FRS106: Art and Science of Motorcycle Design

Mechanical Crew

Leaks, Clutches & Cables

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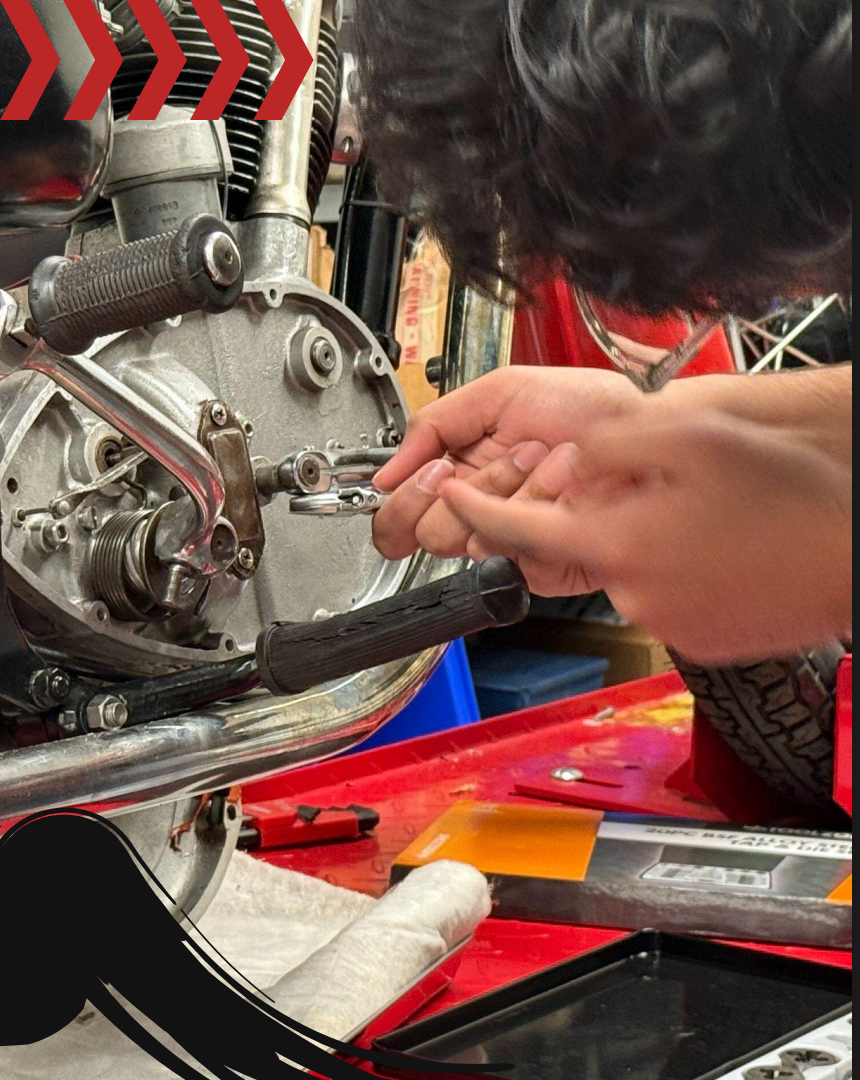

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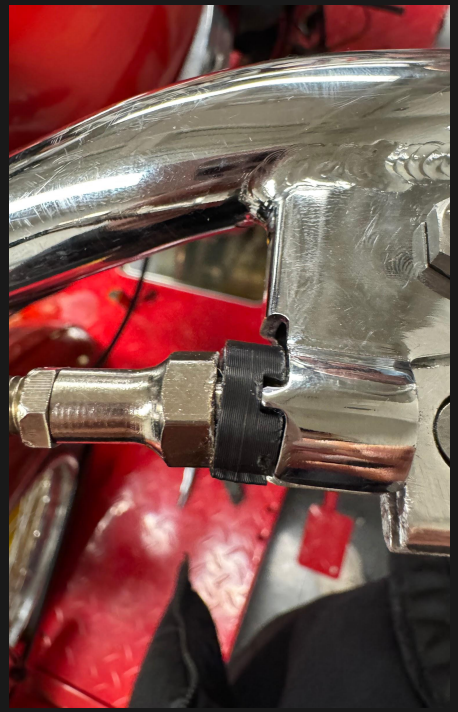
01

Workshop Rundown



Custom Part Manufacturing

We Learned To:

Use the milling machine to shave down metal parts to exact dimensions

Drill holes precisely into steel and aluminum using a drill press

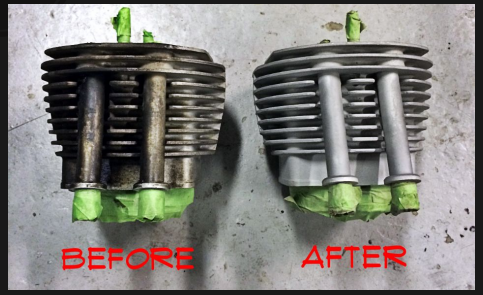
Tap holes—adding internal threads—so that bolts could be secured

Use calipers and micrometers to get accurate measurements (down to the hundredth of a millimeter)

