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John Hopkins P151371

07/05/2020

13:00

MSX02064

CAE & Stress Analysis

1) a) Force on cylinder $\uparrow = p \times A$
 $= p \times dL$

$$\text{Forces } \downarrow = 2 \sigma_H \times L \times t$$

$$2 \sigma_H L t = p d L$$

$$\sigma_H = \frac{p d}{2 t}$$

b) This is because for unit thickness, hoop stress is greater than longitudinal this is shown by comparing:

$$\sigma_H = \frac{p d}{2 t}$$

and

$$\sigma_L = \frac{p d}{4 t}$$

Hoop stress is 2x longitudinal stress.

c) $\rho = 1.0255 \text{ g/cm}^3$

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MSX02064 (AE Stress Analysis)

1) d) $P = \rho g h$

$d = 3.3 \text{ m}$

$t = 3.3 \times 10^{-3}$

Yield $\sigma = 195 \times 10^6$

$P_{in} = 0$

$\rho = 1025.5$

$\sigma = \frac{0.1 \times 3.3}{2 \times 3.3 \times 10^{-3}}$

$\sigma_H = \frac{P d}{2 t}$

$195 \times 10^6 = \frac{\rho g h \times 3.3}{2(3.3 \times 10^{-3})}$

$\sigma_H = \frac{195 \times 10^6 \times 3.3}{2(3.3 \times 10^{-3})}$

$\sigma = 9.75 \times 10^{10}$

$195 \times 10^6 = \frac{1025.5 \times 9.81 \times h \times 3.3}{2(3.3 \times 10^{-3})}$

$\frac{195 \times 10^6 \times 6.6 \times 10^{-3}}{1025.5 \times 9.81 \times 3.3} = h$

$h = 38.77 \text{ m}$

$h = 36.77 \text{ m}$

$h = 19.38 \text{ m}$ ← with safety factor 2.

e) $\frac{(195 \times 10^6 + 0.1 \times 10^6) \times 6.6 \times 10^{-3}}{1025.5 \times 9.81 \times 3.3} = h$

$h = 19.39$

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CAE Stress Analysis.

1) g) Sealing the pressure inside a cylinder increases the amount of external pressure that can be applied onto it.

h) ~~Other factors~~ play a part including ~~defects, welds strength~~. Fatigue must be considered. Stress isn't always linear. Water temperature may also change with depth.

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2. a) The first step is to define the problem. This entails establishing the need, which is derived generally from the consumer. Then you must develop a problem statement, outlining unambiguously the problem. This is achieved by collecting data from on the problem through experiments and computations that allow the need to be expressed as part of ~~an~~ an engineering problem solving process. It should specifically address the need but be broad enough to allow multiple creative solutions. Criteria for success must be established from research and allowing flexibility throughout the design process. Factors such as ~~envi~~ the environment, cost, safety and usability make up the criteria. The next step is to garner relevant information. Even loosely related information could reveal facts that could redefine the problem. Scientific publications, encyclopedias and handbooks, related websites are ~~all~~ all valuable information sources. With all relevant information, it is possible to proceed to the next task; generating multiple solutions. It begins with involving as much creativity as possible to generate new solutions. You can start by deconstructing previous failed solutions, finding out how

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... to improve them with the availability of more current technology, ~~new tools~~ new tools and methods. ~~Using multiple people to brainstorm gives varied outlooks. Dissecting the best of each guarantees flawless final solutions, so long as approached with an open mind, accepting failures along the way.~~ The fourth ~~task~~ is ~~step~~ task is analysing and selecting appropriate solutions. This can be stated by weighing each solution against selection criteria in step 1. Depending on the nature of the solution, this could involve mechanical strength analysis, usability, ergonomics, manufacturability, safety, market analysis, regulations etc. The decision is then based on quantitative evaluation of these criteria. The use of a decision matrix, a mechanical tool which specifies and compares and ranks accordingly. Computer models and prototypes also yield valuable information.

Finally comes testing and implementation. Methods such as prototyping and concurrent engineering should be implemented. Safety and manufacturability must be physically tested, and judged relative to concurrent engineering. Rapid prototyping streamlines this process. Information must then be documented in a clear fashion.

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... for readers with less background knowledge. Unambiguous, clear communication is a must. After this, it is possible to apply for patents if the solution is novel enough, giving rights to the manufacturer for a prescribed period.

2. b) The first two steps, defining the problem and gathering information could benefit from FEA for the following reasons. If crash testing a car, and a clear fault, ~~and~~ or unsatisfactory performance is occurring, FEA allows us to test specific parts to find the root of the issue. By looking at factors such as the yield stress of each component we can determine the weakest part. The 5th step, that is testing and implementing, FEA can be used to determine the success of the replacement part by ironing out any errors. For step 4, FEA could help distinguish the best solution from a range of options. This could include material cost, availability and difficulty to work with.

