9.50 → 1.// MECH 221 Session # 6

a) Fe_3C

b) $m_\alpha = 1 \dfrac{6.7-1.15}{6.7-0.022} = 0.831\ Kg$

c) $m_{pearlite} = 1 \dfrac{6.7-1.15}{6.7-0.76} = 0.934\ Kg$

$m_{Fe_3C} = 1 \dfrac{1.15-0.022}{6.7-0.022}\ 0.168\ Kg$

d) $m_{\substack{pro.\\Fe_3C}} = 1 \dfrac{1.15-0.76}{6.7-0.76} = 0.0656\ Kg$

9.51 → 2//

$m_\alpha = \dfrac{6.7-0.65}{6.7-0.022} 2.5 = 2.2649\ Kg$

$m_{pearlite} = \dfrac{0.65-0.022}{0.76-0.022} 2.5 = 2.127\ Kg$

$m_{Fe_3C} = \dfrac{0.65-0.022}{6.7-0.022}\ 2.5 = 0.235\ Kg$

$m_{\substack{proeu\\\alpha}} = \dfrac{0.76-0.65}{0.76-0.022}\ 2.5 = 0.3726\ Kg$

9.53 3.//

$W_{pearlite} = \dfrac{C_0 - 0.022}{0.76-0.022} = 0.714 \longrightarrow C_0 = 0.549$

or

$W_{pro.\alpha} = \dfrac{0.76 - C_0}{0.76-0.022} = 0.286 \longrightarrow C_0 = 0.549$

Channel 4

1000	96.25	0.000097	19.40	19.4	Tensile	-0.012245339
2000	192.5	0.000189	38.80	37.8	Tensile	-2.589249325
3002	288.9425	0.000282	58.25	56.4	Tensile	-3.169203986
4006	385.5775	0.000377	77.73	75.4	Tensile	-2.992461032
5004	481.635	0.000468	97.09	93.6	Tensile	-3.594095484
Unload		0.000005	0	1	-	

Channel 5

1000	96.25	0.000161	30.54	32.2	Tensile	5.420532876
2000	192.5	0.000318	61.09	63.6	Tensile	4.110961039
3002	288.9425	0.000474	91.69	94.8	Tensile	3.387250287
4006	385.5775	0.000685	122.36	137	Tensile	11.96414233
5004	481.635	0.000788	152.84	157.6	Tensile	3.111771336
Unload	0	0.000005	0	1	-	-

Channel 6

1000	96.25	-0.000045	-30.54	-9	Compression	-239.3814924
2000	192.5	-0.00009	-61.09	-18	Compression	-239.3814924
3002	288.9425	-0.000134	-91.69	-26.8	Compression	-242.1421329
4006	385.5775	-0.000181	-122.36	-36.2	Compression	-238.0127162
5004	481.635	-0.000225	-152.84	-45	Compression	-239.6529976
Unload	0	-0.000001	0	-0.2	-	-

9.56 | 4 // 2.0 Kg

$m_{pro.\alpha} = \frac{0.76-0.4}{0.76-0.022} 2 = 0.9756$ Kg $\quad m_{\alpha} = \frac{6.7-0.4}{6.7-0.022} 2 = 1.887$ Kg

$m_{pearlite} = \frac{0.4-0.022}{0.76-0.022} 2 = 1.024$ Kg $\quad m_{Fe_3C} = \frac{0.4-0.022}{6.7-0.022} 2 = 0.113$ Kg

$m_{eut.\alpha} = m_{\alpha} - m_{pro.\alpha} = 1.887 - 0.9756 = \underline{0.9114}$ Kg

