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TEKNOLOGI  
MARA

Faculty of Civil Engineering

A  
Collection of  
Abstracts 2

A  
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of  
Abstracts 2



Universiti Teknologi MARA

**Faculty of Civil Engineering**

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## **FOREWORD**

In accordance with the mission of our faculty to develop expertise and provide academic programmes in the field of civil engineering through excellence in research and consultancy, faculty members are encouraged to participate in the research activities and not only being a teaching staff. For the past two years, significant academic writings have been produced through the provision of internal and external grants.

This second volume of collection of abstracts is published to keep proper records of knowledge development that are being presented and published in the conferences and journals respectively. Apart from that, it will also act, as a platform to promote our faculty intellectual assets to the market of engineering research and consultancy at the national and international level. The documentation of these abstracts, will serve as a knowledge bridge between senior and junior members of the faculty.

In this volume, the abstracts are categorised into four specified areas: Geotechnical, Highway and Survey Engineering; Structural and Computer; Water Resources and Environmental and Concrete Technology and Construction Materials.

I would like to express my sincere appreciation to all of our faculty members for their commitment and contribution to the success of our faculty. I also wish to convey my sincere gratitude to the valuable input and contribution of the members of the Editorial team for the compilation of this second volume, on "A Collection of Abstracts 2".

Assoc. Prof. Ir. Dr. Mohd Yusof Abdul Rahman  
Dean,  
Faculty of Civil Engineering  
Universiti Teknologi MARA

## **PREFACE**

This collection of abstracts is the second in the series of documenting research activities undertaken by the staff members of Faculty of Civil Engineering, Universiti Teknologi MARA.

This is a continuous effort by the faculty to compile abstracts produced by faculty members. The collection in this volume represents papers that were presented or published in year 2003 and 2004. Compare to the first compilation of abstract, A Collection of Abstracts, this task is relatively easier. However, the process of retrieving the abstracts from faculty members was solely dependant on their cooperation. Again, the busy schedule of faculty members made it difficult for them to respond for the contribution of abstracts. Therefore, the editors must admit that the abstracts collected here do not represent the entire collection of academic writings by our faculty members.

The editors hope that the efforts of compiling these abstracts would benefit the faculty members and the civil engineering world in general, and at the same time, promoting Faculty of Civil Engineering, Universiti Teknologi MARA to the international level. A faint ink is better than a strong memory. Therefore, the editors also hope that this on-going task would continue by the present editors or other faculty members to publish the future collection of abstracts periodically.

Finally the editors would like to express appreciation to all faculty members for their cooperation and Cik Norhafeza Hamzah for her contribution in the typing work.

The Editors  
Faculty of Civil Engineering  
Universiti Teknologi MARA

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**Geotechnical, Highway & Survey Engineering**

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# **A COMPARATIVE STUDY FOR STRENGTH DETERMINATION OF WEAK ROCK**

Zainab Mohamed<sup>1</sup>  
Ibrahim Komoo<sup>2</sup>  
Abd Ghani Rafek<sup>2</sup>  
Nurul Aini Osman<sup>3</sup>

## **ABSTRACT**

A rock material characterization is normally carried out for feasibility study and construction purposes. It is recommended that the physical and mechanical properties of the rock material must be quantified as much as possible to assess its quality so as a suitable engineering design and construction approach can be accordingly applied. Strength index of rock material is one of the vital parameter used in order to conclusively classify the quality of the rock mass for design purposes. Sampling of weak rock has always been the problem that a standard testing procedure may not fit well to assess the material strength. From a comprehensive laboratory study the problems encountered when testing weak and weathered rock material is highlighted. It is recommended that when standard procedure is not possible a modification of testing technique, sampling procedure, analytical approach or ultimately an alternative testing method shall be carried out. From the study conducted shows that this can be a reliable approach to predict the strength index of weak rock.

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**Keywords:** Rock mass characterization, rock strength, weathered rock, weak rock

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16-18 March 2004**

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## **A LABORATORY ASSESSMENT OF WEAK ROCK: A PRESENT KNOW-HOW**

Zainab Mohamed<sup>1</sup>  
Abd. Ghani Rafek<sup>2</sup>  
Ibrahim Komoo<sup>3</sup>

### **ABSTRACT**

A weak rock mass is categorised as a problematic ground by most geotechnical engineers especially in tropical climate like Malaysia. This is due to its physical state that lays between rock-like to soil-like behaviour with heterogeneous structural discontinuities pattern. However physical and mechanical properties of weak rock need to be classified as detailed as possible for better understanding of the material properties representing its potential rock mass behaviour. Unfortunately very limited engineering testing has been carried out so far due to difficulty in sampling and limitation of sample recovery. To a certain extend engineers normally opt for an in-situ test or tends to omit laboratory test from the work schedule. A comprehensive laboratory study was carried out to design the methodology in an attempt to determine the physical properties and strength of weak rock material. It has shown that the physical and engineering properties of weak rock material can be quantified in order to accurately estimate its engineering properties for design and construction purposes. The standard testing procedure needs to be revised to suit the material condition. A sound understanding of soil and rock testing fundamental is vital so as the result obtained shall not be misleading.

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**Keywords:** Weak rock, weathered rock, strength index, structural discontinuities

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# **APPLICATION OF THE BINDER DRAINAGE TEST FOR A POROUS MIXTURE**

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Dr. Meor Othman Hamzah<sup>1</sup>  
Kim Hion-Joon<sup>2</sup>

## **ABSTRACT**

Binder drainage occurs with mixes of small aggregate surface area particularly porous asphalt. The binder drainage test, developed by the Transport Research Laboratory, UK, is commonly used to set an upper limit on the acceptable binder content for a porous mix. This paper presents the results of an investigation to determine the effects of different binder types, binder contents and percentages of additive on the binder drainage characteristics of a porous mix. The three binder types used are the conventional 60/70 pen bitumen, 60/70 pen bitumen with varying percentages of DAMA (Drain Asphalt Modified Additive) and SBS modified bitumen. The amount of binder lost through drainage after three hours at the maximum mixing temperature is measured in duplicate for mixes with the same quantity of aggregate contents but with different binder contents. The maximum mixing temperature adopted depends on the types of binder used. The retained binder is plotted against the initial mixed binder content, together with the line of equality where the retained binder equals the mixed binder content. The results indicate the significant contribution of incorporating additive to minimize drainage in varying degrees depending on modified type and quantity. Their significance is discussed in terms of target binder content, the critical binder content, the maximum mixed binder content and the maximum retained binder content values obtained from the binder drainage test.

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**Keywords:** Porous asphalt, binder drainage, binder, target binder content

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# **DEGRADATION AND ABRASION OF RECLAIMED ASPHALT PAVEMENT AGGREGATES**

Juraidah Ahmad  
Mohd Yusof Abdul Rahman  
Khafilah Din

## **ABSTRACT**

Reclaimed asphalt pavement is considered waste product from rehabilitation works of old pavements. However, it is a common practice to recycle the material back into roadway by incorporating into asphalt paving. Its incorporation is either by hot or cold recycling technique or sometimes used in base or sub-base construction. The aggregates of the Reclaimed Asphalt Pavement material are still valuable and in fact still retain the properties as required for use in virgin mix of the wearing course. This study focused on the aggregates extracted from reclaimed asphalt from both milling and full depth method of recovery which can cause degradation to the aggregates. The aggregates obviously degrade by further refinement of aggregate size but still maintain substantial strength to resist wear and abrasion. The gradation of the extracted aggregates showed that the bulk volume of aggregates retained on sieves size 3.35 mm and 1.8 mm which allow the aggregates to be considered for potential use in virgin mix.

