Science fair- labreport

Forging metal the strength of steel-

Brainstorming

* How much energy can a brick hold
* How healthy are pickles
* Science of sugar
* Strength of steel and how to improve it
* Baking soda chemical reactions
* The best ramen bowl
* What makes something crispy
* How easy it is to scare a kid in comparison to an adult
* How dangerous is cannabis
* Temperature effect on productivity

The strength of steel and how to improve it

Problems / technicalities

1. Hammer holder
2. Metal
3. Best punches to use weights
4. Holders
5. Accuracy

Solutions

1. Hammer holder

I think the best way to tackle this problem would be to make a holder for my hammer and then attach the hammer… via screw.

1. metal

1045 steel. 1045 steel is 0.45% carbon and the quality grade is 10.

1. Steel punches

that are made from tempered steel

Background research

* **Forging** - Heat to 850°C - 1250°C (1562°F - 2282°F). Hold until the temperature is uniform. Cool in a furnace.
* **Annealing** - Heat to 800°C - 850°C (1472°F - 1562°F). Hold until the temperature is uniform. Cool in a furnace.
* **Normalizing** - Heat to 870°C - 920°C (1598°F-1688°F). Hold until the temperature is uniform. Soak for 10 - 15 minutes. Cool in still air.
* **Stress-Relieving** - Heat to 550°C - 660°C (1022°F - 1220°F). Hold until the temperature is uniform. Soak for 1 hour per 25mm of section. Cool in still air.
* **Hardening** - Heat to 820°C - 850°C (1508°F - 1562°F). Hold until the temperature is uniform. Soak for 10 - 15 minutes per 25mm of section. Quench in water or brine.
* **Tempering** - Re-heat to 400°C - 650°C (752°F - 1202°F) as required. Hold until the temperature is uniform. Soak for 1 hour per 25mm of section. Cool in still air.

Steel is non-magnetic when above 1420F or 770C

· What Is Normalizing?

· Normalizing is a heat treatment process that is used to make a metal more [ductile](https://www.metalsupermarkets.com/metal-glossary/ductility/) and [tough](https://www.metalsupermarkets.com/metal-glossary/toughness/) after it has been subjected to thermal or mechanical hardening processes. Normalizing involves heating a material to an elevated temperature and then allowing it to cool back to room temperature by exposing it to room temperature air after it is heated. This heating and slow cooling alters the microstructure of the metal which in turn reduces its hardness and increases its ductility.

## What Is Annealing?

Annealing is a heat treatment process used mostly to increase the ductility and reduce the hardness of a material. This change in hardness and [ductility](https://www.metalsupermarkets.com/metal-glossary/ductility/) is a result of the reduction of dislocations in the crystal structure of the material being annealed. Annealing is often performed after a material has undergone a hardening or [cold working](https://www.metalsupermarkets.com/metal-glossary/cold-work/) process to prevent it from brittle failure or to make it more formable for subsequent operations.

1. As Supplied

a. Measure deflection with known weights

b. Mark center of bar with hardometer

2. Normalize

a. Heat until non-magnetic, then raise temperature a bit, hold for 5-7 minutes and allow to cool as slowly as possible by leaving it in the forge until the whole thing is cooled down

b. Measure deflection with known weights

c. Mark center of bar with hardometer

3. Hardening

a. Heat to non-magnetic, then hold for 5-7 minutes, quench in oil or water

b.

<http://www.interlloy.com.au/our-products/carbon-steels/1045-medium-tensile-carbon-steel-bar/>

