers you can find different relationships available**.**

$$\mathbf{R = \frac{2 \times W \times H}{S+0.1}}$$

And you can make you suffer**.** So, basically in this formula they have incorporated a fact of safety 6, that means 6 times load will be supported by the pile. So, R is the safe load on the pile in pounds, w is the weight of the hammer that is a falling mass in pounds, H is a height of free fall for the mass w in feet and S is a average penetration per blow for last few blows say 5 to 10 blows in inches, so this is a formula derived for single acting hammer.

So, if you want to determine the safe load on the piles or if you want to know the desired driving energy needed, you can make use of this equation.

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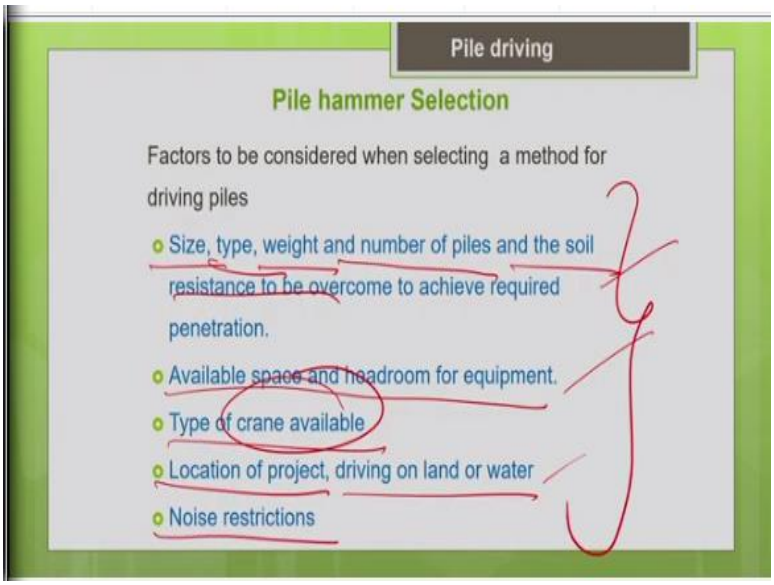

So, now let us see what are all the basic factors which governs the pile hammer selection**.** So, obviously we have to select the pile hammer depending upon the type of a pile**.** So, what will be the size of a pile, weight of a pile according to that you have to choose a weight of the hammer. So, the common guideline is your weight of the hammer should be at least equal to the weight of a pile that is a common guideline, ideal case**.**

But if the concrete piles are going to be very heavier and those equal weight hammers are not available in the market, then at least select the hammer whose weight is equal to one third of the weight of the pile**.** So, basically weight of the pile, your size of the pile and the material type all these things are going to affect your selection of a hammer. Because the hammer which is select for your steel pile and the hammer which is select for your concrete pile will be different.

Because concrete piles are easily likely to get damaged, so that is why we have to be very careful in selection of hammer for the concrete pile. So, when you discuss about the different types of hammers you will understand these factors better. I am just introducing these factors to you. So, in the next lecture after we discussing detail about all the types of pile hammers we will again discuss how you are going to select the pile hammer for a particular soil type and for a particular pile type so**.**

So, what are the guidelines will be discussing again, these are just a brief overview before we move onto part 2**.** So, you know that pile hammer selection is going to depend upon the size of a pile, type of a pile that is material type, the weight of a pile and how many piles you are going to drive the productivity needed the project time schedule say everything is going to govern.

And the important thing is soil type, whether it is going to be very hard terrain condition. The high frictional resistance or a loose soil with a less frictional resistance all these things will decide your hammer selection. Because accordingly you need a blowing energy requirement will vary. And as you know for this piling process we need lot of supporting equipment like crane to hold the pile, to hold the hammer everything in position and to lift it**.**

So, we need whether the available space and headroom is available for the equipment we need to check. And based on the type of crane available, the crane should have the lifting capacity, sufficient lifting capacity, lift your pile, to lift your hammer and even lift your need which will help you to hold everything in proper alignment. So, you should have sufficient capacity, location of a project whether you are going to do the driving operation on land or in water.

Say if it is going to be in water you may need to have some equipments with closed coverings. Noise restrictions, say you know that when you drive the pile into the ground with a hammer, it is going to produce a lot of noise**.** So, if you are going to do the driving operation in a residential area pr near a residential structure or near hospitals**.** So, there will be restriction on noise.

So, in that case we have to select the method which will produce relatively less noise, we have to go for silent pile driving methods like vibratory methods**.** So, we will see what is that later so there are so many factors which governs a selection of your pile hammer.

