Mining Machinery
Prof. Khanindra Pathak
Department of Mining Engineering
Indian Institute of Technology, Kharagpur

Module - 06
Lecture - 10
Longwall Mining Machinery Power Support

Welcome to our discussions on Mining Machinery. So, we have discussed underground mining machines and on that we are discussing Longwall Mining Machinery, and we have talked about the shearer, we have talked about the armoured face conveyor. And today, I will be introducing you some other machines called Power Support.

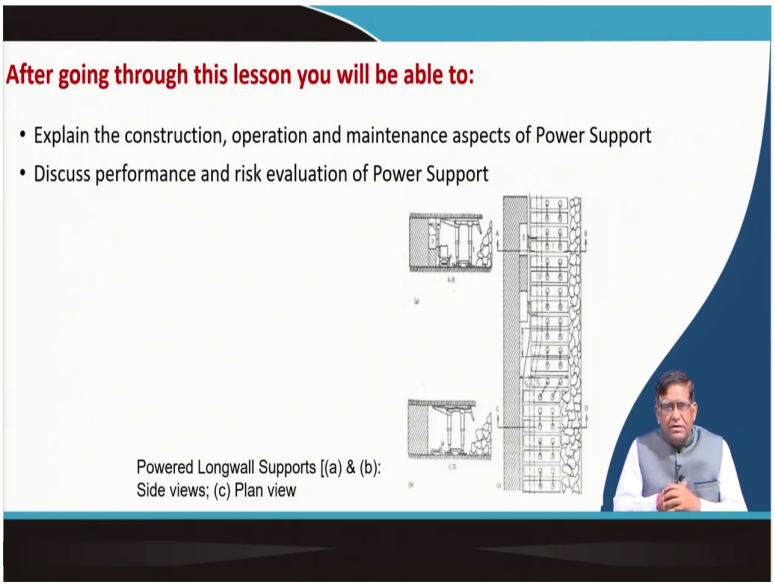
Exactly, these are hydraulically operated hydraulic powered roof supports. Basically it supports the roof when you do underground mining you open a driveways or gallery this need to be supported. So, these are exactly interconnected along the length of the whole longwall phase, in it exactly number of such supports are put there together.

(Refer Slide Time: 01:20)

You can see in this figure, these are all the supports are here connected. So, that this is this portion is taking the load. You can see here this is a unit of a power support.

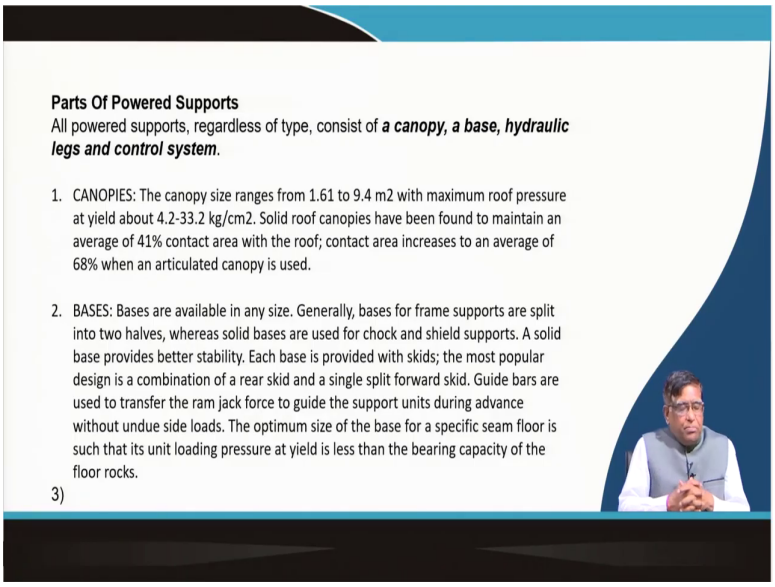
So, today we will be discussing about this power support. And then, this type of system in the longwall mining which gives a very high production rate it exactly started appearing in the 50s and today there has been lot of development in terms of its size and capacity.

(Refer Slide Time: 01:56)



So, we will be discussing about this support system, so that you can explain, that you can classify the different types of these power supports and then how they operate in this. So, this figure gives you an idea about where is it taking a plan view where number of these supports are interconnected together, and you can see that individually if you see a cross section this is the whole roof is being supported over here; where your machines are working, your shearer is working over here on a armoured face conveyor.

(Refer Slide Time: 02:42)



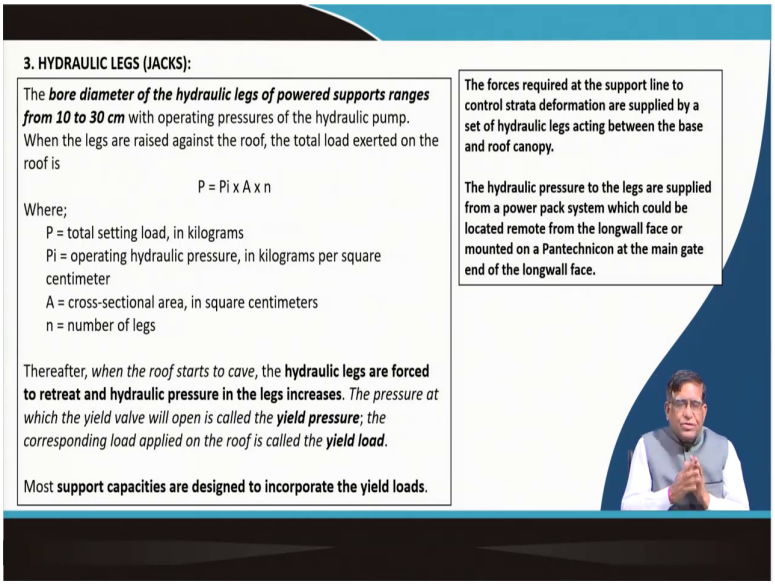
So, this system you can see here that what are the main parts of a power support. As you have seen in that figure that is your if you notice here this is the different component you can see a canopy, a leg, a base and on that you can see that this canopy it is a depending on the size, its total surface area of 1 canopy maybe 1.61 meter square to 9.4 meter square, tip. This shows that there could be a wide range of depending on the site requirement.

And then, this is a when the load will be coming over here then this hydraulic leg it will go on taking the load and after some time that when that valve will be operating it will retreat in yielding. So, that up to that yielding point it can go up to 4.2 to 33 kg per centimeter square.

So, it can take a huge load. Now, this solid roof canopies have been found to maintain an average of 41 percent contact area with the roof. And the contact area increases to an average of 68 percent when articulated canopy is used, that canopy can be articulated, it can be linked.

