Design of Steel Structures
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Module - 5
Lecture - 1
Compression Member

Hello. Today I am going to start a new chapter which will be focusing on compression member. Compression member means the member which is carrying the axial force. Generally, these types of members are termed as compression member. Again compression member are named as like columns, strut, booms, stanchion in different type of structures. Like in case of RCC building, the vertical members which are carrying the load from beam or slab to the ground is called as column.

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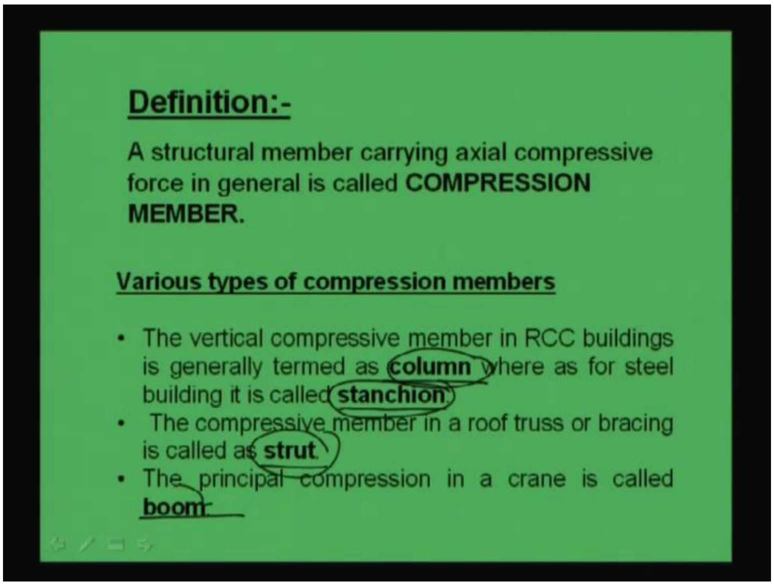

Again if same type of member is used in the steel building, then this is called as stanchion. The compression member in roof, truss or bracing is called strut and the principal compression member in a crane is called boom. That means, the same compression member is termed different way. One is column or stanchion or strut or boom. Like this we used to generally term them.

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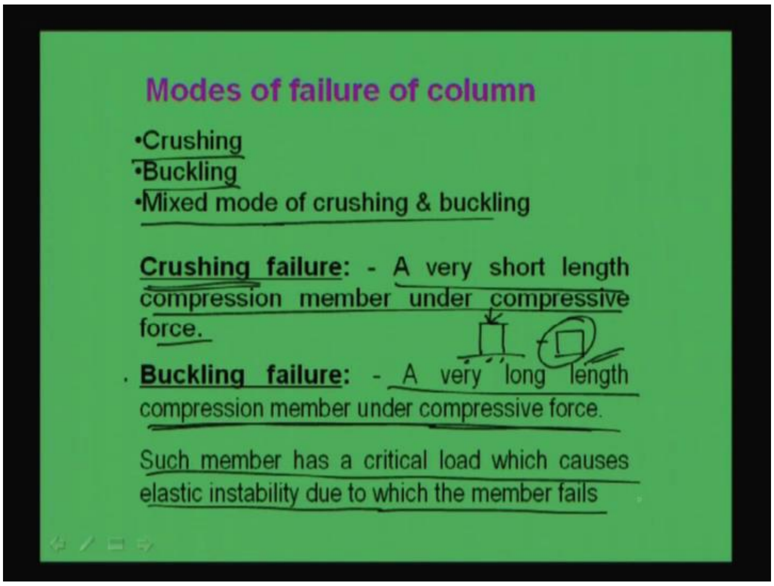

Now, when we are going for design of a compression member, we will see what the modes of failures are. On that basis we have to design. Modes of failures means one is crushing failure, another is buckling failure and another is mixed mode of crushing and buckling. Now, what is crushing failure? Crushing failure means when a very short length compression member under compression force is coming into picture. That means, when the length of the column is short, suppose this is a column. Now, force is there. That means for these types of cases, if we see the cross-section, it is like this. So, only the axial forces are coming into picture majorly. That is why this failure will be because of only crushing failure.

Another is buckling failure. Buckling failure will come into picture when very long length compression member are under compressive force. Such member has a critical load which causes elastic instability due to which the members fails. So, these are basically two type of failure which occurs in column.

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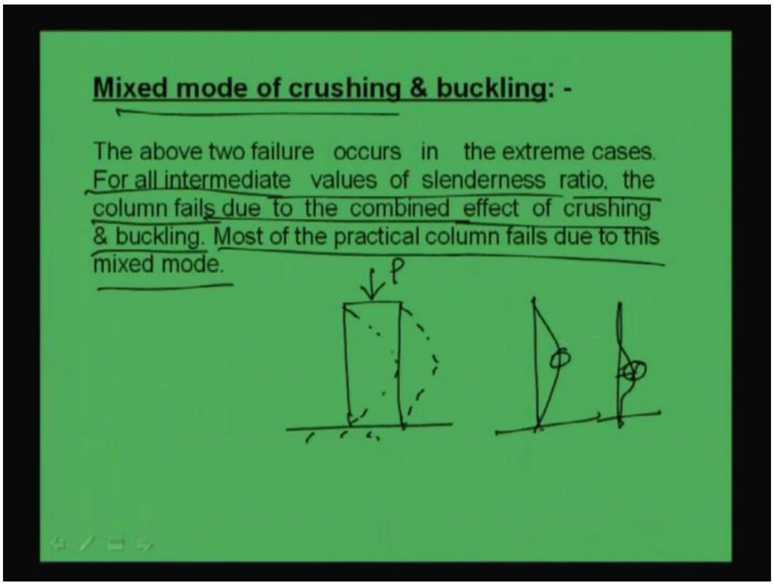

Another failure is the mixed mode of crushing and buckling. This is the most common failure in column we used to see. That is the above two failures in extreme cases. That means for all intermediate values of slender ratio, the columns fails due to the combined effect to crushing and buckling. Most of the column fails due to this mixed mode. That means, when we are going to calculate the column strain, we have to see what is the strain due to the crushing effect and what is the strain due to the buckling effect. Most of columns are going to fail because of these two modes. One is buckling; another is crushing.

So, when we are designing the column or compression member, we have to take care of these two parts. That means when we are going to apply a load, this will mean depending on their end condition. This will buckle like this. So, if I see it like this, so it may buckle like this or it may buckle like this. So, depending on the end condition due to buckling, one stress will develop and due to compressive, another stress will be developed. So, we have to check the column considering these two types of value.

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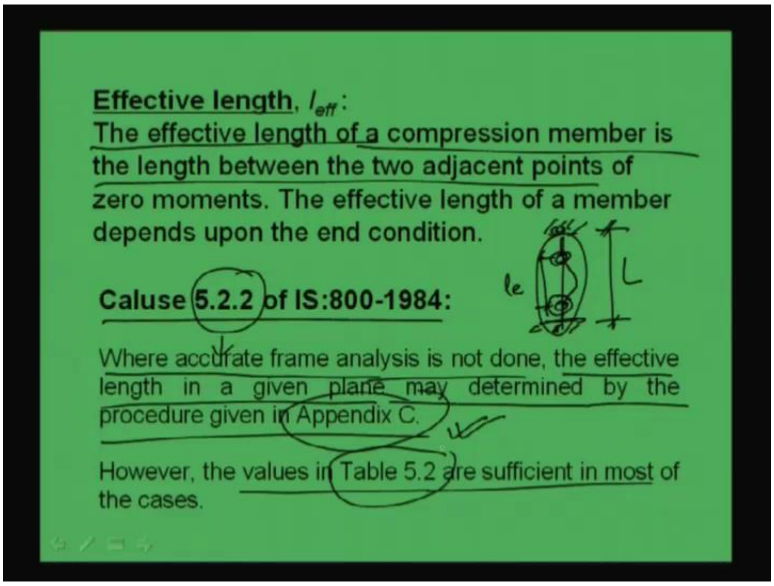

Now, effective length because effective length is important to consider the slenderness ratio of the column or the compressing member because when we are going to calculate the buckling force, the force which is coming due to buckling, we need to know the slenderness ratio and accordingly, the buckling forces will be developing. Now, the effective length of a compression member is the length between the two adjacent points of zero moments. That means, if we have a column like this and if moment is developing like this, then the point of contra flexure will be here and here. That means, zero moments will be here and here.

So, effective length will be this one whereas, the total length means this will be the capital L will be the total length. So, basically the effective length of a member depends upon the end condition. That means, what the end conditions are, whether it is fixed or hinged or free, on that basis the moment will be developing in this column. So, accordingly the point of contraflexure will develop and accordingly, we have to find out the effective length and calculation of effective length has been given in clause 5.2.2 of IS: 800-1984.

Now, in clause 5.2.2, the procedure has been giving and it says that where accurate frame analysis is not done, the effective length in a given plane may be determined by the procedure given in appendix C. So, in appendix C also, the details have been given. So, in clause 5.2.2, what it is told that the accurate frame analysis if cannot be done, then effective length can be find out from the procedure which is given in the appendix C. However, the values in table 5.2 in the code are sufficient in most of the cases. That means, the procedure we can follow which is given in the appendix C or what we can do is, we can find out the table which is given in IS: 800-1984 where for different end conditions, the length of effective length has been given which means most of the common cases has been given in this table.

