

Mechanical behavior of materials

Dr. Niraj Mohan Chawake

Department of Materials Science and Engineering

Indian Institute of Technology, Kanpur

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Lecture-24

Mixed Dislocation Edge and Screw



Mechanical Behavior of Materials (Hindi)

Mixed Dislocation and Burgers Circuit

Namaskar phir se swagat karta hoon aapka is course mein iska naam Mechanical Behavior of Material hai jisko hum Hindi mein padhenge. Last part mein humne dekha tha, do dislocations ko dekha tha Edge aur Screw aur humne is tarah se kuch likha tha tangent vector perpendicular to Burgers vector aur Screw mein likha tha humne tangent vector parallel to Burgers vector. Humne kaha tha agar ye relation satisfy ho raha hai to hum isko kehte Pure nature in dono ka. Par material mein yeh do nature pure form mein milna bahut mushkil hai ya kabhi-kabhi nahi milte. To us type ko dislocation ko hum kehte hain Mixed Dislocation hai. Yani us dislocation mein yeh dono nature present rahenge. To is part hum janenge ki Mixed Dislocation hote kya hai aur yeh Burgers vector hai isko kis tarah se identify karna hai.

To pehle jante hain ki Mixed Dislocation hote kya hai. To maan lijiye mere paas ek crystal hai aur meri ek dislocation line hai kuch is tarah se hai. Agar main dekhunga ki dislocation line is tarah se

jaake andar mein ye jo andar mein gayi hai isko dotted tarah se dikhaya gaya hai aur is face se nikli, yani is face mein enter thi aur is face se nikli meri dislocation ya line vector hai. Ye mera tangent vector hai, ye mera t ho gaya is tarah se nikli. Aur agar main iske coordinates mark kar loon yani is crystal ke to main is tarah se mark kar leta hoon X, Y aur Z ki tarah. Abhi hum dekhenge yahan par iska hum ek 2D picture nikalte kuch is tarah se. Agar hum atomic displacement dekhenge agar upar se hum dekh rahe is plane ko, yeh jo plane maine cut kiya is plane ko agar hum dekhenge to mujhe kuch tarah kuch atomic displacement is tarah milenge. Aap dekhenge mera jo atomic displacement hai jisko main displacement vector ya Burgers vector kehta hoon ye b yahan par hai aur mere tangent vector jo hai kuch is tarah se move ho rahi hai yani is plane mein gayi to yeh plane jo ho gaya mera XY plane ho jayega kuch is tarah se ho jayega XY plane.

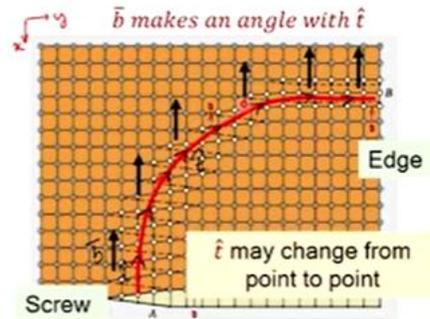
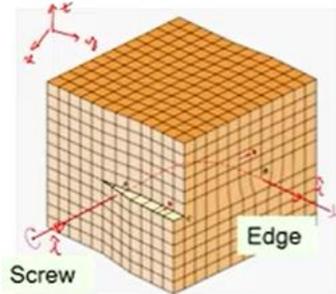
Abhi hum dekhenge ki ye meri tangent vector ho gayi aur yeh tangent jo vector hai isko main is tarah se mark karunga yeh hamesha jaise current flow hota hai us tarah se rehta hai hamesha tangent vector. Iska color change kar lete hain. To yeh jo tangent vector hai kuch is tarah se hai mere paas, yeh ho gayi meri tangent vector. Aur Burgers vector kuch is tarah se hai jo ki is direction mein hai. Ab hum dekhenge ki Burgers vector hai meri tangent vector to change ho rahi yahan par par jo Burgers vector hai woh ek hi direction mein kis direction mein hai. Yahan par maine XY mark ki to yeh meri minus X direction mein hai, negative X direction mein hai mera Burgers vector ka direction. Par aap dekhenge ki complete tangent jo vector hai ya dislocation line vector hai yahan par jo displacement hai woh hamesha jo Burgers vector hai woh hamesha yahan par ek hi side par hai woh change nahi ho raha hai woh constant hai. To yahan par main likh sakta hoon ki t may change from point to point yani point to point t change ho raha hai yahan pe.

