Q3 In a detonation experiment of a concrete specimen, the detonator is mounted at the centre hole. After explosion, the fragmented debris is collected and put together to form the following image.

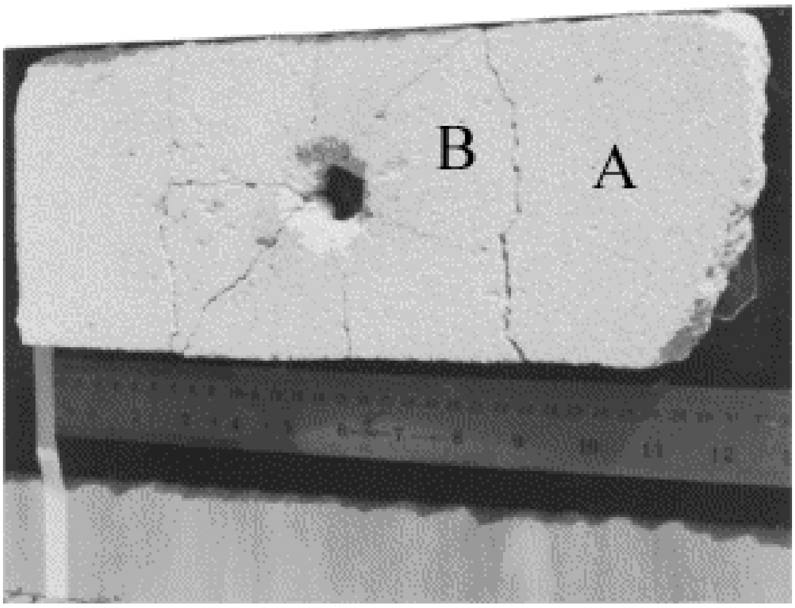

Fig. Q3

(1) On a separate sketch show which of the cracks in the image are spalling cracks. (3 marks)

(2) For debris A and B, which one drops first? Explain the reason. (3 marks)

(3) Describe the formation of the spalling cracks in Fig. Q3. (5 marks)

(4) Describe one applications that use the knowledge of spalling and fragmentation. (4 marks)

(5) The Young's modulus of the concrete is around 30GPa/m^3, and the density is around 2000kg/m^3, estimate the order of sound speed in concrete. Is shock wave speed higher or lower compared with sound speed? (5 marks)

Q4 Fig. Q4-1 shows the experimental data (open diamond symbols) of shock Hugoniot of 6061 aluminum in the shock-particle velocity plane. The density of 6061 aluminum under undisturbed state is $\rho_0 = 2.703\times10^3\,\text{kg/m}^3$.

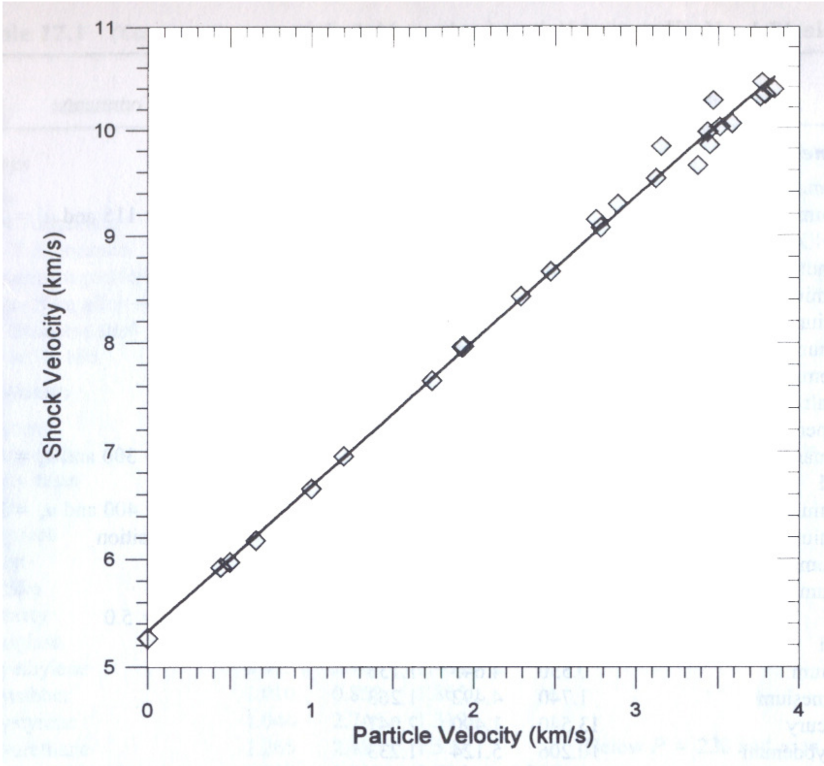

Fig. Q4-1

(1) Experimental results show that the shock velocity D is linearly related to the particle velocity u for lots of materials, and can be expressed as $D = c_0 + su$. Determine the value of c_0 and s for 6061 aluminum from Fig Q4-1. (1 marks)

(2) In Fig. Q4-2, slab A is flying towards slab B at a velocity $u_{\text{impact}} = 4\text{km/s}$. After impact, slab A continues to press upon slab B, sustaining the pressure. Both slabs A and B are made of 6061 aluminum, the material shown in Fig. Q4-1. Calculate:

a) the pressure and particle velocity at the impact surface. (8 marks)

b) the velocity of the shock generated in slab B. (3 marks)

c) the velocity of the shock generated in slab A (relative to the flying slab). (4 marks)

d) the density of the 6061 aluminum in slab B after shock? (4 marks)

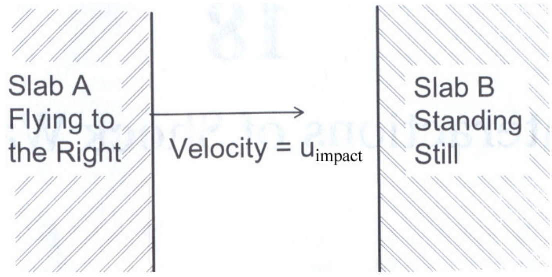

Fig. Q4-2