Then there is a base, base is where exactly it is supported. So, it is supporting the frames and it can be in two halves. Now, the solid base is used for chock and shield supports will be telling you what are the different types of supports here. A solid base provides better stability. Definitely because of the weight it will be giving a better stability. Now, they are provided with a skids and then, so that it can be pushed and it can be moved along with the face movements.

(Refer Slide Time: 04:34)



So, this is a there are the main part exactly there are the your hydraulic legs, that as you have seen in the figure that we are having that hydraulic pistons that props up those legs or jacks.

They have exactly would main force, they applied through those legs and that bore diameter of the hydraulic legs of power support ranges from 10 to 30 centimetre.

Now, the total how much load it will take depending on its dimensions, and the total setting load which is given in kilogram it depends on the operating hydraulic pressure. How much it can come and then the cross sectional area and depending on how many number of legs are there that will be determining. So, by this formula you can calculate out the total setting load how much it can take care of.

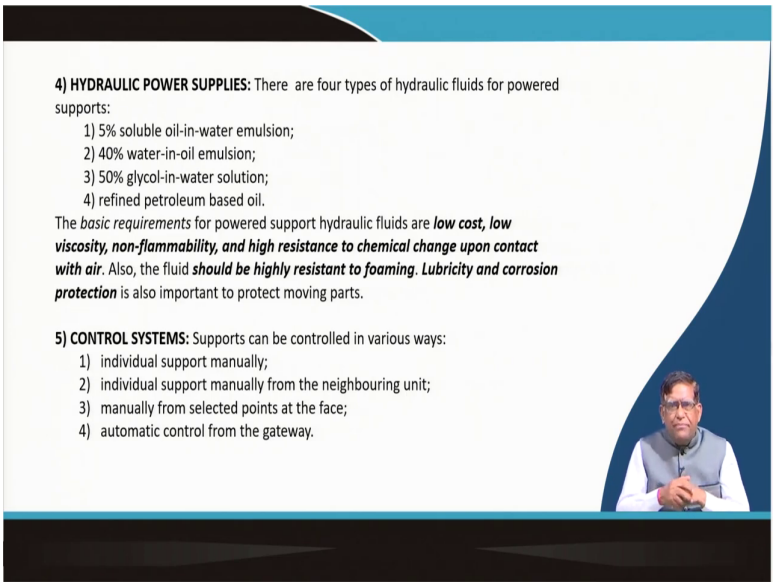
So, when the roof starts to cave, if the roof starts falling that hydraulic legs they are forced to retreat that is exactly when your this legs, your these legs if the load is coming moreover on this canopy it will start retreating. So, that retreating portion exactly when it retreat then this the pressure in the legs will increase.

When that pressure increases that will be opening up, and yield valve at that pressure at which that yield valve will open it is called your yield pressure. And then, at that time whatever the load is there on the canopy is called your yield load. These two terminology are important.

Now, that is exactly this supports capacity, it will be determined by exactly how much yield load it can take. So, this is a the forces required at the support line to control strata deformations are supplied by the set of this hydraulic legs. So, this is how exactly a power support works.

The hydraulic pressure through the legs are supplied from a power pack. Exactly, in longwall mining you will have to have a hydraulic power pack located near to the face and there all the electric motor will be running that pump by which this pressure will be generated. Or it can be there on a pantechnicon that is a vehicle type of things on which you can keep maintain all the power pack over there near the main gate of the longwall face.

(Refer Slide Time: 07:14)



So, this other than that these 3 components you have seen that is a canopy, you have got the base, then the leg then this is your hydraulic power supplies. That is the hydraulic power supplies means your hydraulic fluid which will have to be there in those hydraulic tank, from there it will be pressurised under pressurised fluid will be giving the main supporting your the power required.

Then this could be a 5 percent soluble oil in water emulsion or it can be 40 percent water in oil emulsion or 50 percent glycol in water solution or some refined petroleum based oil. So, depending on only thing which is necessary here they must be fire resistant and it should be corrosion resistance. These two properties are looked into.

And then, if definitely if that oil, you can get it at low cost is always good that is a good property you will require a low viscosity, then you will have to have non-inflammability, and

then there should not be any chemical change in that fluid when it is operating. So, that is a chemical stability and then that is your exactly the air if enters into or water if its gets into. So, there should not be any chemical change in the properties of the fluid.

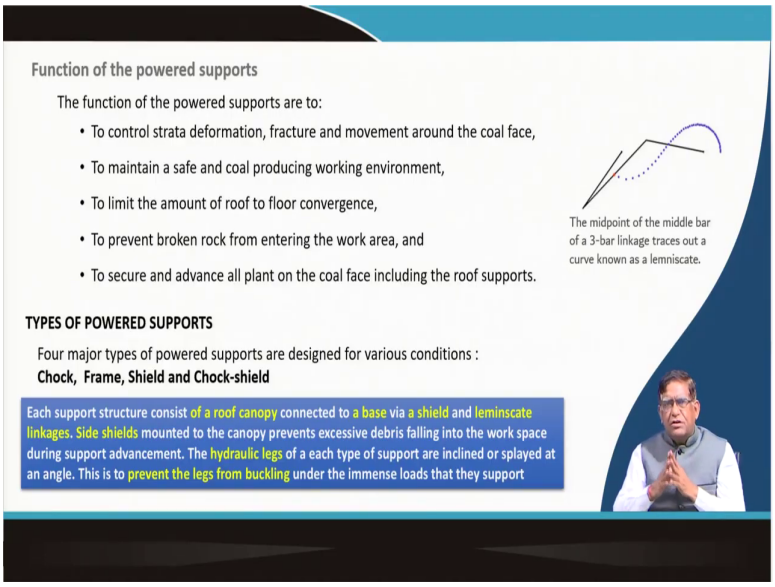
Now, there should be highly resistance to foaming. In some of the fluids, if they get number of the movements and all that thing it may foam and with that exactly the properties will get changed viscosity will get changed that is why there should be anti-foaming that is no foaming should be there on that hydraulic fluid.

So, there is a it will also serve as a lubricant that lubricity and corrosion resistance this or corrosion protection sometimes. So, that when it is working in that the main metal it should not get corroded. So, this along with that there must be a control system.

Now, that control system which is hydraulically electro hydraulically controlled system for which will be necessary for individual support to be controlled manually. Or you can say if there is a series of this supports, now from here you can control the neighbouring, support that type of system is also there or if you want a particular one support you can select from a locations and you can do a remotely that control or the modern development features come you can have an total automatic control.

When, today, this in the automation all man less operations of the support system is possible.

(Refer Slide Time: 09:59)



Now, what exactly role of this power supports? You have seen that a power support is a hydraulically controlled is a particular machines or piece of machinery which are set together to take the whole load of the roof. So, that below that the machines and the people can work properly. Our main requirement over here is that if just under the under any conditions that strata should not collapse or that is the whole load must not come.