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**Keywords:** Reclaimed asphalt, road pavement, degradation, abrasion properties

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# **GEOMECHANICAL BEHAVIOUR OF INTERBEDDED ROCK MASS OF KENNY HILL FORMATION, SELANGOR, MALAYSIA**

Zainab Mohamed<sup>1</sup>  
Abdul Ghani Rafek<sup>2</sup>  
Ibrahim Komoo<sup>3</sup>

## **ABSTRACT**

It requires an integrated understanding of rock and soil materials behaviour as well as its principles of mechanics to predict the potential performance of interbedded sandstone and shale forming Kenny hill rock masses. A series of physical and mechanical tests such as density, hardness, textural study and slake durability were carried out on sandstone and shale materials followed by a point load and uniaxial compressive strength index tests. The objectives were to gauge the deterioration of material properties and strength due to wet tropical weathering. Results showed that wet tropical climate imposed a unique and an aggressive weathering of interbedded rock mass resulted to more than one mode of weathering features. An empirical correlation was developed so as the strength behaviour of the sandstone and shale as a composite rock mass can be interpreted

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**Keywords :** Kenny hill rock masses, deterioration, tropical weathering, aggressive weathering, composite rock

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## MODIFICATION OF AGGREGATE GRADING FOR POROUS ASPHALT

Muhammad Mohktar Samat<sup>1</sup>  
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### ABSTRACT

In the 1970's, the fatality on Malaysian roads exceeded 20. In 1991, a Cabinet Committee on Road Safety was set up to come up with measures to reduce the predicted number of deaths by 30% or translated into a fatality index of 3.14 by the turn of the century. Among the measures suggested included the application of porous asphalt. Up to now, a number of major trunk roads have been paved with porous asphalt. This paper describes the method used to modify a porous asphalt gradation from Korea to suit Malaysian quarry practice. The method involved fabricating porous mixes according to four trial gradations and comparing them with mix properties stipulated in the Korean specifications. The adopted gradation is a trade-off between mix stability and permeability. Samples using this gradation were prepared using 60/70 conventional bitumen and 1% Drain Asphalt Modified Additive (DAMA) and their design binder content determined from the results of the laboratory binder drainage and Cantabrian test. The specimens were then evaluated for Marshall stability and resilient modulus at the design binder contents. The results indicate an improvement in mix properties with the addition of 1% DAMA.

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**Keywords:** Aggregate gradation, porous asphalt, stability, permeability, binder drainage

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**SOIL EROSION ESTIMATION IN LOWLAND AGRICULTURAL AREAS  
USING UNIVERSAL SOIL LOSS EQUATION (USLE) - A CASE IN FELDA  
JENGA 15, PAHANG**

Khairi Khalid  
Elias Mohd Den.

**ABSTRACT**

This short treatise is a small attempt to estimate the amount of soil erosion annually for a lowland agricultural area in FELDA Jengka 15, Pahang employing a widely used mathematical formulation for soil erosion, the USLE. The contributing area under study is around 1574.84 hectares and this is quite a sensible area in order to derive a suitable and sound indication for its erosion problems. On the other hand this is particularly important from a management side since it reflects how effective FELDA handles the erosion problems. The value the annual loss computed for three stages under due considerations; the site clearing (phase I), earthwork activities (phase II) as well as the planting stage (phase III) indicated that the erosion problems are generally *temporary* and found to be more severed during site clearing and earthworks prior to the re-establishment of the vegetations. These values (*4.78/0.57/0.17 tons/hectare/year*) for phase I, II and III respectively also gave us an indication that the study area falls under a *low category* soil loss (Agricultural Department)

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**Structural & Computer**

# **BEHAVIOUR OF SINGLE AND TWIN-WEBBED PROFILED WEB GIRDER UNDER SHEAR LOAD**

Hanizah Abdul Hamid<sup>1</sup>

Azmi Ibrahim<sup>1</sup>

Md. Hadli Abu Hassan<sup>2</sup>

## **ABSTRACT**

Normally, a conventional plate girder involves the use of intermediate stiffeners in relatively slender web plates to avoid catastrophic failure associated with shear buckling of the web. The process involves introducing cold-formed ribs into a flat steel sheet to form alternative stiffeners. The present study therefore seeks to establish comparative performance of conventionally stiffened plate girders and profiled web girders of a specially formed rib arrangement with single and also double webs. Five specimens were tested to failure under a three-point-bending system with the web in each case designed to resist only shear and the flanges designed to resist only bending. Failure of all the profiled web girders, with either a single or double webs, is characterised by a shorter yield plateau and a steeper descending branch. Such failure mode is commonly referred to as 'brittle'.

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**Keywords:** Plate girder, shear buckling, profiled web

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# BUCKLING OF SINGLY AND DOUBLY-WEBBED CORRUGATED WEB GIRDERS UNDER SHEAR LOADING

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## ABSTRACT

Normally, a conventional plate girder involves the use of intermediate stiffeners in relatively slender web plates to avoid catastrophic failure associated with shear buckling of the web. In this study, a corrugated web was used to replace the transversely stiffened web, the former being cut from a commercial profiled steel sheet (PSS). Two specimens namely, SWCWG and DWCWG were tested to failure under a three-point-bending system with the webs in each case designed to resist only shear and the flanges designed to resist only bending, and DWCWG differs from SWCWG in that it had two PSSs with the ribs riveted instead of one (designated SWCWG). Failure of both systems was characterised by a shorter yield plateau and a steeper descending branch.

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**Keywords:** Shear buckling, singly-webbed corrugated web girder (SWCWG), doubly-webbed corrugated web girder (DWCWG)

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Proceedings of the 2<sup>nd</sup> Technical Post Graduate Symposium,  
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## **BUTT JOINT IN DRY BOARD AS CRACK ARRESTER**

Siti Hawa Hamzah  
Yong Chua Bon  
Wan Hamidon Wan Badaruzzaman

### **ABSTRACT**

An experimental investigation was carried out on nine (9) PSSDB walls with window opening. Butt joint in dry board was introduced at the mid section and along sides of opening in which its effect was significant in reduced number of cracks by about 33% and 22 % respectively in comparison to samples without butt joint. All cracks only occurred on the sides of the window opening in samples with butt joint. For samples without butt joint, they showed crack pattern initiation under flexural on upper middle portion of opening which later propagated to the top of the wall, then to the top corners and bottom of the opening as the load increased. Some cracks were observed to pass through screw positions. Introduction of butt joint in the dry board reduces the number of crack lines and act as crack arrester.