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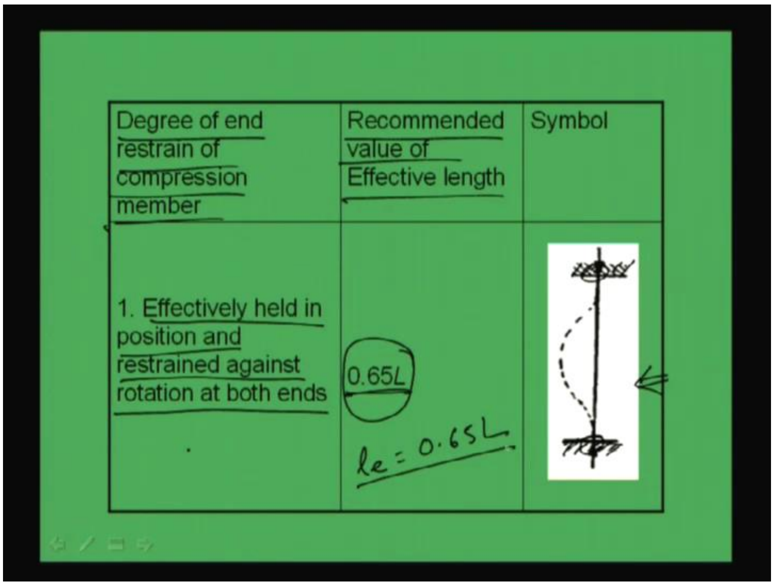

What is this? This is one case which has been given in the table 5.2, that is first is degree of end restrain of compression member means what is the end condition. Then, recommended value of effective length which is given here and the symbol from which easily we can identify what type of fixed means, what type of end conditions we are going to provide. So, in case of first case, effectively held in position if the ends are effectively held in positions and restrains against rotation at both ends, what does it mean? That means effectively held and it position means here vertical displacements has been restrained and also the rotation. That means these are fixed. So, in this case the effective length le will be equal to 0.65 L. So, this has been given in the code which can be used readily.

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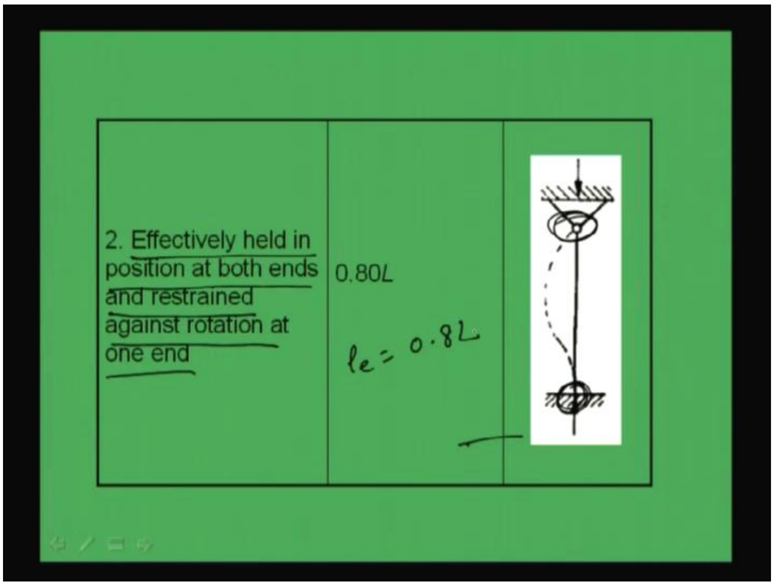

Another case may appear which is like this. That is one hinge in one end and another end is fixed which can be defined as effectively held in position at both ends and restrained against rotation at one end. That means, effectively held at position at both ends and restrained against rotation at one ends. Here against rotation, it is restrained, but here it is not. That means, in one end it is hinged, another end it is fixed. So, in this case the effective length will be 0.8 L, right.

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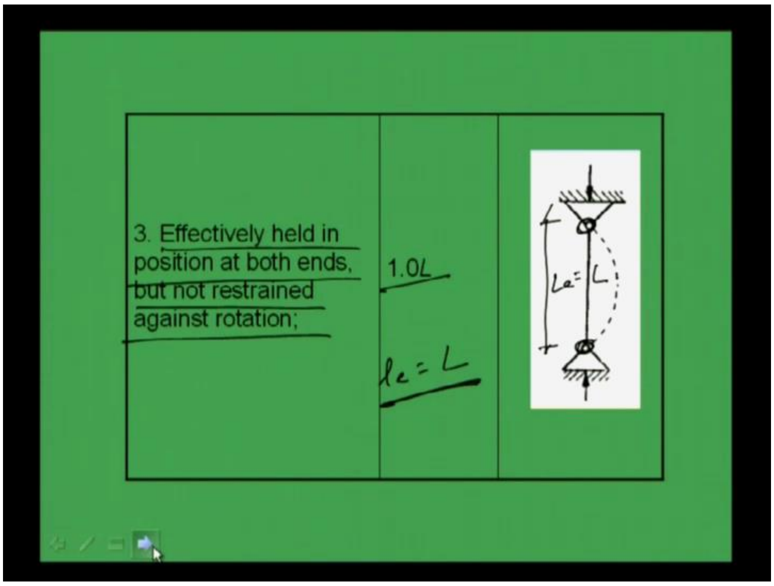

Now, another condition is effectively held in position at both ends, but not restrained against rotation in both the ends. That means, if it is hinged, if both the ends are hinged, then what will happen? The effective length will be the total length, the length between two supports, right. So, in this case effective length we are getting like this. You see this is the place where moment is becoming 0 and this is the place where moment is becoming 0. That is why this le will be equal to L. That is why that means the coefficient is 1. So, this is one condition.

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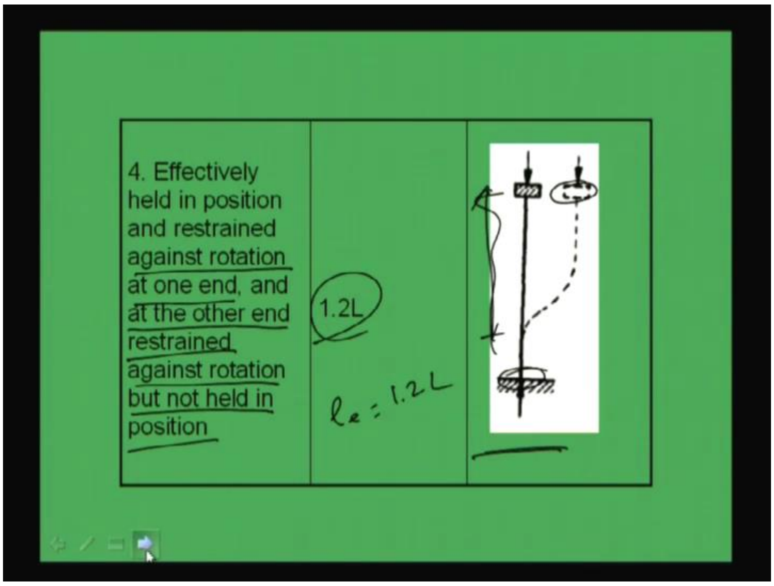

Again another condition can be considered like this that is effectively held in position and restrained against rotation at one end, and at the other end restrained against rotation, but not held in position. What is this meaning? That means, here this side it is fixed, but this side against rotation it is restrained, but it is not restrained the displacement. So, in this case, the effective length will be like this. It means not like this. Effective length will be le is equal to 1.2 L. That means, the length will be 1.2 times the total length.

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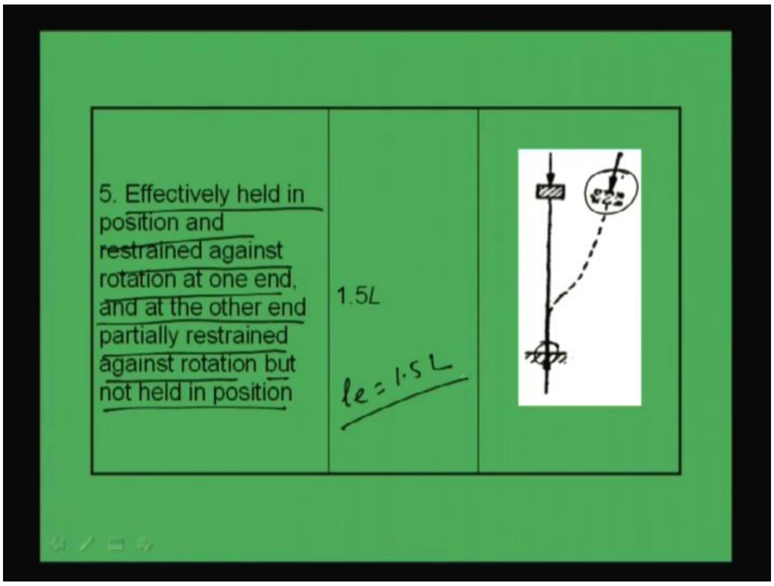

This is another condition where it has been told that effectively held in position and restrained against rotation at one end. That means this one and at the other end, partially restrained against rotation, but not held in position. In this case, the effective length can be calculated from this formula that is le is equal to 1.5 L.

