Lab Notebook

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4/11/2018

METC 143

Lab1 : Miller Indices

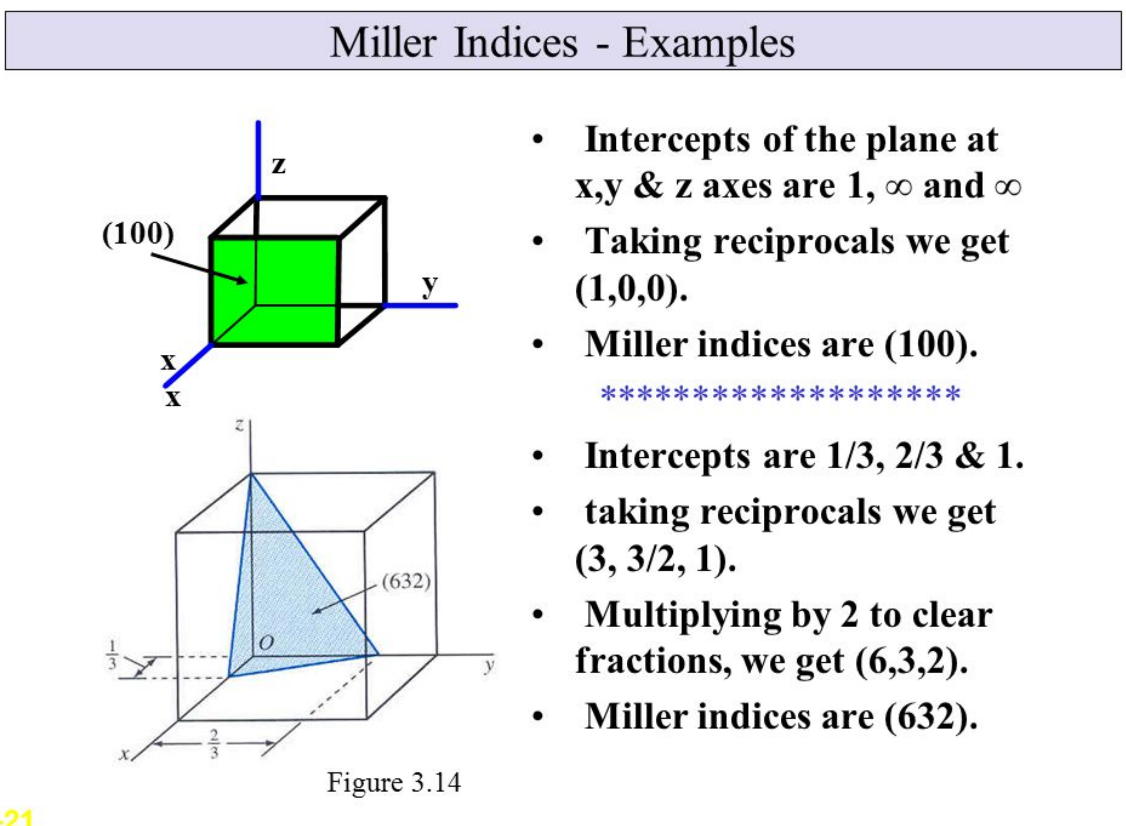
Date : 4/11/2018

Objective : the objectif of this lab is to do some research about the Miler Indices and understand it's concepts.

Summary: The miller indices is defined as any of a set of three numbers or letters used to indicate the position of a face or internal plane of a crystal and determined on the basis of the reciprocal of the intercept of the face or plane on the crystallographic axes

History: Miller Indices was created by British mineralogist and crystallographer William Hallowes Miller, in 1839, has the advantage of eliminating all fractions from the notation for a plane.

Purpose: miller indices are used for the purpose of specifying directions and planes. Miller Indices define the crystal arrangement through the help of indexing points and these indexing points will let us know the kind of structure which that particular material has.



References:

- Britannica, T. E. (2018, February 01). Miller indices. Retrieved April 10, 2018, from https://www.britannica.com/science/Miller-indices

- (n.d.). Retrieved April 10, 2018, from http://www.chem.qmul.ac.uk/surfaces/scc/scat1_1b.htm

Lab 2: Safety Factor

5/1/2018

Objective: The objective of this lab was to understand the importance of safety factors and their utilization in the design of structures.