Aur yeh jo nature hai yahan par agar aap dekhenge tangent vector yahan pe is part pe ya is part pe main dekhunga yahan par Burgers vector jo hai woh parallel hai mere tangent vector ke saath. Yeh mera Burgers vector hai agar aap dekhenge yeh mera Burgers vector hai aur yeh mera tangent vector yahan par. To is location par is location par Burgers vector aur tangent vector parallel hai to ye mera ho jayega Screw nature yahan par dislocation ka. Yeh ho jayega mera Screw nature yahan par. Wahi cheez main yahan par dekhun is face par dekho is face par yani is face par dekhunga to mera ye jo Burgers vector hai aur tangent vector hai ye perpendicular ek dusre ko. To yeh ho gaya mera Edge nature yahan par mujhe mil raha hai Edge nature. In beech mein mujhe kya mil raha hai in beech mein mujhe mil raha hai ki tangent vector aur Burgers vector kuch angle bana rahe hain. To main kuch is tarah se likh paunga tangent vector aur Burgers vector kuch angle bana rahe to mere paas yeh case mein yani beech mein Burgers vector aur tangent vector angle bana rahe to main usko kuch define nahi kar sakta hoon na woh Screw hai na hi woh Edge hai. Humne definition dekhi thi dono ki. To yeh jo nature hai dislocation ka isko main kehta hoon Mixed Dislocation aur yeh material mein hamesha paya jata hai. Humein Pure Screw aur Pure Edge halanki nahi milta hai kuch kuch cases mein milta hai par mostly humein Mixed Dislocation hamesha milenge. To yeh ho gaya mera Mixed Dislocation.



Mixed dislocation

Mixed dislocation



Matr Sci & Eng An Intro_WD Callister

Abhi hum jante hain ki agar main dislocation ko quantify karna chahta hoon mujhe yane Burgers circuit ya Burgers circuit ke dwara main quantify karunga to mujhe mujhe magnitude aur direction of Burgers vector nikalna hai. To yeh circuit pehli baar diya tha Burgers ne jo ek Dutch scientist the unhone kaafi kaam fluid mechanics par kiya hai sirf unka ek paper hai material science mein jo ki Burgers circuit ka construction ke baare mein hai aur yahi paper ek phenomenal paper hai jahan par material scientist istemaal karte is method ko. Burgers vector hai uska magnitude nikalne ke liye aur direction nikalne ke liye. To humein Burgers vector agar identify karna hai to humein Burgers circuit ki zarurat hai. Hamein Burgers vector jo hai uska magnitude or direction along dislocation line ka kyu chahiye humein yeh direction aur magnitude. Yeh chahiye kyunki hum to pehle plastic deformation ko quantify karna chahte isliye humein Burgers vector ka magnitude aur direction chahiye aur iske alawa humein nature of dislocation bhi pata chalega isse ki woh Screw hai, Edge hai ya Mixed Dislocation. To yeh jo method hai woh independent of the slip plane hai.