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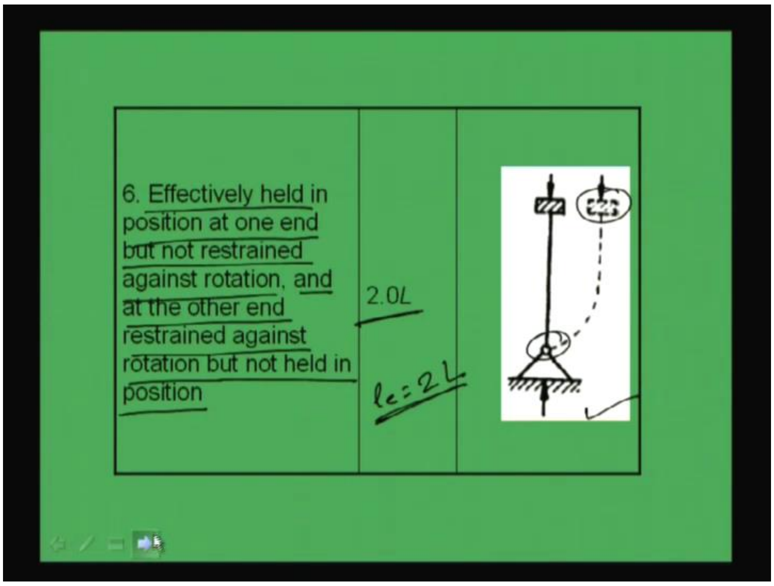

So, another condition which can be occurred in industrial building is like this. This is called like this that effectively held in position at one end, but not restrained against rotation and at the other end. So, in this case, that means restrained against rotation, but not held in position and here that not restrained against rotation, but effectively held in position. In this case, the effective length will become 2 L. So, all these conditions may arrive in case of design of industrial structure. So, that is why the code has given the provision of keeping all this.

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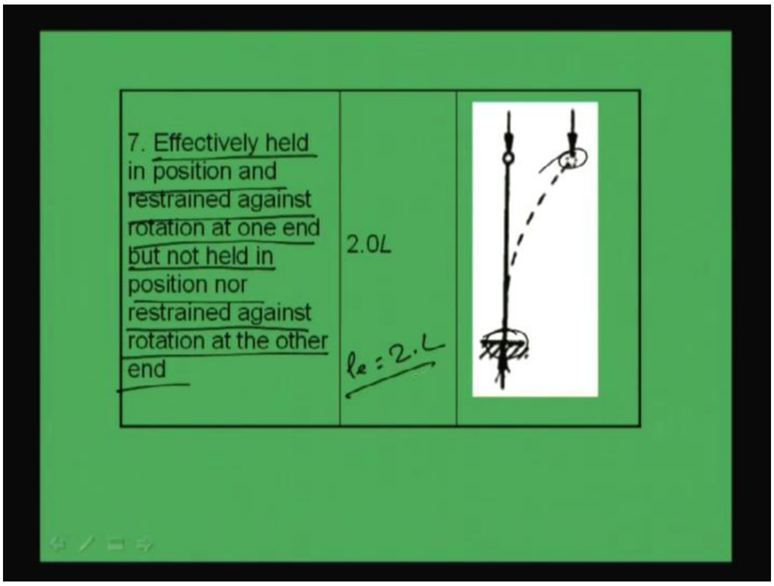

Another option which is given here that effectively held in position and restrained against rotation at one end means, restrained against rotation and position, but not held in position nor restrained against rotation at the other end. This is free. So, at the other end, it is not restrained against rotation and nor the position. So, in this case, the length will be 2 L, right. So, like this the effective length for different cases can be calculated, right.

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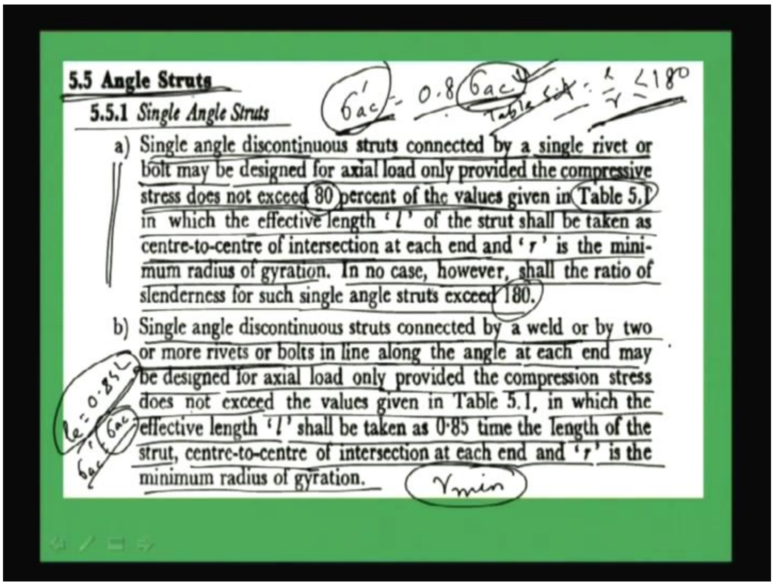

Now, another provision has been given in IS code IS: 800-1984 in clause 5.5 which I am just going to read out because this is important and while designing the angle sections, we have to find out the effective length accordingly. So, in clause 5.5.1, it is told for single angle struts. What is that? Single angle discontinuous struts connected by a single rivet or bolt may be designed for axial load only provided the compressive stress does not exceed 80 percent of the values given in table 5.1. I will come to details about table 5.1 later in which the effective length L of the struts shall be taken as centre to centre of intersection at each end and r is the minimum radius of gyration.

Other thing is in no case however the slenderness ratio for such angle struts exceeds 180. What is this telling? That means that lambda that is L by r should be less than or equal to 180. In any case, this one thing means it should not exceed 180. Another thing is the effective length shall be taken as center to center of intersections at each end. That means where the rivet is given according to that, we have to find out the effective length. Another important thing which is been given here that the compressive stress does not exceed 80 percent of the values given in table 5.1. In table 5.1, allowable compressive stress for different steel and for different slenderness ratio has been given.

Now, the compressive stress for single angle strut has to be reduced 80 percent of. That means, allowable stress whatever given in table 5.1, we have to reduce 80 percent of that to find out the working allowable stress in case of single angle struts, right. So, this is also we have to remember. That means, sigma ac if I say the allowable compressive stress that will be 0.18 to sigma ac, where sigma ac is been given say I am telling this is as sigma ac dash, where sigma ac has been given in table 5.1 which is based on the slenderness ratio and the type of steel used in the section.

So, the working allowable stress in strut, in angle strut will be 0.8 into sigma ac. This is the thing which has been told in clause 5.5.1 a. Another thing is in b. It is told that single angle discontinuous struts connected by a weld or by two or more rivets or bolts in line along the angle at each end may be designed for axial load only, provided the compression stress does not exceed the values given in table 5.1 in which the effective length shall be taken as 0.85 times the length of the strut. So, here what will take? That effective length will take 0.85 into 0.85 into l. 1 means the length of the strut and the sigma ac value will be simply which is given in the table 5.1. That value we will be taking, right.

Now, this is center to center of intersection of at each end and r is the minimum radius of gyration. Always we have to consider r as r minimum radius of gyration will take the minimum radius of gyration under which the worst condition will develop. So, in this clause, what we understood that one thing is for single angle discontinuous struts connected by a weld or by two or more rivets. Then, we have to take effective length as le is equal to 0.85 l and the allowable compressive stress will be simply whatever it is given in table 5.1, and for single angle discontinuous struts connected by a single rivet or bolt, in that case the allowable compressive stress will be 0.8 times of the allowable compressive stress given in the table 5.1. The length will be simply the length from means center to center of intersection at each end, and this sigma ac value has been given in the code in table 5.1, and this has to be checked. That means, slenderness ratio in any case should not exceed 350, right.