9.17 5.//

90 wt% Ag 10% wt Cu $\quad C_L = 85$ wt% Ag $\quad$ figure 9.7

a) T = 850 °C $\quad$ b) $C_{\beta} = 95$ wt% Ag

$W_{\beta} = \frac{90-85}{95-85} = 0.5 \quad W_L = \frac{95-90}{95-85} = 0.5$

9.32 6.//

25 wt% Ag 75% Cu @ 775°C

a) $W_{\alpha} = \frac{91.2-25}{91.2-8} = 0.796 \quad W_{\beta} = \frac{25-8}{91.2-8} = 0.204$

b) $W_{\alpha_{pro.}} = \frac{71.9-25}{71.9-8} = 0.734 \quad W_L = W_{\substack{eutectoil \\ microconst.}} = \frac{25-8}{71.9-8} = 0.266$

c) $W_{\alpha_{eut.}} = W_{\alpha} - W_{\alpha_{pro.}} = 0.796 - 0.734 = 0.062$

4.5/5

DATA AND RESULTS

Dimension of the steel bar: Span	
Length, L	455mm
Width, b	19
Height, H	31.63
Moment of Inertia	50103.71527

Channel 1

P(N)	M(N*m)	Є (micro strain)	σ_{theo}(MPa)	σ_{exp} (MPa)		Percentage Error
1000	96.25	-0.000158	-30.35	-31.6	Compression	4.110961039
2000	192.5	-0.00031	-60.70	-62	Compression	2.134170639
3002	288.9425	-0.00047	-91.12	-94	Compression	3.163611787
4006	385.5775	-0.000623	-121.59	-124.6	Compression	2.474656255
5004	481.635	-0.000781	-151.88	-156.2	Compression	2.842612709
Unload	0	0.000003	0	0.6	-	

Channel 2

1000	96.25	-0.000099	-19.40	-19.8	Compression	-2.04935785
2000	192.5	-0.000195	-38.80	-39	Compression	-0.503155458
3002	288.9425	-0.000295	-58.24	-59	Compression	-1.294627036
4006	385.5775	-0.000391	-77.73	-78.2	Compression	-0.609940946
5004	481.635	-0.000489	-97.90	-97.8	Compression	-0.731810488
Unload		0.000002	0	0.4	-	0

Channel 3

1000	96.25	0.000002	0	0.4	Tensile	-
2000	192.5	0.000001	0	0.2	Tensile	-
3002	288.9425	0	0	0	Tensile	-
4006	385.5775	-0.000001	0	-0.2	Tensile	-
5004	481.635	-0.000001	0	-0.2	Tensile	-
Unload		0.000003		0.6	-	-

MECH 221 Session #7

1.11

a. Cars → high impact resistance for bumper. ABC copolymers

b. Scuba Diving → high elasticity. Poly isoprene rubber

c. Medicine → safety, stability. Polyethylene-polypropylene

d. Computers → hardness and durability → epoxy

e. Kitchen → heat resistance. silicon rubber

f. plumbing → high chemical stability. polyethylene thermoplastic

g. Aerospace → heat resistance. epoxy thermosets.

h. Electrical → high dielectric properties, flexibility, stability, Elastomer PVC

2.11 % crystallinity $= \dfrac{\rho_c(\rho_s - \rho_a)}{\rho_s(\rho_c - \rho_a)} 100$

$$0.105 = \frac{\rho_c(1.2158 - \rho_a)}{1.2158(\rho_c - \rho_a)} \qquad 0.623 = \frac{\rho_c(1.2561 - \rho_a)}{1.2561(\rho_c - \rho_a)}$$

$0.105\rho_c + (1-0.105)\rho_a = 1.2158$ ①

$0.623\rho_c + (1-0.623)\rho_a = 1.2561$ ②

$-\frac{0.623}{0.105}$① + ② → $-4.933\rho_a = -5.957$

a. $\rho_a = 1.208\ g/cm^3$

$\rho_c = 1.285\ g/cm^3$

b. $\rho_s = 0.795\rho_c + (1-0.795)\rho_a = 0.795(1.285) + (1-0.795)1.208 = 1.27\ g/cm^3$

