Introduction to Materials Science and Engineering
Prof. Rajesh Prasad
Department of Applied Mechanics
Indian Institute of Technology, Delhi

Lecture – 101
Marquenching and martempering

One way to avoid the residual stresses we generates in quenching and can lead to quench cracks which we discussed in the last video is a heat treatment called marquenching or martempering, both names are used or the marquenching is probably the better name we will see why.

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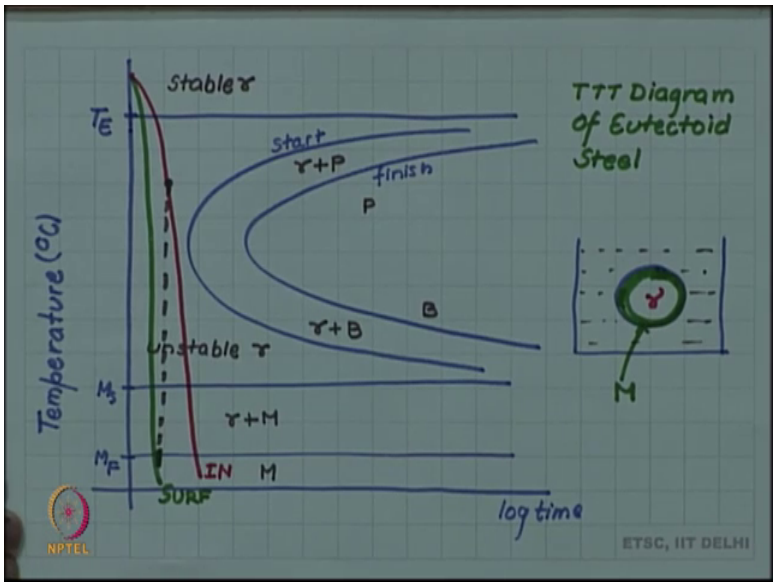

So, we have seen that the residual stress develops because the component size is large and the inside the redline cool slower than the outside the green line the surface. So, when the surface has formed martensite the inside is still warm at that time and it is still austenite. And when that austenite wants to transform to martensite the volume expansion is registered and residual stresses and cracks may generate, but then you can see that this was happening because the whole sample was not able to transform to martensite at the same time, the surface transformed first and subsequently the inside transform.

So, if we can some way equalize the temperature of surface and inside then this problem can be removed. And fortunately, the TTT diagram so just a way out of this that if we

just see above the martensite temperature there is a long-time interval in which there is no transformation happening. Before bainite starts to form we have lot of time available for not a lot of time available without any transformation. So, this time can be used to equalize the temperature of surface and may inside of a component. This is the philosophy or idea behind marquenching or martempering.

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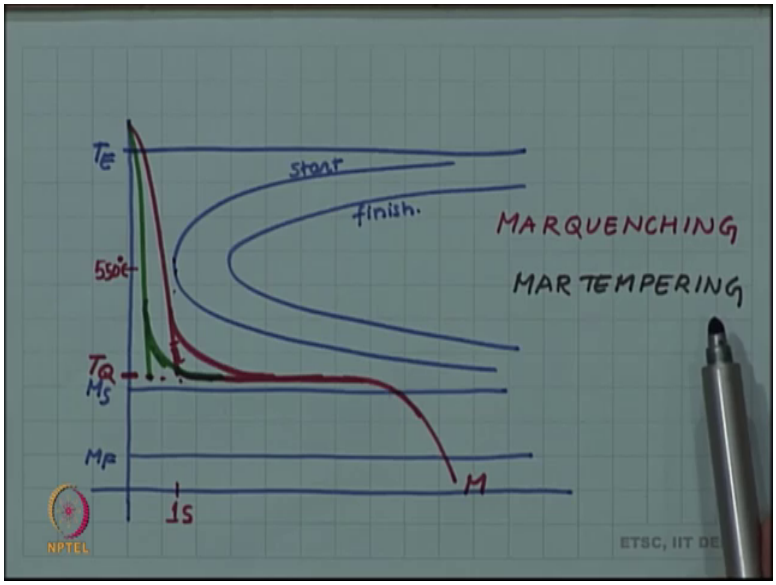

So, what we do is; instead of quenching so this was the surface which was cooling faster. And this was the inside which was cooling much slowly. Now instead of cooling all the way below MS and MF to form martensite we interrupt the quench here. So, our quenchant is held at a temperature above MS. And similarly, the inside now, because we are not cooling directly the inside will also maybe this diagram also needs to be modified from here, because now the quenchant temperature is higher. So, this is the quenchant temperature let us call that TQ.

So, because the quenchant is held at a temperature higher than MS both there will be time enough for the inside and the outside to come to the same temperature. And then once they are at the same temperature they can again be cooled and can be cooled much more slowly there is no requirement for quenching now; recall that the requirement for quenching to produce martensite was because of this small gate which we had here at the nose. So, we had only one second this stem this time is about one second and the temperature was 550 degree Celsius. So, in less than one second, we should cool below

550 degree Celsius to avoid the node, but once we have done that there is no need to keep on maintaining that high cooling rate down to produce martensite. We can use this non-transforming region just above ms to hold the sample and equalize the temperature. And after that again there is no further need for rapid quenching a slow cooling will also give us martensite.

And now I am drawing a single curve only although there will be temperature difference is still between inside and outside, but that difference will not be very high, because we have allowed the time for temperature equalization and we are cooling at a much slower rate. So, this this interrupted quench is called Marquenching. So, ma like quenching marquenching is also producing martensite, but it is avoiding the problem of generation of residual stresses and avoiding the problem of quench crap.

Marquenching is also called Martempering. So, the 2 terms are synonymous, but marquenching is a better term because like quenching, quenching produces martensite marquenching also produces martensite. So, both are actually quenching technique only in marquenching we are interrupting the quench above ms and then cooling it again and this avoids the residual stresses and cracks as we saw.

Martempering can also be used for this process, but remember we discussed tempering and in tempering a quenched martensite was again reheated, but in martempering there is no such a step. So, sometimes martempering can confuse us with tempering there is no tempering involved, martempered specimen again has to be heat treated and tempered. So, martempering does not involve tempering tempering has to follow umm martempering. So, I will recommend marquenching as a better word for this process.