Below are the calculations for question 1 through question 5 that contributed in my understanding of safety factors.

Question 1:

Cable:

Diameter = 0.5 in.

$S_m = 183,674$ PSI

W = 24,000 Lbs

Calculate the safety Factor for the cable shown.

Solution: → strength of material

$$SF = \frac{S_m}{S_a}$$ → stress.

Let's first find the stress of material

$\sigma = \frac{F}{A}$ or we have $d = 0.5 \Rightarrow A = \frac{\pi d^2}{4}$

$\Rightarrow A = \frac{\pi \times (0.5)^2}{4} = 0.196 \text{ in}^2$

so $\sigma = \frac{24{,}000 \text{ lbs}}{0.196 \text{ in}^2} = 122448.98$

Safety factor:

$$SF = \frac{183674}{122448.98} = 1.5$$

Question 2:

$$\frac{F}{\frac{\pi d^2}{4}} = \frac{F \times 4}{\pi d^2}$$

$W = 24,000 \text{ lbs}$

$S_m = 183,674 \text{ psi}$

What diameter would you need if you wanted a safety factor of 4?

Solution

$$SF = \frac{S_m}{S_a} \Rightarrow S_a = \frac{S_m}{SF} \quad \text{or} \quad S_a = \frac{F}{A}$$

$$\Rightarrow \frac{F}{A} = \frac{S_m}{SF} \quad \text{or} \quad A = \frac{\pi d^2}{4}$$

$$\Rightarrow \frac{F}{\frac{\pi d^2}{4}} = \frac{S_m}{SF}$$

$$\Rightarrow \frac{4F}{\pi d^2} = \frac{S_m}{SF}$$

$$\Rightarrow \pi d^2 = \frac{4F \times SF}{S_m}$$

$$\Rightarrow d^2 = \frac{4F \times SF}{\pi \times S_m}$$

$$\Rightarrow \boxed{d = \sqrt{\frac{4F \times SF}{\pi \times S_m}}}$$

$$d = \sqrt{\frac{4 \times 24,000 \times 4}{\pi \times 183,674}} = \underline{0.82 \text{ in}}$$

Question 3:

F = 17,000 lbs

diameter = 2.5 in.

SF = 8

Calculate the material strength

$$SF = \frac{S_m}{S_a} \Rightarrow \boxed{S_m = S_a \times SF}$$

$$\Rightarrow S_m = \frac{17{,}000 \text{ lbs}}{\frac{\pi d^2}{4}} \times 8$$

$$\Rightarrow S_m = \frac{4 \times 17{,}000}{\pi (2.5)^2} \times 8$$

$$\Rightarrow S_m = 27705.89$$

<u>Question 4:</u>

Based on the material strength that I calculated in question3, I would use 1045 steel because it has a higher yield stress than aluminum 1050-H14; consequently it will be able to lift the car with a greater strength without causing the jack to break. (Yield stress is the amount of force required to permanently deformed the material so a higher yield stress = higher force needed).

Question 5 :

for Aluminium 1050- H14, = 14, 900

- calculation of the diameter of rod

$$SF = \frac{S_m}{S_a}$$

$$S_a = \frac{S_m}{SF}$$

$$\frac{F}{A} = \frac{S_m}{SF}$$

$$\frac{F}{\frac{\pi d^2}{4}} = \frac{S_m}{SF}$$

$$\frac{4F}{\pi d^2} = \frac{S_m}{SF}$$

$$\pi d^2 = \frac{4F \times SF}{S_m}$$

$$d^2 = \frac{4F \times SF}{\pi \times S_m}$$

$$d = \sqrt{\frac{4F \times SF}{\pi \times S_m}}$$

$$d = \sqrt{\frac{4 \times 17{,}000 \times 8}{\pi \times 14{,}900}} = 3.41 \text{ in}$$

For Aluminum 1050-H14, I will use a rod diameter of 3.14 inches. The reason for that is because, with this diameter I am able to obtain a safety factor of 8 which will guarantee to lift the car without breaking the jack.