So, it is a, we will have to take a lot of precautions in designing and placing. Exactly designing means designing your gap and that exactly how you are releasing the stresses and then how additional stress may come, this will depend exactly the requirement of the support.

Now, to control strata deformation, fractures and movement around the coal face. So, when you are putting it over there you are exactly when you are taking out the coal you are distressing that particular area. So, there you are applying another pressures by which show

that the balance is maintained, so that inside the coal does not get much deformed that is what is one of the purpose.

Then, you will have to maintain a safe and coal producing working environment. So, roof fall, side wall fall and all those exactly strata related the operational disturbances or the accidents proneness that will have to be minimised, so that you will be maintaining the proper environment.

So, while telling the proper environment, it should facilitate ventilation , it should not key and obstruction from ventilation, it should not it should not create a situation of accumulation of high heat because of the operations of different equipment. So, those environment also will have to be maintained it is a safe environment.

Then it will not the roof or floor it should not get conversed, that roof should not come down. And then the if any broken rock comes from the roof, it should not exactly come to the working area for the working parts components of the machines or through the human being.

So, secure and advance all plant in the coal face including the roof supports, that is it will have to protect all other things as well as it will have to protect itself. So, this is what is the main function. And to do that there are different types of power supports are there. Basically 4 types are very well utilised and it is being manufactured by various companies across the world. So, these are called chock support, frame support, shield support and chock shield support.

These are these supports it consist of as it is to summarise, it consist of a roof canopy connected to a base via a shield and a leminscateling case. You know leminscate case that is your 3 link mechanism where the centre central link their point centre point that reverse a trajectory that is a leminscate, leminscate trajectory.

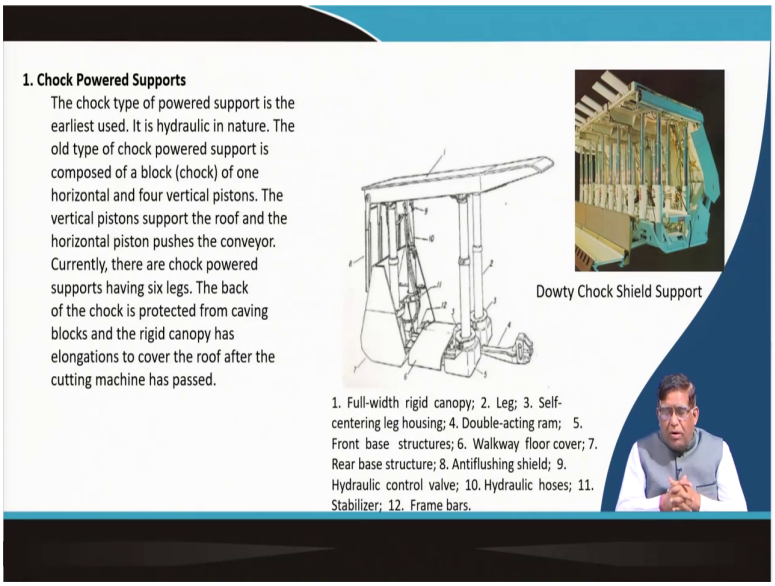
So, that means, your canopy that is your the your you are maintaining a shield with a leminscate linkages, and then the side shields mounted to the canopy that exactly prevent the

excessive debris falling into the work space. So, it will protect itself from that during the support is advancing.

Now, the hydraulic legs of each type of supports are inclined or spread at an angle. It is not necessarily that all the support should be straight depending on that how their load taking capacity and load supporting capacity increase you can have that in angle also. And that only thing is that the if the very high load is coming that your the legs it may buckled.

So, that buckling must not be taking place before that the load distributions to should be proper and those are the design criteria which is considered during the design of this supporter.

(Refer Slide Time: 14:14)



Now, coming to a one by one we will have a general discussions on what these supports are. You can see here a chock support, chock power support. The Dowty was the company in the past they were manufacturing all different type of power supports, robust machine. The chock type power support is that was a very early type and this hydraulically operated chock supports, then they exactly had a block, that block is called your chock.

And then one horizontal and then 4 vertical members. So, these vertical members are the vertical pistons you can see here 1, 2, 3, 4 that is one block. One block is comprising of this horizontal member, one which is your it is called your rigid canopy, and then these two that 4 vertical legs are there. And then there is a self centering leg housing that is your this housing of the leg it will be just. So, that making this leg aligned properly.

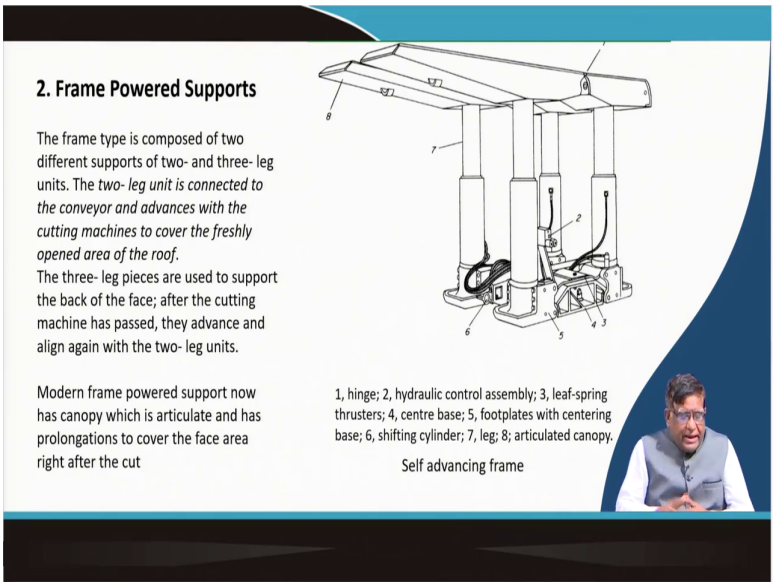
And then in between these two legs there is a walkway. So, the people can walk through this. And then there is a rear base structure at the back side and in the that is a you are having one anti flushing steel that is if anything from the backside from the gob side it will not be striking over here.

So, there is a shield here. And then, it has got this all hydraulic hoses which will be bringing the hydraulic fluid to give that power. And there is one stabiliser, so that it can remain stable over here and then there is the main frame bar on which the things are mounted.

So, this chock type of supports this was originally 4 now there could be with 6 legs also, so that its capacity can be enhanced, ok. So, the back of the showcase you can see that the this caving when it takes place in the goaf area. So, that this should not abstract here that is why in the back side there is a protections. You can see this is your back protection shield is there.