Ab hum janenge ek example lete hain ek ek 2D crystal lete 2D lattice lete hain. To agar yahan par aap dekhenge ki yahan par koi defect nahi hai to yahan se main shuruat kar raha hoon maan lete hain main yeh mera starting point hai to main yahan par kuch teen distance aage badha aur chah distance neech aaya. Wapas jaate hue yahan par teen distance main is direction mein ja raha hoon agar main chah distance upar jata to main jahan se shuruat kiya jahan se start kiya wahin pe pahunch raha hoon. To yeh mera start aur finish point exactly match kar raha hai, ye match kar raha hai iska matlab yahan par koi defect nahi hai. To is tarah se main mark kar leta hoon agar main directions mark karna chahta hoon to yeh mera East main mark kar loonga aur yeh North mark kar leta hoon. To main yahan par kya kiya tha main East direction mein aaya phir South mein aaya phir West mein gaya aur phir se North mein aaya aur main usi point par pahunch gaya. Yeh mera start aur finish exactly match kar raha hai to yahan par koi dislocation nahi hai. Wahi is tarah se samajhte yane isko hum kehte circuit is closed. Yeh circuit jo humne draw kiya tha yeh closed hai aur yahan par koi dislocation nahi hai.

Usi tarah yahan par dekhte hain hum yahan par clear dekh pa rahe hain is picture mein yahan par mera extra half plane hai aur yeh mera slip plane hai. Par jab hum atomic images lete hain aur humein dislocation dhoondhna hota hai to yeh difficult ho jata hai. To ye jo point hai yahan pe independent of the slip plane agar mujhe slip plane pata nahi hai kya main is half plane ko dhoondh paunga yeh mera question tha. Agar main yahan par agar kuch dekh raha hoon to mujhe kuch dislocations nahi dikh rahe par yeh dislocation dhoondhna hai to main kis tarah se dhoondhu. To yahi methodology hamare kaam aayegi.

To maan lete hain hum kisi se chalu karte hain yeh point se humne chalu kiya abhi hum cheh points ya cheh distance hum East mein chal rahe hain to saat point hum neeche aa rahe saat neeche yane South mein aa rahe saat magnitude. Abhi hum cheh point phir se aa rahe hain West ki taraf aur saat phir se upar aayenge kyunki jo humne cheh East mein chale the cheh West mein chalna hai saat South mein chalna hai to saat North mein chalna hai. To abhi hum dekhenge ki ye jo finish point hai aur start point hai yeh match nahi ho raha hai yani ek yeh circuit close nahi ho raha hai. Isko kehte hain closure failure circuit ka closure failure. Yeh terminology istemaal hoti hai aur yeh jo dekhenge yeh jo distance hai between finish and start isko hum kahenge Burgers vector. Aap dekh payenge yahan par kuch points main abhi mark karna chahta hoon yeh jo ho gaya yeh jo displacement hai yahi mera Burgers vector ka magnitude hai. Pehle to magnitude nikalte hain to magnitude yeh ho gaya. Aur aap dekhenge ki agar is case mein agar yahan par failure ho raha hai closure failure ho raha hai to aap dekhenge number of planes jo upar mein hai half plane yani slip plane ke above ye inka number zyada hoga jo number of planes neeche hai. Agar aap dekhenge ki yahan par agar ye pura close hona tha to yahan par saat units chahiye the aur yahan pe cheh units. To aap dekhenge ki ye cheh jo cheh hai woh saat se chhota hai. Hum yeh keh sakte ki number of planes slip plane jo hai uske above agar yeh zyada hai to is tarah se humein kuch closure failure milega aur jo half plane hai woh above lie karega agar number of planes above hai to. To extra half plane is above. To aap dekh payenge maine yahan par dekha nahi tha maine circuit draw kiya aur main is observation se keh sakta hoon ki mera extra plane upar wale side mein lie karega.

