LAB NOTEBOOK

METC-143

James Zartman

4/8/17

Lab #1

Hardness Test Lab

4/8/17

**Background:** 1018 steel and 4140 steel are currently used in production. Parts made with the materials are having issues on the production floor. The dimensions of the part are not correct. The Quality Manager suspects the hardness of the material may not be right. The print for the 1018 steel states a hardness of 71 Rockwell B and a 55 Rockwell C for the 4140 steel.

**Hypothesis:** I predict that one or both steels is not going to meet the specifications required to make the products.

**Parts:** Two test sections of the 1080 steel and 4140 steel

**Tools:** Rockwell hardness tester

**Procedure:** Test a sample of each material on hardness tester

**Results:**

1. Given the material hardness specification, does the 1018 steel and 4140 steel hardness meet the specification? **The 1018 steel meets the specification coming in at 70.1 Rockwell B. However, the 4140 steel only tested at 19.3 Rockwell C.**
2. What would you recommend to the Quality Manager regarding the material? **I would recommend that production be stopped.**
3. Production is currently using the materials, what steps would you take if the material does not meet the hardness requirements? **First, I would halt production, second I would see if there was another lot of steel to pull from for the 4140 steel. Test a sample of another lot if available. If next lot is still bad I would go to the next lot available and keep testing until the steel passes specification. Then get ahold of supplier to figure out what went wrong and get inventory replaced.**
4. The Quality Manager checks the 4140 steel sample you used for your test and gets a significantly different result. What could be a source of error in testing the sample? **The source of the error could be that the Quality Manager is using the wrong scale to test the 4140 steel.**

Lab #2

Miller Indices

4/8/17

**Summary:** Miller indices are used to specify directions and planes, where those directions or planes can be in lattices or crystals. Each plane that is oriented with in a lattice corresponds to the arrangement of atoms in a crystal structure. They also correspond with crystal properties which determine physical and mechanical properties.

**History:** The Miller indices were first introduced by W. Whewell in 1829 and developed further by W.H. Miller, hence where the Miller came from in Miller indices.

**Purpose:** The purpose of miller indices is to be able to know what is going on with the different planes in crystal lattices since they affect the optical properties, reactivity, surface tension, and dislocations. Looking at the figure below there are 3 axis along with a cubic lattice. The plane that is desired to by measured is depicted by the grey plane. So idea is that you extend the plane out so that it intersects the planes. Since the side “b” is never going to intersect the y-axis so it is depicted as ∞. The indices are always put x,y,z format. After you figure out the intercept length then you take the reciprocal of the lengths and clear out the fractions as depicted below. So the Miller Indice in the case is (101)



**Referenced:**

1. **Photo:** [https://www.google.com/search?q=miller+indices&source=lnms&tbm=isch&sa=X&sqi= 2&ved=0ahUKEwiesZbnxpXTAhWE34MKHaEJCnEQ\_AUIBygC&biw=1536&bih=747&dpr=1.25#imgrc=1YUP834sdwnSUM:&spf=199](https://www.google.com/search?q=miller+indices&source=lnms&tbm=isch&sa=X&sqi=%202&ved=0ahUKEwiesZbnxpXTAhWE34MKHaEJCnEQ_AUIBygC&biw=1536&bih=747&dpr=1.25#imgrc=1YUP834sdwnSUM:&spf=199)
2. **Purpose:** <http://www.ece.umd.edu/class/enee416.S2004/report1.pdf>
3. **History:** [http://reference.iucr.org/dictionary/Miller\_indices#History](http://reference.iucr.org/dictionary/Miller_indices%23History)

Lab #3

Safety Factor Lab

5/7/17

**Question 1:**

**The hoist must be able to lift objects having a weight of 24,000 lbs. Calculate the Safety Factor for the cable shown in the picture above.**

Given values: Force=24,000 lb Material strength= 183,674 psi cable diameter=.5

Use stress= force/area to figure out stress

To figure out area use (πd^2)/4 which equals .19635 in^2

Solve for stress by taking 24,000 lb/.19635 in^2 which equals 122,231 psi

Use safety factor= material strength/Stress to figure out safety factor

Solve for safety factor by taking 183,674 psi/122,231 psi which equals safety factor of 1.503

**Safety factor= 1.5**

**Question 2:**

 **Based on the information in Question 1, what diameter of cable would you need if you wanted a safety factor of 4?**

This time use safety factor equation and rearrange it to solve for stress. By multiplying both sides of equation by stress and then dividing both sides by safety factor.

End up with Stress=material strength/safety factor

So, stress=183,674 psi/4 which equals 45918.5 psi

From here use the stress to figure out the area by rearranging the stress equation by multiplying both sides of the equation by area and then dividing both sides by stress.

End up with Area= force/stress

So area= 24,000 lb/ 45918.5psi which equals .523 in^2

Now we need to rearrange the equation for area to figure out the diameter by multiplying both sides by 4, then dividing both sides by π, then taking the square root of both sides. This leaves you with diameter by itself.

