بسمه تعالی

تمرینات مکانیک سنگ سری ۴ (اندازه گیری تنش در محل)

این تمرینات از فصل چهارم کتاب گودمن داده شده در صورت نیاز به جدول یا فرمول به این فصل کتاب مراجعه شود. هر دانشجو دو عدد تمرین بایستی حل کند که در زیر نام هر دانشجو و شماره تمرین مربوطه آمده است.

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Problems

1. Estimate the vertical and horizontal stresses at a depth of 500 m in a zone of normal faulting in Paleozoic sedimentary rocks. Use Figure 4.7*b* and assume the normal faulting is recent.

2. A vertical hydraulic fracture was initiated in a borehole at a depth of 3000 ft. Assume the ground is saturated continuously from the surface and that the pressure in the ground water is hydrostatic. The water pressure was first raised 710 psi above the original groundwater pressure and then it was not possible to raise it further. When pumping stopped, the water pressure fell to a value 110 psi above the original groundwater pressure. After a day, the pressure was raised again, but it could not be pumped to a value higher than 100 psi above the previous pressure (the "shut-in" pressure). Estimate the horizontal stresses at the site of measurement, the tensile strength of the rock, and the vertical pressure at the site.

3. A borehole is drilled and instrumented and then overcored, yielding the following values of the stress components in the plane perpendicular to the borehole:

$$\sigma_x = 250 \text{ psi}$$
$$\sigma_y = 400 \text{ psi}$$
$$\tau_{xy} = -100 \text{ psi}$$

The x axis was horizontal and to the right. Find the magnitudes and directions of the major and minor principal stresses in the plane perpendicular to the borehole.

4. A natural slope rises at 45° for 1000 m and then levels off. The rock has an unconfined compressive strength of 50 MPa. A tunnel is to be driven for an underground pressure pipe beginning with a portal at the base of the slope and continuing directly into the mountain. Based upon Norwegian experience, at what distance from the portal would you first expect to encounter rock pressure problems?

5. In a zone of active thrust faulting (low-angle reverse faulting), in rock with $\phi = 30°$, $q_u = 1000$ psi, and unit weight of 150 lb/ft^3, estimate the major and minor principal stresses at a depth of 3500 ft, assuming conditions for faulting. Compare your estimate with that of Figure 4.7.

6. A rock mass at a depth of 5000 m had a value of K (= ratio of horizontal to vertical stresses) equal to 0.8. If Poisson's ratio is 0.25, what should K become after erosion of 2000 m of rock?

7. What form would the data of the flat jack test assume if the initial stress normal to the plane of the jack were tensile? How could the data be worked to estimate the magnitude of the tensile stress?

8. Two flat jacks, 12 in. square, are placed in the wall and roof of an approximately circular test gallery 8 ft in diameter. Flat jack 1 is horizontal, and placed in the side wall. Flat jack 2 is vertical, with its edge parallel to the axis of the gallery. The cancellation pressures measured were 2500 psi with FJ 1 and 900 psi with FJ 2. Estimate the initial stresses (vertical and horizontal). List your assumptions.

9. The U. S. Bureau of Mines overcoring method is used to measure stresses in a borehole drilled perpendicularly to a tunnel wall. The site of the measurement (the plane of the measuring pins) is 5 ft deep in a test gallery 10 ft in diameter. The measuring borehole has a diameter of 1.25 in. The first pair of buttons is horizontal, pair 2 is oriented 60° counterclockwise from button pair 1; button pair 3 is 120° counterclockwise from pair 1. Deformations were measured as a result of overcoring as follows: pair 1 moved outward 3×10^{-3} in.; pair 2 moved outward 2×10^{-3} in.; and pair three moved outward 1×10^{-3} in. If $E = 2 \times 10^6$ psi and $\nu = 0.20$, determine the stress components in the plane perpendicular to the borehole, and the major and minor normal stresses in this plane and their directions. (Assume the initial stress parallel to the borehole is insignificant.)

10. Stress measurements in a horizontal rock outcrop using a series of vertical flat jacks all give a cancellation pressure of about 80 MPa. The rock is

granite with $E = 5 \times 10^4$ MPa and $\nu = 0.25$. If the rock started its life at a depth of 10 km with $\sigma_h = \sigma_y$ and was brought to the surface by erosion, what should be the value of the horizontal stress? ($\gamma = 0.027$ MN/m^3.) If there is a discrepancy, explain why.

11. Making use of the effective stress principle (Chapter 3), derive a formula corresponding to Equation 4.8 expressing the effective pressure $(p_{c1} - p_w)$ for crack initiation in hydraulic fracturing when the rock has a pore pressure p_w.

12. Bearpaw shale was loaded from 0 to 2000 psi vertically over a broad area so horizontal strain could be assumed equal to zero. Poisson's ratio was 0.40 during loading. Subsequently, the vertical load was reduced to 1000 psi. Poisson's ratio was 0.31 during unloading. (a) Estimate the horizontal pressure corresponding to the maximum and final vertical loads. (b) What natural events could bring about a similar stress history?

13. In a rock with $\nu = 0.3$ and $E = 3.0 \times 10^4$ MPa, "doorstopper" measurements yield the following strains in the arms of a 60° rosette gauge on the bottom of a vertical borehole 10 m deep: $\varepsilon_A = -20 \times 10^{-4}$ in the gage parallel to OX (east-west direction); $\varepsilon_B = -3.8 \times 10^{-4}$ in the gage oriented 60° counterclockwise from OX; and $\varepsilon_C = -5.0 \times 10^{-4}$ in the gage aligned 120° counterclockwise from OX. The hole is parallel to the y axis. Assuming σ_y is due to rock weight alone and $\gamma = 0.027$ MN/m^3, compute the greatest and least normal stresses in the plane of the hole bottom (xz plane) and their directions.