For the load of 200 N, the experimental deformation was -1,84 in the brass beam and x = L/2, so we have:

$$E = \frac{1}{-1{,}84 * 10^{-3} * 3{,}23 * 10^{-9}}\left[\frac{200 * 0{,}2275^{3}}{12} - \frac{200 * 0{,}455^{2}}{12} * 0{,}2275\right]$$

$E = 299{,}1 * 10^{9}$

Table 4: Experimental values for E

Brass		Steel		Aluminum	
Load, N	E_{exp} (GPa)	Load, N	E_{exp} (GPa)	Load, N	E_{exp} (GPa)
200,00	9,91E+10	200,00	8,91E+10	200,00	1,07E+11
400,00	1,08E+11	400,00	1,39E+11	400,00	1,03E+11
600,00	1,09E+11	600,00	1,68E+11	600,00	1,02E+11
800,00	1,10E+11	800,00	1,88E+11	800,00	1,02E+11
1000,00	1,12E+11	1000,00	2,03E+11	1000,00	1,01E+11
E_{exp} avg.	1,07E+11		1,58E+11		1,03E+11

To calculate the error we use:

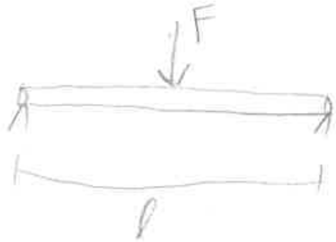
$$\%\text{of error} = \left|\frac{E_{Theo} - E_{exp}}{E_{Theo}}\right| * 100$$

%error: Brass 1,9%

Steel 21%

Aluminum 47,14%

3.)



$d = 6\,mm$ $\quad F = 300N$

$l = 75\,mm$

$$\sigma_{fs} = \frac{Mc}{I} \qquad I = \frac{\pi}{4} r^4 = \frac{\pi}{64} d^4 = \frac{\pi}{64} 0.006^4 = 6.362 * 10^{-11} m^4$$

$$M = \frac{F}{2}\frac{l}{2} = \frac{300}{2}\frac{0.075}{2} = 5.625\ Nm$$

$$c = \frac{d}{2} = \frac{0.006}{2} = 0.003\,m$$

$$\sigma_{fs} = \frac{5.625(0.003)}{6.362 * 10^{-11}} = 265.2 * 10^6\ Pa = \underline{\underline{265.2\ MPa}}$$

4.) $E = E_0(1 - 1.9P + 0.9P^2)$

) $310 = E_0(1 - 1.9(0.05) + 0.9(0.05)^2) \longrightarrow E_0 = \underline{\underline{341.65}}\ GPa$

) $210 = 341.65(1 - 1.9P + 0.9P^2)$

$0.6146 = 1 - 1.9P + 0.9P^2$

$0.9P^2 - 1.9P + 0.3854 = 0$ quadratic

$$P = \frac{1.9 \pm \sqrt{1.9^2 - 4(0.9)(0.3854)}}{2(0.9)} = \cancel{1.88}, \underline{\underline{0.227}}$$

impossible

$$c_1 = -\frac{PL^2}{12}$$ X $C_1 = -\frac{PL^2}{16}$

So: $y = \frac{1}{EI}\left[\frac{Px^3}{12} - \frac{PL^2}{12}x\right]$ X

To calculate the theoretical deformation at x = L/2 and x = L/4 we use:

$$I = \frac{1}{12}bh^3$$

In the x = L/2, x =0,2275 m and for x =L/4 we got x = 0,11375m

With the give E for each material (E = 200 GPa - for steel, E = 70 GPa - for aluminum, E = 105 GPa - for brass), we can calculate for the load of 200 N for steel:

$$y_{theo} = \left[\frac{\left[\frac{200*0{,}2275^3}{12} - \frac{200*0{,}455^2}{12}0{,}2275\right]}{(200*10^9)*3{,}20*10^{-9}}\right]$$

$$y_{theo} = 0{,}00092\ m$$

Table 3: theoretical results

Applied load	Brass		Steel		Aluminum	
	At x = L/2	At x = l/4	At x = L/2	At x = l/4	At x = L/2	At x = l/4
200 N	-1.71	-0.86	-0.91	-0.45	-2.45	-1.23
400 N	-3.43	-1.71	-1.84	-0.92	-4.91	-2.45
600 N	-5.14	-2.57	-2.76	-1.38	-7.336	-3.68
800 N	-6.86	-3.43	-3.68	-1.84	-9.81	-4.91
1000 N	-8.57	-4.29	-4.60	-2.30	-12.27	-6.13

