Sustainable Material and Green Buildings
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Lecture 29
Energy Efficient Design of Building

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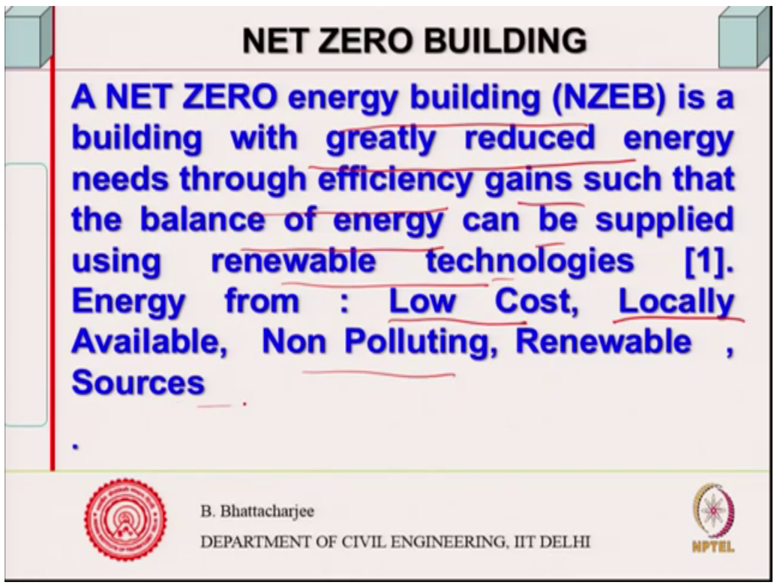

So, we will look into a net zero energy building right. Now a net zero energy building as I said we have so far looked into issues like indoor rare quality. Before that we will look into materials of varieties of kind and one of the component is, and also we have looked into operational energy where it plays role, materials play role. So now we are looking at more at the energy issues and detailed energy efficient building design is not part of this course but the factors and their levels should be clear, what are the factors? How we take account of? Will be clear from this discussion.

So, we are talking of net zero energy building right. Net zero energy building which reduces the energy needs through efficiency gains such that the balance of energy can be supplied using renewable technologies. So, basically (you know) energy first thing is you got to reduce the energy needs and then if you have such system which can generate energy in the building itself then you can even supply back to the grid which is also called net negative building (you now) negatively. So, basically if this energy that we are using from external sources in the building itself that should be locally non-polluting renewable resources and all that.

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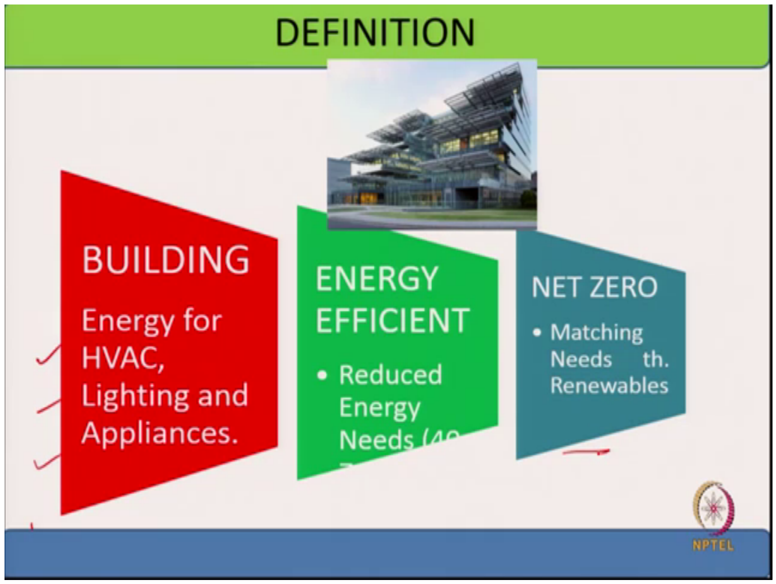

So, major consumer of energy in building is HVAC Heating Ventilation and Air Conditioning, lighting and appliances. So, Energy efficient building of course reduces the energy needs and it can cut it down to 40 percent. Now, net zero would get this energy from renewable resources like solar energy.

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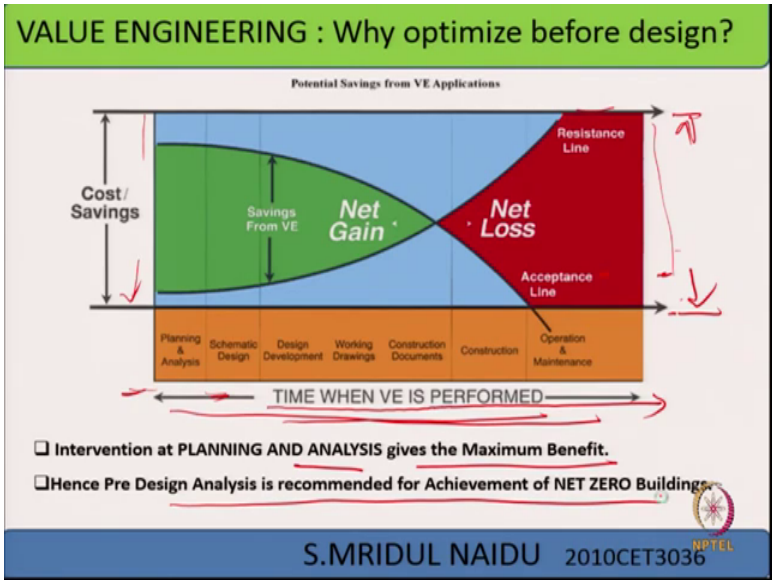

So, you know when I look at the complete time during my value energy, you know value engineering we perform or rather try to see the you know you can say the planning horizon of the building or may be live intended design life of the building. First of planning analysis then systematic design, design development, working drawing etc construction and then operation and maintenance, so this is the thing. So, by doing basically the I can have cost saving largely in this phase right, this phase. So here this basically during this phase initially some cost saving I can arrive it but large saving I can actually reach in this part you know this part.

So, this is a acceptance line, this is the resistance line there I can suggest the you know this is, if you do basically planning and analyze stage so you can get maximum benefit over the period of time. So, pre-design analysis is recommended for ofcourse net zero building.

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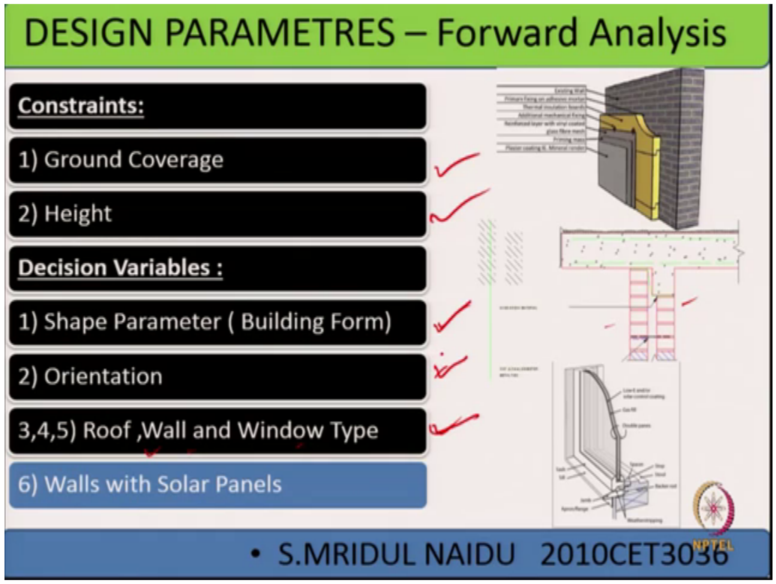

Now what are the factors which go into affects the energy efficient building design? First of all of course this ground coverage that will be part of the building itself, so that is the recommend functional recommend and that is my for my constraint in the sense that I have to ensure a particular level of ground coverage, height.

Then these are the kind of decision variable that means the factors which effect the energy efficiency, building form, orientation then roof wall window type because the materials in the roof or wall let us say there can be several components, we have seen something called U value earlier, several components so roof wall and window all these play a role and ofcourse I can have wall switch solar panels, we should generate energy.

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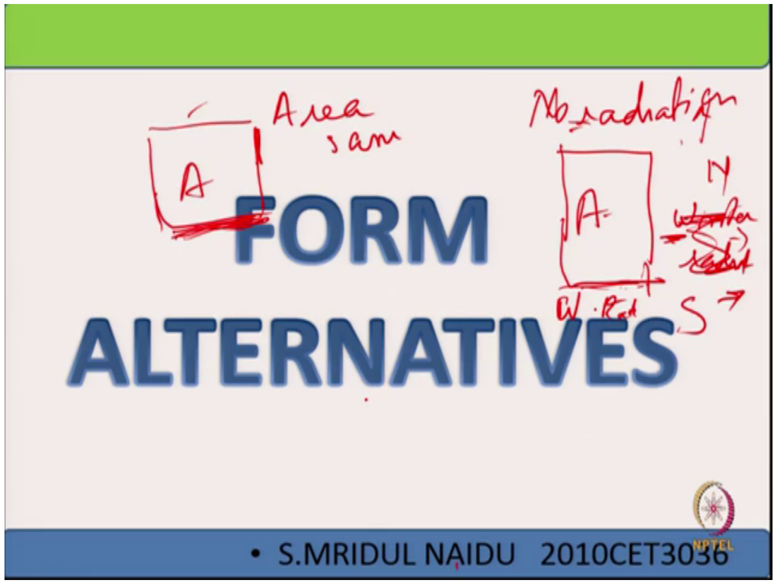

So parameters are, you know like first I can have shape, I am talking of shape parameters that are based on the building form, now how it is relevant? All though we will not do really a calculations here the relationships which we have discussed might have elsewhere. Now supposing I have this shape, this is my north direction, this is south and this is east. Now you know this does not receive no radiation, this receives radiation in some winter, winter radiation, and sorry south receives winter radiation, this, this I mean this east does not, south receives winter radiation.

And east might be in the summer morning and west must be in the summer evening, afternoon. Now same area you consider and say let us say square same area, area is same, Now this will receive depending upon because this will be less than this, so this will receive less radiation during winter right. And this any way will not receive radiation and summer radiation now we its roof area is same, this area if it is A, this is also A, so roof area is same so that does not make any difference. But how orientation effects because now this will receive more winter radiation, this will receive summer radiation in the morning more, this will receive summer radiation in the afternoon more.

So, you can see the amount of radiation received, this is the function of the basically parameter considering the roof same or the surface area of the wall etc-etc. So different alternative if I choose I will get different, you know different energy.

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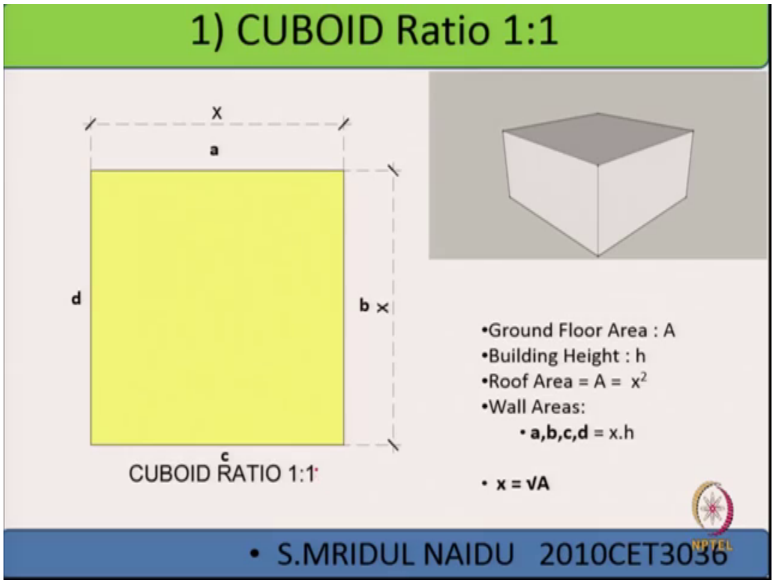

So somebody might take something like a cuboid, the ratio is 1 is to 1, ground floor area is A, building height is H let us say, so roof area is x square wall areas are x into H if it wall 1 is to 1. So x obviously one can find root x under root A.

