DATE 21/10/2016

EXPERIMENT No. - 4

SHEET NO. 4.1

FRICTION STIR WELDING

- Objectives: ➤ To perform friction stir welding (FSW) on two similar aluminium sheets of same gauge by varying the FSW tool rotational and worktable translational speeds.
  ➤ To study the influence of FSW tool rotational speed and worktable translational speed (i.e welding speed), on welding force (F_x), axial force (F_z) and power consumption.

- Theory: In friction stir welding a rotating non-consumable tool with specially designed shoulder and pin is plunged into the abutting edges of firmly clamped work-piece, and then translated along the weld line to form weld. Thereafter, the tool is finally plunged out from the work-piece. The tool serves two purposes, firstly softening of material by heat generation due to friction and plastic deformation, and secondly mixing of material through stirring of pin to form weld.

  There are a number of parameters which affect the FSW process. Broadly they can be classified as-

  - Design Parameters: Tool shoulder shape and size
    Tool pin shape and size
    Joint geometry

  - Process Parameters: Tool rotational speed
    Worktable translational speed
    Tool tilt angle (towards the trailing e
    Plunge depth

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- Material Parameters: Workpiece material
  Anvil material
  Tool material

There are certain conditions in which a few specific kinds of defects are formed, such as -

- Defects due to too cold condition: Lack of fill
  Lack of fusion (kissing bond)
  Wormhole
- Defects due to too hot condition: Ribbon flash
  Nugget collapse
  Surface galling
  Root flaws
- Defects due to fault in design: Lack of penetration
  Excessive indentation
  Oxide Entrapment

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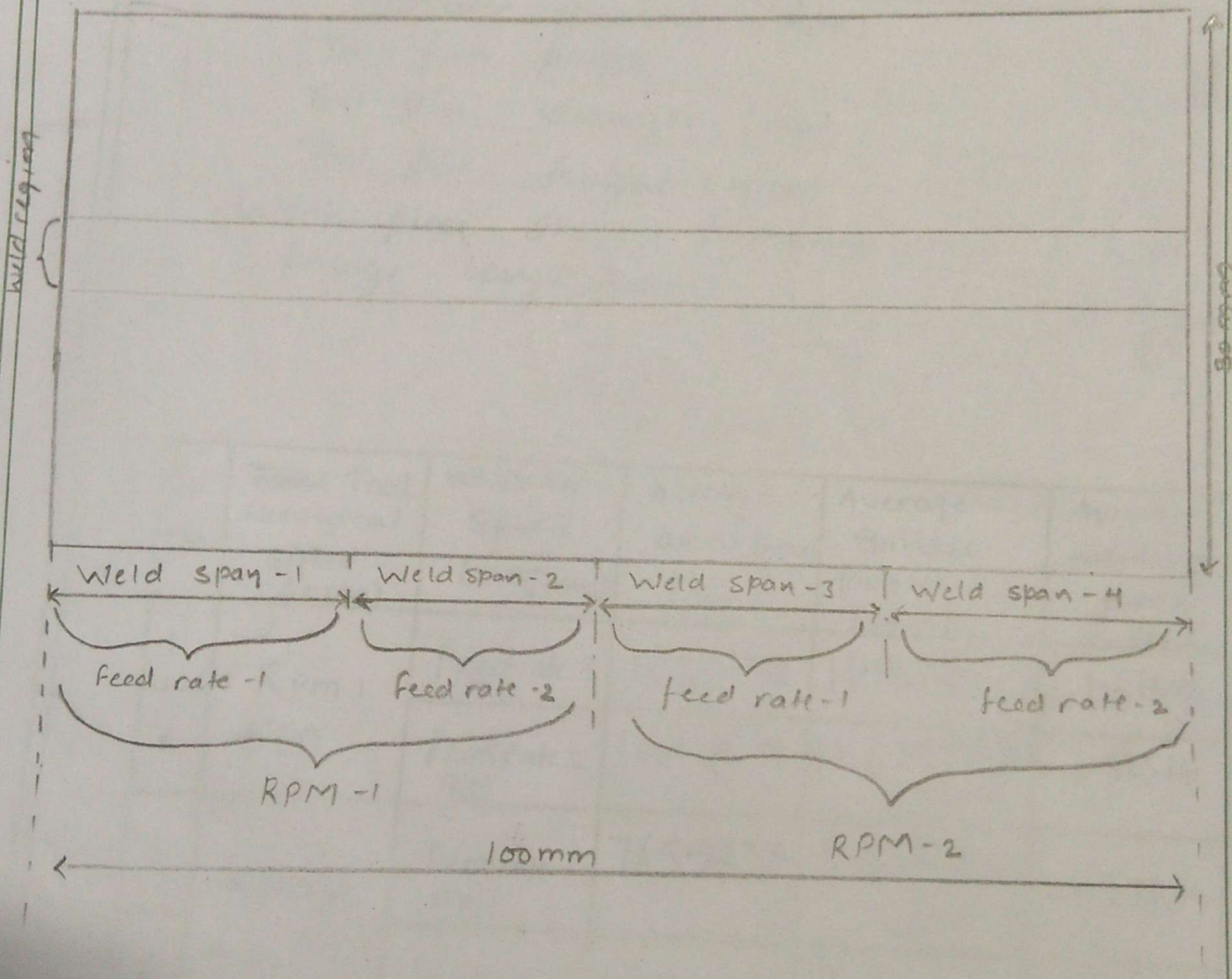
SHEET NO. 4.3



