SOME FACTORS INFLUENCING THE ENGINEERING PROPERTIES OF HAWKESBURY SANDSTONE

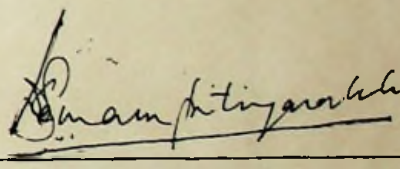
by

DON KANAKACHANDRA DE SILVA MAMPITIYARACHCHI,
B.Sc. (Eng) Hons, Sri Lanka

A thesis submitted to the University of New South Wales for the degree of Doctor of Philosophy

November, 1982.

This thesis has not been previously presented in whole or part, to any University or Institution for a higher degree.



D. K. De S. MAMPITIYARACHCHI

November, 1982.

Dedicated to -

MY PARENTS

ABSTRACT

The Hawkesbury Sandstone is a major rock unit within the Permian-Triassic sediments which form the Sydney Basin, Australia. It covers an area of about 12,5000 square kilometers and has a thickness of about 300 meters. As a result of its widespread occurrence in the region, particularly in the metropolitan area, it is of considerable importance to both the civil engineer and the geologist. This thesis examines the factors causing variations in the engineering properties of Hawkesbury Sandstone. An investigation has also been included to determine the suitability of crushed sandstone as a concrete and road aggregate.

The determination of the mechanical properties of fresh Hawkesbury Sandstone was carried out in the laboratory on small specimens of intact rock, free from obvious macroscopic discontinuities, sampled at different locations in accordance with the standard test procedures. A number of sandstone exposures, in the form of quarries and roadside cuttings, were examined to understand the natural processes of weathering occurring in the field. Samples of weathered rock, representing all stages of weathering, were also tested in the laboratory to determine the effects of weathering on the properties of this sandstone. Thin section studies were made on all fresh and weathered samples to study the mineralogy and the texture of the rock. The clay fraction of the rock was analysed using X-ray diffraction and differential thermal analysis techniques. Samples of fresh Hawkesbury Sandstone were also collected in the field

to produce crushed aggregates having a nominal particle size of 19 mm. Two trial mixes of concrete were made in the laboratory using crushed sandstone as the coarse aggregate. After curing, the strength and the deformation measurements of concrete were made.

The stress-strain relationship of Hawkesbury Sandstone subject to uniaxial compression exhibits strong non-linearity at low stress levels. The results obtained in the measurement of mechanical properties of sandstone showed wide variations. The analysis of these results based on statistical techniques, revealed that the material characteristics of the rock, such as density, porosity, moisture content, mineralogy and texture, significantly influence the strength properties and the modulus of elasticity of the rock.

The physical processes of weathering appears to be more widespread than the chemical process and cover a number of changes. These changes include opening of discontinuities and formation of new discontinuities in the rock mass; opening of grain boundaries and grain fracturing in the rock material. Alternate wetting and drying was found to be the most significant single process of weathering which contributes largely towards the degradation of the rock. The strength and modulus of elasticity of the weathered rock were appreciably lower than those of fresh rock.

The failure of certain properties of the sandstone aggregate to satisfy the limits set by the currently available specifications has proved it to be an unsatisfactory material in the upper courses of a road-pavement. The

success of its use in the lower courses, mainly in the sub-base, depends on its grading, durability and stability to environmental and traffic variations. The performances of crushed sandstone as a concrete aggregate where much poorer than those of conventional types of aggregates.

ACKNOWLEDGEMENTS

I wish to acknowledge and to express my appreciation to Professor F.C. Beavis for his continuous encouragement, assistance and advice offered throughout the experimentation and in the presentation of this thesis, as the Project Supervisor.

Grateful acknowledgement is extended to Dr. M.J. Knight who acted as supervisor for some time, Dr. A.K. Bhattacharyya of the School of Mining Engineering for the valuable advice offered in planning the experimental procedure, Dr. C.Y. Chork for the assistance provided in performing regression analysis of the results and Dr. F.I. Roberts for the several discussions and for reading the manuscript.

I wish to thank Mrs. Swarna Perera for the assistance provided in the preparation of Appendices. The help provided by the general and technical staff of the School of Applied Geology is appreciated.

Much of the material used in this project was obtained from a number of quarries. I wish to acknowledge the co-operation given by the management of those quarries in the collection of field samples. The Department of Mines, N.S.W., provided rock cores used in this study. The use of equipment of the School of Mining Engineering during the experimentation is also acknowledged with many thanks.

I am deeply indebted to my employer, University of Moratuwa, Sri Lanka, for granting leave of absence, and to the Australian Government for providing financial assistance

to undertake this thesis. I wish to thank the Australian Development Assistance Bureau for its continuous interest during my period of award.

Finally, I wish to record my great appreciation to my wife, Thilaka, and many others for their continuous support throughout the period of study and the preparation of this thesis.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES

LIST OF TABLES