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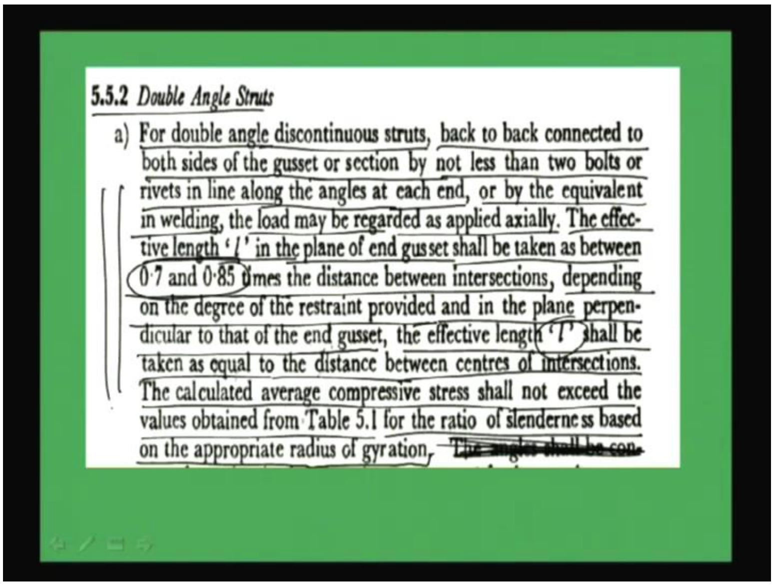

Another clausal provision has been given in 5.5.2 in case of double angle stress. Earlier in 5.5.1, we have seen in case of single angle, here will be seeing in case of double angle. Now, for double angle discontinuous struts back to back connected to both sides of the gusset or section by not less than two bolts or rivets in line along the angles at each end or by the equivalent in welding. The load may be regarded as applied axially. The effective length l in the plane of end gusset shall be taken as between 0.7 and 0.75 times the distance between the intersections.

So, effective length will be in between 0.7 to 0.85 times the distance between intersection depending on the degree of the restrain provided, and in the plane perpendicular to that of the end gusset. The effective length l shall be taken as equal to the distance between centers of intersections. So, in one direction, this will be 0.7 to 0.85 times the distance between intersections and in perpendicular to that. Simply this will be l. The calculated average compressive stress shall not exceed the values obtained from table 5.1. So, whatever values have been given in table 5.1, it should not exceed that for the ratio of slenderness, slenderness based on the appropriate radius of gyration. So, for double angle, these provisions we have to keep in mind while going for design.

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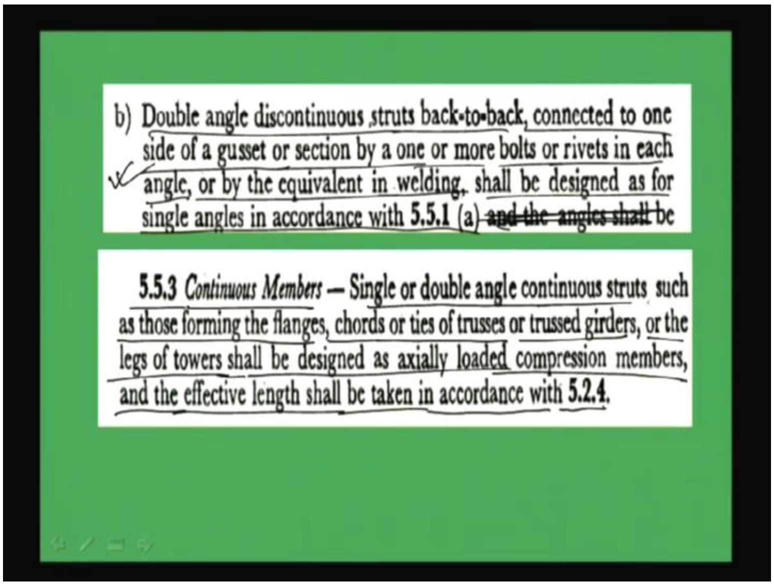

Another thing is that double angle discontinuous struts back to back connected to one side of a gusset, or section by a one or more bolts, or rivets in each angle, or by the equivalent in welding shall be designed as for single angles in accordance with clause 5.5.1 a, right. So, as per the clause 5.5.1 a, which is given here, we have to design means accordingly we will consider the effective length and the allowable permissible stress. For continuous member which is given in clause 5.5.3 that is single or double angle continuous struts, such as those forming the flanges, chords or ties of trusses or trussed girders or the legs of towers shall be designed axially loaded compression members, and the effective length shall be taken in accordance with the clause 5.2.4 which we have already told what should be the effective length. So, accordingly we have to consider. So, these are some points which we have to remember when we are going for analysis and design of the compression member. Now, we are talking about effective length because we need to know the slenderness ratio.

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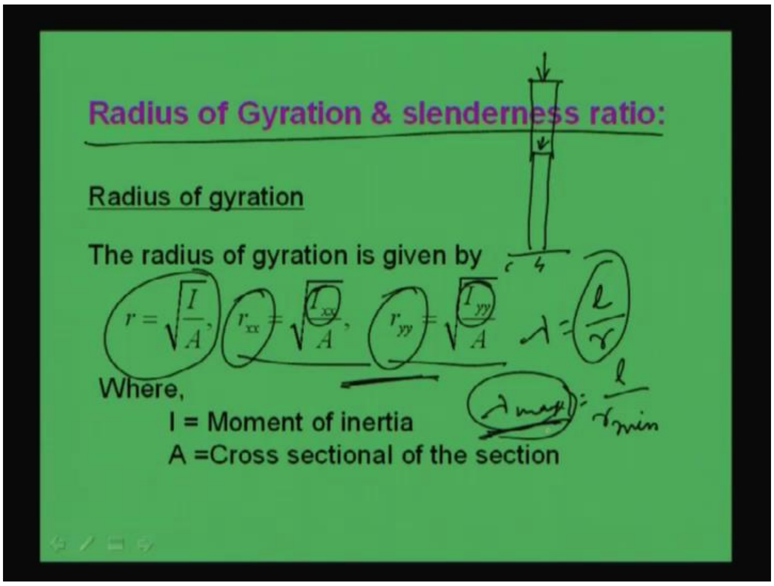

So, before going to calculate the strength of a compression member, we need to know what is the radius of gyration and what is the slenderness ratio and accordingly, we can find out other details. Like we know radius of gyration, we generally can say as r is equal to root over I by A, where I is the moment of inertia and A is the cross-sectional area of the section, right. Now, r xx I can make as root over I xx by A and r yy radius of gyration in y direction can be written as I yy by A. Now, which one of them is minimum that we have to consider for the calculation of the strain of the compression member.

So, we will find out what is r xx value and what is r yy value, or basically I xx value and I yy value and minimum of that we will be going to consider for finding out the slenderness ratio. Slenderness ratio we know is nothing, but l by r length by radius of gyration, right and maximum slenderness ratio will be we can say l by r minimum and for maximum slenderness, you will get minimum strength. As the slenderness ratio increase, the strength is going to decrease.

Why? It is because suppose if we have a compression member like this, now if we increase this length. What will happen? The slenderness ratio is going to increase and then, the load carrying capacity is definitely going to decrease because of the slender effect. That is why we will consider lambda max maximum slenderness ratio of the section for calculation of the strength of the compression member or for design of the compression member, right.

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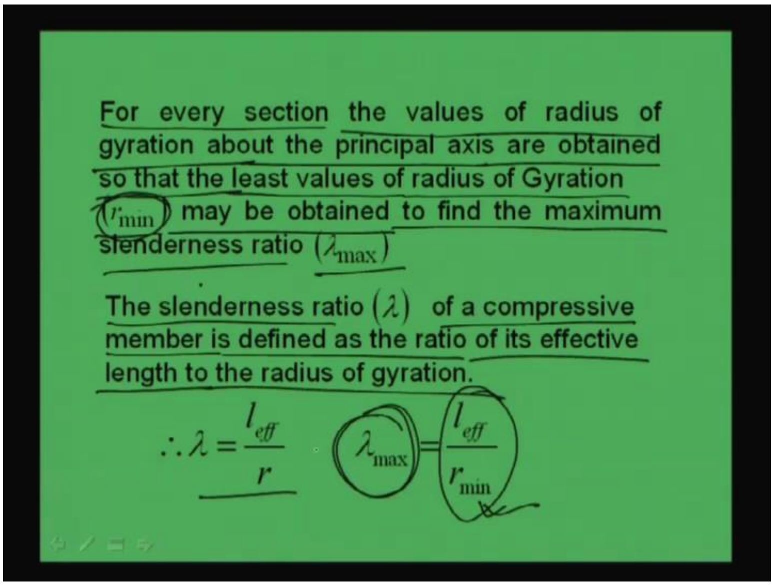

So, for every section, the values of radius of gyration about the principal axis are obtained, so that the least values of radius of gyration or minimum may be obtained to find the maximum slenderness ratio lambda max. So, to find lambda max, we have to find out the r minimum. R minimum means I xx minimum. That means I minimum moment of inertia minimum, right. The slenderness ratio lambda of a compressive member is defined as the ratio of its effective length to the radius of gyration. What we have told earlier effective length by radius of gyration. So, lambda max we have to calculate as l effective by r minimum. When r is becoming minimum, this will become maximum and maximum means stress will become means allowable stress will be becoming less minimum.