End up with d=$\sqrt{4\*Area/π}$ which equals .82 in

**Diameter= .82 inches**

**Question #3**

**You are designing a new bottle jack for a car as shown above. A safety factor of 8 will be used on the support rod because of the potential for personal injury if it fails. Calculate the material strength based on the scenario**

Given values: Force= 17,000 lb Rod diameter= 2.5 inches

First figure out the area of the rod by using equation for area from above: (πd^2)/4 which is 4.91 in^2

Then figure out stress by using equation stress=force/area which equals 3462.32 psi

Now figure out material strength by rearranging the safety factor equation to solve for material strength by multiplying both sides of equation by stress

End up with material strength= SF \*σ which equals 27,698.56 psi

**Material strength = 27,699 psi**

**Question #4**

**Based on material strength you calculated in question 3, which of the materials listed below would you select and why?**

I would choose the 1045 steel to use since the yield strength of the aluminum isn’t strong enough to handle the required strength of 27,699 psi. If the aluminum were to be used the jack could fail due to it not being strong enough. With the 1045 steel the strength is plenty adequate to hold the anticipated loads.

**Question 5:**

**For the other material, you did not select in question 4, what rod diameter would allow you to use it and why?**

Known values: Force = 17,000 lb Material strength= 14,900 psi safety factor= 8

Have to solve for stress by rearranging safety factor equation to end up with σ= material Strength/ SF

σ = 1862.5 psi

Then solve for area by rearranging equation to be Area= Force/stress

Area= 9.13 in^2

Now solve for diameter by using equation from above: d=$\sqrt{4\*Area/π}$

d = 3.41 inches

**Diameter required for aluminum= 3.41 inches**

Lab 4

Tensile Strength Analysis

5/7/17

**Hypothesis:** Steel is stronger than Aluminum

**Results:** To calculate the force of the cylinder I rearranged the equation for stress to be that the pump press was the stress and the cross sectional area was given as .015 in^2. Had to solve for force. Took the equation σ (Stress)= F/A and multiplied both sided by A (Area) to get F (force) by itself so F= σ \* A. Figures out the force for cylinder at all increments of pump pressure. Now to solve for stress I took F/A and calculated the stress, which is equal to the pump pressure. The strain was figured out by taking the (final length of the specimen minus the original length of specimen)/original length of specimen. Calculated the strain for each change in length.

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|  | James Zartman |  |  |  |  |
| Lab No. | 4 | Date | 5/7/2017 |  |  |  |
| **Test Specimen** |
| Cross Sectional Area (in^2): | 0.015 | Type: Steel |  |  |  |
| Increment | Pump Pressure (psi) | Cylinder Force(lb) | Micrometer Reading(in) | Gage Length(in) | Stress(psi) | Strain (in/in) |
| 1 | 0 | 0 | 0 | 3 | 0 | 0 |
| 2 | 200 | 3 | 0 | 3 | 200 | 0 |
| 3 | 400 | 6 | 0.01 | 3.01 | 400 | 0.003333333 |
| 4 | 800 | 12 | 0.012 | 3.022 | 800 | 0.007333333 |
| 5 | 1000 | 15 | 0.0215 | 3.0435 | 1000 | 0.0145 |
| 6 | 1200 | 18 | 0.03 | 3.0735 | 1200 | 0.0245 |
| 7 | 1400 | 21 | 0.0305 | 3.104 | 1400 | 0.034666667 |
| 8 | 1600 | 24 | 0.0308 | 3.1348 | 1600 | 0.044933333 |
| 9 | 1800 | 27 | 0.0311 | 3.1659 | 1800 | 0.0553 |
| 10 | 2000 | 30 | 0.0318 | 3.1977 | 2000 | 0.0659 |
| 11 | 2200 | 33 | 0.0825 | 3.2802 | 2200 | 0.0934 |
| 12 | 2400 | 36 | 0.105 | 3.3852 | 2400 | 0.1284 |
| 13 | 2600 | 39 | 0.107 | 3.4922 | 2600 | 0.164066667 |
| 14 | 2800 | 42 | 0.209 | 3.7012 | 2800 | 0.233733333 |
| 15 | 3000 | 45 | 0.318 | 4.0192 | 3000 | 0.339733333 |
| 16 | 3100 | Fracture | Fracture |  |  |  |

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| Name | James Zartman |  |  |  |  |
| Lab No. | 4 | Date | 5/7/2017 |  |  |  |
| **Test Specimen** |
| Cross Sectional Area (in^2): | 0.15 | Type: Aluminum |  |  |  |
| Increment | Pump Pressure (psi) | Cylinder Force(lb) | Micrometer Reading(in) | Gage Length(in) | Stress(psi) | Strain (in/in) |
| 1 | 0 | 0 | 0.001 | 3 | 0 | 0 |
| 2 | 200 | 30 | 0.001 | 3 | 200 | 0 |
| 3 | 400 | 60 | 0.001 | 3.001 | 400 | 0.000333333 |
| 4 | 800 | 120 | 0.012 | 3.013 | 800 | 0.004333333 |
| 5 | 1000 | 150 | 0.027 | 3.04 | 1000 | 0.013333333 |
| 6 | 1200 | 180 | 0.0315 | 3.0715 | 1200 | 0.023833333 |
| 7 | 1300 | Fracture | Fracture |  |  |  |

**Conclusion:**

The hypothesis was correct, steel is stronger than aluminum. Some sources of error in this lab could be because of an inadequate pump that leaks and isn’t meant to be utilized over and over. Also, the style of clamp used ins inadequate to hold a round object, a flat surface on a round surface doesn’t leave much clamping area. Steel that would survive the force seen in the lab would be 1045 steel. For aluminum, a material that would survive the forces shown would be 2014 T6 aluminum.