Exam 2 NE 591

1/ True stress strain the stress is measured according to the current area of applied force and same for the ~~strain~~ elongation so the initial area and measurement of elongation change through time meanwhile, in engineering stress strain the area is constant and it's the initial area prior to any applied force same for the ~~strain the elongation~~ it's the strain same prior to any load and

$\sigma_{engineering} = F/A_0$, $\sigma_{true} = \frac{F}{A}$

$\varepsilon_{engineering} = \frac{\Delta L}{L_0}$ $\varepsilon_{True} = \ln\left(\frac{l}{l_0}\right)$

2) elastic deformation the material deforms and after ~~remo~~ removing the applied force it return to it's orignal status

plastic Deformation. is a permanent Deformation So The material won't be able To return To it's original Shape after Deformation

3) 0D: Vacancies

3D: Voids

4) - melTing temperature

- Thermal conductivity

- Grain Growth

5) ~~Grain~~ depending on The Size of The grains we have diffrent ~~mech~~ mechanical properties

if we have bigger grains we have
more density ~~of~~ of dislocation inside The
grain So more ductile material
Smaller grains means less density of defects
which means harder material and all
of That depends on The processin etc..

6| Strain hardening after plastic deformat.
if we unload the Sample it still has
the permanent Strain, So now our
material becomes harder but less
ductile what causes strain hardening
is the evolution of the microstructure
as our ~~[illegible]~~ grain will become thinner
after Strain ~~So now more plastic~~
So it's harder but less ductile

7) all fuel performance codes must be able to predict:

The mechanical interaction between fuel and cladding

- the Temperature profile
- the Stress and Volumetric change

8) for fuel densification is burnup "fission"

9) Temperature ~~rotation~~ can affect grain growth more Temperature ~~more grain~~ ~~grai~~ Faster grain growth

10)

a) Thin-wall

$\sigma_\theta = \frac{pR}{\delta}$ $\sigma_z = \frac{pR}{2\delta}$ $\sigma_r = -\frac{1}{2}p$

$\sigma_\theta = 135\ Mpa$

$\sigma_z = \frac{\sigma_\theta}{2} = 67{,}5\ Mpa$

$\sigma_r = -\frac{1}{2}p = -10\ Mpa$

b) Thick walled assumption

$$\sigma_{rr}(r) = -p \frac{((R_o/r)^2 - 1)}{((R_o/R_i)^2 - 1}$$

$$\sigma_{\theta\theta} = p \frac{(R_o/r)^2 + 1}{(R_o/R_i)^2 - 1}$$

$$\sigma_{zz} = p \frac{1}{(R_o/R)^2 - 1}$$

at the midpoint

$r = 5,4 + \frac{0,8}{2} = 5,8\,mm$

~~$\sigma_{rr} = -20 \left(5,4/5,8 \right.$~~

$$\sigma_{rr} = -20 \frac{(6,2/5,8)^2 - 1}{(6,2/5,2)^2 - 1}$$

$\sigma_{rr} = -6,77$ MPa

$$\sigma_{\theta\theta} = 20 \left(\frac{(6,2/5,8)^2 + 1}{(6,2/5,2)^2 - 1} \right)$$

$\sigma_{\theta\theta} = 101,64$ MPa

$$\sigma_{33} = 20 \left(\frac{1}{(6,2/5,8)^2 - 1} \right)$$

$\sigma_{zz} = 140,16$ MPa

حل :

$$\sigma_{rr} = \bar{\sigma}_{rr}$$

$$\sigma_{zz} = \bar{\sigma}_{zz}$$

$$\sigma_{\theta\theta} = \bar{\sigma}_{\theta\theta}$$

11)

$\sigma_{\theta\theta}(\eta) = -\sigma^*(1 - 3\eta^2)$

$$\sigma^* = \alpha \frac{E(T_0 - T_S)}{4(1-\gamma}$$

$$T_0 - T_S = \frac{LHR}{4\pi K}$$

$$T_0 - T_S = \frac{250}{4\pi \times 0{,}1} \qquad T_0 - T_S = 198{,}94\,K$$

$$\sigma^* = \frac{8{,}2 \times 10^{-6} \times 290 \times 198{,}94}{4(1-0{,}3)}$$

$\sigma = 168{,}95$ Mpa

the maximum stree is when $\eta = 1$

so

$\sigma_{\theta\theta} = -168{,}95 \times (-2)$

$= 337{,}91$ Mpa

12/

$$\Delta\, \delta\, gap' = \bar{R}_c \alpha_c (T_c - T_{ba}) - \bar{R}_f \alpha_f (T_f - T_{ref})$$

$\cancel{T_c = ?\quad T_F = ?}$ T_c ! T_F !

$\cancel{T_{ic} - T_{clad} = LHR}$

$\cancel{T_0 - T_{fuel} = \frac{LHR}{4\pi}}$

$$T_{Fuel} - T_{gap} = \frac{LHR}{2\pi R_f h_{gap}}$$

$$T_f - T_{gap} = \frac{325}{2\pi \times 0,5 \times \frac{0,1}{0,02}}$$

$$= 51,72$$

$$T_{fuel} = 51,72 + 450$$

$$= 501,72$$

$$T_{gap} - T_{clad} = \frac{LHR \; t_{clad}}{2\pi R_{fuel} K_{clad}}$$

$=$

T_{gap} $T_{clad} = T_{ic}$

So $S_{gap} = \bar{R}_c \alpha_c (T_c - T) - \bar{R}_f \alpha_f (T_f - T_{ent})$

$S_{gap} = (0,5 + 0,02) \times 4,5 \times 10^{-6} \times (450 - 300) - 0,5 \times 15 \times 10^{-6} \times (501,72 - 300)$

$S_{gap} = 0,0011$

The new temperature

$$T_{fuel} - T_{gap} = \frac{LHR}{2\pi R_{f} h_{ng}} = \frac{325}{2\pi \times 0,5 \; \frac{0,01}{0,02 - 0,001}}$$

$= 48,88$

so $T_{fuel} = 498{,}88\ K$

13/1

$$\sigma_{\theta\theta}(r) = -\sigma^* (1 - 3r^2)$$

$$\sigma^* = \frac{\alpha E (T_0 - T_S)}{4(1 - \nu)}$$

$$T_0 - T_S = \frac{LHR}{4\pi \times K_b} = \frac{200}{4\pi \times 0,05}$$

$$T_0 - T_S = 636,61 \text{ K}$$

$$\cancel{\sigma^* = \sigma^*} \quad \cancel{\sigma^* = 10,5 \times 10^{-6} \times 210 \times 10^{3}}$$

$$\sigma^* = \frac{10,5 \times 10^{-6} \times 210 \times 10^{3} \times 636,16}{4 \times 0,75}$$

$$\sigma^* = 467,57 \text{ Mpa}$$

1

$$-6_{Fr}/\sigma^* = 1 - 3n^2$$

$$3n^2 = 1 + 6_{Fr}/\sigma^*$$

$$n^2 = \sqrt{\frac{1 + 6_{Fr}/\sigma^*}{3}}$$

$$n = \sqrt{\frac{1 + 120/467{,}57)}{3}}$$

$$n = 0{,}6\,47\,x$$