So, it you can easily draw this diagram and then you can find out that exactly for this given area the dimensions of this and that before that what will be the different dimensions for a given or expected load type those calculations have done while designing or then while selecting a particular chock support for a face.

(Refer Slide Time: 17:03)



Then, there was another old type of that was a frame powered support these were exactly the working frame. These hydraulic frames it has nothing it was a very simple one old, there was a 2 leg unit or there could be a 3 leg unit.

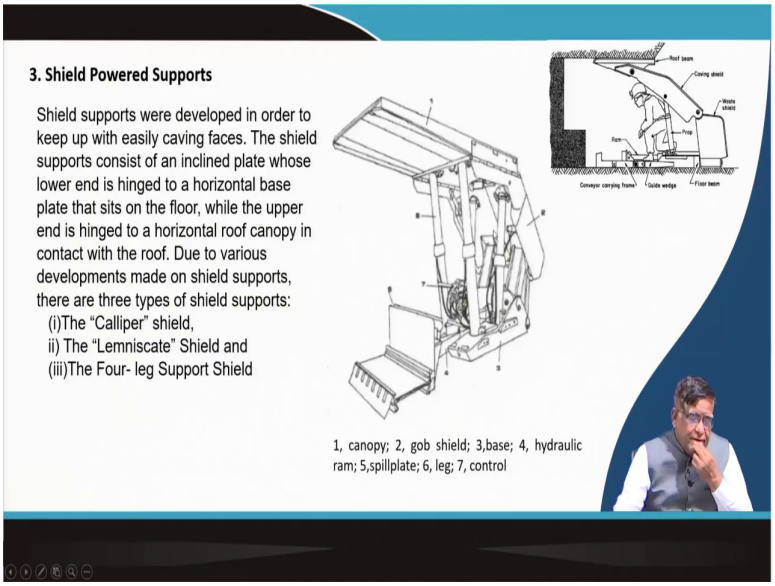
So, here 2 units of these supports are shown. Here we have got only 2 leg. You can see here that is your that your one hinge point is there on that hinge point we have got this canopy and there we have got the a hydraulic control assembly is there, total hydraulic flow which will be controlling this pistons can be coming over here. So, you can see that this is your the hydraulic control assembly.

And then there is a leaf-spring the thrusters which will take the total pressure on it and there is a central base is there. A central base unit is there, and then this your main legs which are

the pistons. And then you have got this is the main canopy, it is an articulated canopy that is around in hinge it can do the articulations over here.

So, this was a simple type of frame powered support. Nowadays, this; this is exactly the machines are working in this area in front of it, it will be doing the cutting. And then, they have the canopy this articulated canopy, it can have a prolong that is your, it can give a longer there, what will be the ratio of this section and the rear section that will depend on, how much weight will be coming over here.

(Refer Slide Time: 18:54)



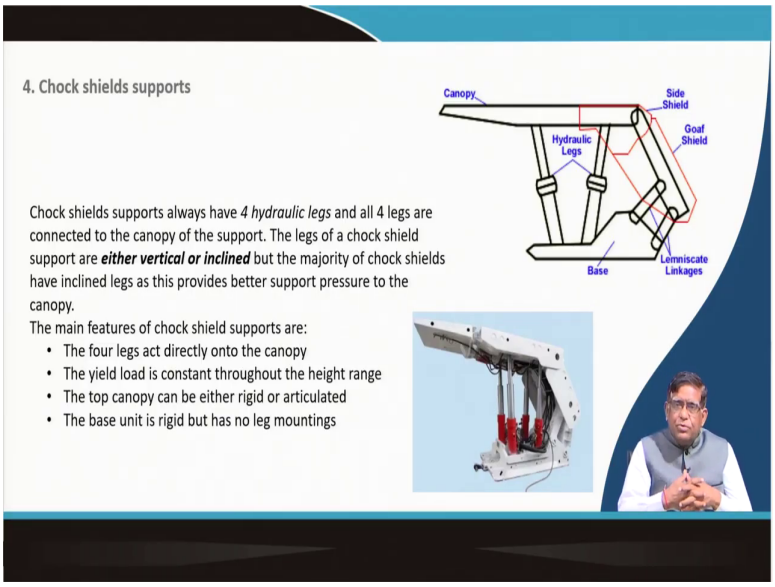
So, the other one is called your shield support these were developed to keep up that easy caving faces that is where exactly while you are doing the mining operations your goaf area you allow it to cave. So, that you are in this shield support area when you are in the back side

that it will be caving in. So, your, these portions where the working and the main face is there this portion is kept protected from this caving. So, that is why it is called a caving shield.

You can see the two part, one is caving shield and then over that there is a roof beam. So, by this way it has got a proper shelter for the when there is a caving operation or the caving takes place at the backside in the gob, ok. So, now, this the shield, this shield support it can be of different type. Sometimes it is called your calliper shield, there is a leminscate shield, there is also 4 leg support shield, different type of shields are there.

So, you can see there is a component wise one block or one unit of this shield type power support has got the canopy, it has got the gob site shield, then it has got the base, and then it has got the hydraulic RAM, and then it has got the spill gate and then it has got this leg and the control system. So, this is in front of this your spill gate here your armoured face conveyor will be located. So, this whole thing come as a unit to get your longwall face canopy.

(Refer Slide Time: 20:40)



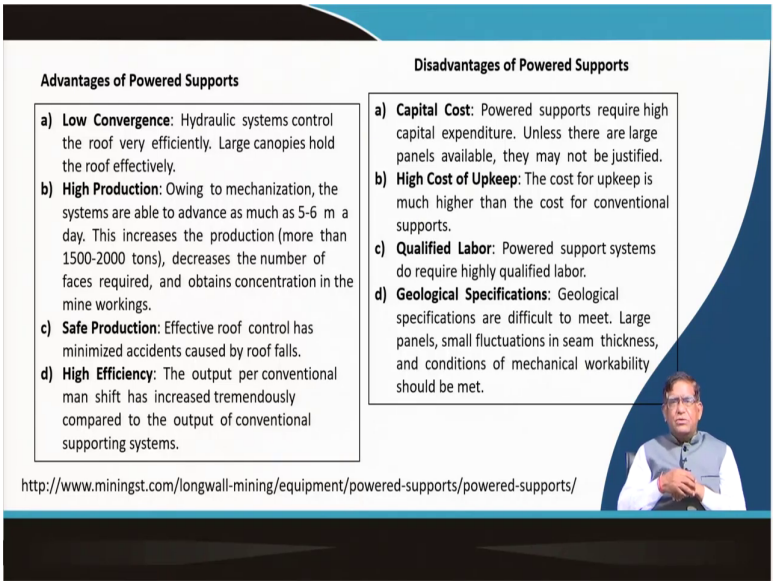
So, then other one is your chock shield support which is very common. It has been manufactured and also in India lot of Chinese chock shield supports were recently procured in our Longwall mining, in Singareni, and also in there were many places these shields are used in your country.

