1pm 08.05.2020 CAE and Stress Analysis M5X020064 PB

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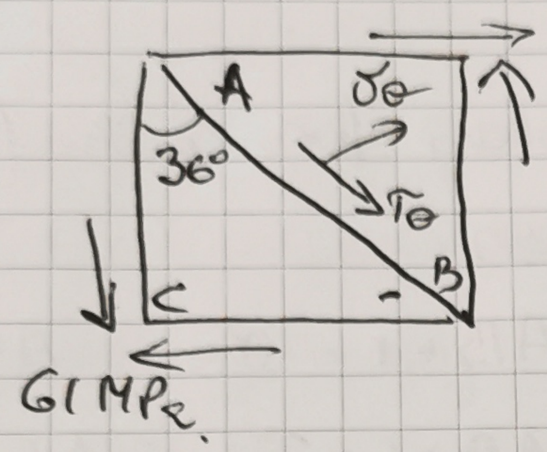
Q4 a) continue

We know that $\sin\theta\cos\theta = \frac{1}{2}\sin 2\theta$

so: $\sigma_\theta = 2\tau_{xy} \times \frac{1}{2}\sin 2\theta$:

$\sigma_\theta = \tau_{xy}\sin 2\theta$.

Q4) B)



$\tau_{xy} = 61$ MPa =

$= 61 \times 10^6$ Pa

$\theta = 36^\circ$

$\sigma_\theta = \tau_{xy}\sin 2\theta$

$\sigma_\theta = (61\times10^6) \times \sin(2\times 36^\circ) =$

$= 58.01 \times 10^6$ Pa.

c) $\tau_\theta = -\tau_{xy}\cos 2\theta$

τ_{xy} on AB = ?

$\tau_\theta = -61\times10^6 \times \cos(2\times 36)$

$\tau_\theta = -18.85\times10^6$ Pa

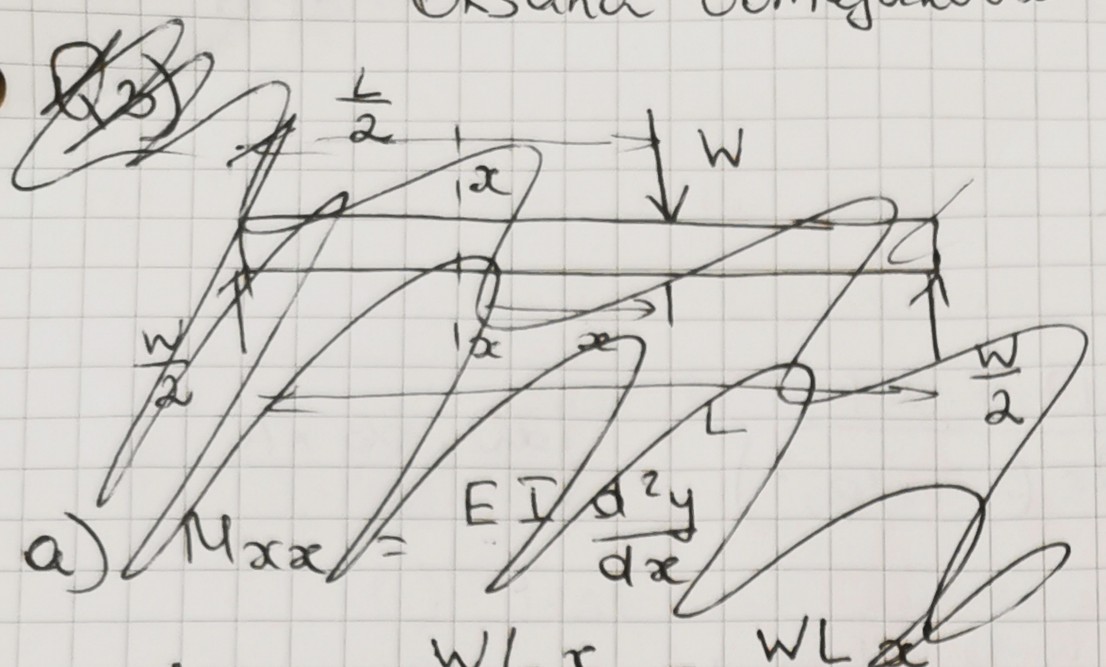
d) When you stretch the piece of material

e) To keep a body in equilibrium, the forces should be equal. $\frac{1}{2}$

A material unlikely to be subjected to the shear stress only, because usually there is normal stress applied too.