To compare the experimental results with the theoretical results we can calculate E using the following equation:

$$E = \frac{1}{yI}\left[\frac{Px^3}{12} - \frac{PL^2}{12}x\right]$$

5.// ethylene $-CH_2-CH_2-$ $M_e = 2(12.01) + 4(1.008) = 28.052\ g/mol$

propylene $-CH_2-\underset{\displaystyle CH_3}{\underset{|}{CH}}-$ $M_p = 3(12.01) + 6(1.008) = 42.078\ g/mol$

fraction of ethylene = $$\frac{\frac{23}{28.052}}{\frac{23}{28.052}+\frac{77}{42.078}} = 0.3094 = \underline{\underline{30.94\%}}$$

fraction of propylene = $1-0.3094 = 0.6906 = \underline{\underline{69.06\%}}$

6.//

a. Tensile strength increases with increasing molecular weight because longer chains can tangle more.

b. Crystalline regions have more secondary bonding than amorphous regions, thus tensile strength increases with increasing crystallinity.

c. During drawing, the orientation of chains align and the tensile strength increases.

d. Annealing increases crystallinity which increases tensile strength.

And for the cantilever beam:

Deflection of the beam		
Applied Load	At x = L	At x = L/2
100 g	-1,36	-0,46
200 g	-2.61	-0,88
300 g	-3,88	-1,33
400 g	-5,14	-1,74
500 g	-6,41	-2,16

To calculate the deflection of the beam we use:

$$\frac{d^2y}{dx^2} EI = M(x)$$

$$\frac{d^2y}{dx^2} = \frac{M(x)}{EI}$$

Integrating both sides:

$$\iint \frac{d^2y}{dx^2} = \iint \frac{M(x)}{EI}$$

For $\quad M(x) = \frac{px}{2}$

$$\int dy = \iint \frac{Px}{2EI}\, dx^2$$

$$y = \frac{1}{EI} \int \left[\frac{Px^2}{4} + c_1\right] dx$$

$$y = \frac{1}{EI}\left[\frac{Px^3}{12} + c_1 x + c_2\right]$$

Using boundary value to find the constant c_1 and c_2:

For: $x = 0$ & $y = 0$, $c_2 = 0$

For: $x = L$ & $y = 0$, $0 = \frac{1}{EI}\left[\frac{PL^3}{12} + c_1 L + 0\right]$

$$0 = \frac{PL^3}{12} + c_1 L$$

5. [crash only]

$\rho = 2.65\ g/cm^3$ AX type cubic

$a = 0.43\,nm$ $A_C = 86.6\ \frac{g}{mol}$ $A_A = 40.3\ g/mol$

which crystal structure is possible?

$$\rho = \frac{n'(\Sigma A_c + \Sigma A_A)}{V_c N_A}$$

$$2.65 = \frac{n'(86.6 + 40.3)}{(0.43 * 10^{-7})^3 (6.022 * 10^{23})} \longrightarrow n' = 1$$

$\longrightarrow$ Cesium Chloride structure

Benoit St-Hilaire
6520383

COURSE TITLE: MECHANICS OF MATERIALS

SEMESTER: 2012 – 2013 WINTER

COURSE NUMBER: ENGR244. SECTION: T

COURSE GIVEN BY: DR Waiz Ahmed

STUDENT LAST NAME: St-Hilaire

STUDENT FIRST NAME: Benoit

STUDENT I/D: 6520383

I CERTIFY THAT THIS SUBMISSION IS MY ORIGINAL WORK AND MEETS THE FACULTY'S EXPECTATIONS OF ORIGINALITY.

