

**A STUDY ON MARINE SAND AS A JOINTING MATERIAL FOR
CONCRETE BLOCK PAVEMENT**

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requirements for the award of the degree of
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I dedicate my thesis to my beloved mother, father, brother, sister, grandpa, grandma, and all my family who always supported me in everything all the time.

My thesis is also dedicated to all my friends who always helped me in completing my research.

Thank You.

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ABSTRACT

Concrete block pavement performance depends on many factors. Jointing material is one of the components that affect the performance of concrete block pavement. As there are many coastal areas around the world, then marine sand may replace the river sand as jointing material. The massive availability of marine sand and the ease of transportation make this material to be selected as a replacement for river sand. This paper presents a study of laboratory research of jointing material that was made from marine sand and mixtures of marine sand and Portland cement in comparison with river sand. The pavement was tested by push-in test and pull-out test under circumstance which was wetted condition. Water seepage test and erosion test were also conducted in this study. This research used 3 mm joint width, two cement percentages (6% and 8%), and three durations of after rain time (1 day, 3 days, and 7 days). The best performing jointing material for push-in test and pull-out test was shown by mixture of marine sand and 6% of Portland cement. In the water seepage test and erosion test, the best performing jointing material was show by mixture of marine sand and 8% of Portland cement.

ABSTRAK

Prestasi turapan blok konkrit bergantung pada banyak faktor. Bahan sambungan adalah salah satu komponen yang mempengaruhi prestasi turapan blok konkrit. Oleh kerana ada banyak daerah pesisir di seluruh dunia, maka pasir laut mungkin dapat menggantikan pasir sungai sebagai bahan sambungan. Ketersediaan pasir laut yang besar dan kemudahan pengangkutan membuat bahan-bahan ini dapat dipilih sebagai pengganti pasir sungai. Laporan ini menyajikan kajian penyelidikan makmal bahan sambungan yang dibuat dari campuran pasir laut dan; pasir laut dan simen Portland yang akan dibandingkan dengan pasir sungai. Turapan yang diuji dengan uji tekan dan uji tarik berada dalam keadaan yang sudah dibasahi oleh hujan buatan. Uji rembesan air dan uji hakisan juga dilakukan dalam kajian ini. Penelitian ini menggunakan jarak sambungan 3 mm, dua peratusan simen (6% dan 8%), dan tiga jangka waktu dari selepas waktu hujan (1 hari, 3 hari, dan 7 hari). Bahan sambungan yang paling baik untuk uji tekan dan uji tarik ini ditunjukkan oleh campuran pasir laut dan 6% simen. Pada uji rembesan air dan uji hakisan, bahan sambungan yang paling baik adalah campuran pasir laut dan 8% simen.

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CHAPTER 1

INTRODUCTION

1.1 Background

Road pavement is an essential part of a road to provide a good driving quality. There are three kinds of road pavement which are usually used; asphalt pavement (flexible pavement), concrete pavement (rigid pavement), and concrete block pavement. Concrete block pavement is one of the popular pavement systems because of many factors. The ease of application is one of the factors.

Concrete Block Pavement (CBP) is made of interlocking blocks that are set on a compacted base of sand or sand and gravel. Jointing sand is vibrated into the space between the units, causing them to interlock, forming a tough, beautiful paved surface that is easily maintained. The history of concrete block paving dates back to 19th Century when paving stones were used in European countries for construction of roads serving as footpaths and tracks for steel-wheeled vehicles. Concrete block paving is presently used throughout most of the world, providing wearing surfaces ranging from lightly-loaded pedestrian precincts to heavily-loaded industrial areas such as dockside paving.

There are four basic components in CBP. The components are pavers, bedding and jointing sand, base course and sub-base, and sub-grade. Each component is affected by some factor. For example, bedding and jointing sand are affected by sand thickness, grading, angularity, moisture, and mineralogy. The sand between the pavers i.e. jointing sand lets them transfer loads to adjacent units. The joints eliminate cracking typical to asphalt or poured concrete pavements. Interlocking concrete block pavements have a host of repair advantages over conventional pavements. The pavements can be removed easily and re-used after repairs to underground utilities are completed.