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Organisation (CAFEO 22), Myanmar, 18 – 19 December 2004**

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## **CRACK PATTERNS IN PROFILED STEEL SHEET DRY BOARD WALL PANEL WITH OPENING**

Siti Hawa Hamzah <sup>1</sup>

Yong Chua Bon<sup>1</sup>

Wan Hamidon Wan Badaruzzaman <sup>2</sup>

### **ABSTRACT**

Profiled Steel Sheet Dry Board (PSSDB) wall panels with door and window openings were tested and crack patterns identified. The tested panels were fixed at 1000 mm high by 600 mm wide. Results showed that the initial cracking loads were between 81 kN to 186 kN and 47.6 kN to 107.5 kN for walls with door and window openings respectively. Flexural cracks were seen initiated under bending at the upper portion of the opening and were propagated to the top of the wall. As load increased, more cracks propagated from the top of two corners of the opening to the top of the wall. The screws remained intact until a stage was reached where some of the screws were observed to lose their grip which causes lateral displacement to increase rapidly and failed. The final failure mode was concluded to be a combined crushing and lateral buckling on the sides of the panel.

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**Keywords:** Crack patterns, profiled steel sheet dry board (PSSDB) wall panel, openings, cracking loads, flexural cracks

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## **EFFECT OF BUTT JOINT IN DRY BOARD IN PSSDB WALL PANEL WITH WINDOW OPENING**

Siti Hawa Hamzah  
Yong Chua Bon  
Nadiah Sa'ari  
Mat Som Marwi

### **ABSTRACT**

An experimental investigation was carried out to determine the effect of butt joint on the structural behaviour of profiled steel sheet dry board (PSSDB) load bearing wall with window opening. The samples tested were three (3) PSSDB walls with window opening and butt joint in the dry boards, and three (3) PSSDB walls with window opening but without butt joint in the dry boards. The samples were subjected to axial compressive load and comparisons were made between the two sets of samples. The average value of the ultimate load capacity for PSSDB load bearing wall with butt joint was found to be 286 kN, while that for the samples of PSSDB load bearing wall without butt joint was 260 kN. The average maximum lateral deflection values for both types of PSSDB walls were 8.9 mm and 13 mm respectively. Significant difference due to butt joint in dry board was seen in the reduced number of cracks by about 33% in comparison to that without butt joint.

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**Keywords :** Profiled steel sheet dry board, butt joint, ultimate load capacity, lateral deflection, cracks

# FATIGUE LIFE OF BOLT SUBJECTED TO FATIGUE LOADING CONDITIONS

Khafilah Din  
Mohd Tajol Hasnan Ghazali

## ABSTRACT

With the aim to create awareness amongst designers and to establish database on fatigue life of bolt, this experimental study was conducted. Two sizes of High Strength Friction Grip (HSGF) bolt were chosen and they were subjected to low and high cycle constant amplitude loading condition. Each of them undergone 4 different stress ranges and at 3 means stress level. Three bolts from each size were tested under static loading in order to obtain their mechanical properties. Unlike for high cycle fatigue, the low cycle fatigue where  $S_{max}/s_y$  is more than 50%, the fatigue life of bolt is not significantly influenced by the mean stress and the stress range. The reduction in fatigue life is quite alarming. The average slope of S-N curve in which indicates the rate of crack growth is in the range of 2 to 3 which is within the range of welded members. This work also suggests an alternative terminology of stress and the important of establishing S-N curve for designing of bolt against fatigue.

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**Keywords:** Bolt, fatigue life, constant amplitude loading, S-N curve, low-high cycle fatigue

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## INTRODUCTORY COMPARISON BETWEEN BS5950 & EC3

Ir. Dr. Sooi Took Kowng<sup>1</sup>  
Ir. Teoh Teck Seng<sup>2</sup>

### ABSTRACT

The Eurocode emerges to harmonize the technical specification within a single European Union. In particular, the United Kingdom (UK) steel design code BS5950 will be made obsolete and replaced by EuroCode 3 (EC3) in the year 2008. It is envisioned that the transition from BS5950 to EC3 in Malaysia will run parallel to that in the UK. This paper is an introduction to the general rules and design principles of structural members using EC3, and the comparison with that using BS5950. It is shown that the design philosophies, material grades, section classification are the same in both codes; no major differences to the design recommendation of structural steel members are anticipated. However, the symbols, nomenclature, subscripts, axis definition and other documentation formats are different in the two codes. Accordingly, the documentation of the design will be different when using EC3 compared to BS5950.

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**Keywords :** Eurocode 3, BS5950, load factors, partial safety factors, steel grades, section classification, tension member, compression member, column capacity, beam capacity, shear capacity

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## PROFILED WEB GIRDER UNDER SHEAR LOAD

Hanizah Abdul Hamid<sup>1</sup>

Azmi Ibrahim<sup>1</sup>

Md. Hadli Abu Hassan<sup>2</sup>

### ABSTRACT

A conventional plate girder involves the use of transverse intermediate stiffeners, especially in a slender web to avoid catastrophic failure associated with shear buckling of the web. In this study, a profiled web was used to replace the transversely stiffened web. The process involves introducing cold-formed ribs into a flat steel sheet to form alternative stiffeners. Available laboratory and field performance data of profiled web girders have so far been confined to not only standard profiled steel sheet but also girders of a single web. The present study therefore seeks to establish comparative performance of conventionally stiffened plate girders and profiled web girders of a specially formed rib arrangement with a single and also double webs. Three specimens were tested to failure under a three-point-bending system with the web in each case designed to resist only shear and the flanges designed to resist only bending. Failure of all the profiled web girders, with either a single or double webs, is characterised by a shorter yield plateau and a steeper descending branch, a failure mode that is commonly referred to as 'brittle'. It was observed that the web sub-panels and that the diagonal tension field are anchored at the junctions between the ribs or stiffeners, and the flanges.

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**Keywords** : Shear buckling, profiled web

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**Proceedings of the 5<sup>th</sup> Asia Pacific Structural Engineering and Construction Conference, Johor Baharu, August 2003**

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## **SAND CEMENT BRICKS AS LOAD BEARING WALLS**

Kartini Kamaruddin  
Siti Hawa Hamzah

### **ABSTRACT**

Conventional approach in design and construction of buildings are built based on frame structure using reinforced concrete, steel or timber as structural member for load transmittal to the foundation. Bricks are normally used as infill materials in such framed structures. However, research has shown that bricks can also be used as an external and internal load bearing walls. With the use of this structural masonry method of construction, cheaper and faster construction can be achieved. The savings in terms of using formwork and reinforcing steel can be made and the rate of construction can be reduced since frames are less or not required at all and the waiting time for the structural concrete to cure or gain their strength can be eliminated. Kartini & Siti Hawa (2001, 2003) in their preliminary studies to determine the physical properties of a brick and a structural behaviour as a wall of sand cement brick found out that the locally produced sand cement bricks are suitable to be used as load bearing wall. It also shows a better performance, with maximum lateral displacement of 3.81 mm, vertical deflection of 6.63 mm and ultimate load of 448.13 kN.