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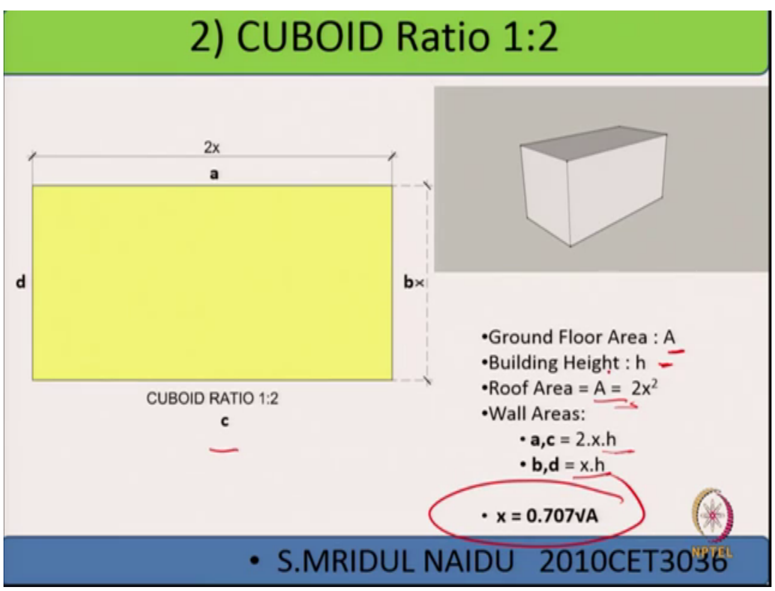

Now if you take this same ground area is A, building height is H, roof area is now, one is x other is twice x, so if x is the smallest dimension, this is x let us say, so area will be 2 x square. So wall area is R, you know 2x into H 2xh and b,d that is XH, this one , this x you know x, this will be X into H. So, one can actually find out X, which will be 0.707 of A, so this is the x dimension right.

So this is also a cuboid ratio of 1 is to 2. And obviously depending upon its orientation so surface areas are different depending upon surface areas are (dependent) different depending upon what is your aspect ratio.

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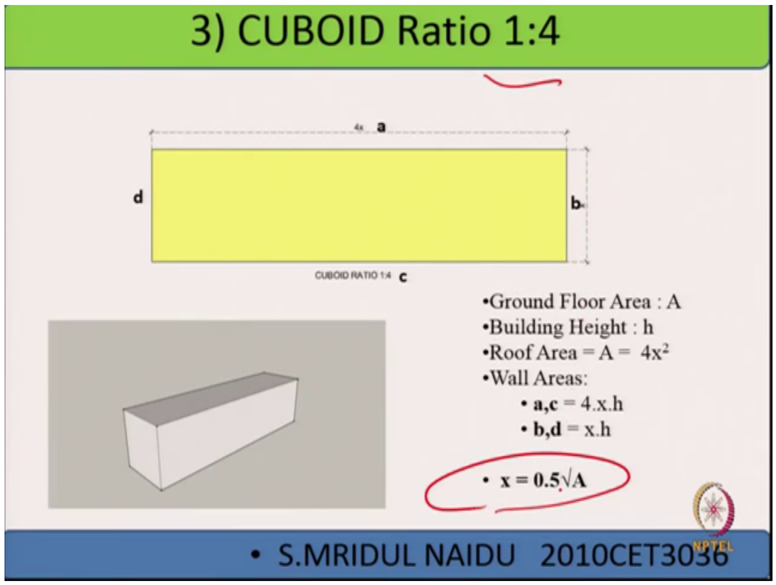

If you take aspect ratio 1 is to 4 you will find this smallest dimension x is equal to 0.5 under root An so on.

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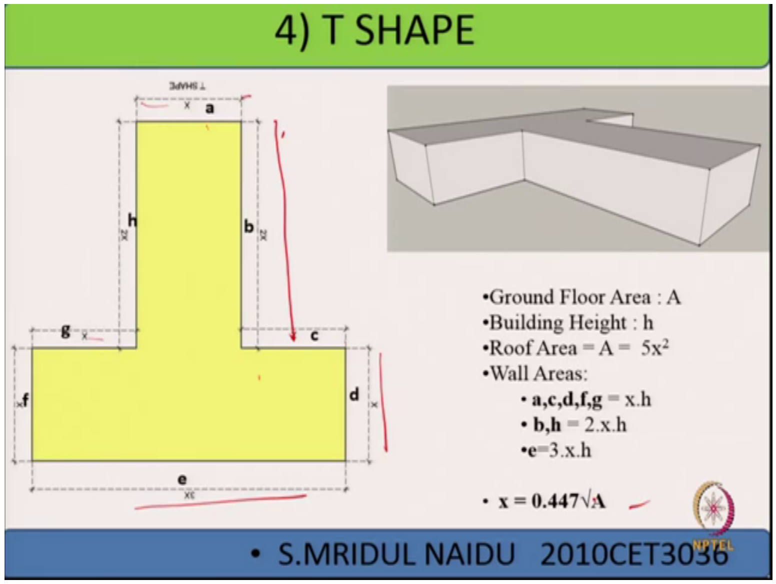

So surface areas so this could be, now take another shape let us say T shape, then this would be if I call this as smallest dimension this as x let us say this is 2 x, this is again x, x and this is again e is 3x and so on because this is x, this is x and this is x, so this is 3 x and this 2 x. So, again it will depend upon this dimension will depend upon area, you know the factor multiplied by area. So this will vary from building to building.

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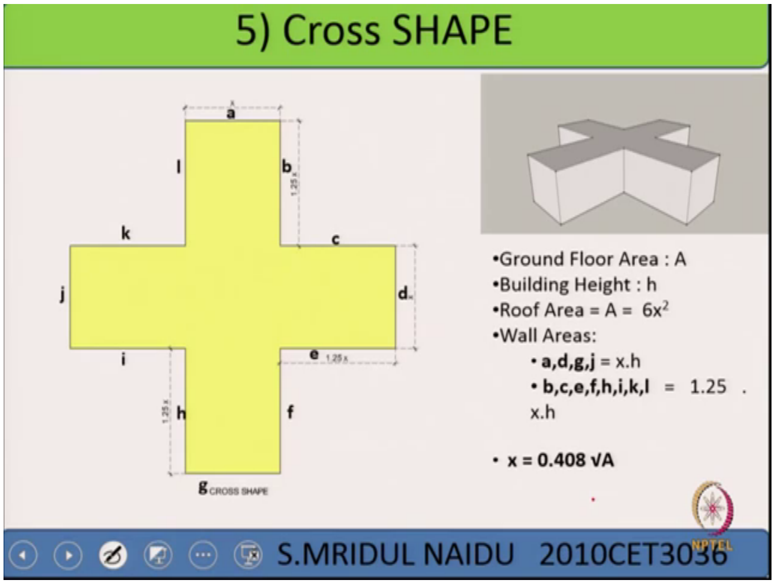

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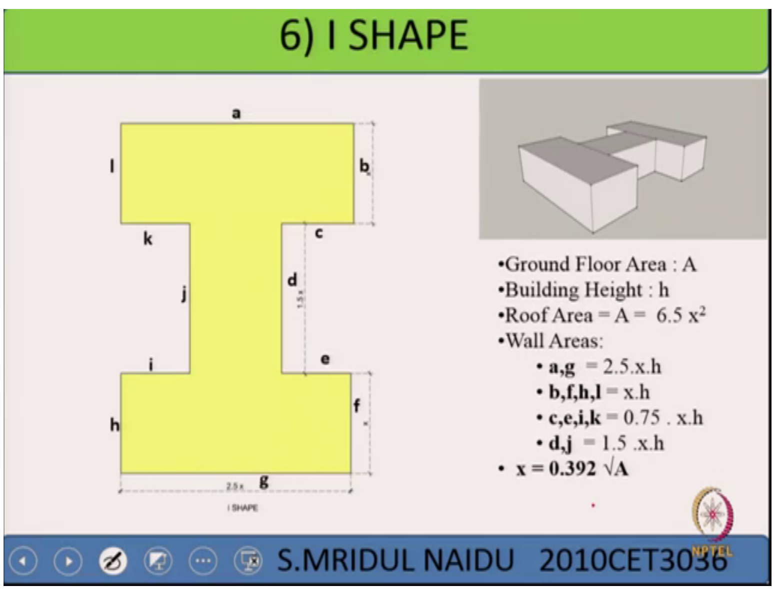

So you can see that shape has got a roll whether it is cuboid or T or cross shape and I shape.

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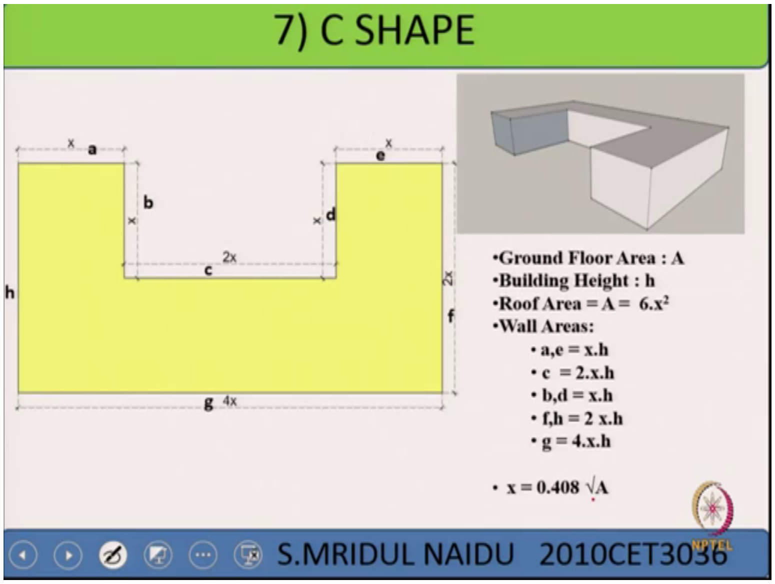

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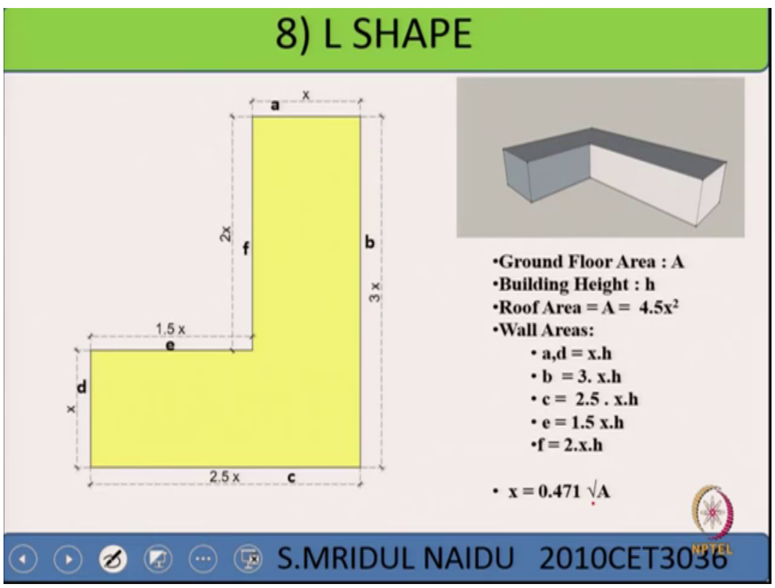

And you know C shape, L shape these is therefore your shape is a factor and you can vary the shape depending upon the constituents of the site, ground coverage etc-etc whatever the site consent. So, one can choose different types of shapes, right, okay.