Abhi aur ek cheez ek indicate karega ki agar iska main direction nikal sakta hoon ye closure failure hai aur main iska ek direction nikalun to ye kuch is tarah se aayega yani finish to start agar main ja raha hoon to yeh direction of Burgers vector kuch is tarah se mark hoga. Abhi hum dekhte hain kuch aur points yahan pe yani jo Burgers vector hai aur iska magnitude hai aur direction of closure failure hai is same for any circuit. Yani agar main circuit draw karunga agar main circuit yahan par bhi draw karta hoon is around dislocation ke liye woh ek magnitude fixed rahega isliye maine bola tha ki magnitude of Burgers vector change nahi hota hai aur iska jo sense hai woh reverse ho sakta hai. Reverse yane mujhe kuch convention follow karne padenge agar yeh maine direction is tarah se mark kiya Burgers vector ka par aap is tarah se mark sakte ulta bhi mark kar sakte ho yahan pe is tarah se bhi mark kar sakte ho aap par aapko ek convention follow karna padega aur woh convention yahan par jo maine follow kiya woh main yahan par likh raha hoon isko main keh raha hoon RHFS. RHFS convention jo hai iska matlab hai Right Hand Finish Start. To yani Right Hand isliye bol raha hoon kyunki main Right Hand ki tarah move kar raha hoon clockwise move kar raha hoon yahan pe to yeh Right Hand ho gaya aur Finish Start yane jo main Burgers vector ka direction mark kar raha hoon to yeh mera finish point tha green wala point aur red wala point mera start tha isliye main finish to start agar ja raha hoon to isko main kahunga ye meri direction ho jayegi Burgers vector ki. Aur ye convention agar main follow kar raha hoon to main isko RHFS convention kahunga. Aapko ye convention hamesha follow karna hai yani koi bhi convention aap LHFS follow kar sakte hain ya LHSF follow kar sakte hain finish to start follow kar sakte hain

start to finish follow kar sakte hain but aap koi bhi calculations kar rahe ho to aapko yeh ek convention ko fix rehna hai. Agar aap RHFS follow kar rahe hain to throughout aapko RHFS hi follow karna hai.

To yeh ho gaya mera Burgers circuit ye ho gaya Edge Dislocation ke liye. Humne dekha yahan pe mera extra plane hai aur ye Burgers vector main dekhunga ki ye perpendicular hoga tangent vector. Tangent vector yahan pe aap dekhenge ki ye is tarah se kuch hai yahan pe perpendicular to this plane.



Burgers Circuit

|| \bar{b} ||

J.M. Burgers (Dutch scientist: Fluid Mechanics): Only one paper in materials science

Identify of the Burgers vector: \bar{b}

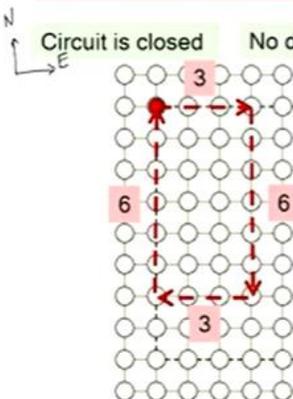
Independent of the slip plane

No. of planes above > No. planes below

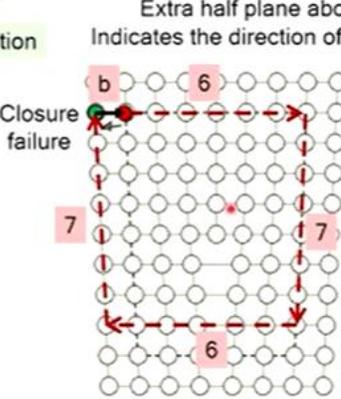
Extra half plane above

Indicates the direction of Burgers vector

Circuit is closed **No dislocation**



Closure failure



- The Burgers vector and its magnitude is fixed for a given circuit
- Sense may reverse based on direction of traverse

RHFS convention
Right Hand Finish Start
(follow one convention)