There are some studies for concrete block pavement and jointing sand is one of the areas being studied. Some studies try to get the perfect jointing sand by mixing it with additive agents. For example by mixing the jointing sand with cement. This mixture will have its own properties that can perform better. This report presents a research about jointing sand made from mixtures of marine sand and Portland cement. The pavement was wetted by an artificial rainfall and tested in certain times later. Portland cement starts to harden after 45 minutes to 10 hours according to the British Standard and ASTM. Even though cement reacts in a short time, it still needs to be tested for the performance when mixed with marine sand. The mixtures were also tested for water seepage through the pavement. In addition, the first three days are most critical in the life of Portland cement concrete. In this period, the hardening concrete is susceptible to permanent damage. After 7 to 14 days, the concrete compressive strength may result in 70-85 % of the 28 days strength.

1.2 Problem Statement

Jointing material in concrete block pavement is a vital part of the pavement. The material for jointing is made from sieved river sand. As there are many coastal areas around the world, then marine sand may replace the river sand as jointing

material. The massive availability of marine sand and the ease of transportation make this material to be selected as a replacement for river sand.

As an unbound material, jointing material is sensitive to erosion. The solution to the erosion problem is by adding an additive material such as Portland cement to hold the sand grains from erosion. The cement must be in low percentage (<10%) in order to prevent the pavement from becoming a rigid pavement. The addition of cement may also strengthen the pavement itself.

1.3 Objectives

The objectives of this study were to:

1. Investigate the performance of marine sand and mixtures of marine sand and Portland cement as jointing materials in comparison with river sand.
2. Determine the best performing material or mixture for jointing sand.

1.4 Scopes of Study

The scopes of study were:

1. This study was limited to jointing sand only.
2. The materials for jointing sand were marine sand, mixture of marine sand and cement; and river sand.
3. Rectangular paving blocks were used in this study.
4. The area width was 161 cm x 91 cm with 3 mm gap width in 90° herringbone pattern. The content of the additive material were 0%, 6% and 8%. The additive material percentages were taken from the previous study for the best result (6% - 8%).

5. Portland cement was used as the additive material.
6. The artificial rain was based on the real rainfall intensity data from the meteorological station in Malaysia.
7. The tests were conducted in various times after the pavement was wetted with water. The times are 1 day, 3 days, and 7 days after.
8. The testing equipment was the push-in and pull-out testing machine available at the Highway and Transportation Laboratory of Universiti Teknologi Malaysia.

1.5 Significant of Study

Jointing material was used to fill the joints of concrete block pavement. The usage of marine sand instead of river sand was to get a replacement material for jointing material in coastal area. The addition of Portland cement in jointing material was to get a better concrete block pavement performance. When it rains, the cement reacted with water (rain) and held the sand grains from erosion. This condition also strengthened the pavement system. This study was to determine the change in performance of concrete block pavement due to the addition of cement to the jointing material.

1.6 Thesis Organization

This thesis consists of five chapters, and the contents of each chapter are explained as follows:

CHAPTER 1: This introductory chapter presents the background of the development of Concrete Block Pavement (CBP) used throughout world. It also explains the statement of problem, objective, and scope of the study and the significance of this research.

CHAPTER 2: This chapter reviews the component of CBP. The application of jointing material made from mixture of sand and additive material such as cement from previous study is also discussed in this chapter.

CHAPTER 3: This chapter presents testing methodology used in this research. The equipment were available in highway and transportation laboratory of Universiti Teknologi Malaysia.

CHAPTER 4: This chapter contains the analysis about the test data. The results from all tests are presented in this chapter. The finding and discussion about the results also presented in this chapter.

CHAPTER 5: This chapter summarizes the main conclusions of this research and recommendations are made.