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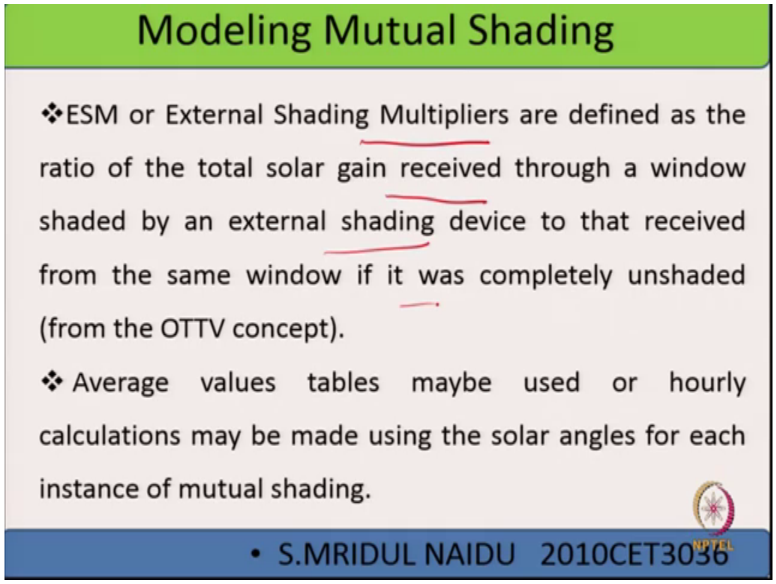

Then external shading multipliers they are essentially the ratio of the total solar gain received through the window shaded by an external shading device to that received from the same window if it was completely un-shading.

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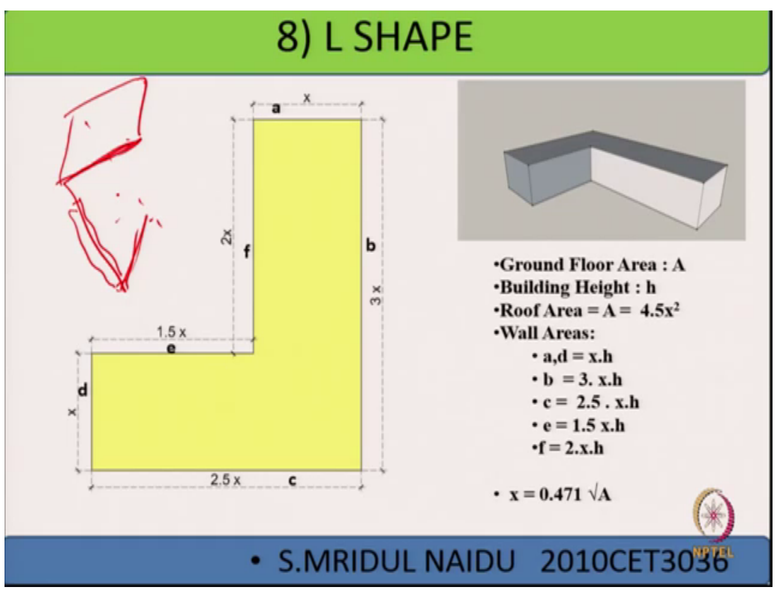

So, basically this is, these are also some variable parameters, this is my window let us say sun shade all though I may not go into the details of this and this one. Now supposing this the sun shade you know this is my window, this is my window, this is my window, this is the sun shade, so they block the solar radiation. So the type of shading that use and the length and dimensions they are also factors they can be also factors you know they could be controlled.

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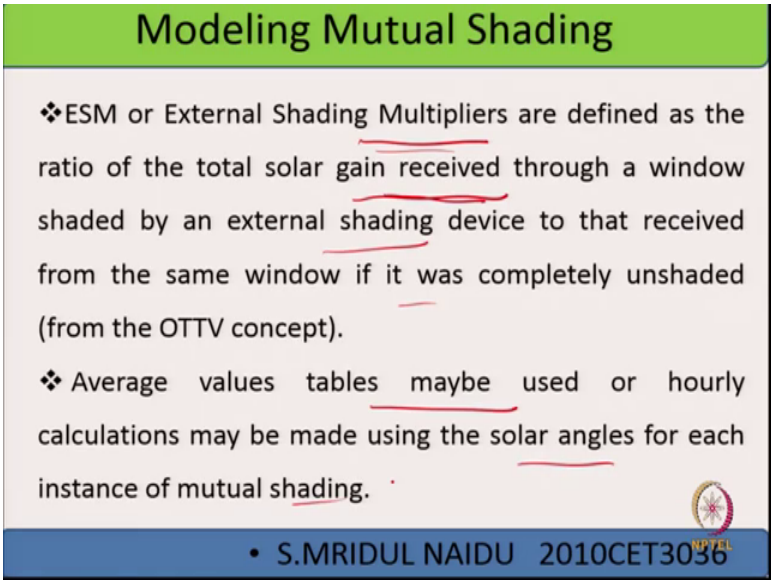

So, shading multipliers are the basically is a factor which is a ratio of total solar gain received through the window shaded by an external shading to that if it was not shaded at all. So, one might have average values or you can actually calculate out for a hourly time and for various solar angles etc-etc all you know this particular one.

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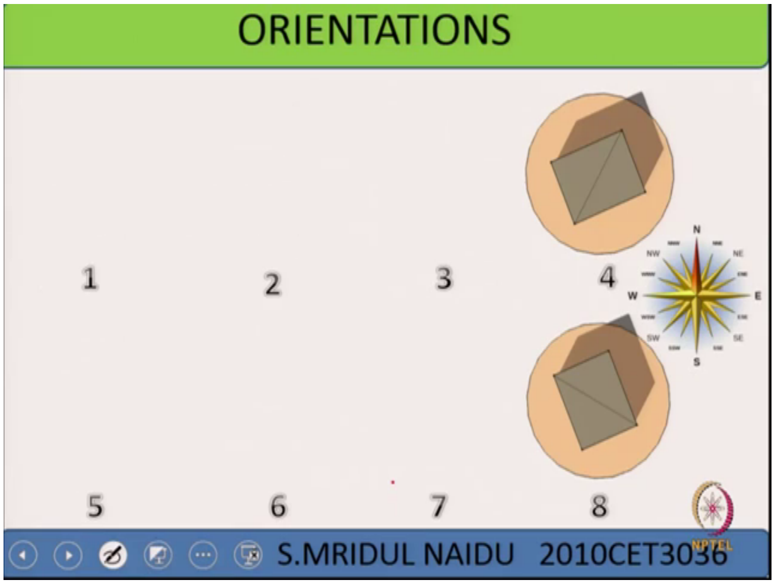

But I think I am not going into that, I am not going into the calculation part of it because this those who have done another course they will develop come to this detail. Next is orientation this is another factor. Orientation for example you know I can have number of orientation possible.

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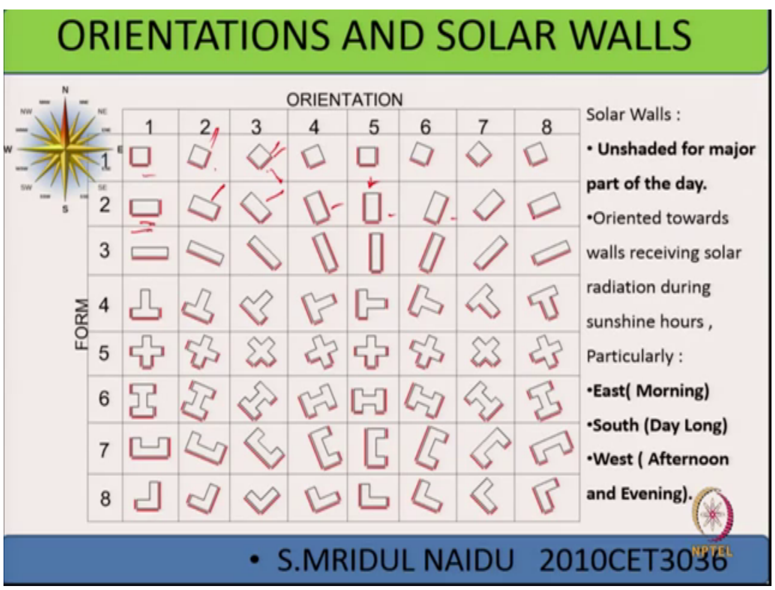

So let us say this is north this is south, east, west etc etc so several orientation are possible. Let us say I can have this is a orientation and this is not, now this facing north-east, this is facing another side you know like you know another side I mean basically it is same one now facing this side as this is east and south or south-east. And this is phasing so this way you can rotate this building here of course it is all square so therefore they look similar but if you look at this, this 3, if I rotate 45 degree another rotation and so on so forth so I can rotate them in different orientation.

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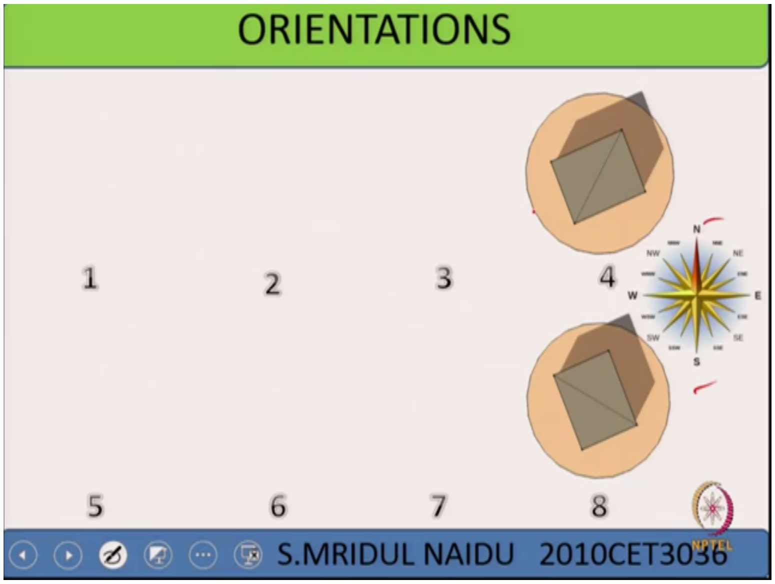

And as my orientation changes the amount of solar radiation received will change. Therefore orientation is the other factor.

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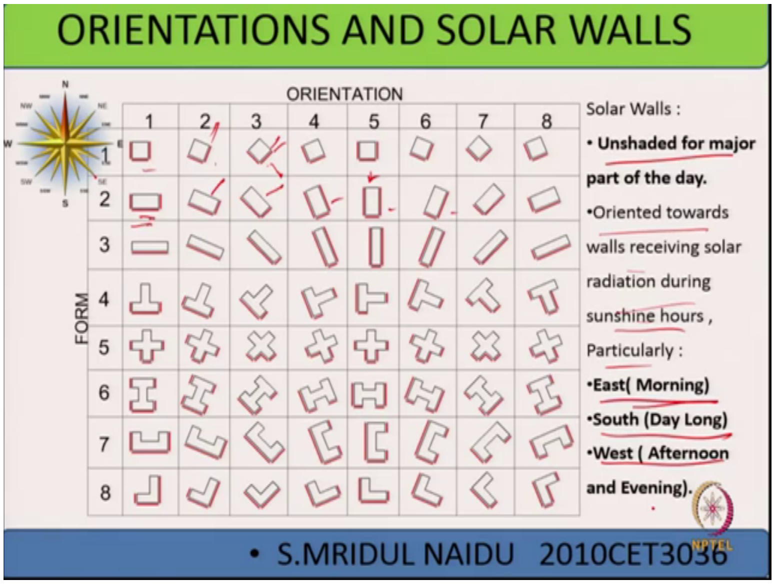

So orientation is the other variable factor and if you look at it for all the shapes. Let us say in this cases there are 8 shapes that I discussed earlier, 8 shapes I have discussed and 8 orientations are possible. So you will have 64 cases and obviously you got to choose the best out of them you know. So far only 64 cases I have taken. Now they can be un-shaded or orientated to our walls receiving radiations, sunshine hours etc-etc okay so as I said east in the morning, south day long in winter, west afternoon and evening so orientation is done.