Lab 3: Hardness Test Lab

Date: 4/15/18

Hypothesis: There is a mistake on the hardness of the material

Tools: Hardness Tester

Procedure: Test the hardness of steel and aluminum by placing it on a hardness test machine. So by doing so, the indenter will quickly apply a force against the aluminum and steel sample that we would like to test and we will be able to obtain directly the hardness of the samples since it will be display on the machine.

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.

Procedure:

Test a sample of each material on hardness tester

Questions to Answer:

1. Given the material hardness specification, does the 1018 steel and 4140 steel hardness meet the specification?
2. What would you recommend to the Quality Manager regarding the material?
3. Production is currently using the materials, what steps would you take if the material does not meet the hardness requirements?
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?

Results for the test of sample:

- **1018 steel hardness = 90.5**
- **4140 steel hardness = 19.3**

Answer to Question:

1. The 1018 steel and 4140 steel hardness does not meet the specification requirement
2. I would recommend the quality manager to re-do the parts by checking that the machines use are well calibrated and also change the dimensions to ensure a product with a desirable hardness
3. If the material does not meet the hardness requirement, I would stop production and make sure that we can obtain the hardness requirement and specifications before restarting production.

4. A source of error in testing the sample can be: wrong calibration of the machines use, or wrong dimensions use, testing on a surface that has already been testing will also cause to have a different values. Last but not least, testing at the corners of the sample will also cause to have a different reading of hardness, due to the fact that extremity or corners are usually made soft that the center of the materials

<u>Lab 4:</u> Tensile Strength analysis

5/02/2018

<u>Hypothesis:</u> Steel is stronger than Aluminum

<u>Procedure:</u> to confirm the statement above we did a tensile test of steel and aluminum in order to compare their values of stress and strain. In addition, we also draw a stress Vs strain curve to better have an idea on how they stresses behave on a graph.

<u>Results:</u>

<u>Formula used in calculations for both steel and aluminum:</u>

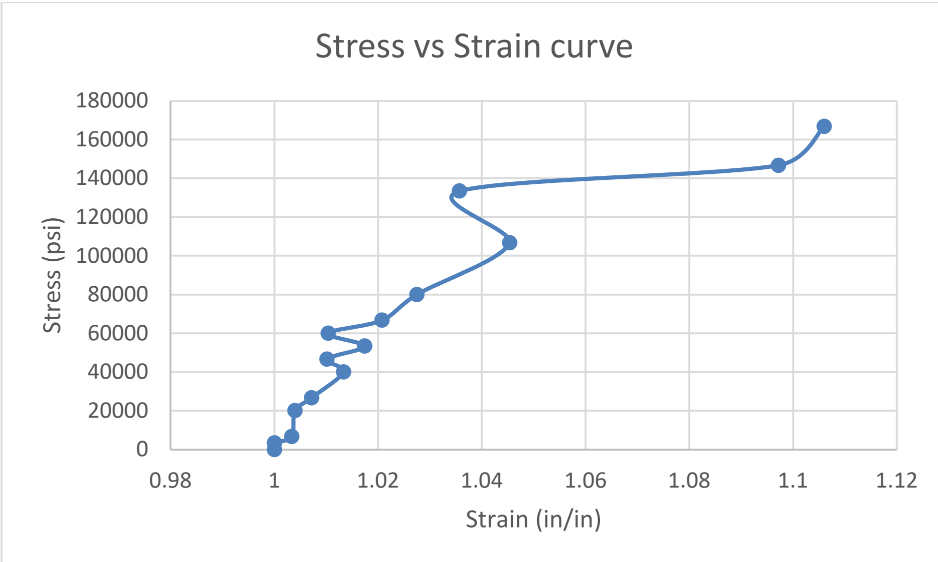
Calculation of strength = Cylinder Force (lb.)/ Cross Sectional Area (in^2)

Calculation of Gauge length = Original length (3) (in) + Micrometer reading (in)

Calculation of Strain = Gauge length(in)/ Original length (in)

