Introduction to Materials Science and Engineering
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Lecture – 53
Burgers vector of a dislocation is constant along the line

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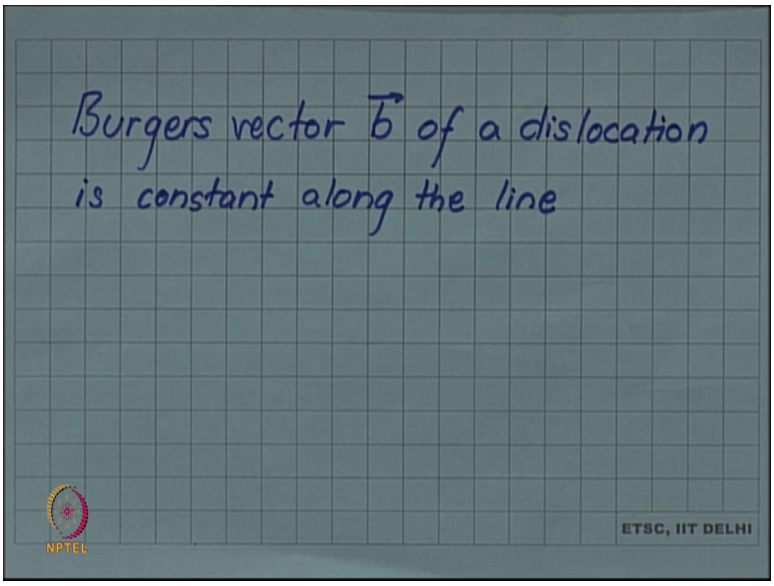

An interesting geometrical property of a dislocation line, is that the burgers vector of a dislocation line is constant along the line.

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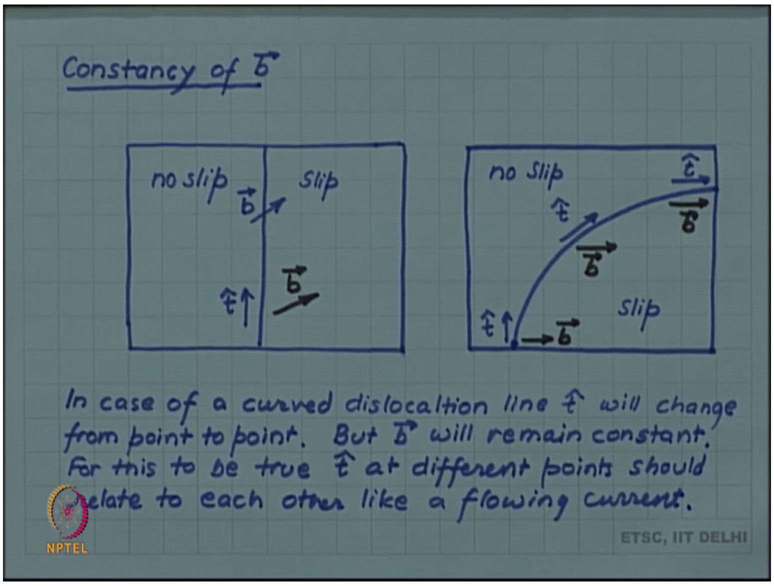

This is something quite simple and follows from the very definition of the dislocation line, as the boundary between slipped and un slipped regions, remember we have been defining the dislocation line as a line, which divides the slip plane into a slip region and a no slipped region, and in the slip region there is a slip of certain magnitude and direction, and that is what is called the burgers vector.

So, the magnitude and direction of the slip is the burgers vector, and the dislocation line itself is characterized by a tangent vector, a unit vector tangent to the dislocation line. Now since the slip region is a single slip, and it will be characterized by the same slip vector or the burgers vector in everywhere in this region, the dislocation line also does not change it is burgers vector from point to point, and has the same burgers vector all along the line. So, anywhere along the line. So, this burgers vector this magnitude of direction and slip is associated with the dislocation line, and at every point of the dislocation line we have the same burgers vector.

For a straight dislocation the t vector also is constant along the line, but an interesting situation occurs if we consider a curved dislocation line. So, if we have a curved dislocation line, a boundary between slipped and un slipped region can be curved also, in this case the t vector will be changing along the dislocation line. So, a t vector at this point will be tangent to the dislocation line at this point, where is as a t vector at this point will change it is direction and a t vector here will be in this direction to be consistent, the t vector along the line as it changes should have the same sense, in the sense that it should appear to follow a current flowing along the line as a wire.