Definitions

* Strength: Resistance to permanent deformation and tearing.
* Toughness: Resistance to warping, tearing , rupturing or breaking, this is measured by the charpy test. Toughness usually increases as strength decreases.
* hardness:A surface's resistance to scratching, abrasion, or indentation. In normal metal alloys.
* brittleness: Brittleness describes how often a material will break before bending or deforming. Brittleness increases as toughness decreases. This is affected by internal stresses as well.
* Plasticity : The ability to mold, bend or deform. that does not return to its original shape instantly.
* [Elasticity](https://en.wikipedia.org/wiki/Elasticity_(physics)): Also called flexibility, this is the ability to deform, bend, compress, or stretch and return to the original shape once the external stress is removed. Elasticity is inversely related to the [Young's modulus](https://en.wikipedia.org/wiki/Young%27s_modulus) of the material.
* [Impact resistance](https://en.wikipedia.org/wiki/Impact_resistance): Usually synonymous with high-strength toughness, it is the ability to resist shock-loading with minimal deformation.
* [Wear resistance](https://en.wikipedia.org/wiki/Wear_resistance): Usually synonymous with hardness, this is resistance to [erosion](https://en.wikipedia.org/wiki/Erosion), [ablation](https://en.wikipedia.org/wiki/Ablation), [spalling](https://en.wikipedia.org/wiki/Spalling), or [galling](https://en.wikipedia.org/wiki/Galling).
* [Structural integrity](https://en.wikipedia.org/wiki/Structural_integrity): The ability to withstand a maximum-rated load while resisting fracture, resisting [fatigue](https://en.wikipedia.org/wiki/Fatigue_(material)), and producing a minimal amount of flexing or [deflection](https://en.wikipedia.org/wiki/Deflection_(engineering)), to provide a maximum [service life](https://en.wikipedia.org/wiki/Service_life)

Problem Statement

How does heat treatment of a steel rod affect the overall strength? Can this be used for forging techniques?

Hypothesis

If you heat treat a steel rod then the strength of the steel will increase because the crystal structure of the carbon will change within the metal rod.

Variables

Controlled:

Environmental

Steel

Water

Forge

Manipulated:

The temper of the steel

Responding:

Strength of steel

Materias

* Steel Rod (1045 steel)
* Hammer holding device
* Hammer
* Punch
* Gauge Meter
* Tray
* Water
* Forge
* Propane
* Gloves
* Safety Goggles
* Pliers
* Face Shield

Procedure

Hammer apparatus tests

1. Set up the hammer apparatus by making a hinge and attaching the hammer with a screw
2. Use the hammer to hit the punch to emboss the lettering on the metal rod

Weight apparatus test

1. Fill a basket will 100lbs of weight
2. Hang a basket with a pulley system
3. Place the metal holder in place
4. Set up the dial indicator

Forge setup

1. Place 2 bricks on the ground
2. Place forge on bricks
3. Place the metal rod inside
4. Wait till demagnetized

Supplied condition

1. Place the steel rod on a stand.
2. Use the premade punch holder and hammer (using holder)
3. Line up the hammer with the punch. then drop it.
4. Record the visual of the rod after
5. Set up the rod on 2 stable holders then place a box with 100lbs on the rod using a stable metal tube.
6. Measure deflection using the gauge

Normalised condition

1. Take supplied rod and heat up until demagnetized
2. Let is cool down to room temperature over several hours
3. Conduct all the previous experiments.

Hardened

1. Take the normalised rod and heat it up until demagnetised
2. Quench rod by fully submerging it in water
3. Repeat previous steps

Tempered

1. Heat up rod to low temperature (200 degrees celsius)
2. Let is slowly cool down until room temperature
3. Perform experiment again

Observations

Sup: 0.028 // soft

Norm: 0.026 // soft

Hardened: 0.009 // hard

Tempered: 0.008 // hardened

Quantitative

Qualitative

•Supplied Condition

•Easy bending. File created marks.

Punches clearly show

•Normalized Condition

•Easy bending. File created marks.

Punches clearly show

•Hardened

•Reduction in bending. File did not mark

Punches barely show.

•Tempered

•Similar to hardened condition for bending, file test and punches

Results

* Slowly heating makes the steal weaker but less brittle
* Slowly heating resets the streel to a relaxed state
* A quench will make a lot of little tiny stresses in the steel causing it to become stronger and more brittle
* Heating it to a low temperature after a quench will make it stronger

Conclusion

The heat treatment process (hardening) used on steel makes the rod stronger and harder.

My hypothesis was correct based on my results and observations.

Sources of error

Human error

Machine error

Inaccurate tools

Uneven whiting

Uneven heating

Machine error

Inaccurate readings

Applications

•Blades – create strong edges that stay sharp

•Tools – hard, durable tools used to cut softer metals

•Machine parts – bearings that last a long time

•Horseshoes – soft metal that can deform and wear to protect the hoof

Benefits

Tempered: e.g. making blades

Hardened: e.g. cutting tools and machine parts

Normalised: e.g. coat hangers and stamps

Supplied: e.g. steel rods

Recommendations

Increase accuracy in measurements

Done more repetitions

More controllable heat source

Diff steel

Diff shapes