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**Keywords :** Sand-cement brick, structural masonry, vertical deflection, lateral displacement and ultimate load

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**Proceedings of the 8<sup>th</sup> International Conference on Concrete Engineering and Technology (CONCET 04), Kuala Lumpur, Malaysia, 19-21 April 2004**

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# STRUCTURAL BEHAVIOUR OF PROFILED STEEL SHEET DRY BOARD SYSTEM WALL PANEL WITH DOOR OPENING

Siti Hawa Hamzah<sup>1</sup>  
Yong Chua Bon<sup>1</sup>  
Wan Hamidon Wan Badaruzzaman<sup>2</sup>

## ABSTRACT

Profiled steel sheet dry board (PSSDB) system as load bearing wall is structurally efficient and economical in transferring loads to the foundation. This paper describes an experimental investigation of the behaviour of PSSDB wall panels under axial load. PSSDB walls with door opening were tested to study the performance as load bearing wall. A proprietary profiled steel sheet, Bondek II (1.00 mm thick), by two Cemboard (12 mm thick) on its front and back sides, via self-drilling, self-tapping screws spaced at 100 mm centre to centre vertically, were used for the tests. The tested panels were fixed at 1000 mm high by 600 mm wide and 78 mm thick. The opening was cut to a size of 680 mm high by 186 mm wide. The results showed that the ultimate loads at failure were between 174 kN to 237 kN and the maximum lateral displacements were between 4.27 mm to 5.68 mm. Flexural cracks were seen initiated under bending at the upper portion of the opening and propagated to the top of the wall. The sudden decreased in cross-sectional area of the wall panel caused other cracks at upper corners of the opening. Further increased in loading, the sides of the wall that acted like columns started to buckle. The final failure mode was a combined crushing and lateral buckling.

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**Keywords:** Profiled steel sheet dry board, door opening, butt joint

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Proceedings of the 5<sup>th</sup> Asia-Pacific Structural Engineering and Construction Conference (APSEC), 26 - 28 August 2003

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# **THE COLLAPSED SKYSCRAPER : AN OVERVIEW WITH A CASE STUDY**

Wardah Tahir

## **ABSTRACT**

The World Trade Centre (WTC) could have survived or at least there could have been enough time for evacuation if only the skyscraper was covered with concrete. Concrete cover would reduce the effect from the tremendous heat (800°C) of the aviation fuel from melting the steel structure like cooked spaghettis. While lack of concrete is said to be one of the main reasons of WTC failure, concrete building is mentioned to be one of the biggest problems in earthquake zone. The paper presents a general overview of collapsed concrete buildings; the reasons for failure and recommendations to reduce failure with examples from several case studies.

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**Keywords :** WTC failure, collapsed, concrete building

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**World Conference on Concrete Materials and Structures, Shah Alam, Malaysia,  
14-16 May 2002**

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## **THE EFFECT OF BUTT JOINT ON THE STRUCTURAL BEHAVIOUR OF PSSDB WALL PANEL**

Siti Hawa Hamzah  
Yong Chua Bon  
Nadiah Saari @ Ash'ari  
Mat Som Marwi

### **ABSTRACT**

An experimental investigation was carried out to determine the effect of butt joint on the structural behaviour of Profiled Steel Sheet Dry Board (PSSDB) load bearing wall with window opening. The samples tested were three (3) PSSDB walls with window opening and butt joint in the dry boards, and three (3) PSSDB walls with window opening but without butt joint in the dry boards. The samples were subjected to axial compressive load and comparisons were made between the two sets of samples. The average value of the ultimate load capacity for PSSDB load bearing wall with butt joint was found to be 286 kN, while that for the samples of PSSDB load bearing wall without butt joint was 260 kN. The average maximum lateral deflection values for both types of PSSDB walls were 8.9 mm and 13 mm respectively. Significant difference due to butt joint in dry board was seen in the reduced number of cracks by about 33% in comparison to that without butt joint

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**Keywords:** Profiled steel sheet dry board, window, butt joint

## **THE LONG CANTILEVER STEEL ROOF - THE LOCAL EXPERIENCE**

Ir. Teoh Teck Seng<sup>1</sup>  
Ir. Dr. Sooi Took Kowng<sup>2</sup>

### **ABSTRACT**

The building industry has undergone tremendous changes to cope with steel structures with fancy geometry to satisfy the client's and architect's requirements. These challenging structures require close cooperation between the consultant's and the specialist contractor during every stage of the project. This paper is a case study of the planning, design and construction of one such structure – a recently completed 14.8m long cantilever steel roof constructed locally.

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**Keywords:** Long span cantilever roof, analysis, design and construction

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## **A CASE STUDY ON STRENGTH AND TREATABILITY OF MUNICIPAL WASTEWATER IN THE KLANG DISTRICT**

Iberahim Jantan<sup>1</sup>  
Zuhaida Mohd Zaki<sup>2</sup>  
Suhaimi Abdul Talib<sup>2</sup>  
Junaidah Ariffin<sup>2</sup>

### **ABSTRACT**

The characteristic strength of municipal wastewater is typically expressed as either the chemical oxygen demand (COD) or the five-day biochemical oxygen demand (BOD<sub>5</sub>). The COD gives the oxygen demand due to chemical oxidation while the BOD<sub>5</sub> gives the oxygen demand due to microbial processes over five-day duration.

The treatability of wastewater depends to a large extent on the biodegradability of the wastewater constituents. BOD<sub>5</sub> provides a good estimate on the treatability of municipal wastewater. However, determination of BOD<sub>5</sub> requires five days compared to COD, which requires only approximately 4-5 hours. A relationship between these two parameters, if established will enable the BOD<sub>5</sub> to be estimated when the COD is known.

This paper presents the results of an investigation to establish the relationship between BOD<sub>5</sub> and COD. From the analysis of 304 samples taken from 14 wastewater treatment plants in the Klang area, it was established that the ratio of BOD<sub>5</sub> to COD lies between 0.42 - 0.51. This indicates that a high proportion of the wastewater constituent is biodegradable, thus relatively easy to treat.

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**Keywords :** Biological oxygen demand, chemical oxygen demand, treatability, wastewater strength.

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**FKA-NASEC Joint Seminar on Research in Civil Engineering,  
Cameron Highlands, Pahang, Malaysia, 12-14 September 2003**

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## ADVANCES IN STUDIES ON SEWER BIOFILMS

Suhaimi Abdul Talib

### ABSTRACT

Rapid developments in research related to sewer processes have taken place over the last ten years. Presently studies on processes under anoxic conditions have gained momentum as there is high potential of applying findings from such investigations to suppression of hydrogen sulphide formation in sewers.

Studies on anoxic transformation under sewer condition were initiated by Abdul-Talib *et al.* (2001). Kinetics of anoxic transformation in the bulkwater phase have been established. This paper presents works on anoxic transformation in the biofilm phase under sewer conditions. Results on denitrification path and nitrate/nitrite utilization rates in the biofilm phase are presented in this paper.

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**Keywords:** Anoxic transformation, nitrate utilization rate, nitrite utilization rate, sewer biofilm

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**Seminar on Advances on Research Sewer Processes, Shah Alam, Selangor,  
Malaysia, 12 Febuary 2004**

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## ANOXIC CONDITIONS IN MUNICIPAL WASTEWATER

Rozita Aris  
Suhaimi Abdul Talib

### ABSTRACT

Design of sewers to incorporate the processes dimension, in addition to the hydraulics dimension is currently hindered by the lack of fundamental knowledge on process kinetics governing the microbial processes. A model concept describing anoxic transformation has been proposed by Abdul-Talib *et al.* (2001b). However, the kinetic parameters needed for the model have not been fully established.