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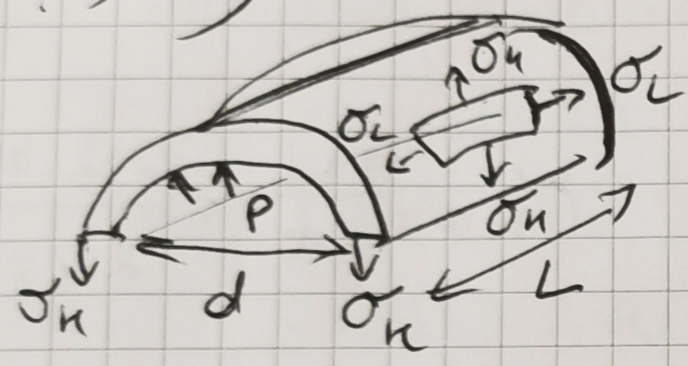
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a) $M_{xx} = EI\frac{d^2y}{dx}$

$M_{xx} = \frac{WLx}{2} - WL\frac{x}{2}$

Q) 1) a) Prove $\sigma_H = \frac{Pd}{2t}$



Lets resolve forces ↑ vertically:

Upwards Force : $F = P \times A$

where $A = dL$

so substitute: $F = P \times dL$

Forces downwards : $F = 2\sigma_H \times tL$

substitute (F) → $2\sigma_H tL = PdL$ cancel

$2\sigma_H t = Pd$

rearrange: $\sigma_H = \frac{Pd}{2t}$

b). Because hoop stress is twice bigger than longitudinal stress. A chycilder gets thinner in the longitudinal direction $\sigma_L = \frac{Pd}{4t}$

c) $P = \rho g h$

$P = 35 psi$

$T = 15°C$

$\rho = ?$

$1 psi = 6894.76 Pa$

$35 psi = 241317 Pa.$

Density of water:

1.0250 kg/m^3 UNITS

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d) $d = 2.7m$

$t = 2.7mm = 2.7 \times 10^{-3} m$

depth?

$$\sigma_H = \frac{Pd}{2t} = \frac{241317 \times 2.7}{2 \times (2.7 \times 10^{-3})} = 120.66 \times 10^6 P_a$$

$P = \rho g h$ where h is depth;

$$h = \frac{P}{\rho g}$$

$\rho = 1.0250 \, kg/m^3$

~~Pressure = p x area~~ =

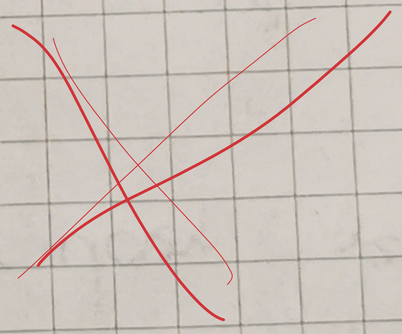
$$\sigma_H = \frac{Pd}{2t} = \frac{P \times 2.7}{2 \times (2.7 \times 10^{-3})}$$

From change in volume equation:

$$\frac{Pd}{4tE}$$

Conductor shrens:

$$\sigma_L = \frac{Pd}{4t} =$$



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Q2). Engineering design process consist 5 core phases:

a)

A) Define the problem

B) Gather information

c) Generate multiple solutions

D) Analyze and select a solution

E) Test and Implement solution.

A) The definition of problem usually includes a list of the product or customer needs and requirements, as well as specifies information regarding product function and features. This is perhaps the most challenging part of the design process. The questions need to be asked:

- What is the problem or need?
- Who has the problem/need?
- Why it is important to solve?

Because, ~~for instance~~, consumers establish a need ~~and~~, such as for travel for instance, so designing engineers not always could recognize this need.

That's why this phase of the design process is crucial.

Once a need is established, then designing engineers could define this need in regards of engineering

In terms to obtain a clear definition, data should be collected.