So, I should not flip the t as I go along this line, it should appear as if something is flowing a current is flowing along this line. So, this is a consistent set of t, but. So, a consistent set of t along a curved line, because the tangent is changing the t vector will also be changing, but is still since we still have a single slip, the burgers vector whatever burgers vector suppose there was a burgers vector b, here this a horizontal vector like this then the burgers vector will remain horizontal at all the locations of the dislocation line, because the dislocation line is dividing the same slip and no slip regions.

So, we can we can make a note of this that in case of a curved dislocation line, t will change from point to point, but B will remain constant, but the burgers vector B will remain constant, but for this to be true, t at different points should relate to each other like a flowing current an interesting case is to consider a single dislocation as 2 dislocations meeting at a node.

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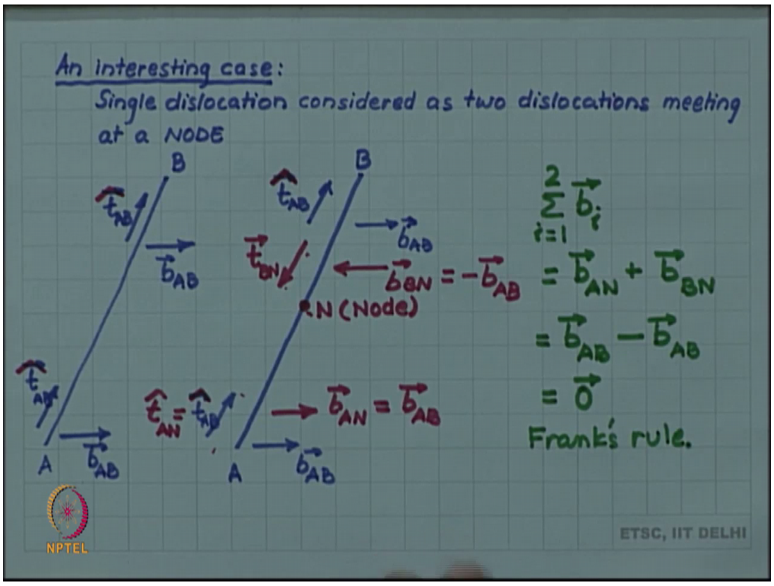

So, let us consider there is a dislocation line AB. So, it has a tangent vector, t A B, and has a burgers vector BAB and tangent vector will remain tangent as we discussed for a straight dislocation it will remain the same, but for a curved dislocation it can change, but the B vector has to remain the same at all points. So, it is the same B vector at all points along the dislocation line, but now suppose I wish to treat is possible although, it is sort of trivial exercise, but it is possible to consider this single dislocation line as 2 dislocation lines, meeting at n which is a node.

So, again draw the tangent vectors and the burgers vector. So, for the original dislocation I am drawing for the original single dislocation, just copying what I have drawn the on the left, but as soon as I consider it as a node, remember the frank for application of franks rule, I have to take the burgers vector. So, sorry the tangent vector such that they are either both pointing to the node or away from the node. So, the original tangent vector of a single dislocation line does not satisfy this condition.

So, if I take if I consider the same I if I keep the dislocation tangent vector for the AN dislocation now we have 2 dislocations an and bn meeting at the node N, and is a unit vector. So, I am putting a carat. So, if I take the N a a tangent vector for the an dislocation same as tab then for the BN dislocation I have to flip the tangent vector to be pointing towards the node like this, and you know that if I change the BN vector, if I flip the tangent vector, then the burgers vector will also get flipped, the burgers vector will remain along the same line of the same length, but will change it is direction.

So, this is now my negative of BAB whereas, the burgers vector of AN will remain the same as the original. So, this exercise reminds you of 2 important condition, that if you consider a node then the tangent vector should be pointing to the node, all the tangent vector of the all the dislocations meeting at the node, they should be pointing towards the node. So, we have done that exercise here for the BN we have flipped. So, that it is pointing to the node AN anyway is pointing to the node.

Then you can see now you can apply the franks rule. So, the sum of the burgers vector all the burgers vector at the node, and here there are only 2 dislocations. So, I have 2 burgers vector. So, which I add. So, one dislocation is AN. So, I have sum of these 2 dislocation B B AN and B BN you have seen that B AN is same as the original B AB, but B BN became negative of B AB, because we flipped the corresponding t vector. So, the B vector also got flipped. So, it became minus B AB which then; obviously, gives you a 0-vector satisfying the franks rule.

So, it is possible to consider a single dislocation any point of a single dislocation can be considered as a node at which 2 separate dislocations are meeting, and is a sort of this exercise summarizes or revises some of the conventions of node that the tangent vector should point towards the node, and the other convention that if the burgers vector if the t vector flips then the B vector also flips and the third that the sum of the burgers vector at the node should be 0 which is we have already introduced as franks rule.