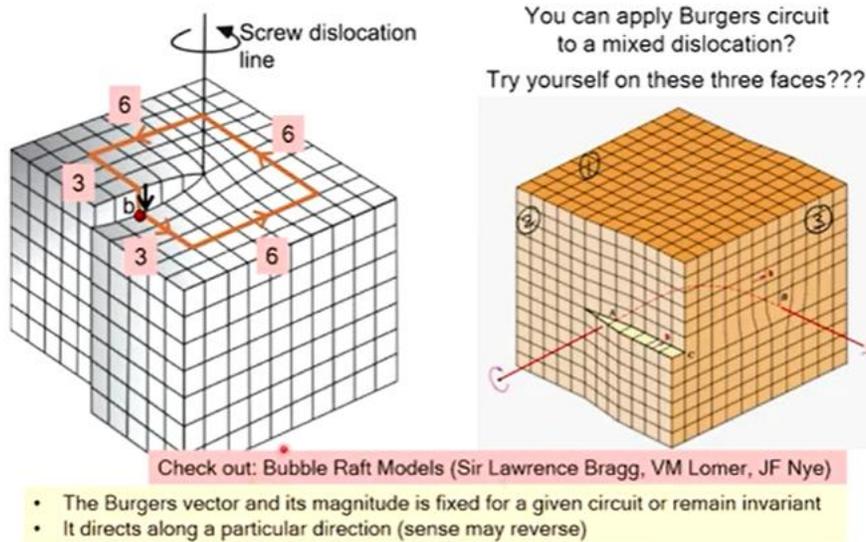
Abhi hum Screw Dislocation ke baare mein jante hain ya Screw Dislocation mein Burgers circuit kis tarah se draw karte hain. Humne already draw kiya hai agar main dekhunga is tarah se main yahan se shuruat kiya tha yahan par pahuncha to ye mera start point hai to main teen unit yahan par aaya phir cheh unit is tarah se move hua phir cheh unit is tarah se move hua phir mujhe cheh unit is tarah se move hona hai aur yahan par maine teen unit already cover kar liye to yahan par main teen unit move hounge to main agar teen unit yahan par aata hoon to main dekhunga ki yeh meri displacement vector ho jayega main upar wale plane par pahunch gaya hoon. Yeh mera finish point hai to yahan par bhi main RHFS follow karunga ya jo bhi convention aap follow karo ek convention ko follow karo. Yahan pe aap dekhenge ki ye jo Burgers vector hai ye mujhe mil raha hai parallel to dislocation line vector mera Screw Dislocation ho gaya aur is tarah se main main magnitude aur direction nikal sakta hoon Burgers vector ki.

Yeh ek point already maine mention kiya tha Edge Dislocation ke liye kisi bhi circuit ke liye agar koi bhi ek particular circuit aap draw kar rahe ho us circuit ke liye iska magnitude Burgers vector ka magnitude constant rahega iska matlab yani woh change nahi hoga is circuit ke end yani iska ek direction humein milega woh jo direction hai aap jo convention follow kar rahe uske hisaab se rahega to yani sense iska reverse ho sakta hai agar aap start to finish le rahe finish to start le rahe usse ye Burgers vector ka direction change hoga. Abhi aap ko ek exercise de raha hoon aap ek kaam kare yahan par aap teen Burgers circuit nikaliye yeh plane pe ya ye mera ek first plane hai ye mera second plane hai aur ye mera third plane hai to agar aap Burgers circuit nikalenge yahan

pe aur aap dekhenge ki magnitude aur direction kya aa rahi hai Burgers vector ki aur check kariye ki aapka nature kya ho sakta hai dislocations ka. Ye humne already dekha tha ki yahan pe ek Mixed Dislocation hai aapko ek find out karna hai ki Burgers circuit draw karke ki direction aur magnitude kya aa rahi hai Burgers vector ki ye aap calculate karke dekhiye. Aur ek cheez main aapko batana chahta hoon interesting cheez ki aapko dekhna hai ki Bubble Raft Models kya hota hai yeh diye hamare Sir Lawrence Bragg aur Nye ne. To aap google kar sakte ho ki Bubble Raft Models kya hai aur isse aapka visualization hai dislocations ka ya defects ka woh achi tarah se ban jayega yani aap bol payenge ki agar stress is tarah se apply ho raha hai to dislocation kis tarah se move hoga ya Bubble Raft Model se visualize kar sakte hain.