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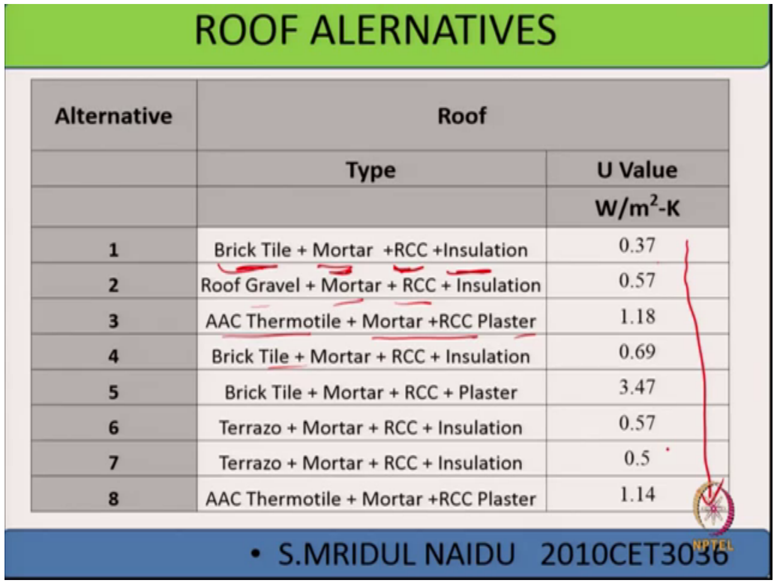

ROOF ALERNATIVES

Alternative	Roof	
	Type	U Value W/m^2-K
1	Brick Tile + Mortar +RCC +Insulation	0.37
2	Roof Gravel + Mortar + RCC + Insulation	0.57
3	AAC Thermotile + Mortar +RCC Plaster	1.18
4	Brick Tile + Mortar + RCC + Insulation	0.69
5	Brick Tile + Mortar + RCC + Plaster	3.47
6	Terrazo + Mortar + RCC + Insulation	0.57
7	Terrazo + Mortar + RCC + Insulation	0.5
8	AAC Thermotile + Mortar +RCC Plaster	1.14

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Now you can have different types of roofs alternatives, so this one (sun) is normally used typically in India scenario. For example most of them are taken for the north Indian scenario actually different types of roof possible are there. So you have several types of roofs for example you have RCC then an insulation inside, mortar then top brick tile , may be same RCC mortar roof gravel there some thermotile mortar, RCC plaster. So, these are typical some eight roof, with different evaluation 1 3 7 etc-etc. So, here we are just taken eight there can be many more.

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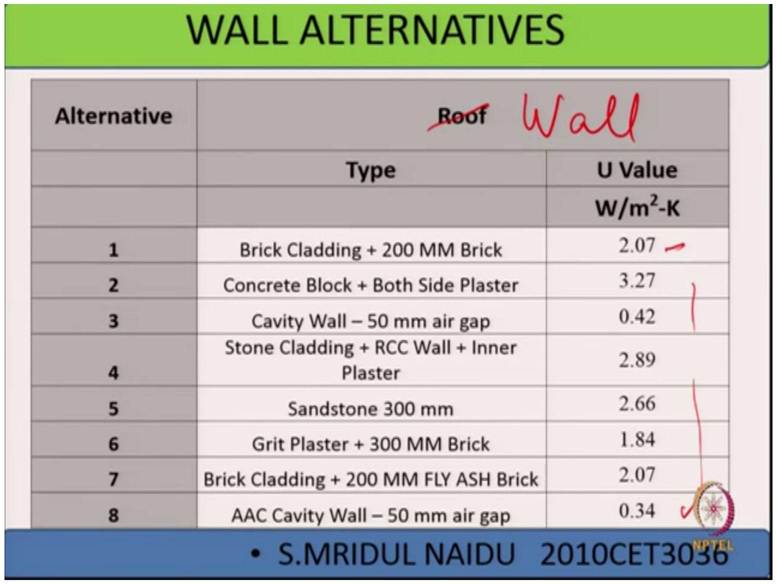

WALL ALTERNATIVES

Alternative	~~Roof~~ Wall	
	Type	U Value
		W/m²-K
1	Brick Cladding + 200 MM Brick	2.07
2	Concrete Block + Both Side Plaster	3.27
3	Cavity Wall – 50 mm air gap	0.42
4	Stone Cladding + RCC Wall + Inner Plaster	2.89
5	Sandstone 300 mm	2.66
6	Grit Plaster + 300 MM Brick	1.84
7	Brick Cladding + 200 MM FLY ASH Brick	2.07
8	AAC Cavity Wall – 50 mm air gap	0.34

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And right, so there could be wall alternative see look at it. This is not roof, this is wall actually wall alternative I can have brick cladding with 200 millimeter thick brick just some examples and the corresponding U values are here. So, if you now look at them I have just taken about eight walls type, normally walls will have same construction in all sides, external peripheral wall can take up envelop part of it. All would have you know generally they would be same, they can be different that it adds more to my variables and all this are my variable.

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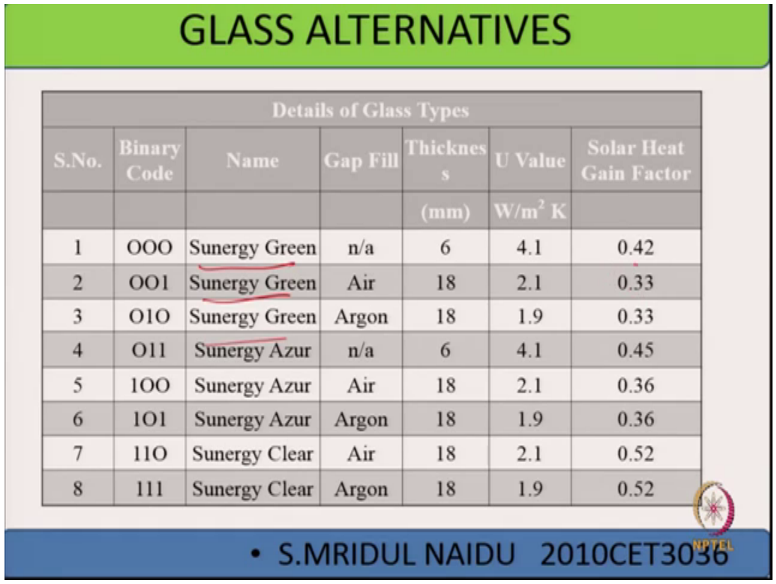

GLASS ALTERNATIVES

Details of Glass Types						
S.No.	Binary Code	Name	Gap Fill	Thickness	U Value	Solar Heat Gain Factor
				(mm)	W/m² K	
1	000	Sunergy Green	n/a	6	4.1	0.42
2	001	Sunergy Green	Air	18	2.1	0.33
3	010	Sunergy Green	Argon	18	1.9	0.33
4	011	Sunergy Azur	n/a	6	4.1	0.45
5	100	Sunergy Azur	Air	18	2.1	0.36
6	101	Sunergy Azur	Argon	18	1.9	0.36
7	110	Sunergy Clear	Air	18	2.1	0.52
8	111	Sunergy Clear	Argon	18	1.9	0.52

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Similarly then glass, glass is the one which brings in maximum energy also light, both you know if it exposed to solar radiation it brings in maximum energy. So there can be different types of glass right, so what you call solar gain factor.

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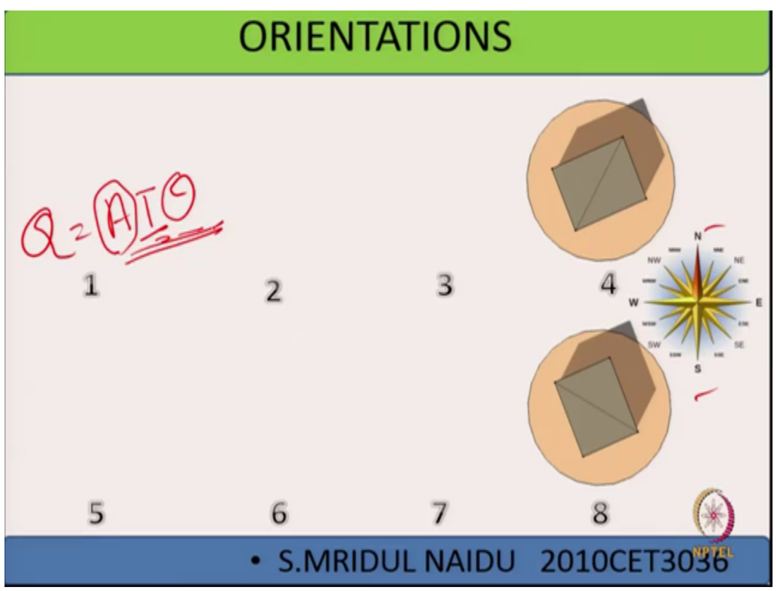

Now those who are not familiar, solar gain factor is defined as, denoted by theta and total heat gain through the glass is written as AI theta. So, I stand for intensity of radiation, area of the glass and theta. So theta is a fraction it gives you that fraction how much you will be included into the building. The energy you know the energy that will be solar radiation energy that will be included in the building and normally as you can understand glass is opaque to long wave radiation.

Glass is transparent to solar radiation, short wave radiation, but it is opaque to long wave radiation, therefore it will bring in the radiation and they would be all stored as heat energy within the enclosed space you know and that is the significant component.

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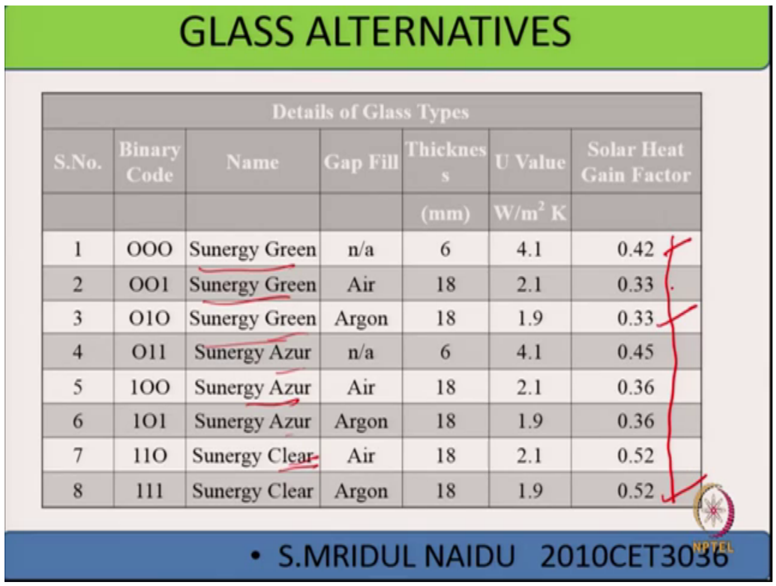

Details of Glass Types						
S.No.	Binary Code	Name	Gap Fill	Thickness	U Value	Solar Heat Gain Factor
				(mm)	$W/m^2 K$	
1	OOO	Sunergy Green	n/a	6	4.1	0.42
2	OO1	Sunergy Green	Air	18	2.1	0.33
3	O1O	Sunergy Green	Argon	18	1.9	0.33
4	O11	Sunergy Azur	n/a	6	4.1	0.45
5	1OO	Sunergy Azur	Air	18	2.1	0.36
6	1O1	Sunergy Azur	Argon	18	1.9	0.36
7	11O	Sunergy Clear	Air	18	2.1	0.52
8	111	Sunergy Clear	Argon	18	1.9	0.52

So glass is therefore there is another kind of variable. So you can have different type of glass right. So there are different types of glasses possible for example some sun energy clear glass etc etc and this is the solar gain factor, all glass do not have same solar gain factor and in fact there is angle of incidence although we can talk in terms of an average solar gain factor. So, for example this brings in only 0.42, 0.33, somewhere this is 0.52 right. So it allows 52 percent of the radiation to come into the room while this will have 33 percent. so glasses are only another variable, well actually important variable.