This paper describes the state of the art apparatus and experimental procedure for determining nitrite utilisation rates and half saturation constant for nitrite during denitrification of municipal wastewater under sewer conditions. The values of half saturation constant for nitrite established in this study represents a breakthrough in modelling of anoxic transformation processes during transport of municipal wastewater in sewer networks.

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**Keywords:** Denitrification, in-sewer processes, half saturation constant for nitrite, nitrite utilisation rates

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Conference on Science and Social Research, Kuala Lumpur, Malaysia,  
26-27 August 2003

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# **ANOXIC TRANSFORMATIONS IN MUNICIPAL WASTEWATER: THE USE OF ELECTRON EQUIVALENCE**

Suhaimi Abdul Talib  
Junaidah Ariffin  
Bahardin Baharom  
Mat Som Marwi

## **ABSTRACT**

Anoxic transformation of wastewater was investigated and the denitrification path in municipal wastewater under sewer conditions was found to be a two-stage processes. Two different electron acceptors were involved during the denitrification process, namely, nitrate and nitrite.

In order to make comparison of these processes possible the concept of electron equivalent was introduced. This concept allows the denitrification rates during different stages and utilizing different electron acceptors to be compared.

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**Keywords:** Anoxic transformation, electron equivalent, nitrate utilization rate, nitrite utilization rate

## **BED LOAD SAMPLING TECHNIQUES AND COMPARISONS ON BED LOAD DISCHARGE MEASUREMENTS**

Junaidah Ariffin<sup>1</sup>  
Suhaimi Abdul-Talib<sup>1</sup>  
Aminuddin Abdul Ghani<sup>2</sup>  
Nor Azazi Zakaria<sup>2</sup>  
Ahmad Shukri<sup>2</sup>

### **ABSTRACT**

Studies on river sediment transport relies heavily on the techniques for sampling and measurements of the bed load. This paper describes the use of the standard Helley Smith bed load sampler, illustrating on instrumentation, measuring procedure and the procedure for calculating bed load measurements in the Langat catchment. These techniques have been successfully applied to rivers of width ranging from 13.5 m to 30 m.

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**Keywords:** Bed load measurements, sampling technique

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**FKA-NASEC Joint Seminar on Research in Civil Engineering, Cameron Highlands, Pahang, Malaysia, 12-14 September 2003**

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# **BENEFITTING FROM MICROBIAL PROCESSES IN SEWER NETWORKS DURING TRANSPORT OF MUNICIPAL WASTEWATER**

Suhaimi Abdul-Talib<sup>1</sup>  
Jes Vollertsen<sup>2</sup>  
Thorkild Hvitved-Jacobsen<sup>2</sup>

## **ABSTRACT**

The sewer system has traditionally been considered as a conduit for transporting wastewater from the various sources to wastewater treatment plants. This paper reviews the development of the sewerage services in Malaysia, highlighting the emphasis given to the developments on the various types of treatment plants and systems, while neglecting the potential of incorporating the sewer network as a treatment system that could be integrated with the wastewater treatment plants. The paper then describes the background investigations leading to better understanding on wastewater quality changes occurring in sewer networks during transport of municipal wastewater.

The sewer is a complex system can be divided into sub-systems comprising of the bulkwater phase, the biofilm phase, the sewer sediment and the sewer atmosphere. It is mainly dominated by heterotrophic biomass that is responsible for the microbial processes occurring in the sewer system. Microbial processes in sewer network may occur under aerobic, anoxic or anaerobic conditions depending on the electron acceptors present in the system.

A discussion on significant breakthroughs achieved on the understanding of microbial processes occurring under sewer conditions is also presented. This new understanding has made it possible to incorporate the process dimension in the design of sewer networks.

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**Keywords:** In-sewer processes, integrated wastewater treatment, microbial transformations.

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# **CONSTRUCTION PRACTICES IN STORMWATER MANAGEMENT AND SOIL EROSION CONTROL**

Ruslan Hasan  
Wardah Tahir  
Roslan Zainal Abidin

## **ABSTRACT**

The paper describes the studies carried out to ascertain the tests required on the soil erosion and storm water modeling works to be carried out on the proposed pilot study area.

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**Keywords :** Soil erosion, storm water modeling works

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**Seminar on Urban Stormwater Management Practices : A Report Card on  
Implementing, Shah Alam, 29 July 2003**

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## **DETECTION OF HYDROLOGIC TREND ON MALAYSIAN RIVERS**

Turahim Abd Hamid  
Ismail Atan

### **ABSTRACT**

Hydrologists commonly apply statistical analysis to river flow records and use the result as a guide for estimating stream flow characteristics in the future. However, significant time trends in river flow data would invalidate the use of statistical analysis because the data population would be changing. In this paper, the annual maxima flow and mean annual flow trend were investigated by computing the statistical parameter or correlation coefficient, Kendall's tau. The Kendall test is a nonparametric or distribution-free test for trends. Kendall's tau is the correlation coefficient that measures the strength of trend, and is appropriate for variables that have skewness and are not normally distributed (as in most Malaysian rivers). Values can range from negative to positive. In general, the more Kendall's tau deviates from zero, the more likely it is that a trend exists. Also, as the sample gets larger, there is less chance of a definite trend occurring by chance alone. The trend (whether it is increasing or decreasing) investigated was plotted on the map and it would serve as a guideline to hydrologists when analyzing river flow data.

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**Keywords :** Trend, Kendall's tau, streamflow

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**First International Conference on Managing River, Shah Alam,  
25-26 August 2004**

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## **DETERMINATION OF BED SEDIMENT LOAD FOR RIVERS**

Junaidah Ariffin  
Wardah Tahir

### **ABSTRACT**

Bed sediment load is essential in calculating the transport rate of sediments in rivers and several empirical equations have been developed using experimental and field data by past investigators. However it should be noted that the equations developed were based on controlled conditions done in the laboratory and sediments were of uniform sizes. Even if the empirical equation derived is based on field data, this does not seem to match with our local conditions. The predicted rate of transport of bed sediments using these equations do not agree with the observed values. In view of this, several field data have been collected from river gauging stations in Selangor namely Kg. Lui Station for Sg. Lui, Kajang and Dengkil Station along Sg. Langat and Kg. Rinching Station along Sg. Semenyih to establish a relationship for the transport of bed load. The number of bed load samples taken at each cross-section in every observation vary between two to nine. The methods employed in the river gauging operation and sediment measurements depend largely on the flow conditions. In this research work the effective grain size of sediments was found from the S-curves. From the sieve analysis tests it was found that the river beds under study composed of more than 60 % of sand which has size ranges from 0.063 micron to 2 mm. A rating curve of discharge versus bed load has been prepared. A relationship for bed load transport have been established for rivers in Selangor.