Burgers circuit and Screw dislocation



Mat Sci & Eng An Intro WD Callister

Abhi aur kuch cheez jante hain dislocation ke baare mein. Humne bola tha ki dislocation displacement late hain ek term yahan pe main introduce karna chahta hoon Disregistry Distortion and around Dislocation. To ek Edge Dislocation ka hi udaharan lete hain. To yahan pe maine jo open circles hai white open circle hai safed open circle se yeh mera original position hai yani yeh without defect jo lattice hai perfect crystal jo hai yeh jo represent kar raha ye mera perfect crystal ko represent kar raha hai. Yeh mere perfect crystal mein jab atoms is tarah se arrange honge woh yahan par mark kiye ya dotted aur ye jo white hai is tarah se. Aur abhi maine kya kiya agar mujhe Edge Dislocation create karna hai to humne dekha tha ki extra half plane insert karna padega ya nikalna padega to main kya kar raha hoon yeh jo perfect crystal hai yahan par agar aap ye white yeh dekhenge yahan par maine jo atoms yahan par ek extra half plane humne add kiya yahan par. Abhi ye add karne se kya hoga ye jo atoms hai yahan par yeh jo atoms the ye ye atom hai is tarah se main 1 1 aur 1 dash kahunga to yeh jo atoms hai yeh push honge is tarah se is tarah se push honge saare atoms agar aap dekhenge ye saare atoms displace honge ya yahan pe mark kiya yahan par dekhiye ye mera equilibrium position tha aur ye extra half plane add karne se yahan pe displacement taiyar ho gaya atoms mein. Isko main naam de raha hoon u_a se isko main naam de raha hoon u_a se isko mark kar लेते हain yeh mera u hai isko main displacements keh raha hoon atoms ke aur yeh jo displacements hai woh change honge. To aap dekhenge ki ye jo atoms hai yahan pe yahan pe maine insert kiya tha ye jo atoms do atoms hai woh push honge yahan par is

tarah se aur yeh jo push ho raha hai yeh kahenge ki yahan par sabse zyada displacement hai aur yeh jo displacement hai jaise jaise main X direction mein move ho raha hoon to jab main X direction mein move ho raha to ye displacement ghat-te jayenge. Aap dekhenge ki ye jo dono ka ye original position tha aur yeh displaced position hai isme dekhenge ki ye jo u hai displacement hai ghat raha hai. Similarly main extra half plane ke neeche bhi likh sakta hoon u_b is tarah yeh jo displace hai atoms is tarah se main likh sakta hoon.