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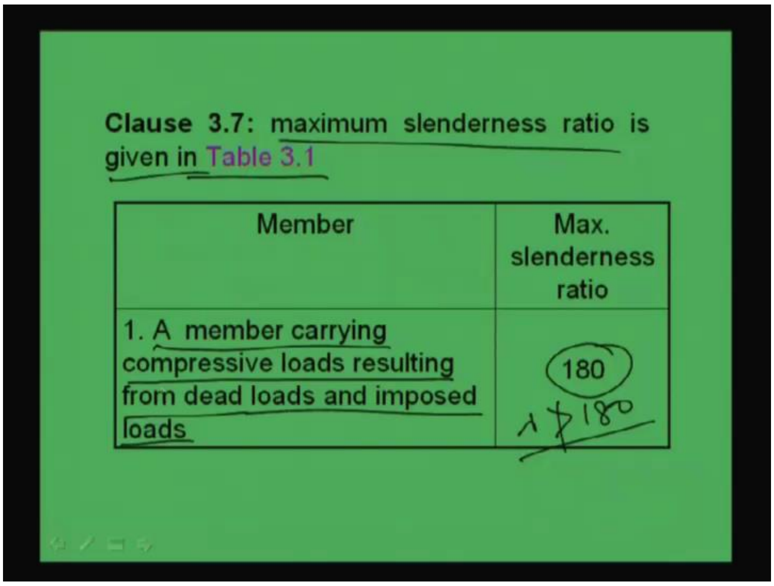

Now, in code IS: 800-1984 in clause 3.7, the value of maximum slenderness ratio is given in table 3.1 of IS: 800-1984, the permissible value of slenderness ratio like when a member carrying a compressive loads resulting from dead loads and imposed load, in that case the maximum slenderness ratio should become 180. That means, lambda should not become more than 180, right. So, when the member is carrying compressive loads resulting from dead load and impose load.

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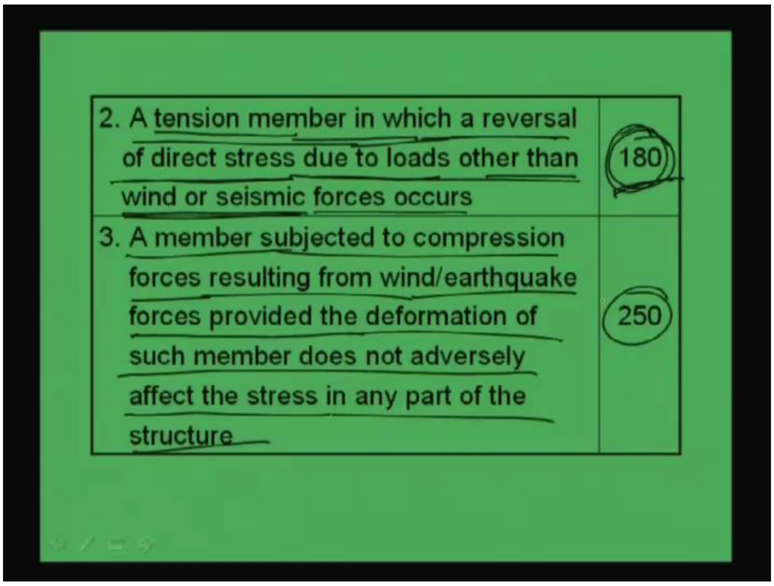

Another case is when a tension member in which a reversible or of direct stress due to loads other than wind or seismic forces occurs. In that case also, we have to consider that lambda maximum as 180. That means the slenderness ratio has to be within the range of 180. I am repeating once again. When it will be 180, when a tension member in which a reversal of direct stress due to loads other than wind or seismic forces occurs. That means, because or may be because dead load, live load, impose load for those things if it occurs, then also the slenderness ratio will become 180.

A member subjected to compression forces resulting from wind or earthquake forces provided the deformation of such member does not adversely affect the stress in any part of the structure. In those cases, we can consider the slenderness ratio as maximum 250. So, for this case, the slenderness ratio maximum will be 250.

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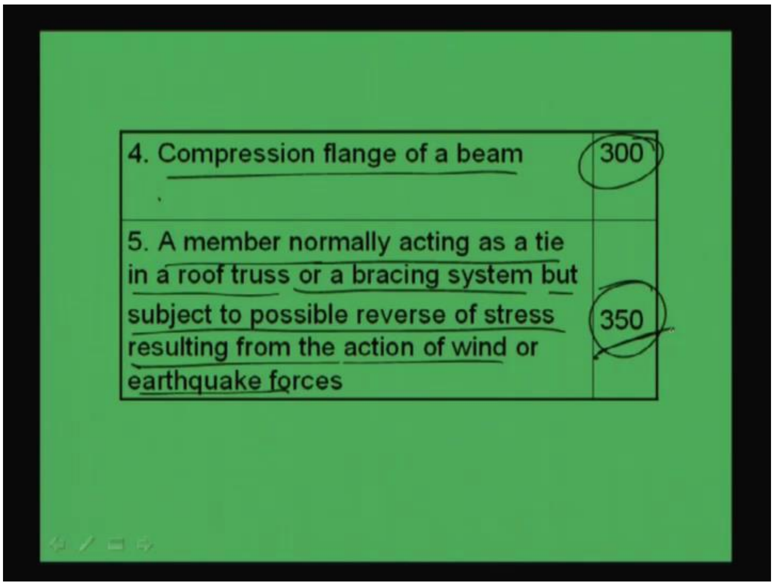

In case of compression flange of a beam, the slenderness ratio limit is 300 and when a member normally acting as a tie in a roof truss or a bracing system, but subject to possible reverse of stress resulting from action of wind or earthquake, not dead load or imposed load resulting from action of wind or earthquake, in this case 350, and for dead load and live load is given 180. For this case, this is 350. If it is wind load or earthquake load, in that case we can allow up to 350. So, these are the provisions has been given for limiting values of slenderness ratio. Now, as we told that compression member fails due to crushing and due to buckling, either of crushing or buckling or both, right.

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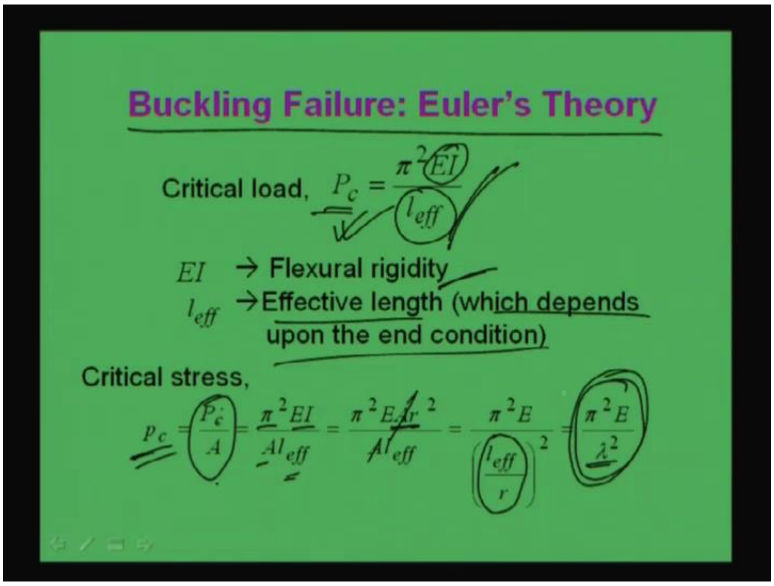

So, for buckling we know the Euler's theory to find out the critical load which can be given by this equation as critical load equal pi squared EI by l effective, where EI is the flexural rigidity and l effective is the effective length which depends upon the end condition. So, if we know the effective length of the compression member and the flexure rigidity, then I can find out the critical load Pc. Similarly, I can find out also the critical stress as Pc by A because the critical load by area will be equal to critical stress. So, if I divide this Pc is nothing, but pi square EI by l. So, this will become pi square EI by A into l effective, right.

Again I is defined as A into r square. I can be written as Ar square, where r is the radius of gyration and A is the cross-sectional area, right. Now, if we make this will get A A will get cancel. So, it will become pi square E by l effective by r whole square, where l effective by r is nothing, but the slenderness ratio which can be named as lambda. So, we can make simply pi square E by lambda square. So, critical stress due to buckling can be termed as pi square E by lambda square which will be required for calculating the allowable stress in compression in the compressive member, right.

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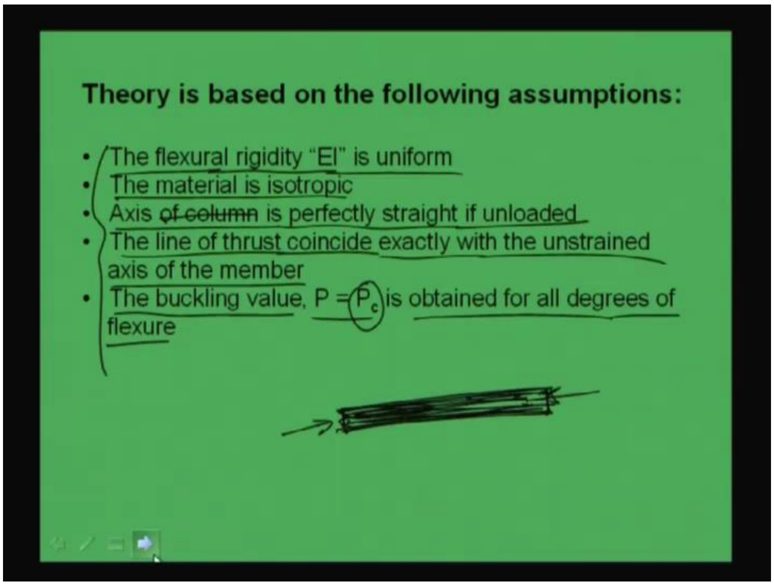

Now, this theory whatever the Euler's theory is discussed, that is based on the following assumptions which we should remember. One is the flexural rigidity. EI is uniform. That means, throughout the compression member, the flexural rigidity will be uniform, right. If the compression member is like this, so throughout this length the things are uniform. Another thing is that the material is isotropic. This is one assumption. Another assumption is axis of column is perfectly straight if unloaded. That means, when unloaded the axis of column is perfectly straight, on this assumptions only the Euler's theory will work. Another assumption is the line of thrust coincides exactly with the unstrained axis of the member. Another assumption is the buckling value P is equal to Pc is obtained for all degrees of flexure. Buckling value can be find out where Pc is the critical load, right.