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CAE Stress Analysis

3) a) moment = $\frac{W}{2} (L - x)$

$$\frac{WL}{4} - \frac{Wx}{2} = EI \frac{d^2y}{dx^2}$$

$$EI \frac{dy}{dx} = \frac{WLx}{4} - \frac{Wx^2}{2} + A$$

$$EI y = \frac{WLx^2}{8} - \frac{Wx^3}{12} + Ax + B$$

let $x=0$ $A=0$

$x = L/2$ $y = 0$

$\therefore B = \frac{WL^3}{96}$ $y = \frac{1}{EI} \left[\frac{WLx^2}{8} - \frac{Wx^3}{12} - \frac{WL^3}{96} \right]$

b) max y when $x=0$

$$\therefore y = \frac{1}{EI} \left[\frac{WL(0)^2}{8} - \frac{W(0)^3}{12} - \frac{WL^3}{96} \right]$$

$$y = -\frac{WL^3}{48EI}$$

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CAE Stress Analysis

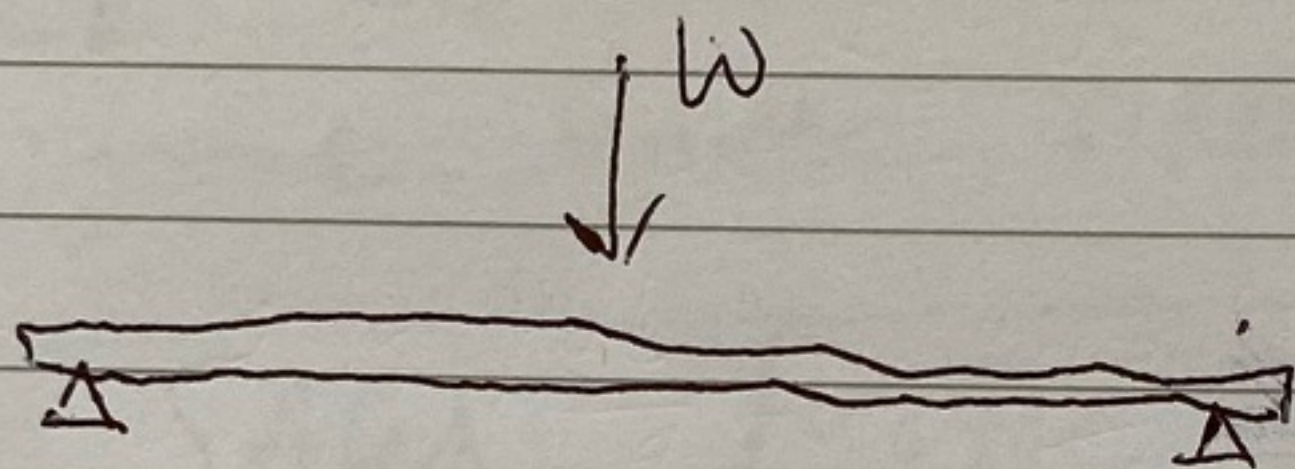
3) c) $y = 10 \text{ mm}$

$$W = 45 \text{ kN}$$

$$E = 212 \text{ GPa}$$

$$I = 57 \times 10^{-6}$$

$$L = ?$$



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

$\approx$

$$212 \times 10^9 \times 57 \times 10^{-6} \times \frac{d^2 (1 \times 10^{-3})}{dx^2}$$

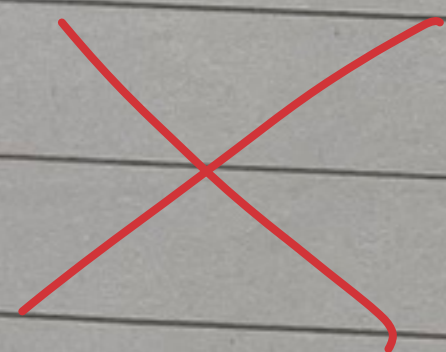
$$\text{For } EI \frac{d^2 y}{dx^2} = -\frac{W \times L}{2 \times 2} \rightarrow -\frac{WL}{4}$$

$$EI \frac{dy}{dx} = -\frac{WL^2}{8} + A$$

$$EI y = -\frac{WL^3}{24} + Ax + B$$

$$\text{at } L, y = 0$$

$$y = 0$$



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CAE & Stress Analysis

3) d) The train may not be of uniform mass. The elastic modulus may not be ~~linear~~ constant. It would be on sleepers which would minimise deflection. Soft ground under sleepers would change results.

e) Safety factor