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**Keywords:** Bed sediment load, transport rate, S-curves, sieve analysis tests

# DEVELOPMENT AND VALIDATION OF A REAL-TIME FLOODPLAIN MAPPING SYSTEM

Sahol Hamid Abu Bakar<sup>1</sup>  
Ferdaos Mohamed<sup>2</sup>  
Shanker Kumar Sinnakaudan<sup>3</sup>

## ABSTRACT

A significant constraint in managing floods is the availability of information on the location of the structures impacted by floodwaters in real-time. At present, no functional system is available to provide such information in Malaysia. In this research, a method of integrating hydrologic models with GIS and SCADA system has been presented, for real-time floodplain mapping. A distributed hydrologic model was developed for computation of excess runoff based on distributed rainfall, loss-rates, and continuous simulation modeling and locally adapted routing procedures. This model was further integrated with a comprehensive GIS database on Selangor River catchment and a network of SCADA stations located in this catchment. The integrated system initially works on hourly basis for several days pre-real-time historic data recursively change these parameters in real-time, and to view updated catchment maps and hydrographs instantly. A Graphical User Interface (GUI) was developed to facilitate the user to operate the integrated system. The integrated system included GIS pre-processor and attribute databases, development of empirical relationships and computer system interfaces. It was found that for predictive analysis, real-time rainfall observations are more useful than real-time water level measurements in the upstream areas. The modeling system was validated and interface components of the integrated system were tested independently. Simulation results showed that parameters defining distribution of soil moisture deficit (SMD), basin recharge (BR) and lag are more influencing than other water balance parameter. If the model ignored distribution of loss rates, the simulated hydro-graph resulted in higher peaks.

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**Key words:** Flood, SCADA, GIS, real-time

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Proceedings of 3<sup>rd</sup> National Civil Engineering Conference (AWAM04), Penang,  
20-22 June 2004

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# **DEVELOPMENT OF AN INTEGRATED TRIANGULAR IRREGULAR NETWORK (ITIN) MODEL FOR FLOODPLAIN GEOMETRY DATA EXTRACTION**

Shanker Kumar Sinnakaudan<sup>1</sup>

## **ABSTRACT**

Flood inundation extent is highly dependent on topography. Therefore, shallow flood plain gradients means that small errors in modeled water surface elevations may lead to large errors in the predicted inundation extend. The foundation for detailed modeling requires an accurate GIS based Multi-resolution terrain model. The research presented here, introduces an integrated procedure for creating a multi-resolution triangular irregular network model (ITIN). The constructed ITIN model later used for extracting geometric data to fed the SFlood model requirements, which were used in the flood risk analysis.

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**Keywords:** GIS, integrated triangular irregular network, flood plain

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**International Symposium and Exhibition on Geoinformation 2004 (ISG2004),  
Kuala Lumpur, 21-23 September 2004**

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# **DEVELOPMENT OF THE UITM CAMPUS FACILITY INFORMATION MANAGEMENT SYSTEM (GEOCAMPUS)**

Shanker Kumar Sinnakaudan<sup>1</sup>

Sahol Hamid Abu Bakar<sup>2</sup>

Joe Davylyn Nyuin<sup>3</sup>

## **ABSTRACT**

Campus facility and human resources management involves the understanding and manipulation of a large number of variables. The spatial nature of the facility and their associated resources makes Geographic Information System an ideal database management tool. This paper, reports the pilot study that deals with the development of a university facility management system namely GeoCampus at Universiti Teknologi MARA Pulau Pinang using GIS. Arc View GIS 3.0a, ArcView Spatial Analyst, Avenue Scripting Language and Dialog Designer had been chosen to construct this system. Relational database management system was used to connect spatial and descriptive data of buildings, rooms, roads, institutes and persons of the university. The user-friendly menu interface guides the user to understand, visualize, build query, conduct repetitious and multiple analytical tasks with spatial and non-spatial data. The initial results of this study clearly show that GIS provides an effective environment for facility management

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**Keywords:** GIS, Facility Information Management, GeoCampus

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**International Symposium and Exhibition on Geoinformation 2004 (ISG2004),  
Kuala Lumpur, 21-23 September 2004**

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# ELECTRON ACCEPTOR UTILIZATION RATE IN MUNICIPAL WASTEWATER UNDER ANOXIC CONDITION

Siti Maizurah Misuan<sup>1</sup>  
Suhaimi Abdul-Talib<sup>2</sup>

## ABSTRACT

Electron acceptor, electron donor and heterotrophic biomass are elements that must be present for microbial processes in sewer system to occur. Microbial processes in sewer networks may occur under aerobic, anoxic, or anaerobic conditions depending on the type of electron acceptor present. In the presence of dissolved oxygen (DO) aerobic process will occur. In the absence of DO, nitrate/nitrite will be used as electron acceptor, creating an anoxic condition. Finally, if DO, nitrate and nitrite are depleted from the system, then anaerobic condition will prevail, where sulphate is used as the electron acceptor. This paper presents the results of a study on anoxic transformation processes in the bulkwater phase of municipal wastewater. Experiments were conducted under conditions of excess electron donor and excess electron acceptor under sewer conditions. The two-stage anoxic transformation process established by Abdul-Talib *et al.* (2001) will serve as an example to establish how the concept of electron equivalent can be used to compare the utilization rate of different types of electron acceptors, *i.e.* nitrate and nitrite. The study found that the median of electron acceptor utilization rates during Stage I and Stage II are 0.798 e-eq m<sup>-3</sup>h<sup>-1</sup> and 0.501e-eq m<sup>-3</sup>h<sup>-1</sup> respectively.

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**Keywords:** Anoxic condition, electron acceptor, electron donor, electron equivalent, microbial processes

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# **ELECTRON TRANSFER RATES AND ENERGY RELEASES DURING DENITRIFICATION OF MUNICIPAL WASTEWATER**

Suhaimi Abdul-Talib<sup>1</sup>  
Zaini Ujang<sup>2</sup>  
Jes Vollertsen<sup>3</sup>  
Thorkild Hvitved-Jacobsen<sup>3</sup>

## **ABSTRACT**

This paper presents the results of studies on denitrification of municipal wastewater in the bulk water phase under conditions of excess electron acceptor and excess electron donor. Experiments conducted on 13 wastewater samples have shown that the denitrification process in the bulk water phase could be simplified by a two-stage process. In the first stage, nitrate was utilised with significant accumulation of nitrite. In the second stage nitrite was utilised when nitrate is depleted.

Denitrification rates during the two stages were expressed in terms of electron equivalents (e-eq.) in order to compare the process when different electron acceptors, namely, nitrate and nitrite were utilised. The energy release rates during the two stages were calculated and compared.

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**Keywords:** Denitrification, in-sewer processes, nitrate utilisation rate, nitrite utilisation rate, electron transfer rate

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United Kingdom**

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## EXTENDING THE TRANSPORT FUNCTION OF SEWERS

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### ABSTRACT

The sewer is a complex system that comprises of the bulkwater phase, the biofilm phase, the sewer sediment and the sewer atmosphere. It is mainly dominated by heterotrophic biomass that is responsible for the microbial processes occurring in the sewer system. Microbial processes in sewer network may occur under aerobic, anoxic or anaerobic conditions depending on the electron acceptors present in the system. Significant breakthroughs have been achieved on the understanding of microbial processes occurring under sewer condition. This new understanding has made it possible to incorporate the process dimension in the design of sewer networks.