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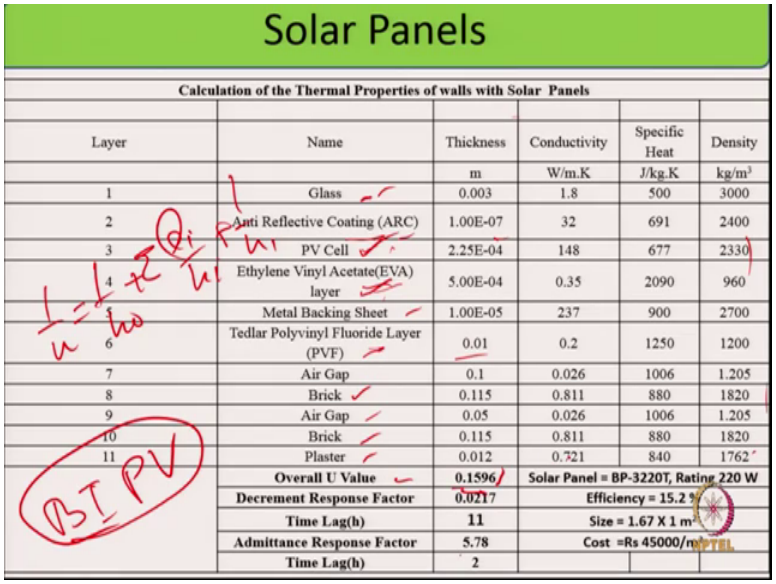

Solar Panels

Calculation of the Thermal Properties of walls with Solar Panels					
Layer	Name	Thickness	Conductivity	Specific Heat	Density
		m	W/m.K	J/kg.K	kg/m³
1	Glass	0.003	1.8	500	3000
2	Anti Reflective Coating (ARC)	1.00E-07	32	691	2400
3	PV Cell	2.25E-04	148	677	2330
4	Ethylene Vinyl Acetate(EVA) layer	5.00E-04	0.35	2090	960
5	Metal Backing Sheet	1.00E-05	237	900	2700
6	Tedlar Polyvinyl Fluoride Layer (PVF)	0.01	0.2	1250	1200
7	Air Gap	0.1	0.026	1006	1.205
8	Brick	0.115	0.811	880	1820
9	Air Gap	0.05	0.026	1006	1.205
10	Brick	0.115	0.811	880	1820
11	Plaster	0.012	0.721	840	1762
	Overall U Value	0.1596	Solar Panel = BP-3220T, Rating 220 W		
	Decrement Response Factor	0.0217	Efficiency = 15.2 %		
	Time Lag(h)	11	Size = 1.67 X 1 m²		
	Admittance Response Factor	5.78	Cost =Rs 45000/m²		
	Time Lag(h)	2			

So, supposing we have put in some solar panels right, so PV cell then there U values are also to be taken into accounts. So when I am looking at net zero building or buildings which can generate energy one the ways is what you called building integrated photovoltaic. So, you know these cells and then they also contribute to the E value or properties of the wall itself or roof itself. For example you have put in something on top of the roof it will be, it will be you know it will, this will also contribute to the thermal properties of the roof system itself.

So, supposing I have you know thermal properties of wall with solar panels if I look at it, I can have several overall U value for example you have glass, anti-reflecting coating you know EVA , metal backing etc-etc. and thickness could be so much that and so you know thermal conductivity is and therefore specific heat is this, density is this. So all this properties of all this must be known to me. And overall whole thing, the overall U value of the whole thing I got to take. So this is the combination of several layer in the wall which is brick, air gap, brick plaster then you know polyvinyl fluoride layers, small very thick layer on which metal backing sheet because PV cell will have several layer, so this is what is a PV cell layer all together.

Anti-reflective coating of the glass on top of the PV photo voltaic panel right and the glass will be on the top and anti-reflecting coating, so if you look at it U value the way we have calculated, same way you know 1 over U is equals to 1 over HO plus sigma LI by KI plus 1 by HI. You remember we talked about this, so thickness of each one divided by their conductivities are known anyone can find out the overall U value of the whole thing so this is one can look into.

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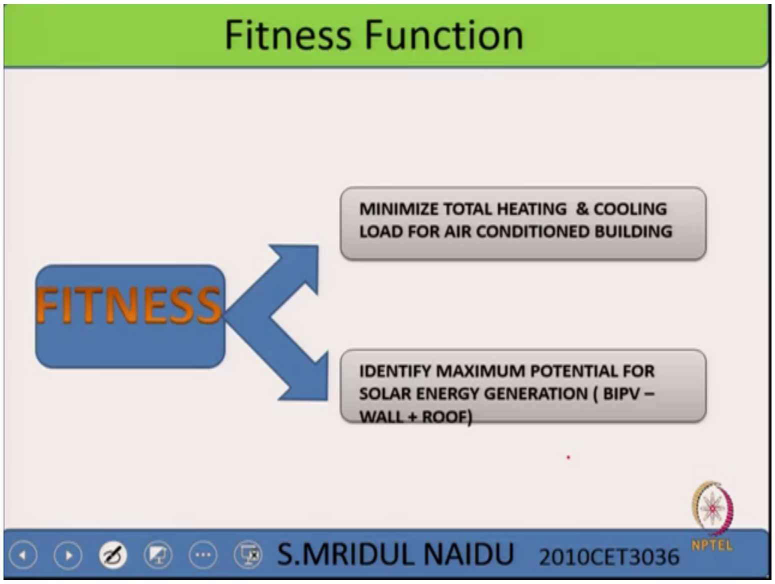

Therefore now that many variables you have, now how many then therefore you have? There are 8 glasses, 8 walls, let us say 8 roofs I have just taken 8 orientations and 8 shapes.

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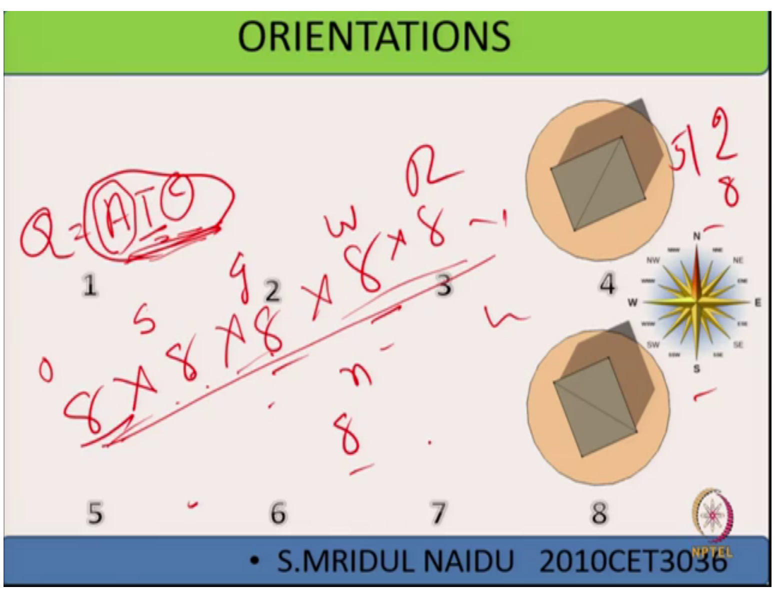

So 8 shapes, 8 orientation, 8 types of roof, 8 types of wall right 8 types of wall and if you are putting photovoltaic on some of them then that would be even more. This was 8 orientations right this is we started from 8 orientation, 8 shape right, 8 shapes. 8 glasses, 8 walls, 8 roofs and may be there maybe more. Now just in this particular case and also I have shading device, shading I can think in terms of various shading so there could be many more. So if you just find out how many variables I have? This would be 8 into 8 into 8, 64 into 8, how much this will make? 8 to the power, 8 to the power n whatever it is.

So, this is 64, 64 into 8 is 512 and that multiplied by 8 , 4000 something and that multiplied by 8, something like that on that number of options you have, that many number of options you have and you got to select one or the best out of them. Which is therefore is a problem of essentially is a problem of optimization. We will discuss about this simple optimization that can be applied to such system subsequently. So, you see the design would be selecting the best out of all this and this are simply scenario of discrete domain.

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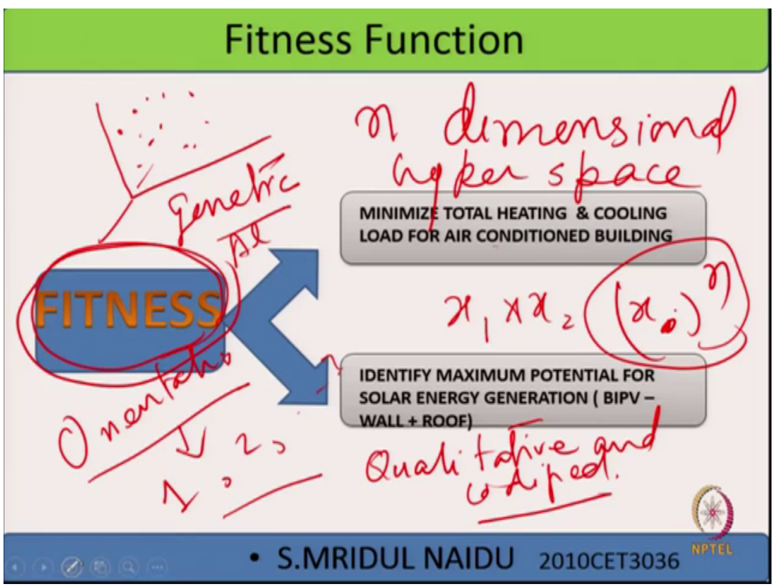

That means my domain is n dimensional hyperspace, n dimensional hyperspace right, n dimensional means orientation is one, shape is another two dimension wall variables are wall variable you know wall type is another, so there can be n n if I each one has got a let us say n dimensional hyper space and let us say each variable is let us say number of variables, number of levels of the first one is let me call it as x1 into x2. And if they are all same that will xi to the power n where xi is a you know xi is a x to the power n, x would be the number of option for each one of them, you know number of alternatives available to me, levels available to me for each one of them.

So, that many number of possibilities are there and if I plot it try to plot this there are all discrete points, these are all discrete points, they are all continuous means wall type 1 to wall type 2 is not a continuous variable, right it is not a continuous variable in between there is nothing, so they are discrete points. So each one would be a discrete point I have to select the best out of them. So, this is n dimensional hyper space and such things can be done by some optimization technique.

I will talk about the optimization technique which you can use, but conventional optimization techniques you may not be able to use them. The reason is because these are not continuous domain, continuous value are not there, some of them are not qualitative, I am talking in terms of orientation, right. How do you quantify them? You can quantify them by, you can codify it, orientation 1, orientation 2, orientation 3 orientation 8.

So, but you cannot quantify them easily, you can quantify them through angels but that is relatively complicated. Similarly shapes, how do you shape you cannot quantify in any manner. Aspect ratio you can do it is all rectangular. If it is T type then the aspect ratio also would not work. So therefore many of these variables are actually qualitative and can be codified.

What directly we may be able to use them, so such kind of things we can optimize using modern day evolutionary algorithm which works on coded variable rather than coded variable rather than actual variable, value of the variable themselves. So this is we talk, okay we will come to that one so in that case we talk in terms if it is, if you are using as such evolutionary algorithm. One of them is genetic algorithm there are advanced versions of this but I will just give you simple one which can be applied to similar sort of this system.

So, it works on analogy to the evolutionary process so goes from a set of given assume solution to improved solution keeping the fit population they are and the one which are not fit population we just remove them. So, that is why the terminology fitness has come, now I am sure most of you have done some course on optimization, linear programming etc etc and you have heard something called objective.