So, under these assumptions only I can write this equation that is critical stresses pi square E by lambda square and critical load is pi square E by EI by l effective and critical stress pi square E by lambda square can be written from this assumptions, right.

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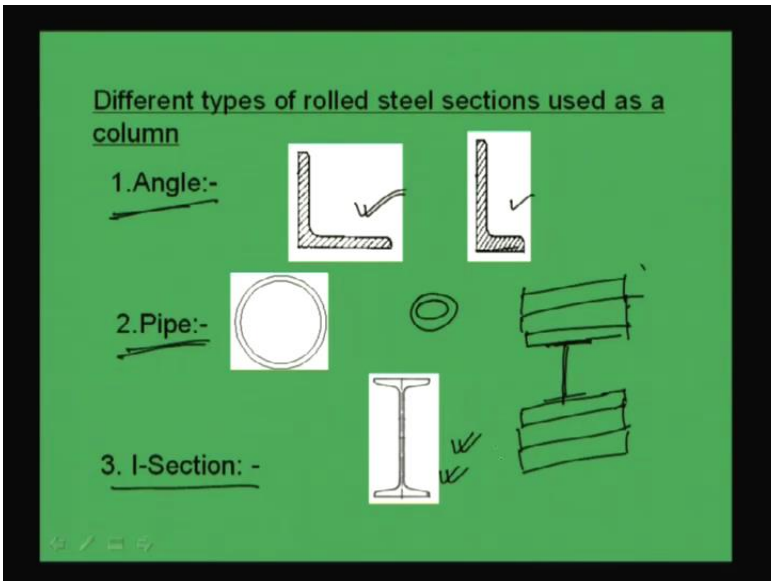

Now, when we are going for design of different types of compressive members, we have to see what the available compression members are and which type of members we are going to use. In general, we used to use like this type of section. One is angle section is generally used for compression member. Angle section again may be equal and it may be unequal. This longer leg and smaller leg, there are equal sections. Another is like pipe section means circular. Another important section which we use to use in compression member is the I section. I section is very commonly used in case of compression member. Of course in case of compression member with moment if we consider I section is mostly used.

Again we will see later that this I section, if this is I section again we may add some plate extra as per the requirement of the design. So, it may go on adding another plate. So, this will become a built up section means as per the requirement it may go on increasing. So, all these we will see later that how built up sections we use for the design of compression member. We will see later. Now, column design formula. So, how we will design, what will be the formula through which we can find out the allowable compressive stress in a compression member, how do we make? It is because most of the compression member fails in the mixed mode. Mixed mode means crushing failure and buckling failure. So, we have to take care of both. One is due to crushing, another is due to buckling. So, these can be found out from different formula.

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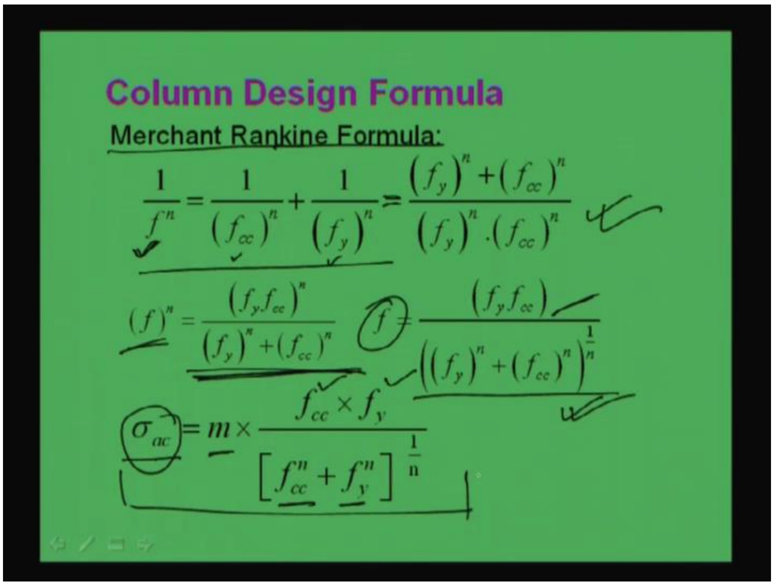

Merchant Rankine formula is mostly used to find out the allowable compressive stress in a compression member. What is that? That merchant Rankine formula is told that 1 by f to the power n is equal to 1 by fcc to the power n by plus 1 by fy to the power n, where fcc is the critical stress due to buckling and fy is the yield stress of the steel, right and AP is the allowable stress which is coming from these two stresses means resultant stress, right. So, if we find out this resultant of this 1 by f to the power n, this will become like this and f to the power n will become finally this. That means, fy fcc whole to power n by fy to the power n plus fcc to the power n, where f is nothing, but the resultant stress which will be developing in the column or in compression member, or we can say the stress which can be allowed in the member. So, from this I can find out f, the stress resultant stress.

Now, resultant stress will become fy into fcc by fy to the power n plus fcc to the power n whole to the power 1 by n. So, from this formula I can find out the value of f, and then finally with a factor of safety, the formula can be rewritten as like this because in case of design always we used to consider some sort of factor of safety. So, sigma ac, the allowable compressive stress can be written as m into fcc into fy by fcc to the power n plus fy to the power n whole to the power 1 by n. So, sigma ac value can be found out from this equation, right.

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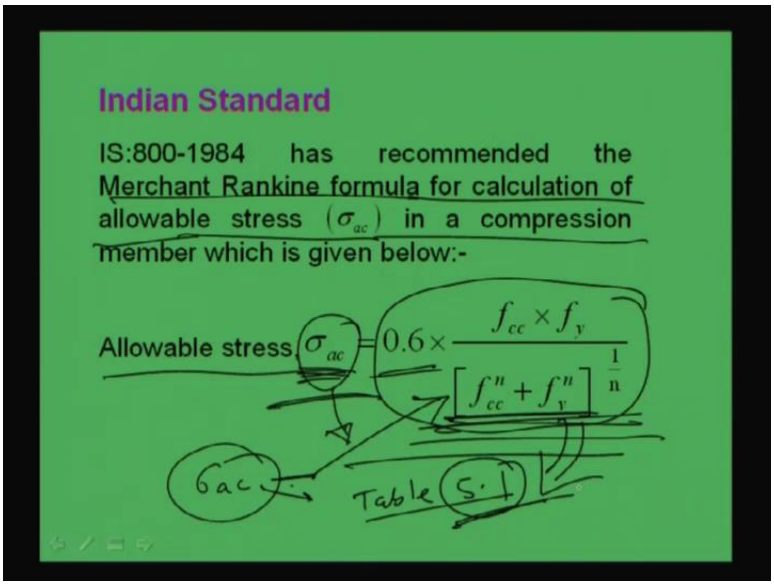

Now, in IS code: 800-1984, it has been recommended that the Merchant Rankine formula has been recommended with some modification that is the factor is considered as 0.6, right. So, the allowable stress sigma ac in a compression member can be found out from this formula. So, allowable stress in compression member sigma ac is equal to 0.6 into fcc into fy by fcc to the power n plus fy to the power n whole to the power 1 by n. So, this is the allowable stress on a compression member which undergoes buckling and crushing means due to direct stress and due to buckling. So, the allowable stress can be found out from this formula.

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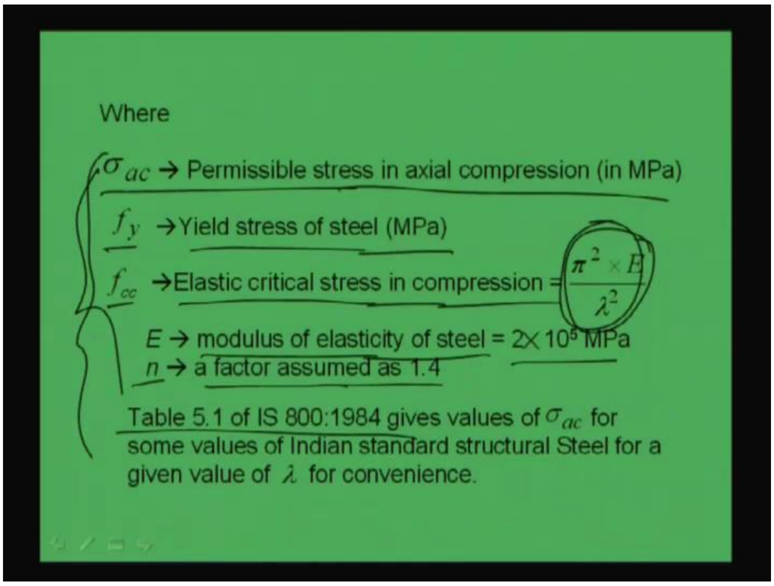

Where sigma ac we have telling that permissible stress in axial compression in Mpa and fy is the yield stress in steel, and fcc as I told earlier that is elastic critical stress in compression which can be found from this equation pi square E by lambda square. So, elastic critical stress in compression can be found out from here and E is nothing, but the modulus of elasticity of steel which can be written as 2 into 10 to the power 5 Mpa and n is a factor which is generally assumed as 1.4, right. So, with these parameters, the sigma ac value has been calculated which is 0.6 into fcc into fy by fcc to the power n plus fy to the power n whole to the power 1 by n. So, in this way we can find out the sigma ac value, where terms, different parameters are given.