SIGNATURE:

DATE: 21/03/13

7.) $TS = TS_\infty - \dfrac{A}{\overline{M}_n}$

A: some constant

TS_∞: tensile strength at infinite molecular weight

$50 = TS_\infty - \dfrac{A}{30000}$ ①

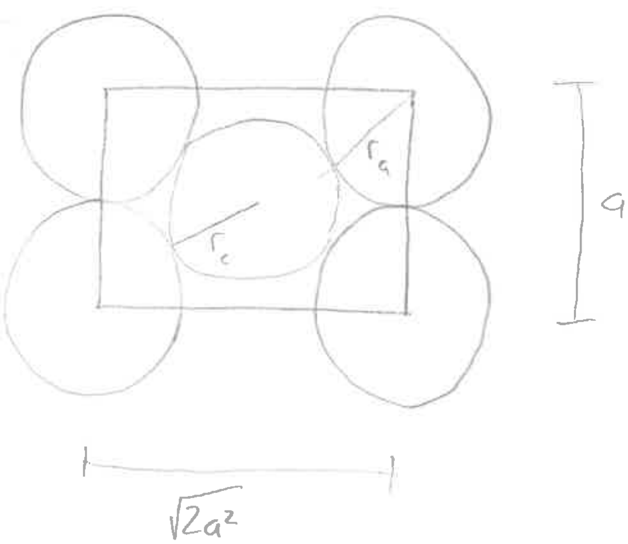
$150 = TS_\infty - \dfrac{A}{50000}$ ②

② − ① $\Rightarrow$ $100 = \dfrac{A}{30000} - \dfrac{A}{50000} \longrightarrow A = 7.5 * 10^6$

$TS_\infty = 300\ MPa$

$TS = 300 - \dfrac{7.5*10^6}{40000} = \underline{\underline{112.5\ MPa}}$

8.)



$a = 2r_a$

$2r_c + 2r_a = \sqrt{a^2 + 2a^2} = \sqrt{3a^2} = \sqrt{3}\,a$

$2r_c + 2r_a = \sqrt{3}\,2r_a$

$2r_c = (2\sqrt{3} - 2)\,r_a$

$\dfrac{r_c}{r_a} = \dfrac{2\sqrt{3} - 2}{2} = 0.732$

3. Procedure

1/1

In the experiment, the first thing is measure the dimensions of the beam to be analysed at the moment (steel, brass or aluminum). After that we put the beam in position to be analysed and make sure that both deformation gauges are in place. When the beam is in the right place and the gauges are properly reset, the load is applied using a hydraulic load machine, increasing by 200 N till 1000 N and the measure of the gauges is take simultaneously. This methodology is used for all of the beams.

The second experiment was the cantilever beam: the measure of the specimen is taken and them the load is applied: 100g up to 500g of maximum load. The deformation is measured in each new load.

4/5

4. Results

The result for the first parte we can see in the tables below the dimensions and the results:

Table 1: dimensions of the beam.

Dimensions	Brass	Steel	Aluminum
Span length, L (mm)	455	455	455
Width, w (mm)	19,01	19,14	19,31
Height, h (mm)	12,68	12,62	12,89

Table 2: experimental results of the test.