Nowadays, they have got a 4 leg, 4 hydraulic leg, all legs are connected to the canopy of the support. You can see here this is your gob shield, you have got this your side shield, and then we have got this canopy. Like that you have got these 3 unit, this portion is your gob shield, this is your side shield, and this is your canopy.

And then these legs it can be a little vertical or inclined or you can see that is a more inclinations can be there as it is required. So, that, they such type of things are the 4 legs act directly onto the canopy and then the yield load is constant throughout the height range, the

top canopy can be either rigid or articulated, or the base unit rigid but not no leg mountings are there. So, this is a simple and also very capable robust support system.

(Refer Slide Time: 22:05)



So, you have understood now, that is your what is the purpose of the power support, what are the main components of the power support, what are the different type of power supports. So, there is a in your board and pillar mining you have seen that other type of supports like your hydraulic prop or you have got the steel arts or you have been doing that your cable bolting and this that way you do the bolting of the roofs there also.

Now, what is the advantage of this power support? Basically, there is a hydraulic system control the roof very efficiently. So, large canopies can hold the roof very effectively and as a result nowadays it is possible to dig a very big about more than 5 meter thick seems are also being cut by designing this power support in a big way.

Now, the high production it is possible because you are when you are maintaining a very high gallery, size or the high thick, thick coal can be taken up bigger machinery can be deployed. So, the performance of the mine it will be enhanced.

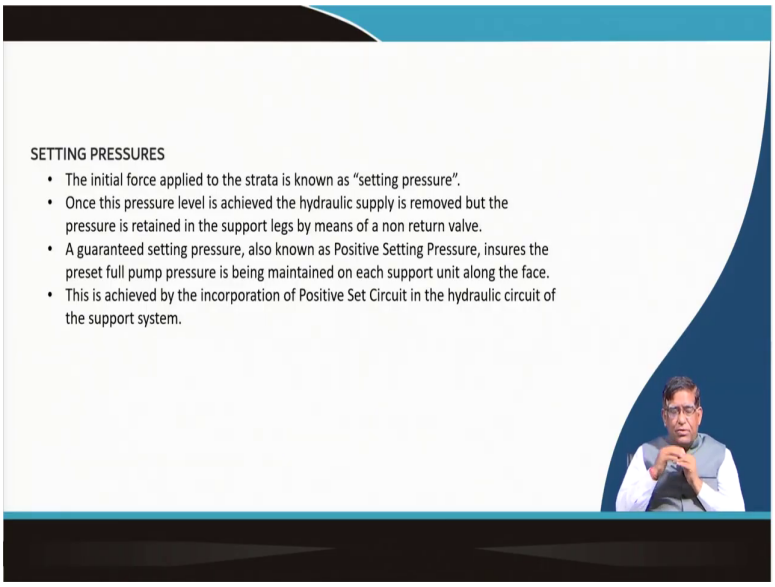
Then, there is a your productions become safer because the main problem in underground mining is the roof control. Once such type of supports are deployed you can get a safer environment for working and because of this the overall efficiency is higher.

But as a disadvantage there will be high capital cost and a the maintenance and of the whole system that also is very it is costly. And then, to operates and such type of mines because the your miners they will have to be educated and properly skilled to handle the electrical, electro hydraulic and that numerous things you will have to note the pressure readings, you will have to keep watching on the signal which is coming up if there is any dangers.

So, that they will have to understand and then act. So, that is why your labour force need to be very qualified one. And then, that is exactly sometimes the most difficult thing is there the geo mining conditions, geological conditions. The situations may not be very suitable and it cannot adjust with the changes of things that there is a that flexibility is not there. It is designed for one particular situations cannot suddenly be taken into another one.

So, these type of problems are associated with them.

(Refer Slide Time: 24:49)



So, what you need to know about is what is called your a setting pressure is what, that is your that when at pressure at which it will be working, that is your the initial force applied to the strata that is known as the setting pressure.

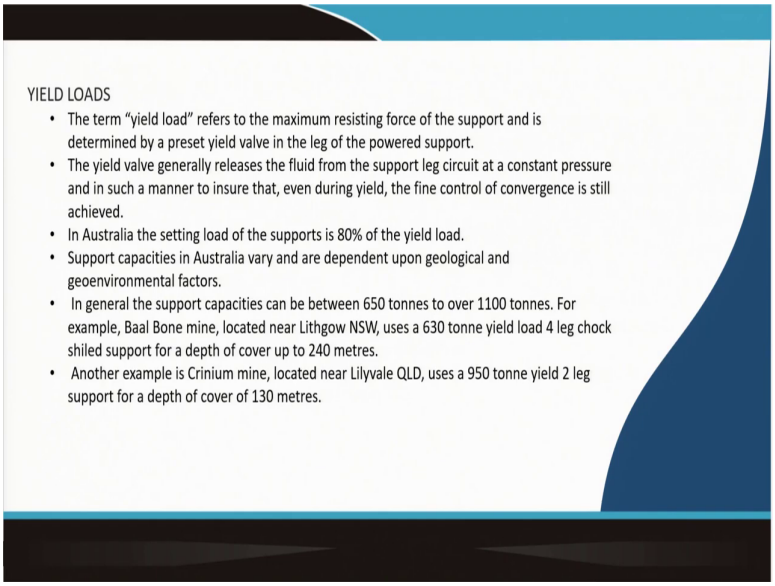
So, that means, that as you said as the load increases then it will be start and you will be going up to the yield pressure, but before that you will have to put it with a particular load it will be taking over here that is called your setting load. So, once the pressure level is achieved, the hydraulic supply is removed, but the pressure is retained in the support like by means of a non-return valve this is important thing.

That is when you give the setting pressure at that time whatever the pressurised fluid will be there. You are having a non-return valve, so that it will retain that one and it will work. Now,

the guaranteed setting pressure also known as a positive setting pressure, ensures that the pressure pre-set full pump pressure is being maintained on each support unit along the face.

So, that is your you are guarantying; that means, that manufacturer they will be giving a guaranty come what may if this setting pressure is this much, means our pump and that pressurised fluid will be all the time continuously maintaining that pressure. Then, the positive set circuit in the hydraulic circuit, is these are so designed that this pressure is maintained.

