A STUDY OF HOUSE VIBRATIONS FROM QUARRY BLASTS

by

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INTRODUCTION

In the early days of cement mills when quarries were located several miles from the nearest municipality, their blasting of limestone or shale caused little or no inconvenience to anyone. As the cities expanded, however, residential districts were developed nearer and nearer to the quarries. The dwellings here were often expensively constructed, and their owners, hearing and feeling the vibrations from the quarry blasts in their homes, began to fear that damage would result from these operations. Lawsuits against the quarry companies frequently followed the appearance of supposed damage to these houses resulting from the blasts.

> The proximity of residential districts to quarry operations has long caused concern to quarry operators and civic organizations charged with responsibility for municipal expansion and safety. In many instances, litigation has been instituted in which the resident claimed that vibrations transmitted through the ground from blasts in the quarry caused damage to his home. Until recently there was no accurate means for measuring such seismic vibrations and evaluating their damaging effects, if any, on adjacent structures. At the request of the quarry industry the Bureau of Mines undertook research to ascertain the physical characteristics of seismic disturbances from blasting in quarries and to evaluate their effect on typical structures. (258, p. 1)*

*For this and other references to authors and their works, see Bibliography.

The Bulletin from which the above is quoted is perhaps the latest and best study of the effects of quarry blasts from the standpoint of vibrational destructiveness of buildings. However, the investigation of the Bureau of Mines was of a practical character and left unanswered many important theoretical questions. One of these is the nature of the vibration itself as it exists in the building and its transformation as it passes into the building from the medium which surrounds it. To answer this question is the purpose of this dissertation.

In 1938 the Department of Geophysics of Saint Louis University was asked by some of the cement companies in the vicinity to record the intensity of their blasts on portable seismographs. The purpose of this project was to secure expert testimony on the quantitative effect of each blast - testimony which could be presented in court in the event of a lawsuit. The seismographs used by the field parties who measured these companies' blasts were vertical Taylor-Macelwane optically recording instruments. Many interesting phenomena were discovered, including the fact that the explosions were always well below the

"index of damage" of the Bureau of Mines (258), but it was felt that a detailed investigation would increase both the theoretical and the practical knowledge of what occurs in a blast.

One of the most interesting investigations is that of the actual form of the seismic wave in a building and its transformation as it passes into the structure. This research was undertaken by the writer, who considers himself fortunate in having performed it as a student of Geophysics in Saint Louis University. For, in the first place, he has had the cooperation of several quarry companies without which it would have been impossible to collect data, and secondly, he was privileged to work with the members of the Department of Geophysics who unselfishly gave him of their time and labor both in the field measurements and in the laboratory calibration of the seismographs. To these, Rev. Victor Blum, S.J., Brothers Ellis Haworth, S.J. and Nicholas Reeff, S.J., and Dr. Ross Heinrich, the author expresses his profound gratitude. Miss Florence Robertson and Dr. Edward Walter placed at the writer's disposal their unpublished research data -- a favor for which he can never be sufficiently grateful. Especially to Rev. James B. Macelwane, S.J., Director

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In the following dissertation the writer will present the results of his study. Chapter I will review historically the previous investigations of the problem so as to give the results achieved, indicate the controverted points, and outline the field of the present research. Chapter II will describe the method of that research, showing how the seismographs were designed and placed so as best to detect the various characteristics of the vibrations. Chapter III will develop the theory employed in computing ground or building motion from the photographic records. Chapter IV will outline the methods by which the theory was tested. Chapter V will present the data obtained in the form of graphs of building and ground vibrations. The characteristics of these vibrations will form the subject of Chapter VI, while the conclusions of the research will be given in Chapter VII.