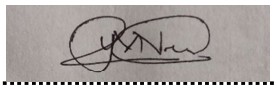
Indian Academy of Sciences, Bengaluru
Indian National Science Academy, New Delhi
The National Academy of Sciences India, Prayagraj

SUMMER RESEARCH FELLOWSHIPS — 2021

Format for the Four-week Report*,^

Name of the candidate	:	Yogesh Mahendra Nemade
Application Registration no.	:	ENGS1516
Date of Commencement of work	:	24-05-2021
Mode of work	:	From Home: ✓ Guide's Laboratory:
Name of the guide	:	Dr. Shyamprasad Karagadde
Guide's institution	:	Indian Institute of Technology, Bombay
Place of stay during the tenure of the fellowship (if working in guide's institution)	:	Hostel provided by Guide Own arrangement Other (Specify)

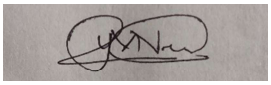


Signature of the candidate

Date: 27-06-2021

Signature of the guide

Date: 27-06-2021

INSPIRE/KVPY FELLOWSHIP (please fill this box)#			
1.	I am currently a recipient of	INSPIRE FELLOWSHIP	□ Yes / ☑ No
		KVPY FELLOWSHIP	□ Yes / ☑ No
		If, YES, fill cols. 2, 3 & 4	
2.	**INSPIRE/KVPY** Fellowship is from_____[month]/_____[yr] to_____[month]/_____[yr]		
3.	I receive a monthly fellowship of Rs._____from INSPIRE/KVPY towards my living expenses		
4.	I also receive towards contingencies a sum of Rs._____per year		
I affirm that the information given above is correct.  **Signature of the candidate**			

(For office use only; do not fill/tear)

Candidate's name:		Fellowship amount:
Student:	Teacher:	Deduction:
Guide's name:		Amount to be paid:
KVPY Fellow:	INSPIRE Fellow:	A/c holder's name:
PFMS Unique Code:		Others:

IMPORTANT NOTES:

*** The four-week report could be between 300 and 350 words.**

^ This format should be the first page of the report and should be stapled with the main report.

 # Mandatory to fill this section, this should be filled and signed by you even if you are not an INSPIRE/KVPY Fellow. Otherwise release of fellowship amount will be withheld.

Design and Simulations of Material Flow During Non-Uniform Deformation of Alloys

Yogesh Mahendra Nemade

App. No. ENGS1516, Indian Institute of Technology, Bhubaneswar

Guide: Dr. Shyamprasad Karagadde

Indian Institute of Technology, Bombay

4-Week Report

Plastic working of metals is one of numerous methods permitting the manufacture of products of desired shape and size. It consists in applying compressive forces of appropriate magnitude to the metals being deformed. Industrial practice uses various plastic working techniques such as rolling, forging, pressing, stamping, extrusion or drawing.

During rolling the desired shape of metal is obtained by plastic deformation taking place between two rolls with parallel axes, revolving in opposite directions. Sometimes, instead of cylindrical rolls, conical rolls or discs set at an angle to each other are employed.

We have been working on designing roll pass for making bulb bar using hot rolling. The rolling of bulb bars involves difficulties that are associated with a great difference in thickness between the bulb of the bar and the relatively little thickness of its flat part. This feature might contribute to the unstable behaviour of the band during hot rolling.

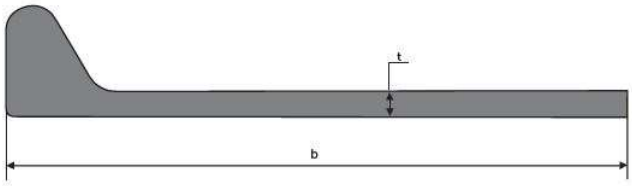


Figure 1: Bulb Bar

It has been found from industrial tests carried out that a non-uniform distribution of mechanical properties occurs on the cross-section of bars produced by the conventional method. The difference in the value of yield point between the bulb and the flat of the bar may reach 35%.

Initial few days were utilised to understand the theory concepts required to get started with the project that include fundamentals of rolling, parameters of rolling, flow of metal in rolling, roll pass design and terms related to shape rolling. To get started with computer simulation for designing roll pass ABAQUS was used with fully coupled thermal stress analysis. Such analysis is performed when the mechanical and thermal solutions affect each other strongly and, therefore, must be obtained simultaneously.

Our aim is to do a parametric study for rolling of bulb bar in 5-6 passes and obtain results for varying rolling parameters like speed, temperature, draft, etc.

But some issues faced for such simulations in ABAQUS were:

- Remeshing was difficult after deformation and distortion.
- Its uses explicit module for rolling operation which is constrained by larger time step size.

Hence to get a better hand on these problems we have started to work with another software specifically used for forming operations i.e., DEFORM 3D.

DEFORM 3D Simulation

Parts

- The workpiece is a deformable plastic body of a rectangular cross section rolled by a cylindrical rigid roller over its length.
- Material for both the parts was taken 1045 steel (900-1200 C).
- The initial simulations are carried out for adiabatic condition gradually increasing the number of passes for rolling.

Boundary conditions

- A half symmetric model is used i.e., symmetric boundary condition on one face.
- Initial contact was established with the help of a curve on the workpiece.
- Constant angular velocity given to the roller.

Simulation control

- 250-time steps taken with time increment of 0.1 seconds.
- Coulomb friction of 0.3 and the contact surface.

Mesh

- Uniform meshing was done over the workpiece.
- A total of around 20,000 elements were taken with size ratio of 1.

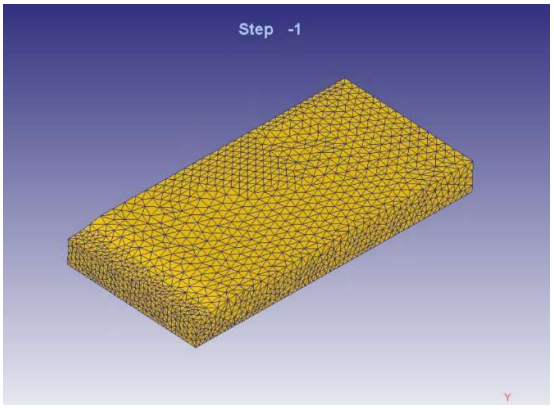


Figure 2: mesh used for simulation

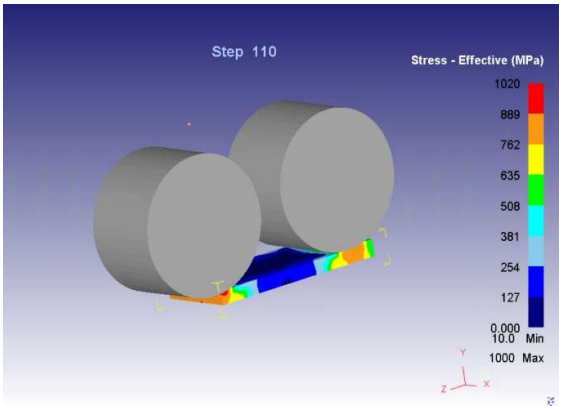


Figure 3: stress contour obtained