(Refer Slide Time: 26:27)



So, then the yield load is another terminology you need to know. The term in yield load refers to the maximum resisting force of the support and is determined by a pre-set yield value in the leg of the power support. The yield valve generally releases the fluid from the support leg

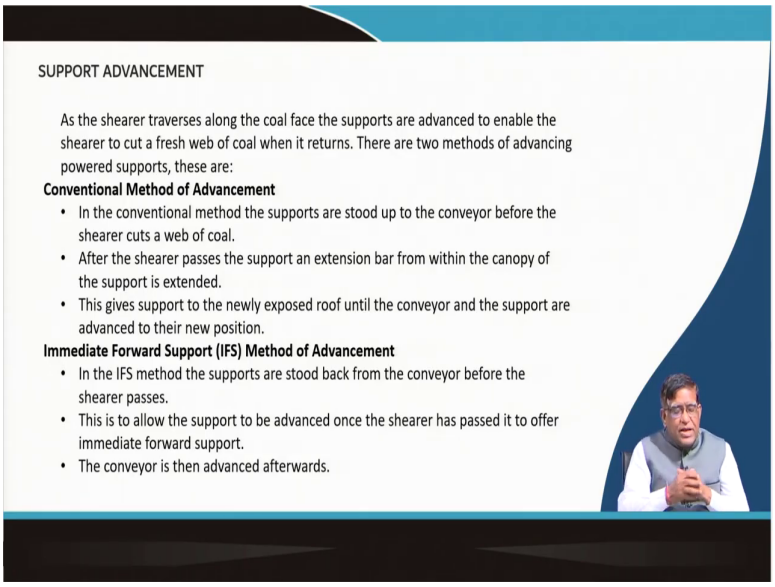
circuit at a constant pressure and in such a manner to ensure that, even during yield they find control of the convergent is still a shift.

So, that is it is it will withstand. So, that will not coming and collapsing things. And now, this yield load it depends only what is the geological conditions and that is why in country to country they will be putting into indifferently. Sometimes it is the their safety regulatory agencies of different countries they put it over there.

So, in general support capacities can be between 650 ton to 1100 ton. For example, that we have got some literature says that in a new south wales there are 630 tonnes yield load for 4 leg chock shields. So, you can collect such figures from a for our Indian conditions.

You will see the Longwall mining in India, first started at Moonidih mines, then there are all in SCCL mines and now also there was this Jhanjra mines of Eastern Coal Fields. So, you please collect the systems of supports which are there in these Indian mines and their specifications you collect that will be good for you to learn.

(Refer Slide Time: 28:09)



And then you can think of how these systems can be improved, their reliability study, the risk analysis these are the study we will have to be taken by you as a young mining engineers of today.

And there particularly in Singareni coal fields, they have been doing a lot of instrumentations on the power supports and the strata control, because this is a very good area of the mining engineers, where strata control with a power supports they do, and then lot of artificial intelligence applications are going on in this with then lot of new sensors and data acquisitions.

So, they support, how they support exactly advances. This is for the advancing is done as your shearer will be cutting one at that time that will be exactly. Now the next cut will be given,

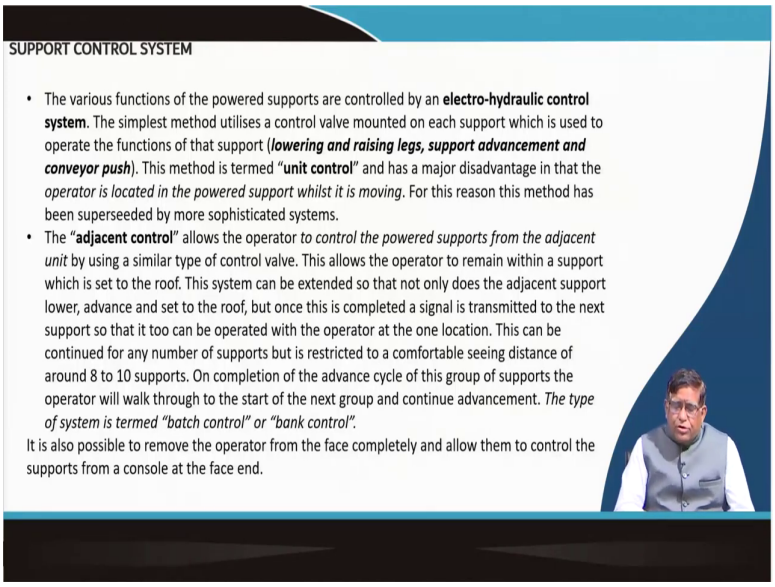
between that time the support also will be moving and all these operations are done hydraulically operations.

So, there is a convenient conventional method of advancement is that is your the supports are stood up to a conveyor before the shearer cuts a wave of coal. And after the shearer pass passes they support an extension bar from within the canopy of the support is extended, and then this gives a support to the newly exposed roof until the conveyor and the supports are advanced to their new position.

But there is another way of your immediate forward support system in which the in the immediate forward support the supports are stood back from the conveyor before the shearer passes. Now, this is done, so that we can allow the support to be advanced once the shearer has passed through a over a that is an immediate forward supports there.

And then whatever the conveyor is done advanced afterwards. So, that is exactly a sequence is maintained, so the shearer cut new face is coming shield going and then it is moving. So, in that sequence your support advancement is taken.

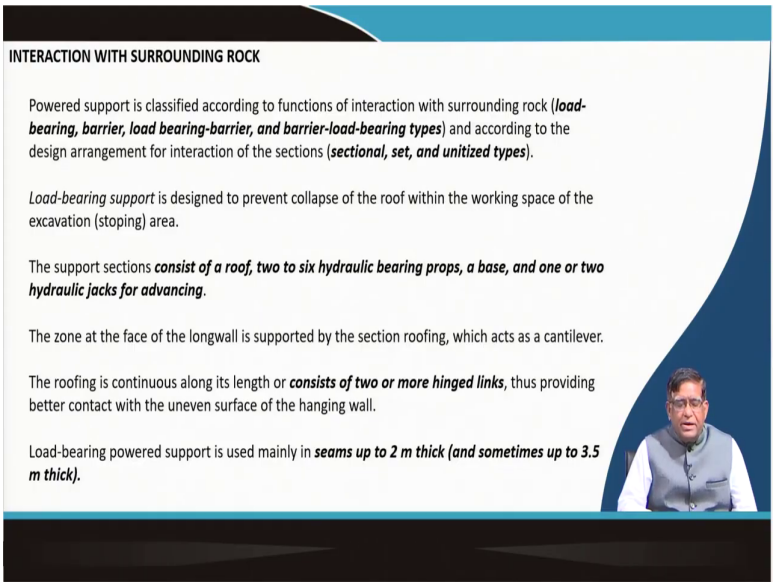
(Refer Slide Time: 30:21)



Now, there is a for controlling the support there are electro hydraulic control systems are there, they will be doing that lowering and raising of the legs, support advancement and the conveyor push and all these things can be done one by one as unit that.

