National Exams December 2015

09-Mmp-B2, Rock Fragmentation

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a CLOSED BOOK EXAM. One aid sheet written on both sides is permitted
   Any non-communicating calculator is permitted.

3. QUESTION 1 plus FOUR (4) questions from questions 2-7 constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Some questions require quantitative answers. Please state your assumptions clearly and provide clear answers.

5. Provide short and precise answers

Question 1 (4 marks per question; 40 marks total)

1. Define oxygen balance. Calculate the Oxygen Balance for AN/FO (AN: 94%, FO: 6%)
2. Provide parameters that control the ideal (maximum) velocity of detonation of an explosive.
3. Provide parameters that control the critical diameter of an explosive
4. What is the expected velocity of detonation and the expected detonation pressure of:
    a. AN/FO with Ammonium Nitrate in prill format at a diameter of 75 mm and density of 0.8 g/cm^3
    b. AN/FO with Ammonium Nitrate in rills at a diameter of 311 mm and density of 0.8 g/cm^3
    c. Emulsion, density of 1.1 g/cm^3 at a diameter of 40 mm
5. a. In what conditions would you use an Emulsion/ANFO blend 30% / 70% by mass?
   b. In what conditions would you use an Emulsion/ANFO blend 70% / 30% by mass?
6. What is the difference between Peak Particle Velocity and Peak Vector Sum?
7. What is air-decking? Provide two different examples where air-decking can be used.
8. Three different blast designs use a delay of 17 ms between holes of the same row and three times this the delay between rows. The delay is accomplished using surface shock tube (NONEL) delays and in the hole delays. You are considering 100 ms, 375 ms and 1000 ms in the hole delays. Which one would you use and why?
9. In point form provide steps to reduce ground vibration and air blast.
10. How does blasting affect downstream operations. Which operation is affected the most and why?

Given are: Ammonium Nitrate: NH_4NO_3, Fuel oil: CH_2, Atomic weights: C:12, H:1, N:14, O:16

Question 2 (a, 10 marks, b, 5 marks - 15 marks total)

a. In a quarry you are using 102 mm diameter holes in a 12 m high bench loaded with ANFO, having density of 0.85 g/cm^3. The burden and spacing are 2.5 m and 3 m respectively. To increase productivity you are planning to use 165 mm diameter holes. Assuming that you want to maintain the average fragmentation, provide the new pattern dimensions and loading information for each hole.
b. Which controllable (blast design) parameters affect fragmentation and how?

Question 3 (a, 10 marks, b, 5 marks - 15 marks total)

A drift has a cross section with a width of 6 m and height 4.7 m. The diameter of the holes is 51 mm.

a. Design the first few rounds (3) of the cut, assuming an advance per blast of at least 5 m.
b. Provide appropriate delays. Assume any modern delay system can be used. Use an explosive of your choice.

Question 4 (a, 5 marks, b, 10 marks - 15 marks total)

The drilling pattern of an open pit blast is shown in Figure 1.

a. Suggest a delay pattern for a blast that will result in a muckpile, which can be loaded by a rope shovel and, at the same time protect the final wall of the pit. Show how the muckpile will move.
b. If the diameter of the main blast is 254 mm, the diameter of the buffer holes is 160 mm and the diameter of the wall control holes 100 mm, show how you will load the holes of the blast. Assume that the explosives of choice are ANFO and ANFO-Emulsion blends except for the wall control, where you need to specify the explosive of your choice. The free face has a slope of 80 degrees.

Question 5 (15 marks total)

What is the expected damage radius from an emulsion charge, having a diameter of 102 mm, density 1.2 g/cm^3 and length of 4 m? The spherical charge attenuation relationship is:

$$u = 700\frac{W^{0.7}}{R^{1.4}}$$

where u is the particle velocity (mm/s), W is the weight of the charge (kg) and R is the distance from the centre of the charge to the point of interest (m). Discuss approximations you have made as well as the implication of such approximations.

Question 6 (a, b, c, d, e – 3 marks each; 15 marks total)

a. What are rotary drill air requirements depend on?
b. What does air bailing velocity depend on?
c. What do air bailing velocity requirements depend on?
d. What is the effect of high altitude on drilling?
e. What controls drilling deviation?

Question 7 (15 marks total)

A 30 m long drop raise must be developed with a cross section of 2.4 m x 2.4 m. The raise is accessed from a top. The borehole diameter is 89 mm, while the

explosive of choice in emulsion, density 1.25 g/cm^3. Recommend a blast design for the raise.

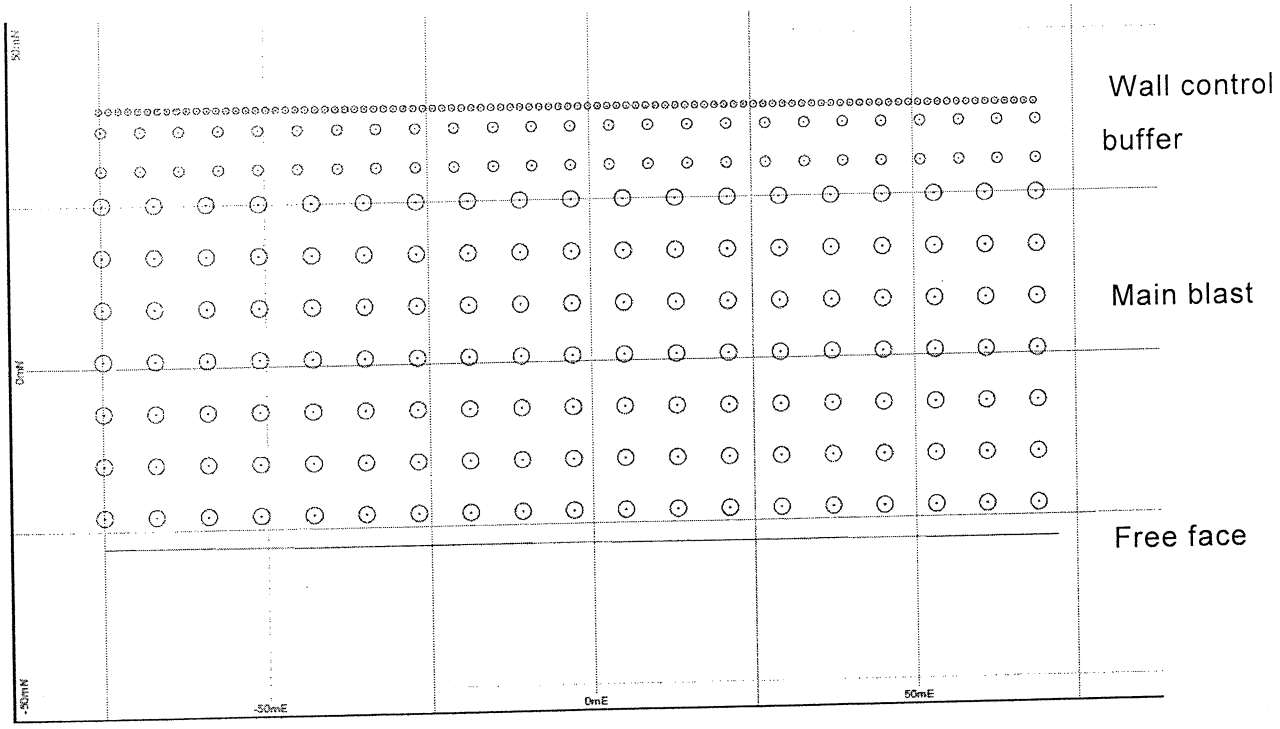

Figure 1. Schematic of blast of Question 4.