Now, with this formula, we can find out the value of sigma ac or in other way also, we can find out through the table 5.1 of IS: 800-1984 which is given on the basis of this formula, right. So, either we can directly calculate the allowable stress sigma ac from this formula or the sigma ac value can be found out from table 5.1, where the values has been given from this formula only because this is a big formula. So, in place of calculating all these, we can simply use table 5.1 and can find out the value of sigma ac, right. So, in table 5.1, we will see that sigma ac for some values of Indian standard structural steel for a given value of lambda has been given.

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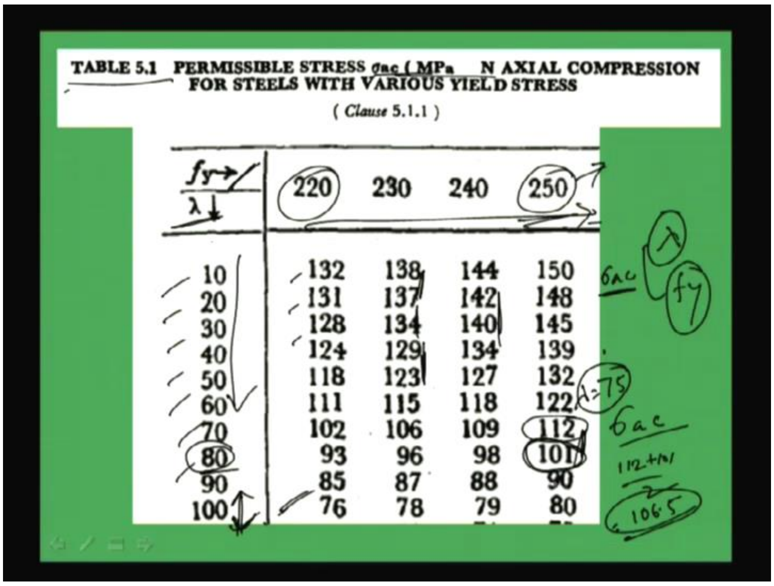

TABLE 5.1 PERMISSIBLE STRESS σ_{ac} (MPa N AXIAL COMPRESSION FOR STEELS WITH VARIOUS YIELD STRESS

(*Clause* 5.1.1)

fy→ λ↓	220	230	240	250
10	132	138	144	150
20	131	137	142	148
30	128	134	140	145
40	124	129	134	139
50	118	123	127	132
60	111	115	118	122
70	102	106	109	112
80	93	96	98	101
90	85	87	88	90
100	76	78	79	80

So, for lambda and for different steel, the values have been given sigma ac, values have been given here. If we see the table 5.1 in IS: 800, this is given that permissible stress sigma ac in Mpa. Now, these are the value of lambda. Lambda means the slenderness ratio. For different slenderness ratio, we can find out thus value of sigma ac for different grade of steel. In case of 250 with a slenderness ratio of 80, we can find out the value as 101 Mpa, right. So, from table 5.1, directly we can find out the value of sigma ac for a value of means for a given value of lambda and fy for a particular grade of steel, and for a particular value of slenderness ratio, the sigma ac value, the allowable compressive stress in that member can be found out.

Suppose for 75 means for lambda is equal to 75 slenderness ratio. If it is 75, what will be the sigma ac value? It will be the allowable compressive stress value for yield steel of 250. How do you find out? That means for 80, it is 101. For 70, it is 112. So, we can find out the value from these two by the method of interpolation. That means, it will become for 75, it will simply become 112 plus 101 by 2. That means 106.5. So, in this way we can find out. That means, in between values can be found out by linear interpolation. This is not the whole table. A big table has been given up to 180. This lambda value for and for different grade like 415, 500 all grades of steel has been given. If we produce the whole table, it will not be visible. That is why a part of the table has been shown here, right. Now, we can go for an example that how to find out the strength of a compression member.

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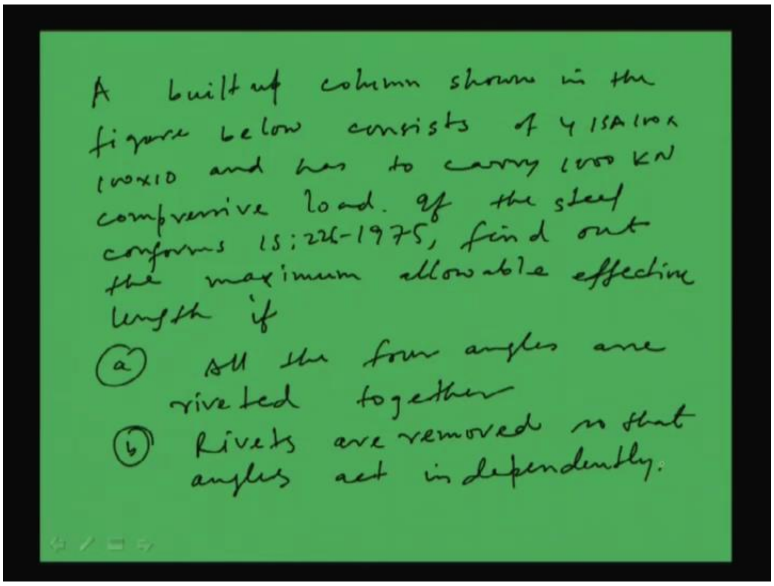

So, examples told that a built up column shown in the figure below consists of 4 ISA: 100 by 100 by 10 and has to carry 1000 kilo Newton compressive load. If the steel confirms IS: 226-1975, find out the maximum allowable effective length if all the four angles are riveted together. B rivets are removed, so that angles act independently, right.

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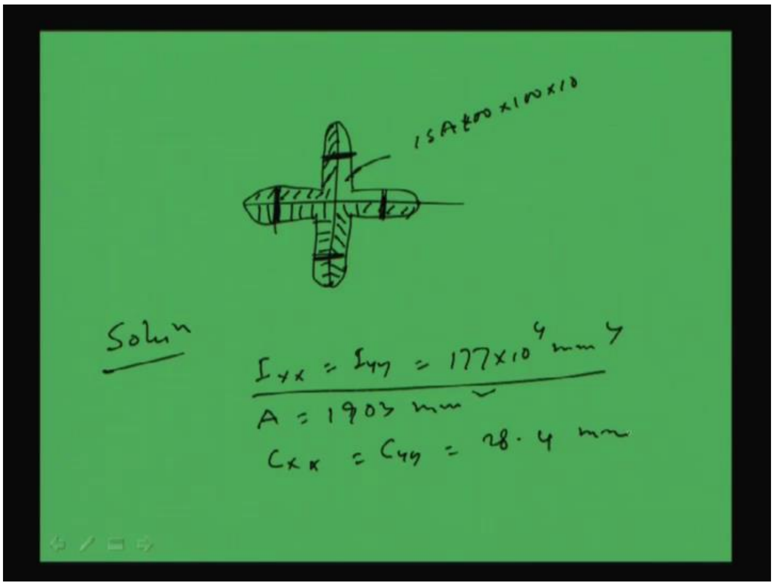

So, let us see the orientation of the angles. So, these are placed like this. So, it has been riveted like these angles are ISA: 100 by 100 by 10, right. So, these are ones angle, this is another angle and this is another angle, right and this is another angle. So, for finding out the solution, what we see that from steel table we can find out Ixx is equal to Iyy is equal to 10 to the 4 millimeter to the 4. From steel table for ISA: 100 by 100 by 10, the values has been given Ixx as Iyy is equal to eta, and A is equal to 1903 millimeter square. Cxx is equal to Cyy is equal to 28.4 millimeter. These are the things which have been given. Now, let us come to the first case. First case means all the four angles are riveted together.