Moreover, at this stage criteria for succes need to be established as well. This criteria is based on previous knowledge and the research that have been taken.

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P4

Q2) Next step is Gather information. At this phase
a) all the relevant data and information of the given problem need to be collected. At this stage could be revealed facts that ~~are~~ weren't considered before and problem might be ~~refo~~ redefined. there are many questions to ~~be~~ address -

- Is this problem real and its definition is accurate?
- What are the existing solutions to this problem?
- What are the economic factors, that are driving forces?
- Are all factors included and not missed out?

At this stage the information need to be collected from all available sources - handbooks, books, encyclopaedias as well as internet.

c) At this stage new ideas are generating and different solutions creating.

One of the approaches could involve to deconstruct existing solution and focus on how to improve limitations. New ideas, tools, knowledges and approaches will produce new, creative solution to the problem or need.

Designing team should not be affraid revolutionary ~~solutions~~ and creative solutions.

At this stage ~~dif~~ designers with different knowledges are creating new solutions to the problem

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D). After the most vialable and promissing solutions are found / created they need to be analyzed deeply. The analyze need to be carried to cover all possible stages of life cycle of the product - such as analyze the functions of the product, ergonomics (one of the most driving factors nowadays), manufacturability (how easy to manufacture it), regulations and standards (if it fits in the current legal requirements) etc.

Different solutions are analysed, compared and evaluated, and final design concept is established which should ~~fit~~ consider all the above factors. In order to evaluate each solution, a quantitative evaluation is needed to avoid any subjective judgement. Usually decision-matrix is used. This mathematical tool helps the ranking desirable criteria for design solution.

E) Testing. Usually this stage involves a building a prototype of the product. It could not be fully tested or fully work, but the main aim is to test the design solution in real conditions this allow to verify a final design solution or / and if needed to modify it

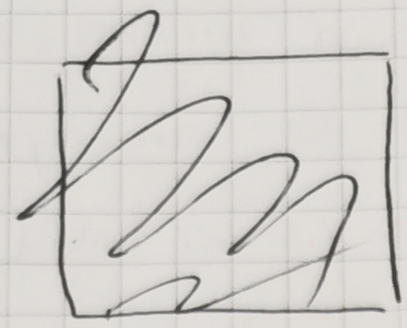
Each stage of the design procen is complicated, but this allow to make a right decision before final design will be sent to manufacturer, to meet all requirements and factors to avoid any failures or ~~re~~ undesirable consequences.

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P6

~~Q4).2a2)~~



Q 2)

b) FEA includes these stages.

1) Splitting a complex problem into small elemens

2) Interpreted the geometry

3) Material information adding

4) Physical property adding

5) loading

6) Evaluation of results.

The first 4 stages of FEA are about preprocessing, which means the gathering the information. and considering all factors.

So, ~~design~~ the first 3 stages of the engineering design process are crucial as they include all the information gathered.

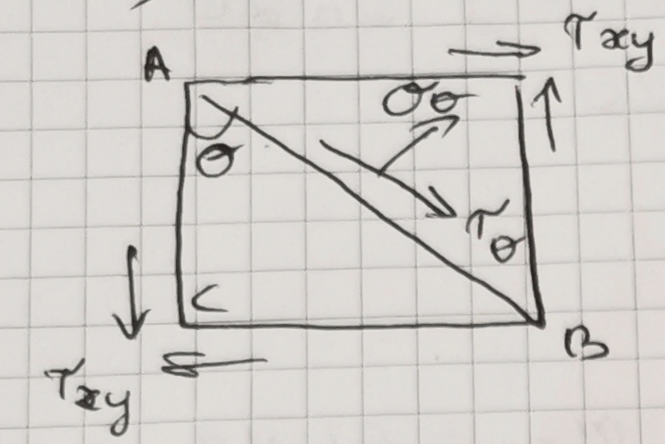
Analyze stage is important too, but at least extent.