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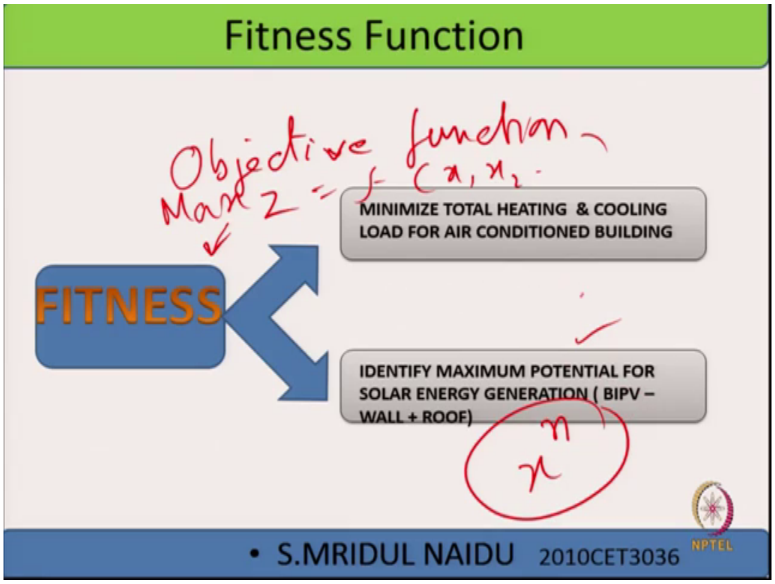

You have something we have heard something called objective function, z maximize z equals to you know some function of the decision variable x1, x2 etc etc that is what you have done and it could be linear function in case of linear optimization problem. Here same thing we call as fitness functions. So according to this we decide which is fit and then we are able to choose the best out of x to the power n, options said. So, basically that is how we go about it, so we will come to this sometime later on

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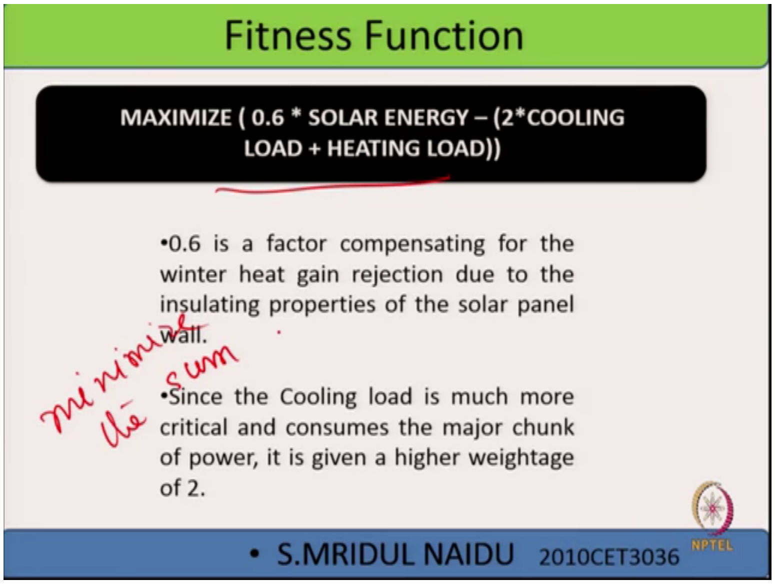

Generally we maximize ok I will just come to this before that I will come to I will just not look at this first. So, first let us say we will like to minimize the heat gain.

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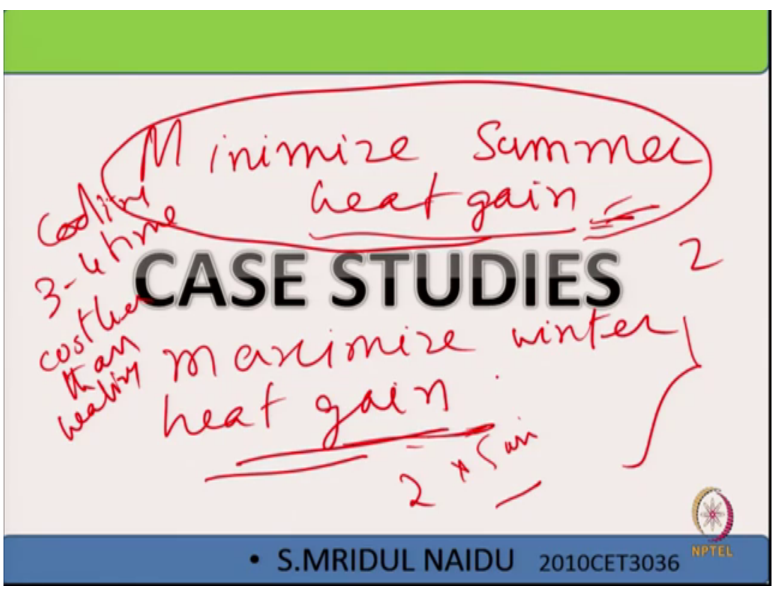

Minimize summer heat gain and maximize winter heat gain, especially climates in climates where there is severe winter, winter is also there and summer is there. So, like New Delhi you see this will have winter is cold in the winter and warm in the summer in fact you have three distinct seasons which I will not talk here. But where let us say Chennai or Mumbai or similar sorts of climates are there then this may not be a major issue. Now so this is what we would like to do. If I am not putting any additional energy generation into the building, so if I want to maximize this and minimize this now one can use a weightage factor, why? The cost of cooling is 3 to 4 times, so this is 3 to 4 times more than cooling is 3 to 4 times costlier than heating.

So you know cooling is costlier, therefore you can understand this actually because heating means I can directly heat the space right or while heating system may be there, so which the losses are relatively you know losses is there but the process where withdrawal of heat is there, the energy consumed is much higher work done is much higher sometime you have to go much below the temperature at which you want to maintain the space because of issues like condensation and removal of you know moisture etc-etc.

So, control you know control of humidity and so on. So usually this 3 to 4 time costlier but typically what we do is in this types of situations we take this as twice so we multiply the twice summer heat gain, summer heat gain minus the so we minimize or if I maximizing then I will maximize winter heat gain minus twice summer heat gain right.

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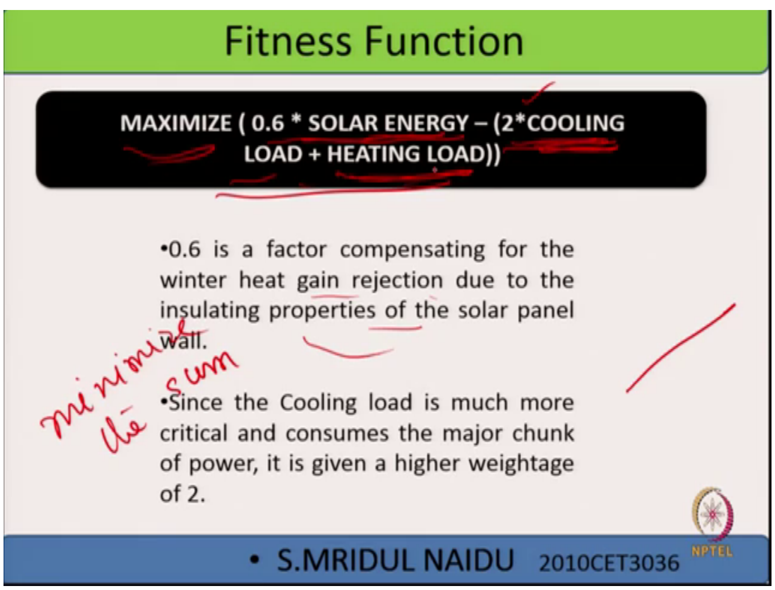

Now you see if I am generating so that is what is being done, twice cooling load plus the heating load. Now if I am generating some solar energy, take 60 percent is a factor compensating for the winter heat gain rejection due to the insulation properties to the solar panel in the wall. So, if I put a solar panel this will not also allow winter heat to come in right, it will absorb all of it, if it was not there the advantage that you would have got that is not there, therefore as 0.6 factor is used here to multiply. For if I am using a building integrated PV panel minus twice cooling load plus heating load so that is I am trying to maximize.

So, this is that means I am trying to maximize this, envelop design should be done which will actually reduce my cooling load and this is twice then the heating load. So this is now I like to maximize this function . In fact this I want to minimize and this I want to maximize right, so this I want to. Since cooling load is much more critical and consume major chunk of power, it is given higher weightage to, so that is what is done right, that is what is done.

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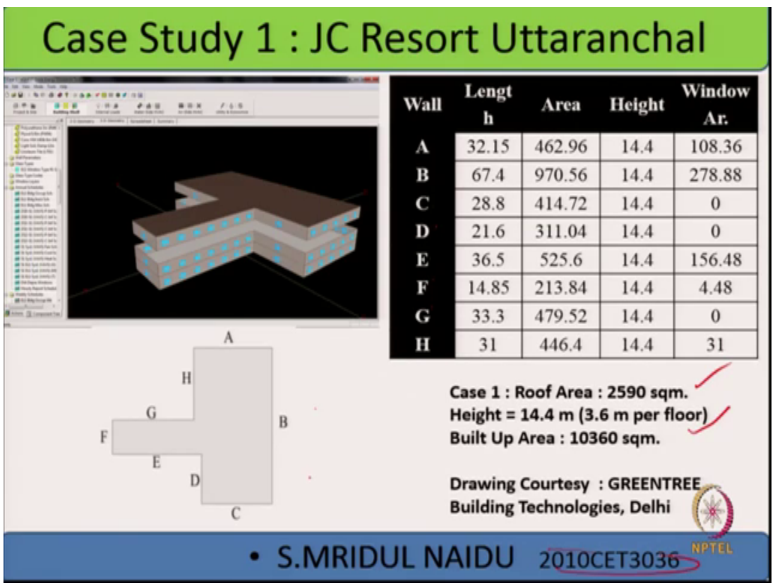

So, if you look at some cases, so we will look into some case studies, one case study or one or two case studies let us say. Let us say it is a resort building in Uttaranchal and length, you know there are different this is a kind of shape of the building, area, height, window area right and the other length 3, 4, 5, 6, 7, 8, 8 possible type of walls are there and corresponding the lengths are given. Roof area is 2590 meter square, 3.6 meter per floor so it is a 3 storied building as you can see from here 3 storied building making it sorry 4 storied, 4 storied building.

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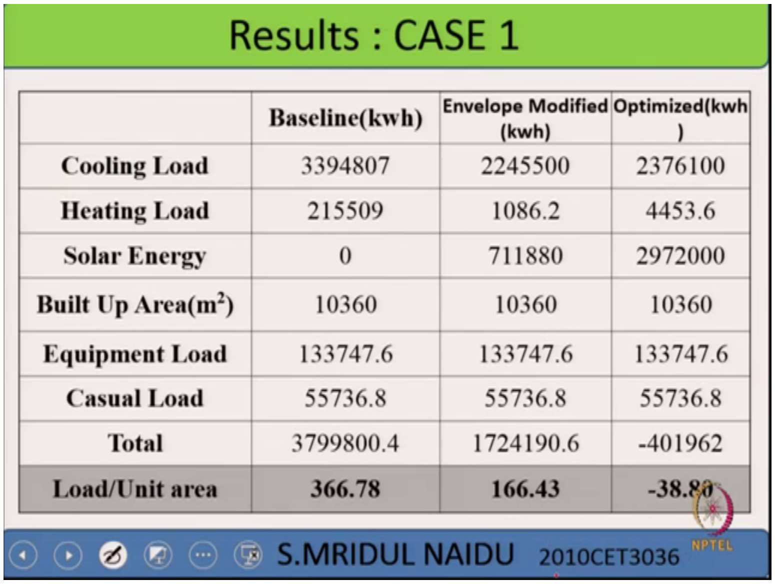

Results : CASE 1

	Baseline(kwh)	Envelope Modified (kwh)	Optimized(kwh)
Cooling Load	3394807	2245500	2376100
Heating Load	215509	1086.2	4453.6
Solar Energy	0	711880	2972000
Built Up Area(m^2)	10360	10360	10360
Equipment Load	133747.6	133747.6	133747.6
Casual Load	55736.8	55736.8	55736.8
Total	3799800.4	1724190.6	-401962
Load/Unit area	366.78	166.43	-38.80

And built up area is this much and then cooling load, if you calculate out for each one of them.