3D Printed a spacer for the handlebars & clutch

Part Restoration: Sandblasting

Cleaning and Learning from an Engine



What we learned:

- How to operate the sandblaster to remove decades of rust, grime, and buildup from steel components
- How to protect sensitive surfaces, threads, and structural integrity during cleaning
- Gained hands-on practice on an engine, which helped us build confidence and familiarity with machine
- Contributed to broader project by assisting another group with their parts

Why it mattered:

- Sharing skills and tools improved progress for the whole class
- Gave us the skills to restore usable metal parts if replacements weren't available; strengthened restoration techniques
- With more time, we could have blasted other parts like engine covers, brackets, or fasteners on our bike
- Reinforced when sandblasting is useful, and when it's not (springs or soft materials)

Oil leak and refill.

What was the problem?

As a group we began to notice substantial oil leaks coming from either the engine or transmission. Upon further inspection over time, and multiple failed attempts. We found the source of the leak coming from the engine and needed to tighten the bolts in order to prevent it from continuing to happen. Then using a funnel we were able to replace the oil lost.

Why is this important?

The main reasons motorbikes need oil are for lubrication, cleaning and cooling. Without oil, metal parts would rub against each other causing friction and leading to parts wearing out. Preventing the bikes longevity.

Clutch repair

What did we do?

We had to replace the springs in the clutch that had worn down over time, causing them to compress into a smaller shape. This in turn causes the clutch harder to pull and cause it to engage suddenly when used instead of smoothly.

Challenges to overcome

The springs we were given were too short and would take countless ingenious methods from Atti and Drew to make them the correct size to be placed

Thread Repair & Tapping

What is Tapping?

Process of cutting internal screw threads inside a hole

Requires choosing correct size drill bit + tap for thread pitch

Example:

We accidentally snapped a U-bolt — taught us about torque limits

Can failure torque using:

Torque = Force × Lever Arm
(Mention material strength & stress)

02

Science behind it...

Mechanical Physics Topics

1. Tapping + Drilling Holes

2. Strength of Fasteners

3. Spring Compression

4. Sandblasting

Tapping and Drilling Holes – Stress on the Metal

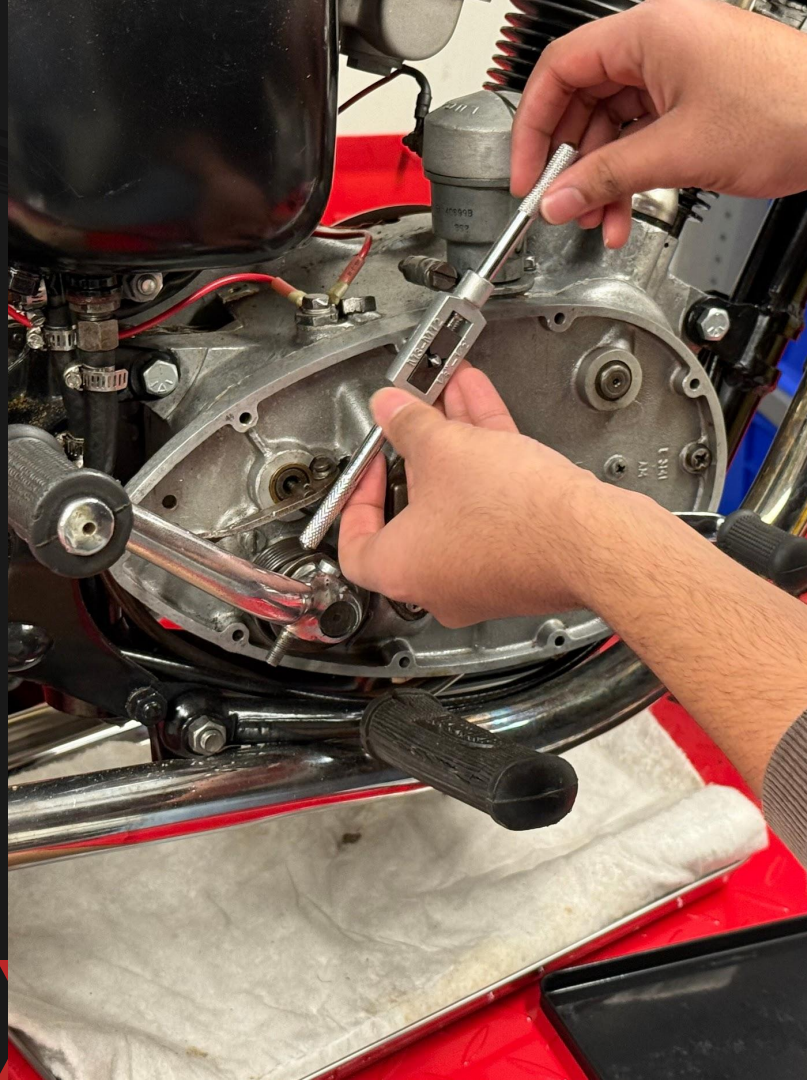
- When you drill into a part, you remove material, reducing strength.
- Tapping threads adds twisting force that stresses the inside wall of the hole.
  - This measures how much “pulling” or “pushing” force a material can handle per area
  - 6 mm hole and 150 N tapping force, the material experienced ~796 kPa of shear stress

