Structural Reliability
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Lecture –245
Target Reliabilities (Part - 08)

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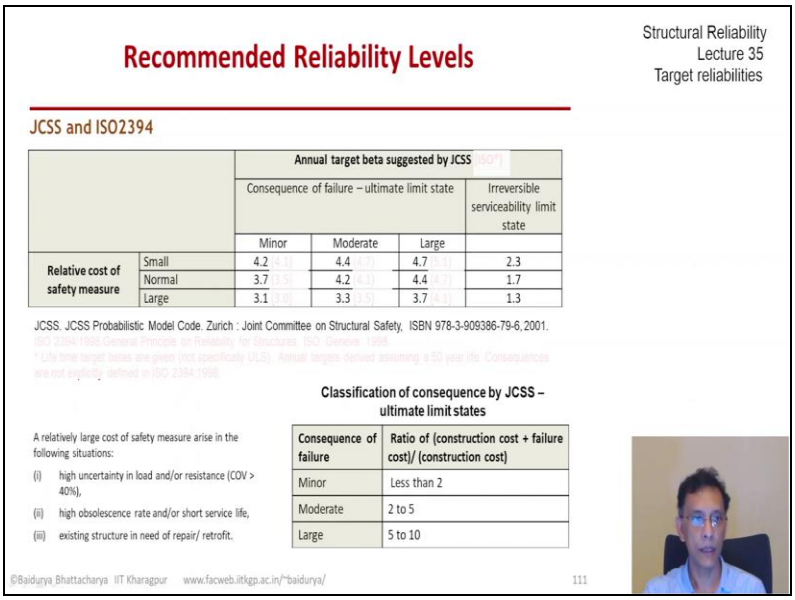

So moving away from marine and offshore structures towards more terrestrial ones we now look at two codes that came out at the turn of the 90s and early 2000s the joint committee on structural safety probabilistic model code and the 1998 revision of ISO 2394 general principles on reliability of structures. So, there are certain interesting features and we will identify them one by one the importance of consequence of failure is still there in this code.

For example here in the ultimate limit state we see there are three levels of consequences minor moderate and large and the codes have defined actually JCSS have defined the these three levels of consequence but interestingly and that is the first feature that we are going to bring out is that this consequence is not in terms of lives at risk or potential environmental damage it is clearly in terms of cost or cost ratios.

So, the three consequences of failure are given in terms of the ratio of construction cost plus

failure cost normalized by the construction cost and apparently the range is from 2 to 10 it is claimed or it seems that if the failure cost is of the same order as the construction cost then the consequence of failure for such a structure would be minor and for large consequences the failure cost is about nine or ten times at most of the construction cost.

So, it could be that more consequential structures or facilities are not being considered here but again the point to note is that any effect of lives lost or any effect of pollution is not considered directly explicitly but presumably indirectly through cost the cost implication would presumably consider such losses which would take the form of compensations legal fees and so on. The other feature that we would like to point out is we saw in the last two examples at least that the nature of failure or the availability of warning is an important consideration in deciding the target reliability.

Here however we do not see something like that but rather the degree of freedom has become the relative cost of safety measure and three levels have been considered small normal and large. And here is one example of a structure having a large cost or a relatively large cost of safety measure and that would be could be because of high uncertainties because of high obsolescence rate or a short life or an existing structure in need of repair and retrofit.

So, this is this is indeed interesting because we see that the target reliabilities are higher for lower relative cost of safety measures. So, and this is something that we have seen with lack of warning or lack of redundancy in the earlier quotes. So, can we conclude that lower relative cost of safety measure is in some sense equivalent to less redundancy at least if we have to consider be consistent with the earlier codes now.

So, this was all from JCSS and now let us put side by side the values proposed by the 1998 edition of ISO 2394 we are going to see later the 2015 edition of ISO 2394 which has certain differences from this distribution. But if we have to compare the values of JCSS for the same three relative cost measures but for the same and also for the same three levels of consequence you will see them in the red within parenthesis.

However I should mention that this 2394 does not explicitly define what the consequences are they are just listed as minor moderate and large in fact there is an even lower consequence than minor. So, these numbers more or less match we could see that for moderate and large consequences the ISO standard proposes a little higher reliability but they are more or less in the same ballpark. Now we are going to look next at the en 1990 the structural Euro codes that came out in 2002 around the same time.

And how these numbers compare with those of the euro codes and in particular we are going to compare this normal relative cost of safety measure for the three consequences. So, let us look at the structural Euro codes next.

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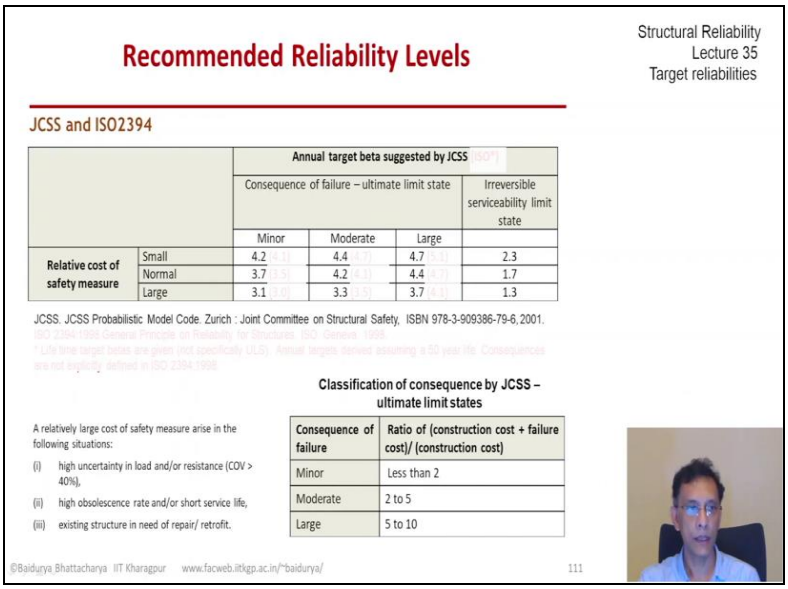

We have seen this before when we were discussing the structure and philosophy of reliability based design codes. So, as you remember EN1990 has defined three consequence classes one two and three and define them and given examples of such buildings as well or such structures. So, for consequence class one it is low consequence for loss of human life typically unoccupied buildings and also environmental consequences smaller negligible. So, we see some consistency or some continuity with the earlier codes like CSA and DNV that I already discussed.

In the next consequence class CC2 we have medium consequence for human life and considerable potential of environmental damage and an example is given. So, this would be an

office building or a residential building. So, this probably would be the most commonly occurring consequence class. And then high consequence class CC3 is for high consequence for loss of human life and very great potential of economic social or environmental heart and these are major infrastructural facilities and you see certain examples in the right column.

Now how and then compared to these three consequence classes three reliability classes have been defined which are RC1, RC2 and RC3 and the one-year target beta values are given as you can see starting from 4.2 for the lowest consequence class to 5.2 for the highest consequence class for a one-year reference period. Now let us compare them with the set that we decided we looked at before in the previous ISO 2394.

So, here we are looking at normal relative cost of safety measures and for again the three consequences which presumably would match CC1, CC2 and CC3 and the values are 3.5 4.1 and 4.7 compared to 4.2, 4.7, 5.2 respectively. So, these are actually not small differences if one converts these to Pf numbers then this would be quite a noticeable and significant difference. Now it is quite possible that the beta values for EN1990 are higher simply because life safety has been considered explicitly and which presumably was not done in the JCSS and IC ISO 2394 documents.