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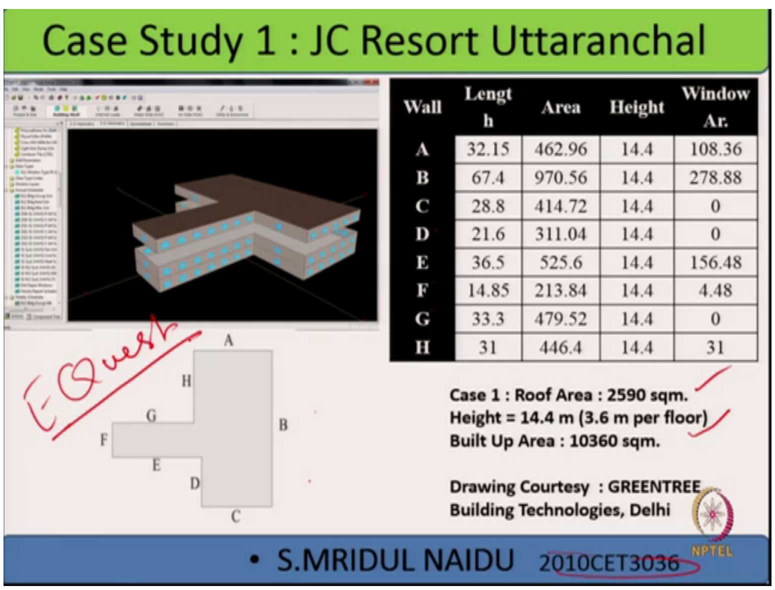

Case Study 1 : JC Resort Uttaranchal

Wall	Length	Area	Height	Window Ar.
A	32.15	462.96	14.4	108.36
B	67.4	970.56	14.4	278.88
C	28.8	414.72	14.4	0
D	21.6	311.04	14.4	0
E	36.5	525.6	14.4	156.48
F	14.85	213.84	14.4	4.48
G	33.3	479.52	14.4	0
H	31	446.4	14.4	31

You can calculate out cooling load by modeling them in various you know like, there are number of open sources softwares. You can moral them E quest for example, I will not you know E quest, there are many energy placers several of them. You can try it out your hand in any building, in any of them they are open source software.

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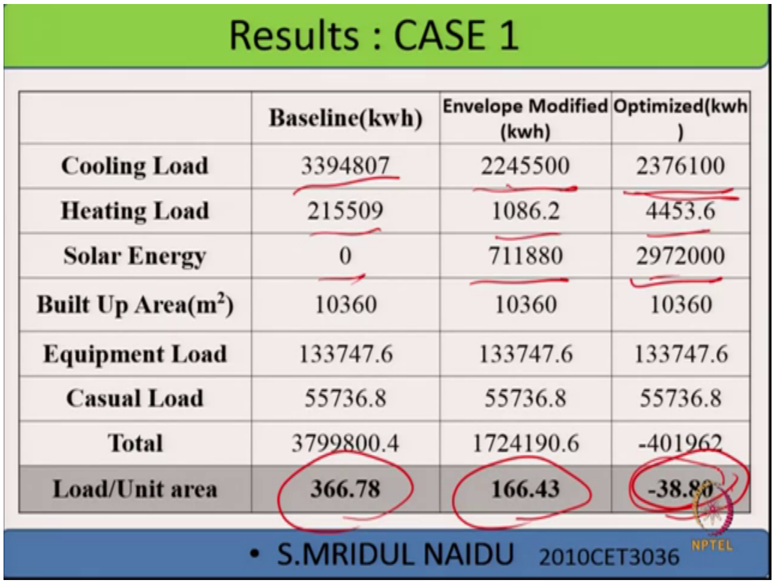

	Baseline(kwh)	Envelope Modified (kwh)	Optimized(kwh)
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Total	3799800.4	1724190.6	-401962
Load/Unit area	**366.78**	**166.43**	**-38.80**

So, cooling load if you modify this and optimize this somewhere modification this and if you optimize then you might get something like this. Heating load you can optimize, you can get it like this, this one had no solar energy this would have something like this and finally if you find out load per unit area you can reduce it to down to in fact optimize, if you optimize it maximize your solar energy then you might actually load per unit area even can go to negative, load per unit area can go to negative. So, as long as you use you know building integrated photo PV systems you can actually increase it right.

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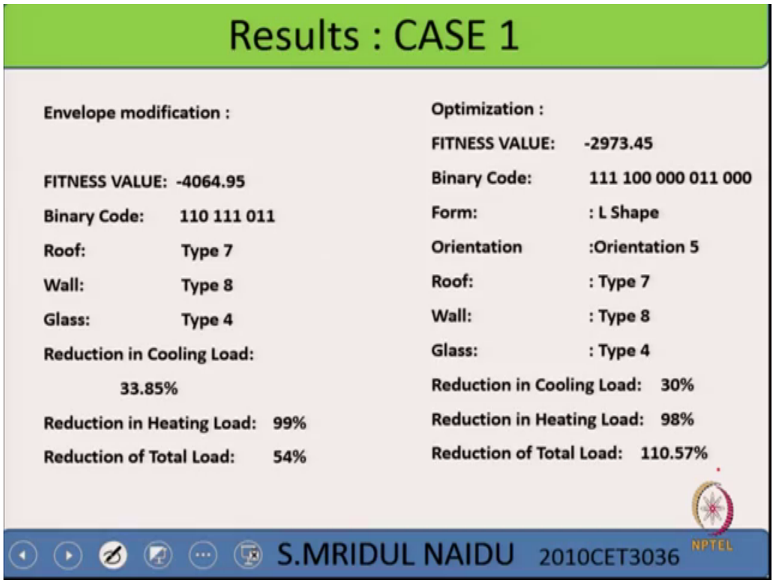

So, this was this is something like this now how it is done?

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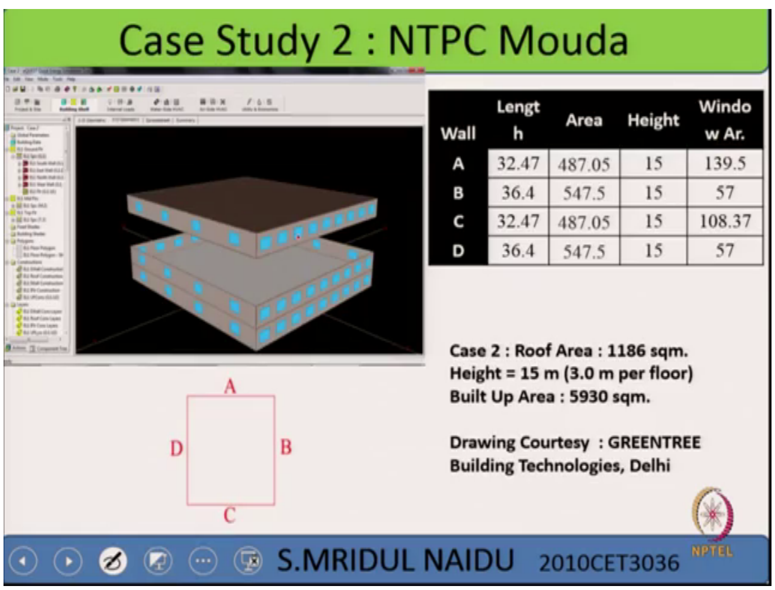

How it is done? Okay there is another case study I will come back to this.

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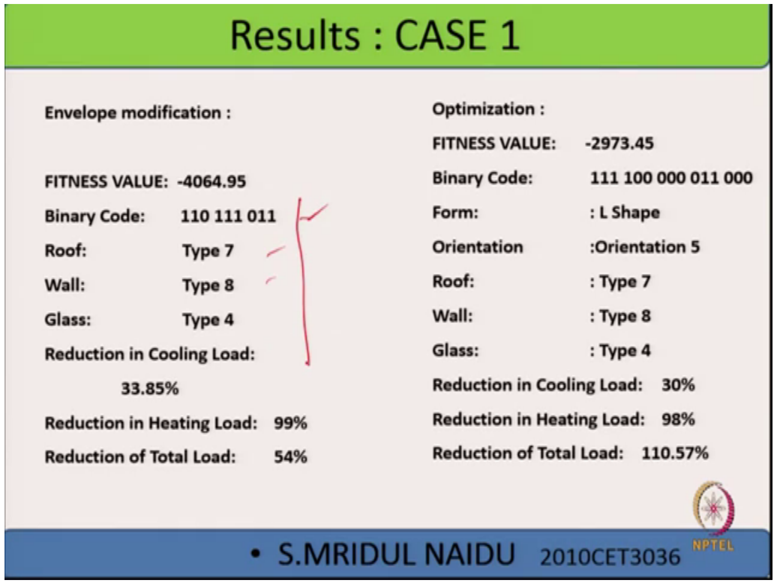

This at the moment I not really explaining what this is, I will come to this sometime later on.

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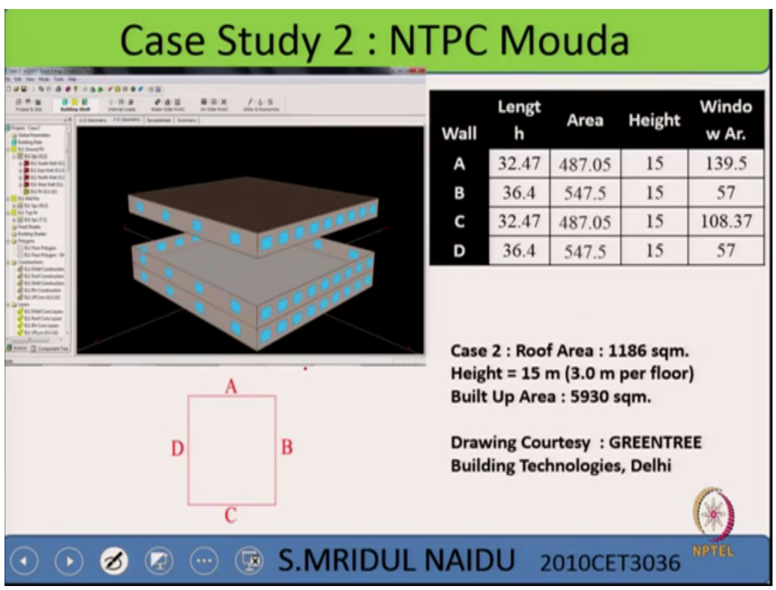

But this is another case for example another case building, this is another building and if you have roof area 186, so this is showing 4 world type and again story height is 15 meter, 5 stories and you know the 2, 3, 4, 5 stories and again if you model this and find out optimized ofcourse optimization you have to know written separate program written for that.