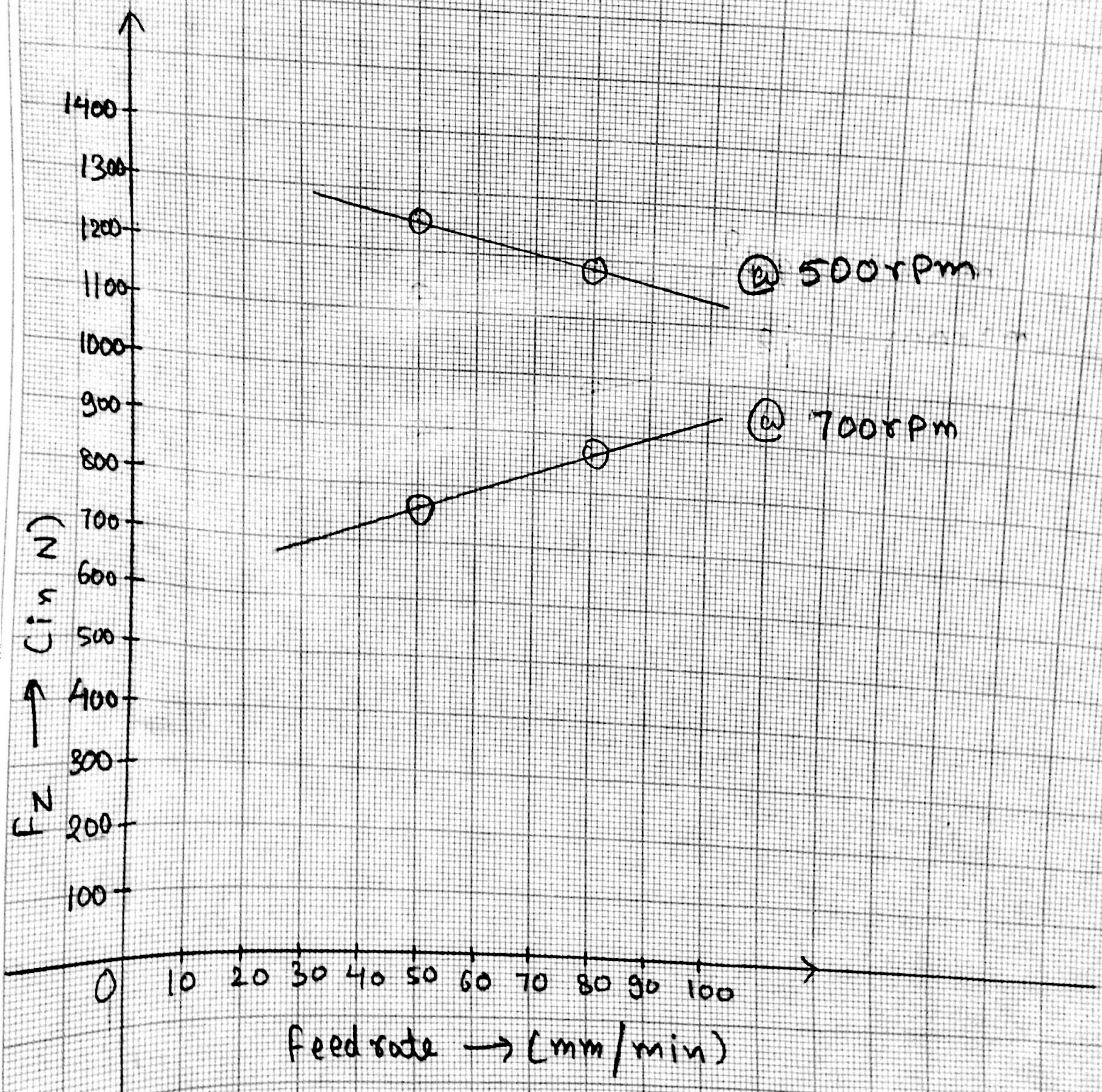
Observation table

Work-piece dimension (lengthx width, mm²	
Tool Shoulder diameter (mm)	12
Tool pin profile	Circular
Tool pin diameter (mm)	3
Tool pin hieght (mm)	2
Work-piece Sheet thicknen (mm)	2·5
plunge Length (mm)	0·05

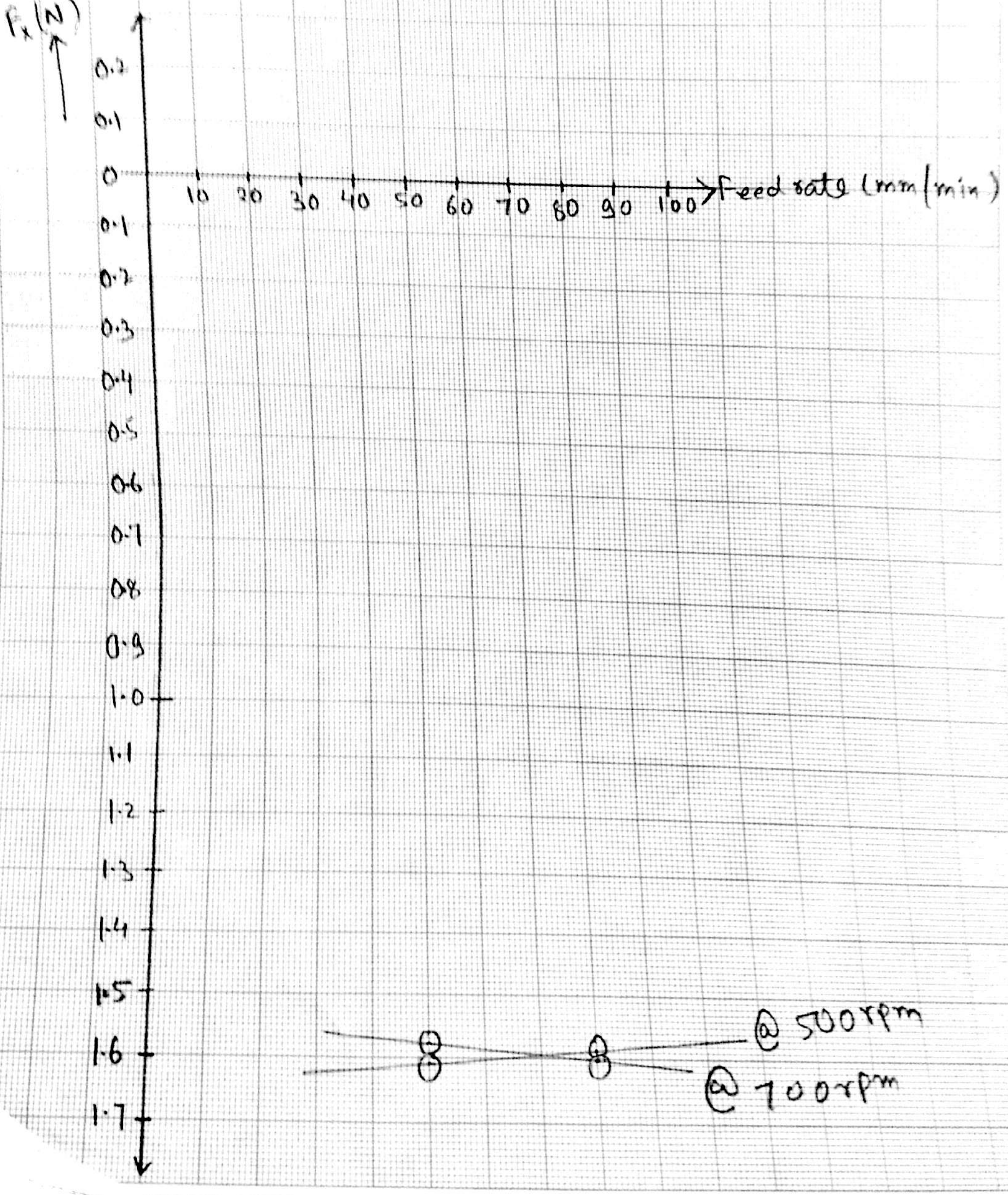
Sr. No	~~Total~~ Tool rotational speed (rpm)	welding Speed (mm/min)	Average axial force F_z (N)	Average Spindle torque (Nm)	Average welding force F_x (N)
1	Rpm 1 500	feed rate-1 50	1250·702	11·19165	-1·61096
2		feed rate 2 80	1182·8358	11·675869	-1·58519
3	Rpm 2 700	feed rate-1 50	765·9238	8·8924	-1·57800
4		feed rate-2 80	867·902	9·7579	-1·60237

