Introduction to Materials Science and Engineering
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Lecture – 104
Hardenability of steels

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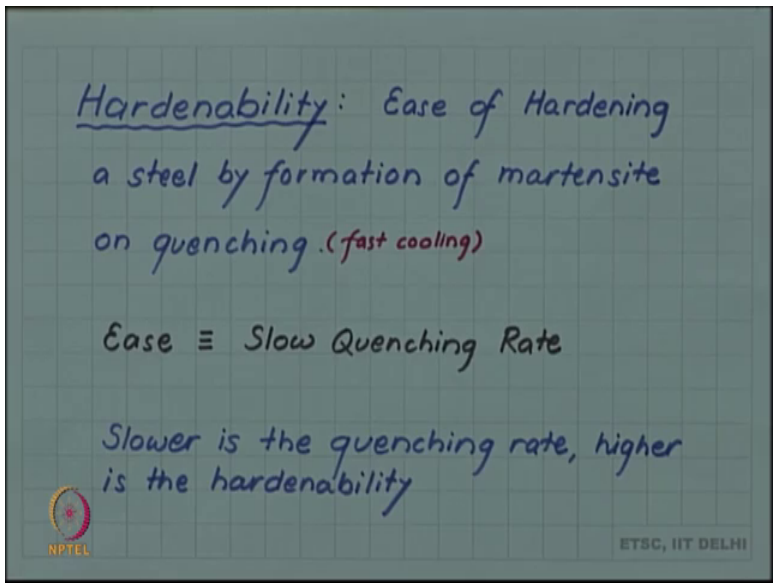

Let us discuss hardenability of steels, it is an important property of a steels. And let us look at that. We define hardenability as ease of hardening a steel, by formation of martensite on quenching, we have seen that quenching by sufficiently fast cooling rate. So, quenching is fast cooling.

So, if we cool fast enough such that we miss the nose of the C curve then we can end up forming martensite, and martensite is very hard and brittle. So, it gives hardness to the steel. So, easier it is to have martensite by this quenching process, higher is the hardenability and the measurement of ease or the definition of ease, is the slow quenching rate. Which means slower is the quenching rate higher is the hardenability and we have seen, while discussing the effect of alloying addition on the TTT diagram. We saw that in the plain carbon steel, we have a single nose and pearlite and bainite C curves merge at the nose.

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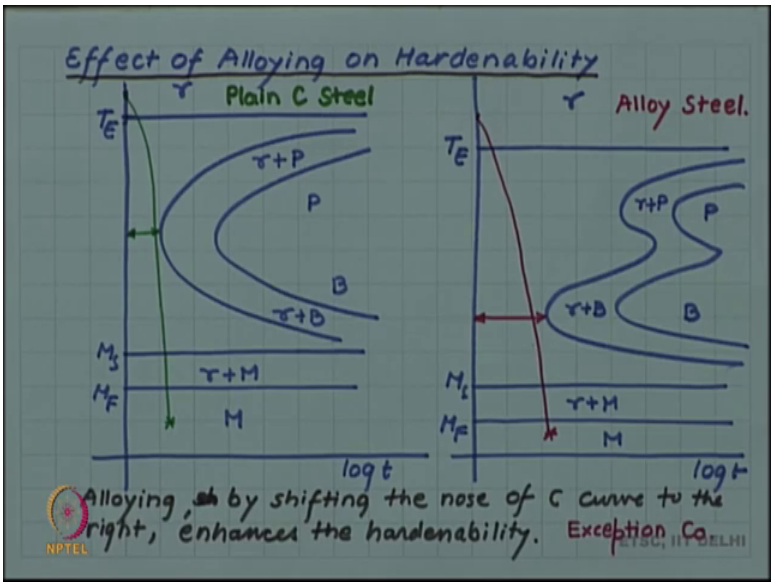

Whereas in alloy steel, in the C curve bifurcates into two noses the pearlite nose and the bainite nose, and also the C curve shifts to the right, that is to the higher time which means there is a higher time window, available for quenching in alloy steel than is available in the plain carbon steel.

So, we have to quench at a rate much faster to form martensite in plain carbon steel whereas, we can go a little slower , you form martensite in alloy steel. So, an important conclusion from this is that, alloying increases the hardenability of a steel. So, let us note that, alloying alloying by shifting C curve to the right enhances the hardenability . This is true for all alloying additions, there is only one exception known and that is cobalt. So, only exception to this rule is cobalt. Cobalt does not shift the C curve to the right, and that is why it does not enhances the hardenability, it is important to keep the distinction between hardness and hardenability clear.

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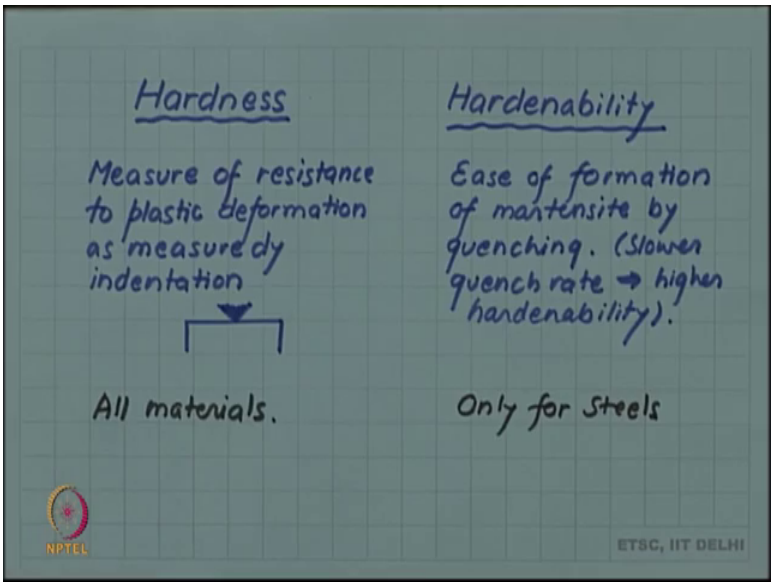

So, let us write that down, we have talked about hardness when we were talking about the different heat treatment, that how different heat treatment can give us different hardness. And now we are talking of hardenability, and sometimes one may mix up or confuse these two terms, but they are very different concepts.

So, hardness is a measure of resistance to plastic deformation, as measured by indentation, as you have seen that we push an indenter of some hard material, onto the sample and we measure how much the indenter went in, and that is a measure of hardness. For a higher hardness material, the indenter will go less, into the material for lesser hardness material it will penetrate more.

So, this is what is hardness whereas, hardenability has nothing to do with this hardness. Hardenability is ease of formation of martensite by quenching. So, slower is the quench rate higher is the hardenability. Now since this martensite formation and hardening of steel by martensite is a specific, to steel the concept of hardenability applies only for a steel. So, this concept is applicable whereas, hardness is applicable for all alloys.