Conventional design of sewer networks considers only the hydraulic dimension. It is well known that more than half of the cost to provide a sewerage system is taken up by the sewer network. Therefore it will be a waste if the treatment capability of the sewer network is not fully utilized. Sewer networks can and should be designed to promote microbial processes that will deliver wastewater of quality that is suited to the receiving wastewater treatment plants.

This paper illustrates how model concepts describing microbial processes occurring during transport under aerobic, anoxic and anaerobic conditions could be utilized in designing sewer conditions that will enable the sewer network and the receiving wastewater treatment plants to function as an integrated wastewater treatment system.

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**Keywords:** In-sewer processes, integrated wastewater treatment, microbial transformations.

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**Conference on Water and Drainage 2003, Kuala Lumpur, Malaysia,  
28-29 April 2003**

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## **EXFILTRATION FROM SEWERS PIPES – EFFECTS OF FLOWRATES, DIFFERENT LEAKAGE AREA AND SOIL BEDDINGS**

Mohd Ashaari Ab Wahab  
Suhaimi Abdul Talib  
Bahardin Baharom  
Mat Som Marwi

### **ABSTRACT**

Sewerage system plays an important role in ensuring public health, environmental protection and enhancing the standard of living of the general population. Exfiltration has been identified as one of the problems to sewerage system where sewer leakage occurs due to broken or damage pipes. Wastewater can escape into the surrounding soil and potentially, into the groundwater. Exfiltration can cause groundwater pollution if the rate or volume of wastewater leakage exceed the ability of the subsurface soil to attenuate the flow. Many sources of sewer leakage can be identified such as structural defects, including cracks, fractures, joint displacements, deformations, collapses, reverse gradients and unsealed connections. The problems caused by exfiltration are much more difficult to value.

This research was conducted on exfiltration of wastewater from gravity sewers. Exfiltration through different types of sewer leaks and soil beddings were studied. With the different size of leakage areas and a constant thickness of soil bedding, it was found that the exfiltration rate reduces and became constant after several days. This is also true for exfiltration from pipes with the same leakage area but on soil bedding of different thickness. By knowing the exfiltration rate, the time taken for the polluted water exfiltrated from sewer pipes to reach the groundwater can be determined so that measures can be taken to prevent it.

From the experiment, it can be shown that the increased in the clogging zone resulted in the decreased of exfiltration rate due to the accumulation of organic matters at the edge of the leakage area and trapped in the pores of the bedding soil.

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**Keywords:** Exfiltration, sewerage systems, sewer leakages, wastewater, gravity sewers, clogging zone

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**1st Asian Junior Scientists Workshop on Sewer Network Processes and Urban  
Drainage, Malacca, Malaysia, 7-10 February 2004**

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## **FITTING LOGISTIC DISTRIBUTION TO MALAYSIAN FLOOD DATA**

Ismail Atan  
Jurina Jaafar

### **ABSTRACT**

The design of culverts and bridges required to estimate the probability of future flood. In recent years, a number of distributions has been used to fit the flood data that would conform the nature of physical nature of the river flow. It is demonstrated that logistic distribution has many properties well suited for modeling of flood frequency data. This distribution is capable of reproducing almost the same degree of skewness and more robust to the presence of extreme outliers in the upper tail of the distribution. The study will investigate the performance of logistic distribution when fitted to Malaysian flood data.

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**Keywords :** Logistic, outliers, flood

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21-23 September 2004**

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## **FLOOD INUNDATION ANALYSIS USING HEC-6 AND ARCVIEW GIS 3.2A**

Shanker Kumar Sinnakaudan<sup>1</sup>

Aminuddin Ab Ghani<sup>2</sup>

Chang Chun Kiat<sup>3</sup>

### **ABSTRACT**

An integration procedure namely AVHEC6.avx has been created between ArcView GIS 3.2a and HEC-6 hydraulic model to perform flood inundation analysis. The procedure was tested using hydraulic and hydrological data for Pari River channel and floodplain with the reach approximately 4 km long. HEC-6 Model was simulated using Yang sediment transport equation with four flood hydrograph in 12 difference flooding scenarios and subsequent flood inundation maps were produced. The flood plain visualization was further enhanced using the ArcView Spatial Analysis and 3D Analysis. The results of these research clearly show that incorporating floodplain geometric data besides river channel data in the modeling process can produce more accurate flood plain maps. GIS is proven to provides an effective environment for flood inundation mapping and analysis. The research has further extended in the development of an embedded floodrisk analysis model that has fully operates in the GIS environment.

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**Keywords:** Flood, Inundation Mapping, HEC-6, GIS, River

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# **FLOOD MAPPING USING MIKE 11- GIS : A CASE STUDY OF SUNGAI KAYU ARA**

Sabariah Arbai  
Wardah Tahir

## **ABSTRACT**

The process of urbanization generally will bring along certain kind of disaster such as flash flood if it lacks of monitoring and control. Some precaution measures such as flood prediction and warning are wise to be taken to avoid the unprecedented disaster. The paper discusses the integration of Remote Sensing (RS), Geographic Information System (GIS) and a flood modeling software application to perform flood simulation and mapping. Sg Kayu Ara catchment is selected to be modelled, as a case of a rapid urbanization example, with recent flood occurrence. The work produced flood map for the catchment, which may be used for prediction and decision making.

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**Keywords:** Flood prediction and warning, geographic information system, flood map, MIKE II

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**Proceedings of International Conference on Disaster Management,  
Langkawi, Malaysia, April 2003**

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# FLOOD RISK MAPPING FOR PARI RIVER INCORPORATING SEDIMENT TRANSPORT

Shanker Kumar Sinnakaudan<sup>1</sup>  
Aminuddin Ab Ghani<sup>2</sup>  
Mohd. Sanusi S. Ahmad<sup>2</sup>  
Nor Azazi Zakaria<sup>2</sup>

## ABSTRACT

Geographic Information Systems (GIS) are an efficient and interactive spatial decision support tool for flood risk analysis. This paper describes the development of ArcView GIS extension — namely AVHEC-6.avx — to integrate the HEC-6 hydraulic model within GIS environment. The extension was written in an Avenue Script language and Dialog Designer with a series of ‘point and click’ options. It has the capability of analyzing the computed water surface profiles generated from HEC-6 model and producing a related flood map for the Pari River in the ArcView GIS. The user-friendly menu interface guides the user to understand, visualize, build query, conduct repetitious and multiple analytical tasks with HEC-6 outputs. The flood risk model was tested using the hydraulic and hydrological data from the Pari River catchment area. The required sediment input parameters were obtained from field sampling. The results of this study clearly show that GIS provides an effective environment for flood risk analysis and mapping. The present study only concentrates on the flood risk within the boundary of the bunds.