S No	~~[illegible]~~ Tool Rotational Speed rpm	~~[illegible]~~ Tool Rotation Speed rad/s	Feed rate or welding speed mm/min	Average Spindle Torque Nm	Average Axial force F_z (N)	Average welding Force F_x (N)	Average Power W
1.	500	52.36	50	11.19	1250.70	−1.61	585.91
2			80	11.68	1182.84	−1.59	611.56
3	700	73.30	50	8.89	765.92	−1.58	651.637
4			80	9.76	867.90	−1.60	715.41

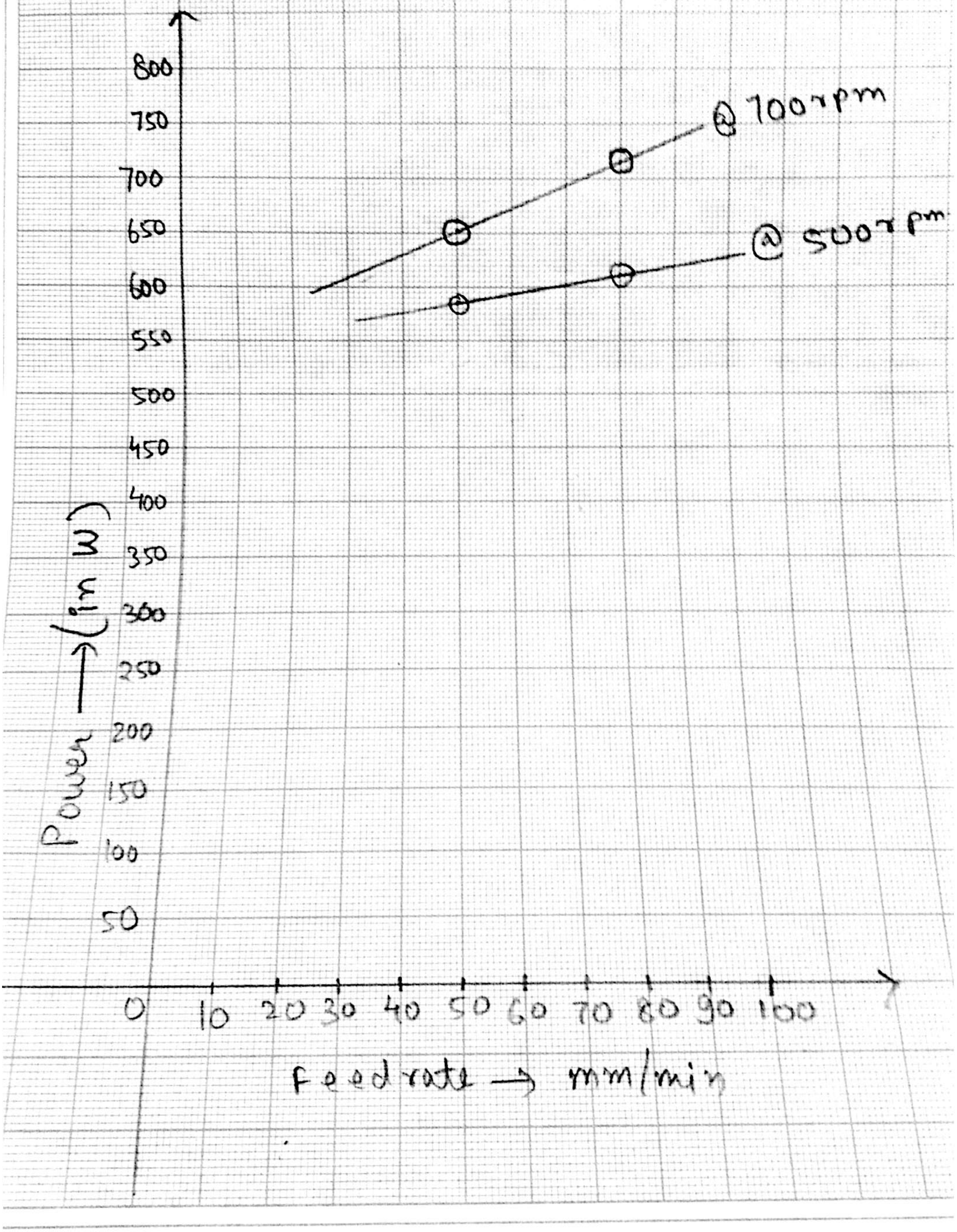
Scale x axis 1 unit = 10 mm/min
Y axis 1 unit = 100 N



Scale x axis :- 1unit = 10 mm/min
y axis :- 1unit = 0.1 N



Scale x axis 1 unit = 10 mm/min
Y axis 1 unit = 50 W



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Questions:-

Q1. What is the signifance of axial force on FSW?

Ans Axial force or axial pressure is an important parameter to avoid defect formation. The axial force must be greater than a certain value for a defect free weld. The formula to avoid defect formation which incorporates axial pressure is

$$P_{*}\ \text{rate} \geq \frac{V}{K(r_{show} - r_{pin})}$$

If ~~ethe~~ axial force determines frictional force (increases as axial force ↑) and forging speed also increases with increase in FSW tool axial force

Q2. How does temperature stabilisation occur in FSW?

Ans Temperature stabilization occurs in FSW. A typical FSW cross section consists of 4 zones nugget zone 1. ~~#~~ Thermo mechanically affected zone. heat affected zone and have metal zone base. Thermo-mechanically affected zone is subjected to heat from NZ and material in HAZ is subjected to heat. Temp in HAZ is less as compared to that in fusion welding. After HAZ the region which remain unaffected is called BM. Too hot condition leads to defects like ribbon flash, nugget collapse, surface galling and rout flaws.

Q3) What is the role of welding speed in FSW?

A. Welding speed determines the volume of material centrifugally forged into micro-hole per second, and also the time for which the shoulder play on micro hole comes into effect.

$$t = \frac{r_{shoulder}}{V_w} \qquad \frac{r_{shoulder}}{V_w} \geq \frac{V}{S}$$

Q4) Why does the weld power increase with increase in tool rotational speed?

A. Weld power increases with increase in tool rotational speed as it has a direct influence on tool torque.

$$\boxed{\text{Torque} \times \omega = \text{Weld power}}$$