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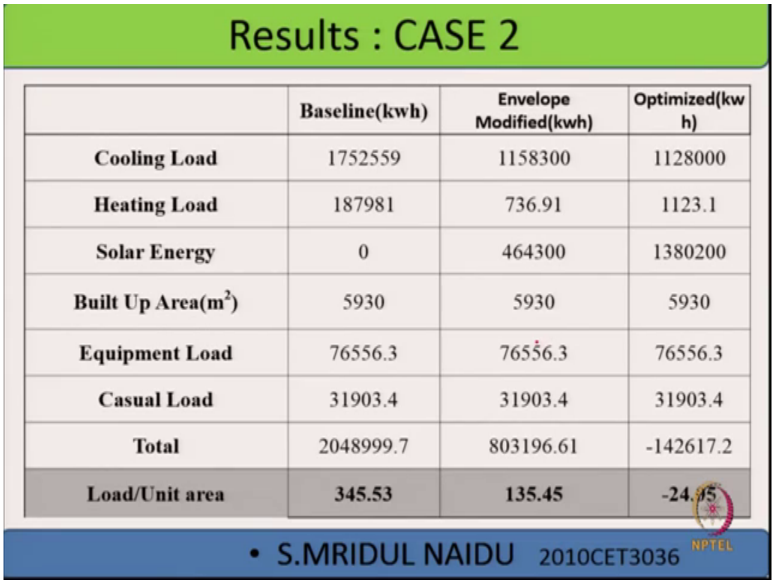

Results : CASE 2

	Baseline(kwh)	Envelope Modified(kwh)	Optimized(kwh)
Cooling Load	1752559	1158300	1128000
Heating Load	187981	736.91	1123.1
Solar Energy	0	464300	1380200
Built Up Area(m^2)	5930	5930	5930
Equipment Load	76556.3	76556.3	76556.3
Casual Load	31903.4	31903.4	31903.4
Total	2048999.7	803196.61	-142617.2
Load/Unit area	**345.53**	**135.45**	**-24.05**

• S.MRIDUL NAIDU 2010CET3036

And you find that you can actually gain total there can be an energy saving. So, it will be percentage saving could be 24 percent, earlier one was?

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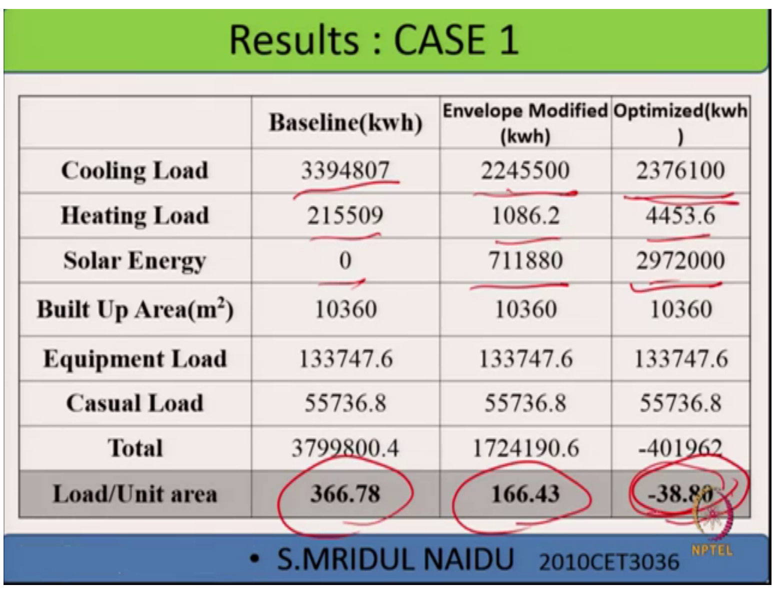

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Earlier one was 38 percent, load per unit was minus 38.

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Results : CASE 2

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Cooling Load	1752559	1158300	1128000
Heating Load	187981	736.91	1123.1
Solar Energy	0	464300	1380200
Built Up Area(m^2)	5930	5930	5930
Equipment Load	76556.3	76556.3	76556.3
Casual Load	31903.4	31903.4	31903.4
Total	2048999.7	803196.61	-142617.2
Load/Unit area	**345.53**	**135.45**	**-24.05**

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And here load per unit area is same. So, you can actually by putting in building integrated photovoltaic you can actually save on to the energy, it can be net negative, here its net negative.

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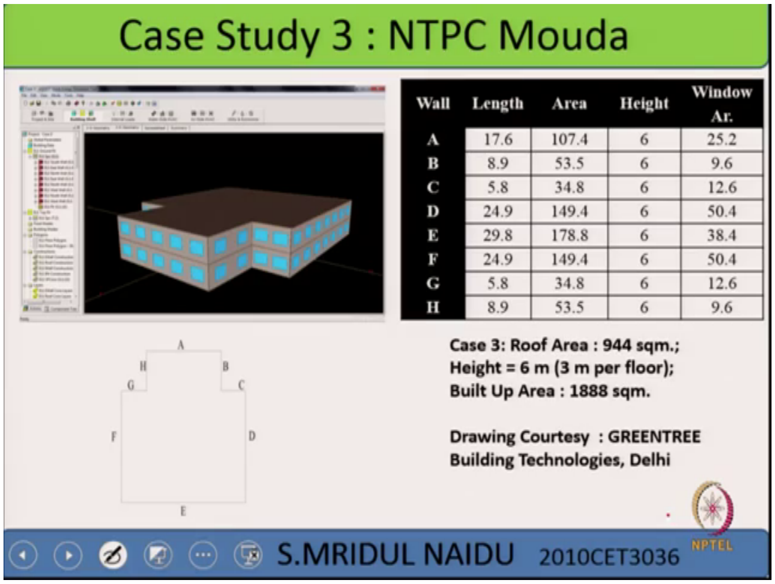

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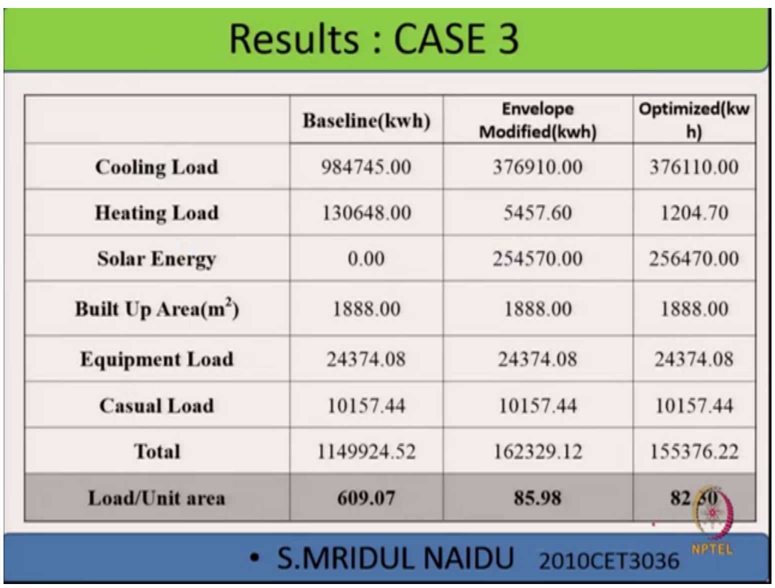

Results : CASE 3

	Baseline(kwh)	Envelope Modified(kwh)	Optimized(kwh)
Cooling Load	984745.00	376910.00	376110.00
Heating Load	130648.00	5457.60	1204.70
Solar Energy	0.00	254570.00	256470.00
Built Up Area(m^2)	1888.00	1888.00	1888.00
Equipment Load	24374.08	24374.08	24374.08
Casual Load	10157.44	10157.44	10157.44
Total	1149924.52	162329.12	155376.22
Load/Unit area	609.07	85.98	82.30

Third case, okay fitness value I will come to this the same one, another case and it will show you the load per unit area is you know not negative here but it is just reduced from 85 to, you know modified if you modify this envelope and finally optimize you get 82.30.

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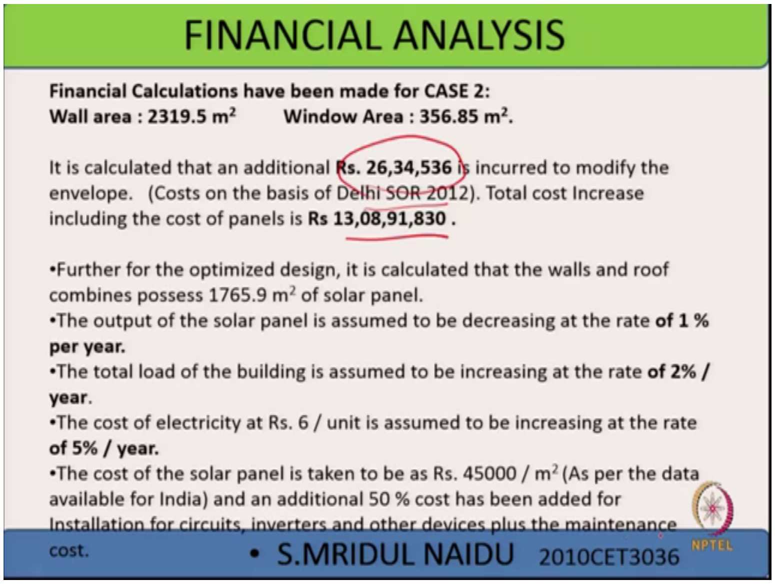

There is another case, so if you look at this. If you look at and calculate the economics of it over the years, how much you are getting? It would give you this know initially you might have additional cost, but if you calculate out on the basis of Delhi schedule of rates the cost increase is this much.

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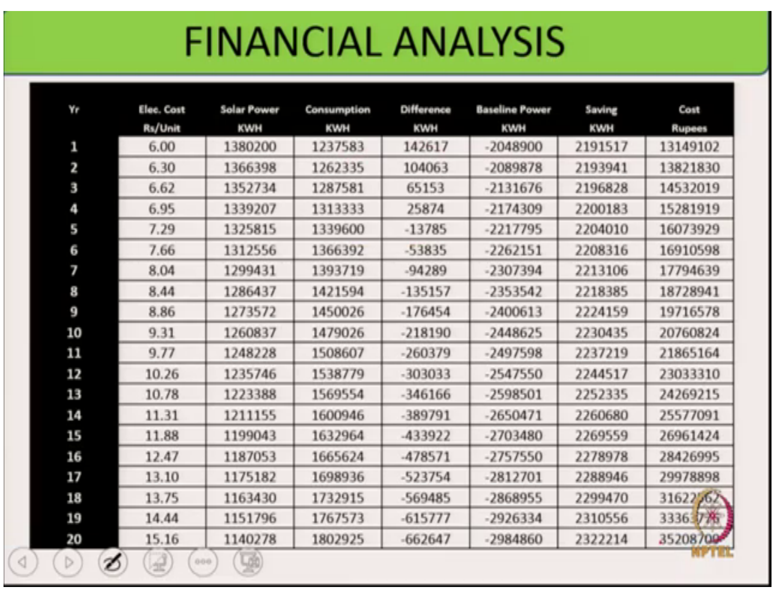

But if you finally you know find out total financial analysis, I will just not go through the table or anything of that kind.

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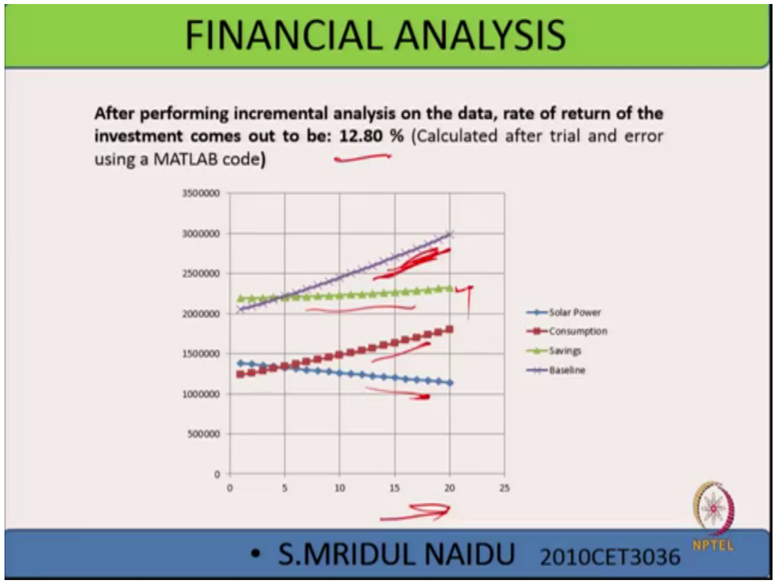

It might give you something like, this is the year and solar power generated is given by solar power. So this is the original you know the total cost if you look at it, saving is this much, this is the consumption and this is basically solar power generation, total cost saving could be something like this. So, green one shows us total cost saving, it is around 12.8 percent also. So, you can actually save on to cost, right.