Whichever unit you want to do you are working on that. And another is an adjacent control, you can do this control with the neighbouring this neighbouring supports and in that way either you do unit control or you do the adjacent control, this type of controls are available.

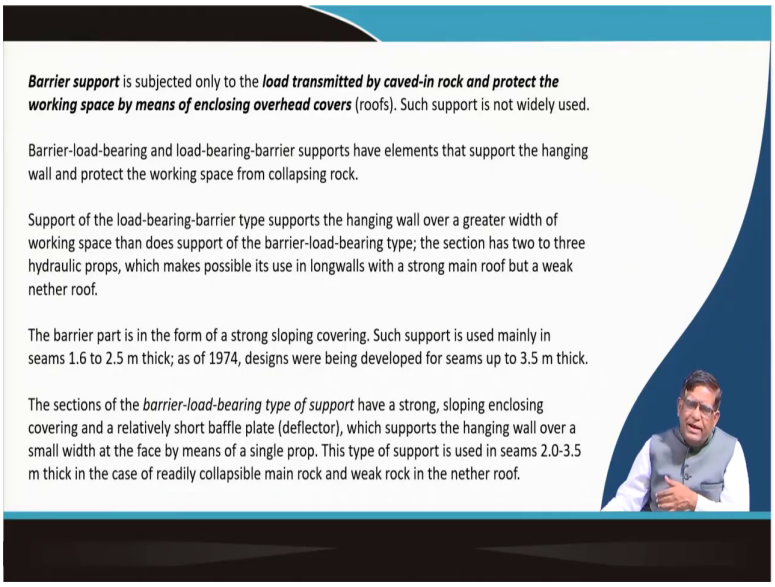
(Refer Slide Time: 30:57)



So, there is a you can do all interactions with the surrounding block and then basically the power support is classified according to their function interactions in the surrounding rock; how it is exactly interacting with that, particularly how load bearing barrier load bearing barrier and the barrier load bearing types. So, different type of how with the rock it is taking the load, and then how it is exactly moving and allowing to giving this takes place.

So, now the support sections will be consist of a roof your hydraulic bearing probes base and one or two hydraulic jacks for advancing. With that they will be interacting with type of rocks which will be arriving over here.

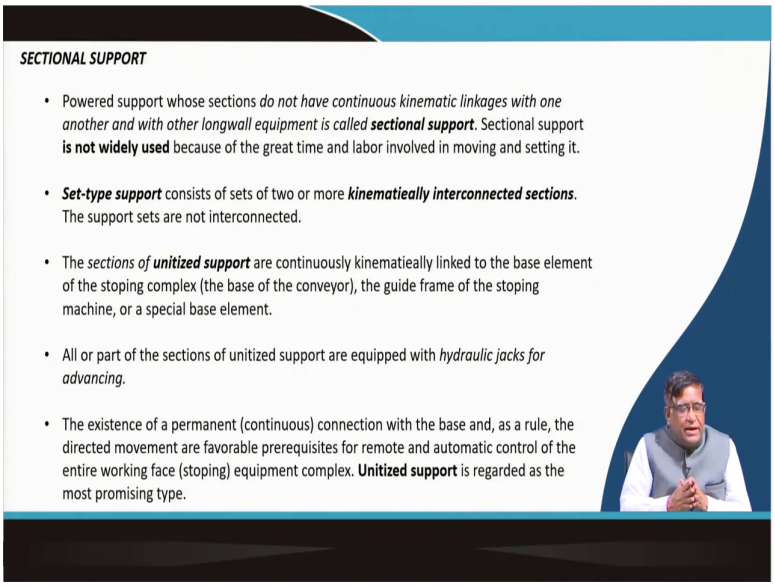
(Refer Slide Time: 31:48)



So, this supports that is it is subjective to load transmitted by the caved in rock and protect the working space by means of enclosing overhead covers. So, basically the whole functioning system is how you are protecting the machines and the people by giving your the tape making the canopy to take load.

And as you have seen in the other in a discussion of AFC we have said that when this if you are making them to cave in and you are loading into a that is your rear side another AFC is there, then your this power support will guide the material to the next AFC. So, that operation is also done.

(Refer Slide Time: 32:39)

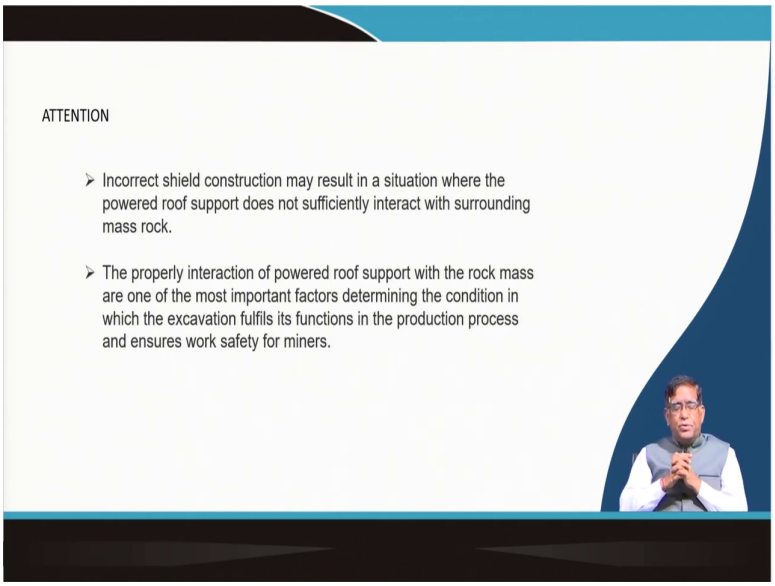


So, there the supports could be also power support whose sections do not have a continuous kinematic linkage with one another and with other longwall equipment is called your sectional support it does not have a interconnected link. But if there is a inter connected that is called you shape type support; that means, the two or more shapes they are having a kinetically interconnected sections.

So, that they respond the way the neighbouring one is taking over there then it will be also actuated. So, there is a unitized supports are continuously kinematically linked to the base element of the stopping complex or in that where your the main base of the conveyor is there; that means, the armour face conveyors, and the guide frame of the stopping machines or a special base element.

So, that is you can give a unitized support or you can give a sectional support that is the way how your support system will be working.