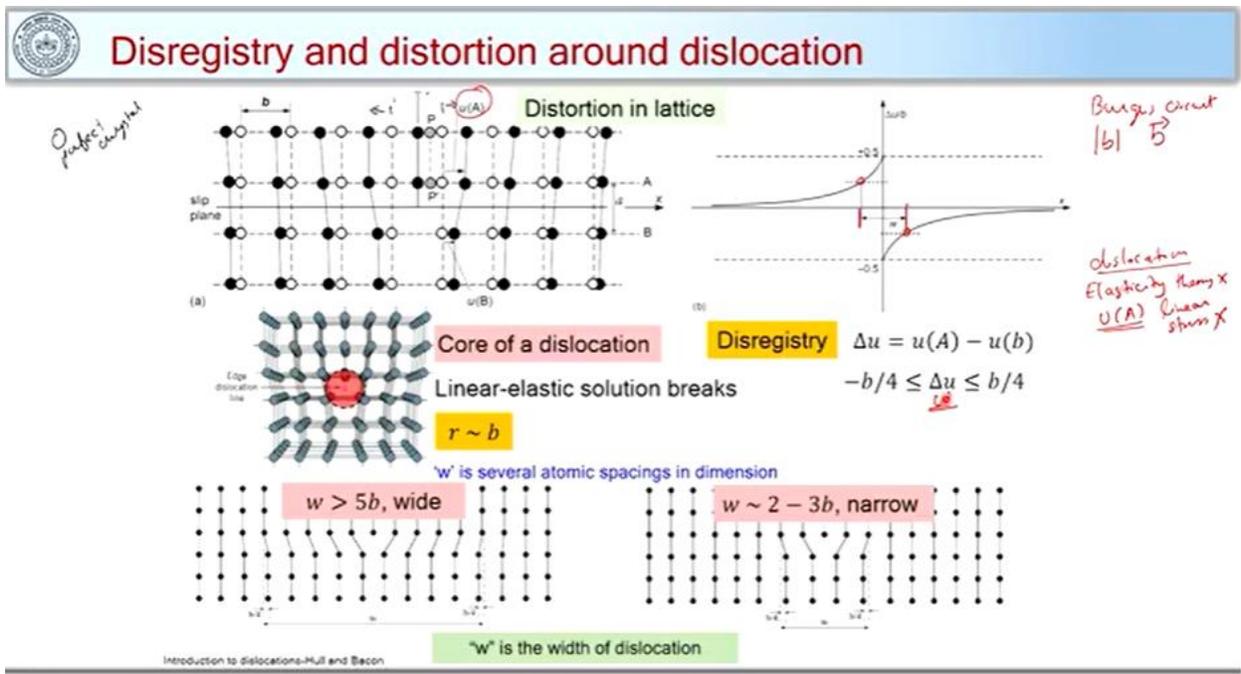
To jab main isko kahunga yeh jo displacement hai isko main kehta hoon distortion in lattice. Yeh mera lattice distort ho gaya yahan par ab abhi samajh pa rahe honge ki jab main dislocation ya defect ki baat karta hoon to yahan par bonds broken ya easy easily make aur break ho jate ye isliye hote kyunki mere mera jo lattice hai woh distorted hai. To yahan pe lattice mein ek distortion hai aur ek main cheez yahan pe define karna chahta hoon jo dis-registry hai. Dis-registry is tarah se main define karunga yane yeh delta u is tarah se define karunga $u_a - u_b$ yani jo slip plane ke upar wale jo displacement hai yeh u_a hai aur slip plane ke neeche wale jo yeh hai yeh u_b hai aur in dono ka main subtraction karunga yeh jo displacement hai aur yeh displacement mein isko subtract karunga isko main kehta hoon delta u isko hi main naam deta hoon dis-registry dislocation ke language mein. Agar main ye dis-registry plot karta hoon to kuch is tarah se dikhegi mujhe yani maine bataya tha ki yeh displacement is tarah se aage ghat rahe hain to aap dekhenge ki ye jo dis-registry hai kuch is tarah se vary hogi. Agar main positive direction mein move kar raha hoon to meri dis-registry pehle is tarah se thi aur woh is tarah se change hogi aap samajh sakte hain agar main $u_a - u_b$ karunga to kuch is tarah se move hoga aur agar main is direction mein dekhunga to yeh kuch is tarah se move hogi.

Abhi yeh jo dis-registry hai isko main limit laga deta hoon ek limit is tarah se lagata hoon ki ye jo dis-registry hai isko main bol deta hoon ki agar yeh dis-registry $-b/4$ ya b kya hai yahan par mera Burgers vector ye $b/4$ yani $0.25b$ hai $-0.25b$ aur $+0.25b$ ke beech mein hai isko main yeh dis-registry ko main kuch naam dunga is is dis-registry ko main kehta hoon delta u ko kehta hoon w . Aap yahan par is figure se samajh payenge agar main yahan par mark kar raha hoon dekhiye yeh jo hai 0.25 hai ya $b/4$ hai aur yeh jo distance hai yeh jo distance hai isko main naam de raha hoon w . Yeh jo distance hai isko naam de raha hoon w isko main kehta hoon Width of the Dislocation yani ye dislocation ka width hai yani dislocation ka width yeh darshata hai ki yeh dislocation ka spread kitna hai.