$$\sigma = \frac{P}{A}$$

σ – Normal Stress

P – Axial Force

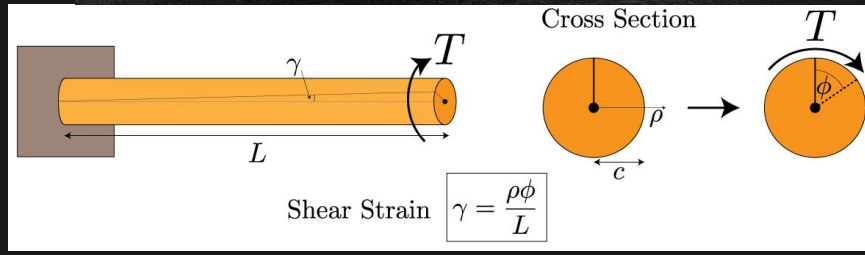
A – Cross Sectional Area



U-Bolt Failure – Torque, Torsion, and Material Limits

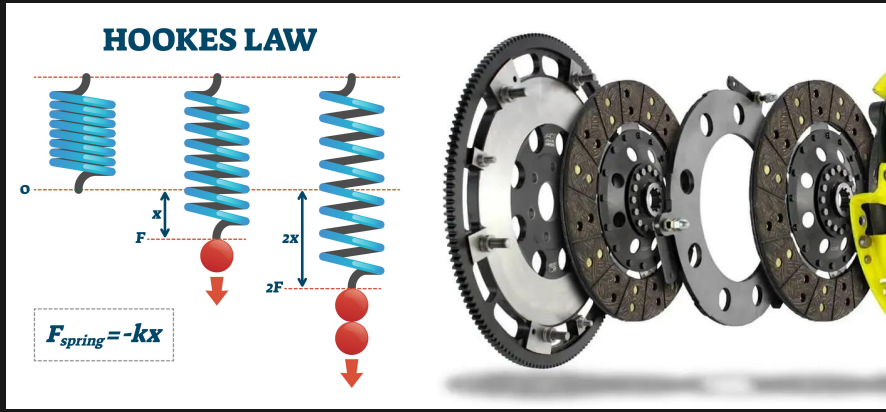
- Applied torque that caused the bolt to twist.
  - only handle so much internal twisting force — called **torsional shear stress**
  - **p**: torque applied (Nm)
  - **Φ**: outer radius of bolt (m)
  - **L**: polar moment of inertia, measures the bolt's resistance to twisting

With a 6 mm bolt and about 12 Nm of torque, the internal stress reached 283 MPa — just over the shear strength of mild steel (~250 MPa)



Clutch Spring Compression – Why It Was Slipping

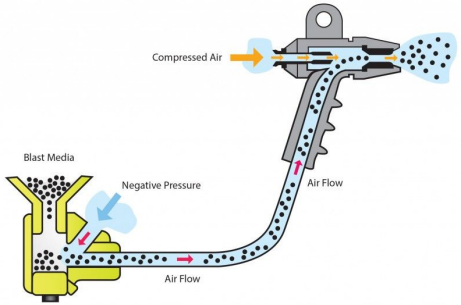
- The springs in a clutch apply pressure to keep the plates together.
- If the springs are too soft or permanently compressed, they can't generate enough force — the plates slip and the engine power doesn't fully transfer to the wheels.
  - The force a spring applies depends on how stiff it is (k) and how much you compress it (x).
  - F: spring force (N)
  - k: spring constant (N/m)
  - x: compression distance (m)



$$k = \frac{G \cdot \pi^4 \cdot r^4}{8 \cdot L^3}$$

Spring Length	Force (N)	Force (lbf)
38 mm	1,524 N	343 lbf
42 mm	1,128 N	254 lbf

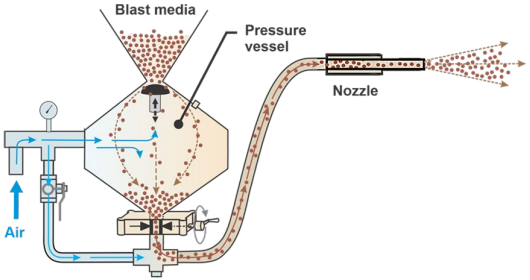
4. Sandblasting Technicalities



OPERATING PRINCIPLES - *SUCTION SYSTEMS*

Siphon Blast Cabinet (what we used)

- Also called a suction cabinet
- Uses compressed air to create a vacuum that draws sand into the nozzle
- Allows for more precision on small/detailed parts → Best for lighter jobs and general cleaning
- Requires higher air pressure to maintain flow



OPERATING PRINCIPLE

Why Not Pressure Blasting?

- Pressure blast cabinets use a pressurized vessel to force media out
- More aggressive and faster → harder to control
- Better for heavy-duty industrial stripping; not ideal for our classroom/shop setting

THANKS FOR A GREAT SEMESTER!