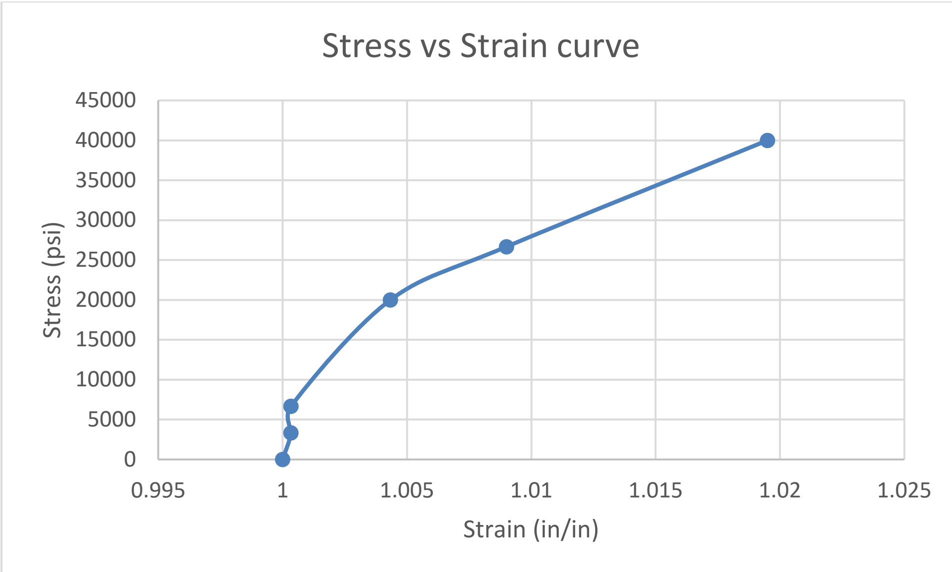
- <u>Steel:</u>

Name	Adama Samba					
Lab No.	4	Date	5/2/2018			
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	1
2	200	50	0	3	3333.333	1
3	400	100	0.01	3.01	6666.667	1.003333
4	800	300	0.012	3.012	20000	1.004
5	1000	400	0.0215	3.0215	26666.67	1.007167
6	1200	600	0.03	3.04	40000	1.013333
7	1400	700	0.0305	3.0305	46666.67	1.010167
8	1600	800	0.0308	3.0523	53333.33	1.017433
9	1800	900	0.0311	3.0311	60000	1.010367
10	2000	1000	0.0318	3.0623	66666.67	1.020767
11	2200	1200	0.0825	3.0825	80000	1.0275
12	2400	1600	0.105	3.1361	106666.7	1.045367
13	2600	2000	0.107	3.107	133333.3	1.035667
14	2800	2200	0.209	3.2915	146666.7	1.097167
15	3000	2500	0.318	3.318	166666.7	1.106
16	3100	Fracture	Fracture			



<u>Aluminum:</u>

Name	Adama Samba					
Lab No.	4	Date	5/2/2018			
Test Specimen						
Cross Sectional Area (in^2):		**0.015**	**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	1
2	200	50	0.001	3.001	3333.333	1.000333
3	400	100	0.001	3.001	6666.667	1.000333
4	800	300	0.012	3.013	20000	1.004333
5	1000	400	0.027	3.027	26666.67	1.009
6	1200	600	0.0315	3.0585	40000	1.0195
7	1300	Fracture	Fracture			



Conclusion Questions:

1) The hypothesis is correct due to the fact that it takes a larger force to cause fracture for steel (>2500 lb.) compared to aluminum (>600 lb.)

2) The source of errors for the lab was probably a wrong calibration of the tensile test machine and also incorrect reading of micrometer. Another reason might be a wrong positioning of the material during testing

3) A steel that would not break at the maximum force during this lab would be AISI 4140 Steel, annealed at 815°C (1500°F) furnace cooled 11°C (20°F)/hour to 665°C (1230°F), air cooled, 25 mm (1 in.) round. The reason for that is because this steel has an ultimate tensile strength of 95,000 psi which is greater than 2500 psi (max force)

   An aluminum that would not break during this lab experiment would be: Aluminum 1050-H14. The reason for that is because it has an Ultimate Tensile Strength of 16000 psi which is much greater than the one used during our experiment.