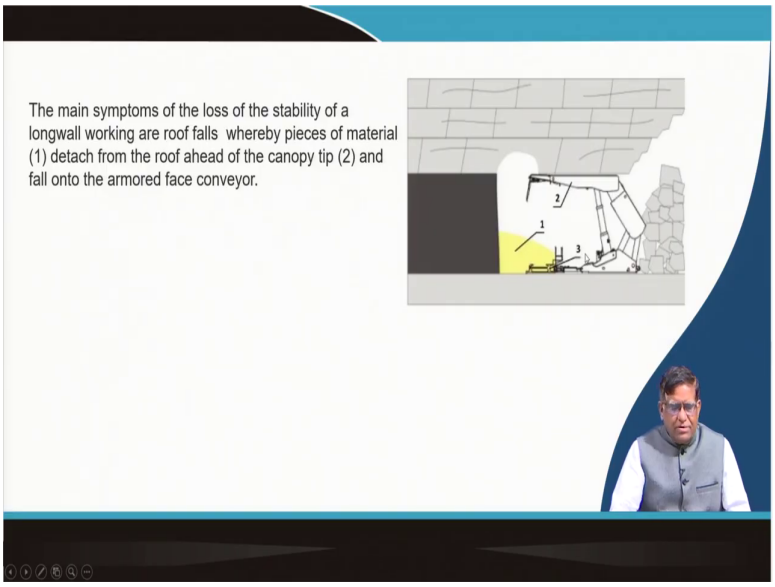
(Refer Slide Time: 33:39)



Now, what it should be taking care of that incorrect shield constructions may result in a situation where the powered roof support does not sufficiently interact with the surrounding mass rock. So, this can be a one situations.

Then, the properly interactions of powered roof support with the rock mass are one of the most important factors determining the conditions in which the excavation fulfils its functions in production process and ensure work safely in the mines.

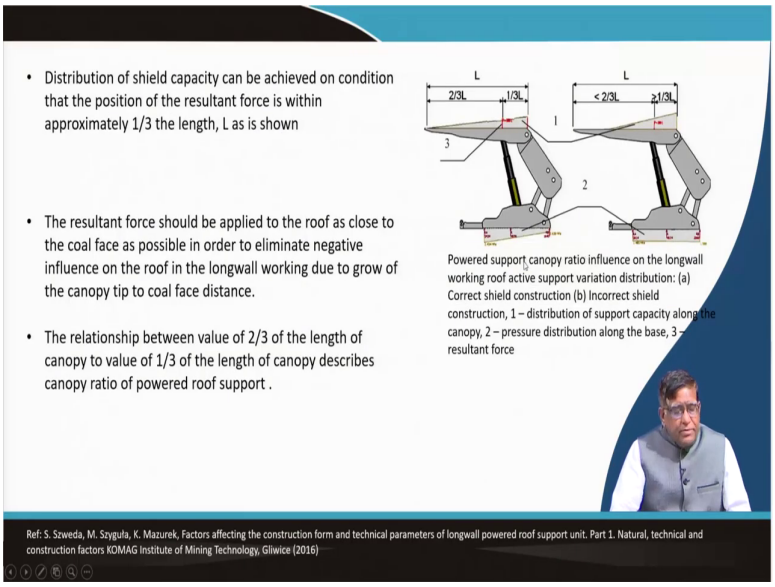
(Refer Slide Time: 34:11)



So, that is where the main symptoms the loss of stability of the longwall working are the roof falls. Now, this you can see here that there is whole that support will be taking the whole load and this is the goaf area, there is exactly the rock fall has fallen down. Now, in these conditions this will have to remain stable.

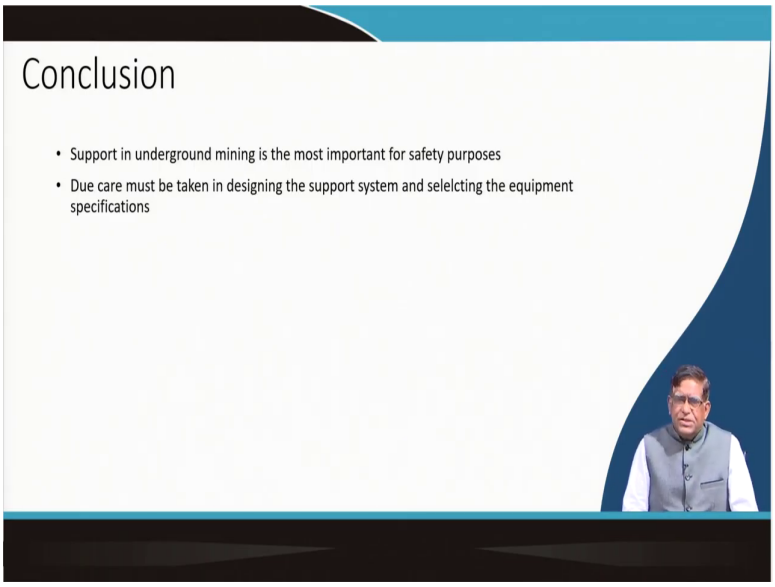
Now, if the setting load and that your total pressurise which is the capability of this is less, then under this it will collapse, this legs will buckle or it may just get pressed down. There had been accidents in longwall mining where such type of power supports there incapable of holding this and they collapse. So, that is the basically that is attributed to the design mistake; that means, a design could not apprehend that a huge load will be coming and the situation will become unstable.

(Refer Slide Time: 35:13)



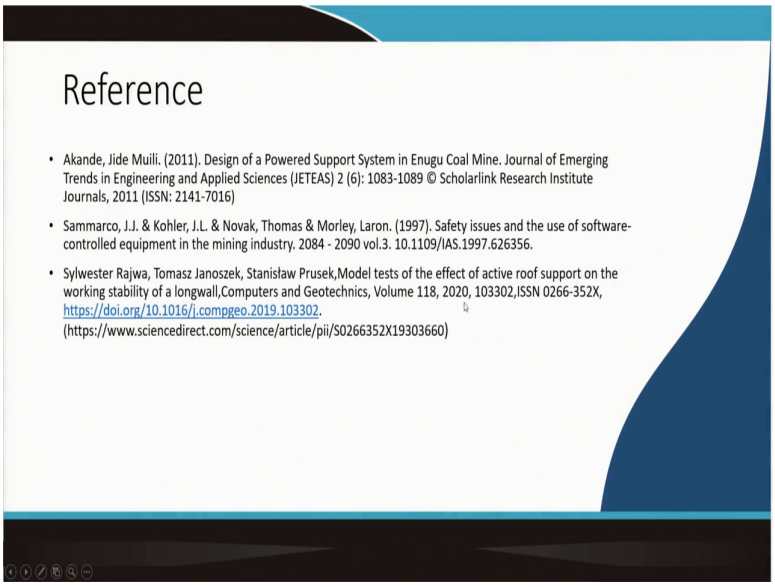
So, you can see here that is your how the distribution of the capacity distribution of the load on various units come.

(Refer Slide Time: 35:22)



So, this is way how exactly a support you will have to study the basic types, their operations, their requirements, and then how to select a support in your while you are studying longwall mining you will be doing detail exercise on this.

(Refer Slide Time: 35:38)



There are lot of research and support, please go through it.

Thank you very much.