PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A
MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

# Introduction

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# INTRODUCTION

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The meeting will begin by considering the physics of liquid impact and the nature, magnitude and duration of the stresses which are produced when a solid is struck by a jet or by a drop of liquid. Even with moderate impacts the pressures developed in the solid are considerable and at high velocities the pressures are very great indeed, and are sufficient to produce deformation of the strongest solids.

As we shall see a small water drop, the size of a raindrop, striking a solid moving at a speed of about 500 m/s (Mach 1·5) will exert a pressure of *ca.* 130 Kg/mm$^2$ ($1{\cdot}9 \times 10^5$ Lb./in.$^2$) on the surface of the solid. The effect resembles that of a small explosion and at this stress level most solids and structural materials are permanently damaged either by plastic flow or by fracture. Since the pressure is applied for a very short interval of time (a few microseconds), it is the dynamic strength properties of the solid at very high rates of strain which are important. Both the nature and duration of the stresses and the mechanism by which deformation occurs will be considered. Apart from the shock pressure the rapid tangential flow of the liquid across the surface will produce deformation and these two effects interact. If the solid is subjected to multiple liquid impact, deformation will occur at much lower impact velocities and pressures. We shall consider the physics of both these processes.

These observations have a bearing on three technological problems which are of great importance at the present time. One is 'rain erosion', that is the damage of aircraft and of missiles flying through rain. Even at a few hundred miles an hour the damage may be appreciable and at higher speeds, e.g. Mach 1·5, the impact of a single raindrop may cause marked damage to the radar dome or to the metal structure. The second is the damage of turbine blades rotating in wet steam. In the present designs of turbines the tip speed of the rotor may reach 600 m/s and the impact of water droplets present in the steam causes them to be severely eroded. The third is the damage produced by cavitation. In this process a cavity forms at a point in the liquid which is in tension. If the cavity then moves into a region of positive pressure it will collapse rapidly and again set up an impact pressure. This liquid impact pressure is common to all these processes and we wish to consider how they are interrelated. We know of course that in these practical problems the chemical attack may also play an important role, but our emphasis here is on the physics of the processes. Liquid impact may also be used as a practical method of 'cutting' or fracturing solids and brief mention of this will be made. We are fortunate to have present to take part in the discussion some 150 scientists and engineers from nine different countries, and their knowledge covers a wide spectrum from the pure to the applied side in each of these fields. We hope that something of interest may emerge from this impact of science and technology.

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The papers given at the meeting are all included here and the relevant discussion and extra contributions are grouped after each section. Some concluding remarks are added which were prepared in collaboration with my colleagues Dr J. H. Brunton, Dr J. E. Field and Mr G. P. Thomas. I should like to take this opportunity of thanking them for the great assistance they have given in organizing this discussion and in arranging the papers. I also wish to thank Dr T. Brooke Benjamin for his help and Dr T. Boddington for translating Professor Shal'nev's contribution. We are all grateful to the President and the Officers of the Royal Society for having made this discussion possible and for the active part they have taken in it.



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