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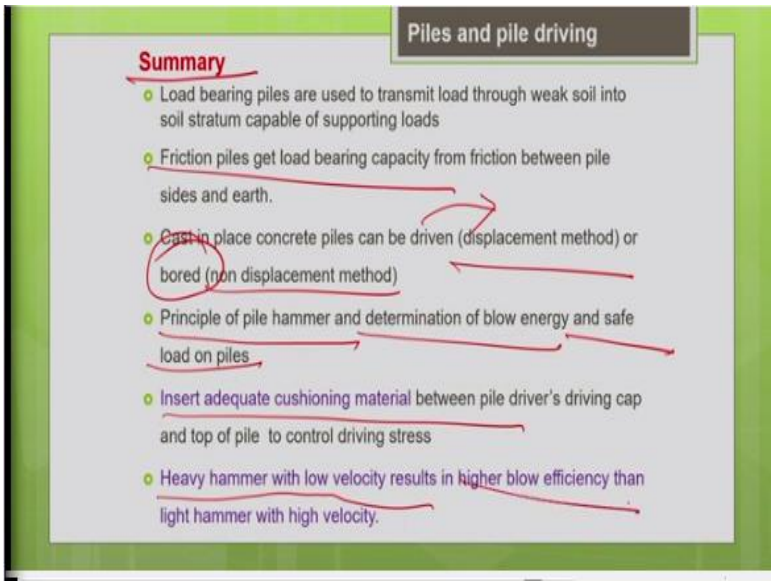

So, we have come to the end of this lecture, let me now summarize what we have discuss so far earlier. So, we have discussed about different types of piles, so classification based on it is use, based upon the load transfer, based upon the material type and based upon the course of fabrication. So, based upon the installation process from different perspectives we have classified the piles.

So, based on load transfer, so the load transfer can be occurring either to the end then we called as an end bearing pile or it can be through the friction between the surface of the pile and the surrounding soil, then we call it as a friction pile. then cast in place concrete piles based upon the displacement it is going to result the create to the surrounding soil you can call it as a displacement method or you can call it as a non-displacement method**.**

There are two approaches by which you can go for cast in place concrete pile making either you can go for driving method with hammers or you can go for boring method. So, we have discussed the principle of the pile hammer and how to determine the blow energy of the hammer because that is going to define the size of a hammer and how to determine the safe load on the piles.

And how to control the pile grain stress we have to insert adequate cushioning material between the pile and the hammer particularly for the concrete pile is very important to protect the pile head from the damage. And another important guideline you should always keep in mind is it is preferable to go for heavy hammer with low velocity. So, we should go for a shortest stroke, so

that will result in higher blowing efficiency and it will also protect your the concrete pile from damage due to impact.

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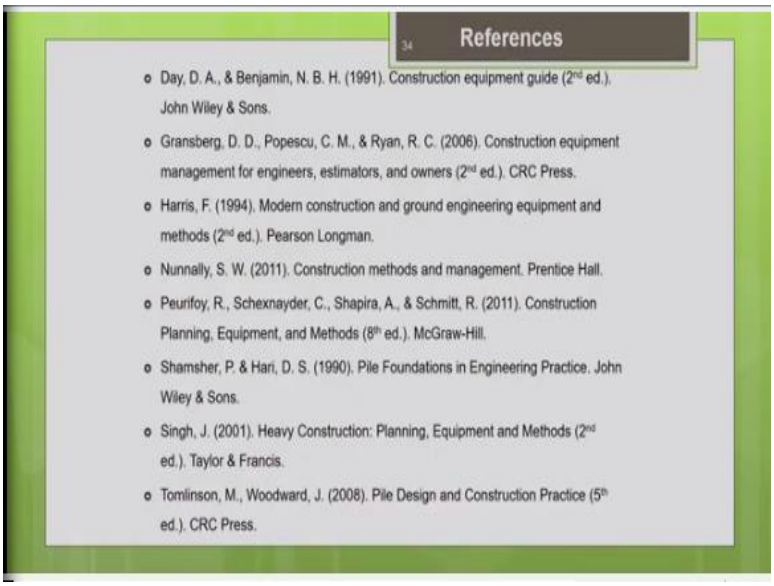

So, these are the important references which I have referred for this lecture. In the next lecture as I mentioned earlier we will be discussing about what are all the different types of the pile hammers available, their mechanism**.** And how to make the selection of the pile hammer according to the pile type and according to the soil type**.** So, how to make the selection? That is what we are going to discuss in the next lecture, thank you.