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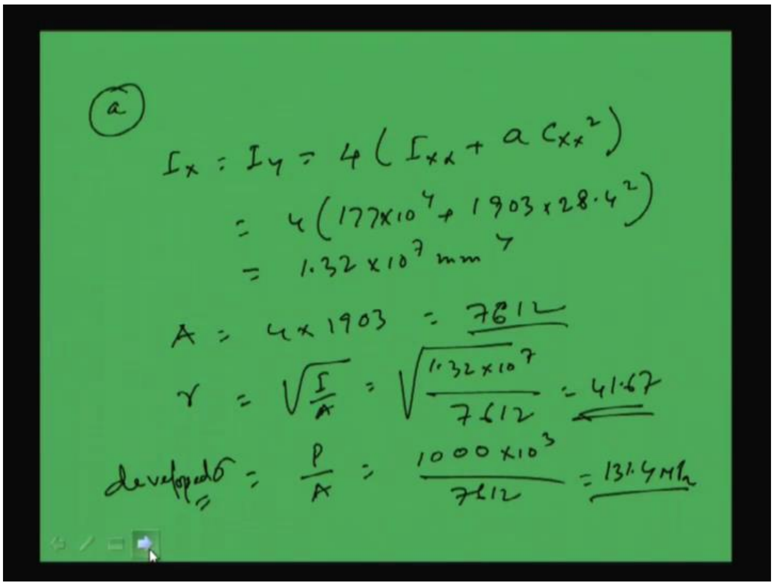

If it happens like this, then what will happen? For first case, then Ix will be basically Iy which will be equal that will be 4 Ixx plus area into Cxx square, right. So, this will become 4 into Ixx values are 177 10 to the 4, EI is 1903 and Cxx is the cg distance 28.4. So, this we are going to get 1.32 into 10 to the power 7 millimeter to the power 4, and total area will become 4 into 1903 is equal to 7612. That is why we can find out r as I by A, this will become I is 1.32 and 10 to the 7 and area is 7612. This will become 41.67, right.

So, we are getting the value of radius of gyration. Now, we can find out what is the developed stress sigma. Sigma is P by A here. P is given that is 1000 kilo Newton, right. So, 1000 into 10 cube by area. Area is given as 7612. So, this is coming 131.4 Mpa, right. So, the developed stress, this is developed stress. It is 131.4 Mpa.

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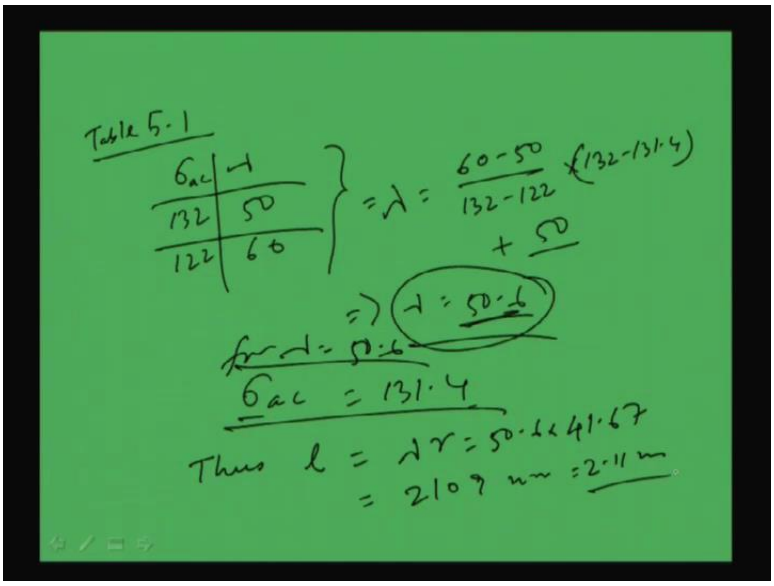

Now, from table 5.1 of the IS code, we can see that values are given like this for 132. This is 50 means if sigma is 132, the sigma ac value, then radius of gyration is becoming 50 and this is 122 and this for 60. So, from these I can find out the value of lambda for the stress which is given as 131.4. So, this will become 60 minus 50 by 132 minus 122 into 132 minus 131.4 plus 50. So, from this I can find out lambda value as 50.6. That means the developed stress 131.4 Mpa, whatever we have found for that lambda value has to become 50.6.

In other sense, we can say that if the radius of gyration becomes 50.6, then the allowable sigma ac can be taken as this value that 131.4. That means for lambda as 50.6, sigma ac value is becoming 131.4, right. Thus, we can find out length will become lambda into r. So, lambda is becoming 50.6 into r. We have already 41.67. So, this is becoming 2109 millimeter. That means 2.11 meter.

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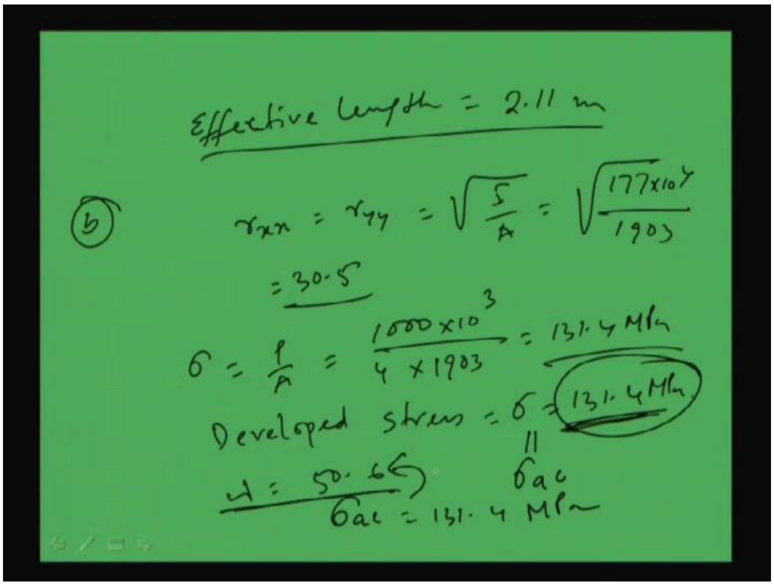

So, we can say that effective length will become 2.11 meter to carry 1000 kilometer load. Now, if we go for second case, that means if angles are acting independently, then what will happen? In that case, rxx will become that is individual I by individual A. That means 177 into 10 to the 4. It was an individual I and A was 1903. So, this will become 30.5, right. Now, developed stress will become sigma. This will become 1000 kilo Newton, and it has to be shared by four angles, so 4 into 1903. So, this is becoming 131.4 Mpa.

So, this is the developed stress that is 131.4 Mpa. That means to develop this much stress, this much stress can be allowed. If the lambda becomes 50.6 as we have calculated earlier here, we have calculated 50.6, right. So, lambda will become 50.6 if we have to allow the stress as 131.4 Mpa. So, this will become finally sigma ac. So, sigma ac is becoming 131.4 Mpa if the lambda becomes 50.6.

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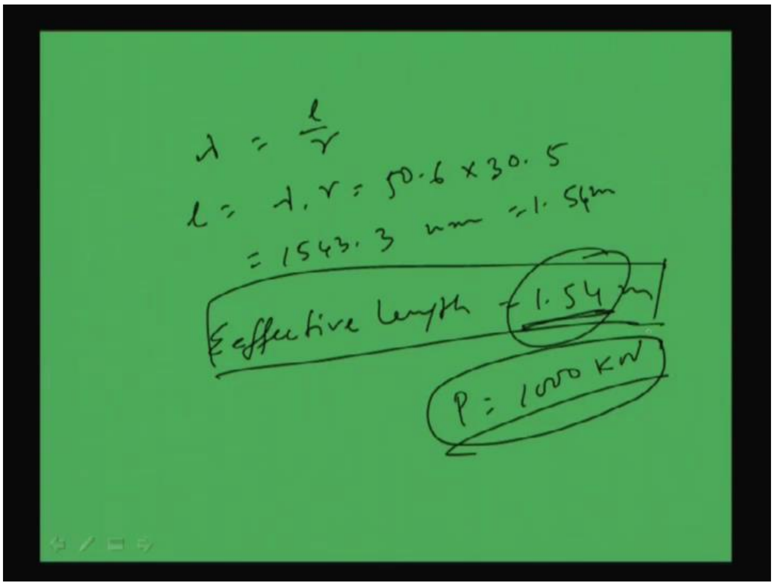

So, lambda is basically we can calculate as l by r. That means l is equal to lambda into r. So, 50.6 into r is given as 30.5 which we have calculated. So, this will become 1543.3 millimeter into 1.54 meter. So, in this case effective length we are getting as 1.54 meter. So, what we have seen here that if the angles are acting independently, if it is not connected, then effective length will become 1.54 to carry the load 1000 kilo Newton. To carry a load of 1000 kilo Newton, the length should not become more than 1.54 meter whereas, in case of acting together, the length can become 2.11 meter. That means for carrying 1000 kilo Newton load, the length of the member can become 2.11 meter.

Maximum load length to carry that 1000 kilo Newton load when the sections are acting together. That means connected by the rivet. So, that means if it acts together, it can take more load or if in other words, we can say to carry same load, the length can be increased if the sections are tied together. So, I think now it is clear how to find out the compressive load, allowable compressive load on a compression member. Now, next day we will discuss about the design of compression member means how to design. Here we have seen how to find out the strength of a compression member which is going to mean we under direct compressive force as well as indirect that buckling force. That means, the columns are under crushing and buckling stress. So, for buckling and crushing how we have to calculate the strength of the column, which we have discussed here.

In next class, we will discuss the same thing to design the column, how the design can be started. We will discuss in next class.