

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1.(20%)

- (a) What are the differences among five types of Portland cement? Give some suitable applications for each type of cement in practice.
- (b) Why is the gradation of aggregate important?
- (c) Discuss the role of water in fresh concrete.

2. (20%)

Define the following terms:

- (a) elastic strain (b) plastic strain (c) creep strain (d) stress relaxation (e) stress concentration

3. (20%)

A plate of an aluminum alloy is subjected to in-plane loading so that $\sigma_{33} = \sigma_{13} = \sigma_{23} = 0$. Strain components measured in the plate are $\epsilon_{11} = 0.002$, $\epsilon_{22} = 0.005$ and $\epsilon_{12} = 0.004$. Elastic constants for aluminum are given by Young's modulus of 70GPa and Poisson's ratio of 0.35.

- (a) Determine σ_{11} , σ_{22} , σ_{12} , and ϵ_{33} .
- (b) If the same aluminum solid of volume 100 cm^3 was subjected to a hydrostatic pressure $p = 20\text{MPa}$, what is the change in volume?

4. (20%)

- (a) The slip planes of b.c.c. iron are the $\{110\}$ planes. Sketch the atom arrangement in these planes, and mark the $\langle 111 \rangle$ slip directions.
- (b) If a stress of 100MPa is applied in the $[001]$ direction, calculate the resolved shear stress along $[\bar{1}11]$ on the (110) plane.
- (c) The atomic diameter of iron is 0.25 nm. Calculate the interplanar spacing d_{011} .

5. (20%)

An alloy component was tested under an applied cyclic stress about a mean stress of zero. The alloy failed under a stress range, $\Delta\sigma$, of 280 MPa after 10^5 cycle; under a stress range of 200 MPa, the alloy failed after 10^7 cycle. Assuming the fatigue behavior of the alloy can be represented by

$$\Delta\sigma(N_f)^a = C.$$

Find the number of cycles to failure for a stress range of 150 MPa. How will this change if the mean stress of cyclic stress is 10MPa?