Session 31 Homework: R5V2/3 Materials Data, S and Z

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Mentor Guide Questions

1.2 State the materials data required to carry out an initiation assessment to R5 Volume 2/3 in the most general case.

1.3 State the Ramberg-Osgood equation for monotonic and cyclic stress-strain behaviour, and the variants used in R5.

1.4 Discuss creep ductility and the factors upon which it depends

1.5 Discuss the effects of prolonged service exposure to high temperatures on the material properties relevant to an R5 crack initiation assessment

Numerical Questions

[1] You need to derive a best estimate monotonic stress-strain curve at 500°C for a structure made of 316H but for which no complete test stress-strain curve data are available. However test data for the 0.2% and 1% proof strengths are available. Use the 0.2% proof strength (133 MPa) and the 1% proof strength (162 MPa) to derive the Ramberg-Osgood parameters A' and $m = 1/\beta'$ for the monotonic stress-strain curve applicable up to ~1% plastic strain.

[*Hint: Do recall that the 0.2% and 1% proof strengths are defined such that it is the plastic strain which equals 0.2% or 1%, not the total strain. You can probably figure out how to solve for the parameters yourself – but explicit expressions can be found in R66 Section 3.1*].

[2] Evaluate the factor by which the multiaxial creep ductility is reduced compared with the uniaxial creep ductility according to the Spindler fraction with parameters $p = 2.38$ and $q = 1.04$, for the following states of stress:-

(i) $\sigma_1 = \sigma_2,\ \sigma_3 = 0$

(ii) $\sigma_2 = 0.5\sigma_1,\ \sigma_3 = 0$

(iii) $\sigma_1 = \sigma_2,\ \sigma_3 = 0.25\sigma_1$

How do (i) and (ii) compare with the alternative advice for biaxial stressing in R5V2/3 Appendix A1, Section A1.11.1.2?

What do you conclude from (iii) regarding the effects of relatively small additions of stress in the third direction?

[3] Three different non-stress-relieved welds in 316H parent each have principal residual stresses in the ratios given in Qu.[2]. They are subject to little service loading and all operate at the same temperature (525°C). The elastic follow-up factors, Z, for the welds are: (i) Z = 4; (ii) Z = 3; (iii) Z = 2 for the three welds respectively. Which welds are likely to initiate reheat cracks? (Assume the S and Z values relate to the same, most onerous, point).