Deflection of beam						
Applied load	Brass		Steel		Aluminum	
	At x = L/2	At x = l/4	At x = L/2	At x = l/4	At x = L/2	At x = l/4
200 N	-1,84	-1,5	-2,06	-1,09	-1,6	-1,27
400 N	-3,39	-2,62	-2,65	-1,55	-3,33	-2,52
600 N	-5,03	-3,78	-3,27	-2,01	-5,01	-3,72
800 N	-6,61	-4,89	-3,9	-2,48	-6,73	-4,95
1000 N	-8,15	-5,98	-4,52	-2,93	-8,46	-6,17

9.11 use figure at beginning of document

a. CsI $\quad Cs^+ \; r_c = 0.17\,nm \qquad I^-: r_a = 0.220\,nm$

$$r_c/r_a = \frac{0.17}{0.220} = 0.772 \longrightarrow \text{coord. \# } = 8$$

Cesium Chloride structure

b. NiO $\quad Ni^{2+}: r_c = 0.069\,nm \qquad O^{2-}: r_a = 0.140\,nm$

$$r_c/r_a = \frac{0.069}{0.140} = 0.493 \longrightarrow \text{coord. \# } = 6 \rightarrow \text{Rock Salt}$$

c. KI $\quad K^+ \; r_c = 0.138\,nm \qquad I^-: r_a = 0.220\,nm$

$$r_c/r_a = \frac{0.138}{0.220} = 0.627 \longrightarrow \text{coord. \# } = 6 \longrightarrow \text{Rock salt}$$

d. NiS $\quad Ni^{2+}: r_c = 0.069 \qquad S^{2-}: r_a = 0.184$

$$r_c/r_a = \frac{0.069}{0.184} = 0.375 \longrightarrow \text{coord. \# } = 4 \rightarrow \text{Zinc Blende}$$

1. Objective:

The test of deflection in supported beams and cantilever beam is performed in order to determine the modulus of elasticity of the material. In this experiment were used: steel, aluminum and brass. With this test we can see the relationship of the load applied and the deflection of the beam.

2. Introduction

When a beam is submitted to a load it will deflect due to this load. This degree of deflection depends on variables like the place of the load, the place where the load is applied, the moment of inertia of the beam. It's very important to determine the equation of this deformation. In the elastic limit, the curvature of the neutral axis is obtained by:

$$\frac{1}{\rho} = \frac{M(x)}{EI}$$

Where:

ρ is radius of curvature

M(x) is bending moment which is a function of x

E is the modulus of elasticity

I is the moment of inertia of the cross section about the neutral axis

Or we can write:

$$\frac{1}{\rho} = \frac{d^2y}{dx^2}$$

x is the distance of a point on the beam

y is the deflection of the beam.

Combining these two equations we have:

$$\frac{d^2y}{dx^2} EI = M(x)$$

By integrating twice the previous equation, we can get the deflection of the beam at any location.

10.

propylene $-CH_2-\underset{\underset{CH_3}{|}}{CH}-$

a. $\overline{M}_n = \sum x_i M_i$

b.

Range	M_i	x_i	w_i	$x_i M_i$	$w_i M_i$
8000 - 16000	12000	0.05	0.02	600	240
16000 - 24000	20000	0.16	0.10	3200	2000
24000 - 32000	28000	0.24	0.20	6720	5600
32000 - 40000	36000	0.28	0.30	10080	10 800
40000 - 48000	44000	0.20	0.27	8800	11 880
48000 - 56000	52000	0.07	0.11	3640	5720
			Σ	33040 g/mol	36240 g/mol

c. $DP = \dfrac{\overline{M}_n}{m}$

repeat unit molecular weight

$m = 3(12.01) + 6(1.008) = 42.078$ g/mol

$$DP = \frac{33040}{42.078} = 785.2$$

11.

a. $1.188 = 0.673\rho_c + (1-0.673)\rho_a$ ①

$1.152 = 0.437\rho_c + (1-0.437)\rho_a$ ②

$① - \frac{0.673}{0.437}② \Rightarrow -0.5861 = -0.54\rho_a \rightarrow \rho_a = 1.085\ g/cm^3$

$\rho_c = 1.238\ g/cm^3$

b. $\rho_s = 0.554\rho_c + (1-0.554)\rho_a = 0.554(1.238) + (1-0.554)1.085 = 1.17\ g/cm^3$

Concordia University

Deflection of beams

Igor José da Silva Cherubin

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Montreal

10/06/2013

14/15