Ab isko jante hain iska importance kya hai. Jaise maan lijiye mere paas yeh Edge Dislocation hai yahan pe maine extra half plane add kar diya aur yahan tak mera dislocation hai yani delta u jo hai woh $b/4$ tak hai yani point yahan par aap dekhenge $b/4$ tak yahan pe meri dis-registry mil rahi hai agar ye width hai yahan pe aur is case mein aap dekhenge ki jo atomic planes hai extra half plane se yahan par dekhenge one two aur left hand aur right hand side mein bhi do do plane hai. Yahan par aap dekhenge one two three four five five aur yahan par dekhenge ki jo width hai woh small hai. To jo width hai woh several atomic spacing hai in dimensions is case mein width kam hai aur is case mein width zyada hai. Yahan par dekhenge ki jo width hai is greater than $5b$ is type of dislocation ko hum kahenge Wide Dislocation aur yeh jo dislocation hai jahan par width jo hai dislocation ka width hai woh 2 to 3 b hai is type of dislocation ko kahenge Narrow Dislocation.

Yani ab isko aap thoda sa aur samajhiye jab se maine extra half plane add kiya yahan par displace honge atoms aur ye jo atoms displace ho rahe hai above slip plane aur below slip plane usko main darsha raha hoon displacement se u_a aur u_b se aur $u_a - u_b$ mujhe milega dis-registry aur ye dis-registry ki value ko ek main cap laga deta hoon 0.25 of b . b kya hai mera Burgers vector hai to is

par agar main cap laga diya aur yeh agar main width define karunga to yeh agar isko main w define kar diya to yeh jo width hai jab yeh condition rahegi is width ye agar greater than $5b$ hai ye mera Wide Dislocation hai aur less hai aur 2 to $3b$ hai to ye mera Narrow Dislocation. Abhi dekhte hain iska implication kya hai yani agar main ek aur cheez aapko explain karna chahta hoon yahan par extra half plane maine add kiya yeh meri dislocation line ho gayi yahan par humne dekha tha yeh jo part hai yeh hai mera Core of Dislocation. Is part ko main kahunga ki Core of Dislocation yahan par sabse zyada distortion aapko milega aur yahan par theory of elasticity apply nahi hoti. Theory of elasticity kya hoti hai yani Core of Dislocation mein elasticity theory ko apply nahi kar sakte yani mere jo displacement hai yahan par u yeh jo displacement hai yeh linear nahi honge ya isko main stresses ke saath apply nahi kar sakta yahan par koi relation mujhe nahi mil sakta elasticity theory se. Ye jo dislocation ye jo arrangement hai isko main Core of Dislocation kehta hoon aur ye generally jo Core ka jo radius hai yeh hoga mera around b yani magnitude of my Burgers vector. Burgers vector ke magnitude ke hisab se hota hai yahan par linear elastic solution yahan par break hote hai.



Hum next part mein janenge yani hum aap jab aage badhenge jab width wide hai mera dislocation wide hai ya dislocation narrow hai iska mere dislocation moment par kya asar hota hai yani yeh agar small hai ya bada hai to dislocation movement ke liye asar yani jab main baat karunga to main jab stress apply karunga ya shear stress apply karunga to mujhe kitna force lagega is dislocation ko move hone mein. Humne dekha tha ki jo shear stress ab main apply karunga to yeh dislocation yahan se left to right move hoga to yeh jo stress lagega is dislocation ko move karne mein woh kya rahega woh depend karta hai ki mera dislocation ka width kya hai. Isko janenge hum agli part mein. Abhi ke liye yahan par rukta hoon aur is part mein kya padha tha main summarize karna chahta hoon. Humne dekha tha Burgers circuit humne Burgers circuit draw kiya tha aur yahan se main magnitude aur direction nikal sakta hoon Burgers vector ka. Humne dekha tha Mixed Dislocation ka concept humne Mixed Dislocation kya hota hai ye dekha aur humne do teen terms jaane the jaise ye mera extra half plane add hota hai to mere paas distortion taiyar hoga is distortion

ko main measure karta hoon disregistry se aur disregistry ka ek typical value ke liye main usko Width kahunga aur ye Width ka asar hoga mere dislocation ke moment pe.

Thank you.