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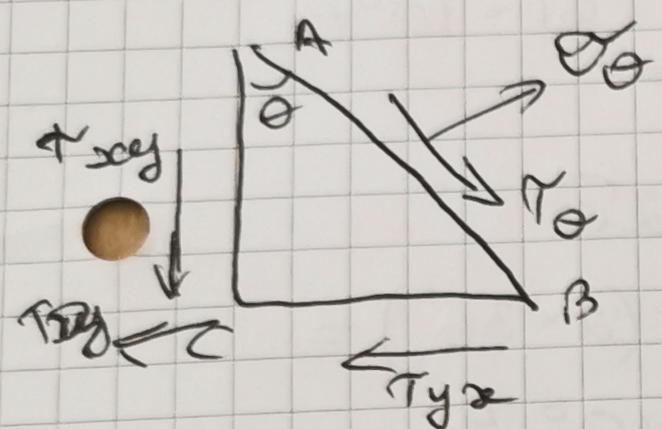
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Q4) a)

Prove $\sigma_\theta = \tau_{xy} \sin 2\theta$



redraw!



let's calculate forces for each face:

$F = \text{area} \times \text{stress}$

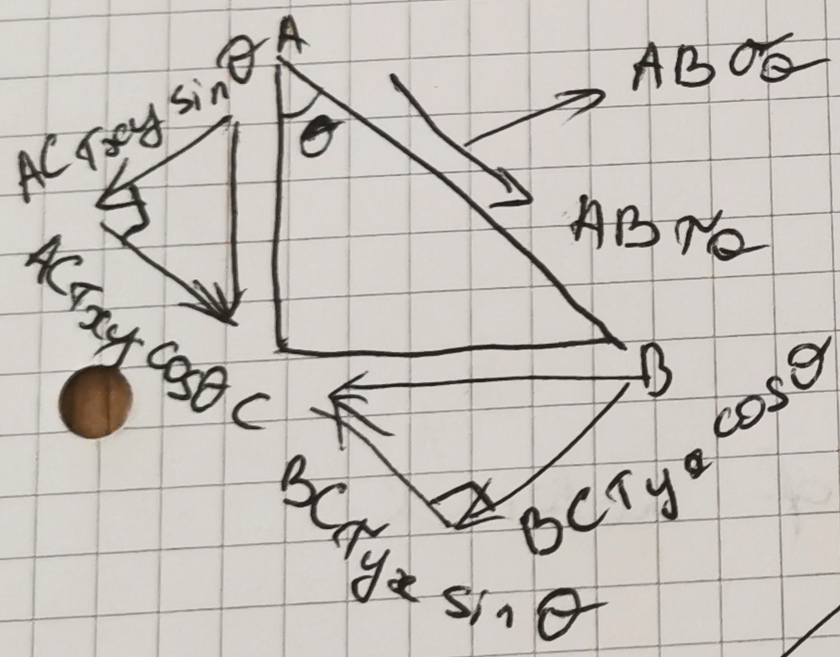
AB due to $\sigma_\theta = AB \times 1 \times \sigma_\theta = AB\,\sigma_\theta$

AB due to $\tau_\theta = AB \times 1 \times \tau_\theta = AB\,\sigma_\theta$

AC due to $\tau_{xy} = AC \times 1 \times \tau_{xy} = AC\,\tau_{xy}$

BC due to $\tau_{yx} = BC \times 1 \times \tau_{yx} = BC\,\tau_{yx}$

Now redraw with forces on the plane!



For the equilibrium

$\sum F$ perpendicular to $AB = 0$

$AB\sigma_\theta = AC\tau_{xy}\sin\theta + BC\tau_{yx}\cos\theta$

$S\frac{O}{H}\quad C\frac{A}{H}\quad T\frac{O}{A}$

$\frac{BC}{AB}\qquad \frac{AC}{AB}\qquad \frac{BC}{AC}$

divide by AB:

$$\sigma_\theta = \frac{AC}{AB}\tau_{xy}\sin\theta + \frac{BC}{AB}\tau_{yx}\cos\theta$$

$$\sigma_\theta = \cos\theta\,\tau_{xy}\sin\theta + \sin\theta\,\tau_{yx}\cos\theta$$

so, $\sigma_\theta = \tau_{xy}\sin\theta\cos\theta + \tau_{yx}\sin\theta\cos\theta$

$$\sigma_\theta = 2\tau_{xy}\sin\theta\cos\theta$$