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**Keywords:** GIS, River; Flood Risk Mapping, Sediment Transport, System Integration

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# HALF SATURATION CONSTANT FOR NITRITE UNDER ANOXIC CONDITIONS IN MUNICIPAL WASTEWATER

Rozita Aris  
Suhaimi Abdul Talib

## ABSTRACT

Design of sewers to incorporate the processes dimension, in addition to the hydraulics dimension is currently hindered by the lack of fundamental knowledge on process kinetics governing the microbial processes. A model concept describing anoxic transformation has been proposed by Abdul-Talib et al. (2001 b). However, the kinetic parameters needed for the model have not been fully established.

This paper describes the state of the art apparatus and experimental procedure for determining nitrite utilisation rates and half saturation constant for nitrite during denitrification of municipal wastewater under sewer conditions. The values of half saturation constant for nitrite established in this study represents a breakthrough in modelling of anoxic transformation processes during transport of municipal wastewater in sewer networks.

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**Keywords :** Denitrification, in-sewer processes, half saturation constant for nitrite, nitrite utilisation rates



## HURST PHENOMENA IN MALAYSIAN FLOOD PEAK SERIES

Ismail Atan  
Mohd Shani Awaluddin

### ABSTRACT

In flood frequency analysis, the annual peak flow data are assumed to be independent random event. This assumption can be verified by a number of statistical tests. However, the independent test only effective to short term correlation and insensitive to long term correlation (Hurst phenomena). In this study, the level of significant is decided as 10%. The summary of the results for short-term dependence and long-term dependence were shown in the Table 1 and Table 2. In Table 2, using the parametric test of Hurst's  $K$ , long-term dependence was found that about 52% (at 10% significant level). This clearly indicated the long-term serial correlation for more than half of the rivers investigated was found to be significant. The value is higher than the results for the short-term dependence tests, 34% (autocorrelation ( $r_1$ )) and 30% (Von Neumann Ratio) of the 50 rivers investigated. The serial correlation structure of annual flood series from 50 Malaysian rivers was analyzed. It was found that significant long-term serial correlation as measured by the Hurst's  $K$  statistic is present in large number of rivers. This long-term dependence cannot be ignored or disregarded as in flood frequency analysis and it should be taken into account as it may considerably increase the risk associated with the future peak flows.

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**Keywords :** Hurst, von neumann ratio, flood

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**Conference on Water Management for Sustainable Enviroment, Penang,  
21-23 September 2004**

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# **INTEGRATED TRIANGULAR IRREGULAR NETWORK (ITIN) MODEL FOR FLOOD RISK ANALYSIS, CASE STUDY: PARI RIVER, IPOH, MALAYSIA**

Shanker Kumar Sinnakaudan<sup>1</sup>  
Aminuddin Ab Ghani<sup>2</sup>  
Mohd. Sanusi S. Ahmad<sup>2</sup>  
Nor Azazi Zakaria<sup>2</sup>  
Chang Chun Kiat<sup>3</sup>

## **ABSTRACT**

Accurate river channel and flood plain representation plays vital part in flood risk analysis. Terrain models such as TINs and DEMs are normally used to represent floodplains. But unfortunately finding a terrain model with a high density of stream channel elevation points that are sufficient for hydraulic modeling is not a easy task. However for years engineers and researchers have developed a high-resolution cross-section data for hydraulic modeling from field surveys, photogramtries and topographic maps. This research presented here introduces the procedures for creating integrated multiresolution TIN (ITIN) models for high-resolution flood plain representation for flood risk analysis. The high-resolution river channel geometric data stored in HEC-6 hydraulic model and low-resolution flood plain data in the form of DEM created in ArcView GIS 3.2a were integrated by resolving the coordinate incompatibility in the both system. An integration procedure (ArcView extention) namely AVHEC6.avx has been developed between HEC-6 Hydraulic Model and ArcView GIS 3.2a to visualize model outputs in a more presentable manner through 3D capabilities of GIS.

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**Keywords :** ITIN, DEM, GIS, HEC-6, flood risk

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**Proceedings of Thirteenth Asia and Pacific Division Congress of International Association of Hydraulic Engineering Research on Hydraulic and Water Resource Engineering in early 21<sup>st</sup> Century, Singapore, 6-8 August 2002**

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**LAND-USE DESCRIPTION FROM IMAGE DATA ACQUISITION TO  
PREDICT PEAK RUNOFF VALUES USING SCS MODEL FOR FLOOD  
SIMULATION AND MODELING USING MIKE 11-GIS**

Sabariah Arbai  
Wardah Tahir  
Faizu Hassan

**ABSTRACT**

Flood simulation and mapping using MIKE-11 GIS requires the input of peak runoff values. Peak values calculation by the Soil Conservation Service (SCS) model depends upon the soil curve number (CN) which depends highly on the land-use of a particular area. The paper discusses the determination of curve number for Sungai Kayu Ara catchments based on land use description from the image data acquisition. The curve numbers are used for the calculation of peak runoff values which are processed as data input to the MIKE-11 GIS flood modeling to perform flood simulation which produce flood map for the catchment.

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**Keywords:** Flood simulation and mapping, MIKE – 11 GIS, soil conservation service (SCS) model, surve number (CN), land use description

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**Proceedings of International Conference on Soft Soil (ASSET), Putrajaya,  
Malaysia, July 2003**

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**MODEL CONCEPT FOR NITRATE AND NITRITE UTILIZATION DURING  
ANOXIC TRANSFORMATION IN THE BULK WATER PHASE OF  
MUNICIPAL WASTEWATER UNDER SEWER CONDITIONS**

Suhaimi Abdul-Talib<sup>1</sup>  
Zaini Ujang<sup>2</sup>  
Jes Vollertsen<sup>3</sup>  
Thorkild Hvitved-Jacobsen<sup>3</sup>

**ABSTRACT**

A two-stage anoxic transformation process, involving growth of biomass utilizing two types of different electron acceptors, namely nitrate and nitrite has been observed. The present water quality modules established for sewer processes cannot account for the two-stage process. This paper outlines the development of a model concept that enables the two-stage anoxic transformation process to be simulated. The proposed model is formulated in a matrix form that is similar to the Activated Sludge Models and Sewer Process Model matrices. The model was successfully applied to simulate changes in nitrate and nitrite concentrations during anoxic transformations in the bulk water phase of municipal wastewater

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**Keywords:** Anoxic transformation model, in-sewer processes, nitrate utilization rate, nitrite utilization rate

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**4<sup>th</sup> International Conference on Sewer Processes and Network,  
Madeira, Portugal, 22-24 November 2004**

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# **MUNICIPAL SOLID WASTE MANAGEMENT IN MALAYSIA: FUTURE TRENDS IN TECHNOLOGY AND MANAGEMENT PRACTICES**

Suhaimi Abdul Talib<sup>1</sup>  
Wan Ramle Wan A.Kadir<sup>2</sup>

## **ABSTRACT**

This paper presents the changing scenario of municipal solid waste (MSW) management in Malaysia. A new legislation to regulate the municipal solid waste industry is soon to be introduced in Malaysia. The legislation is expected to institutionalise the municipal solid waste industry as one of the main economic service providing entity.

The new legislation will transform the technology used and management practices in the collection, transport, transfer, treatment and final disposal of municipal solid waste in this country. It will not only affect the operators, regulators, suppliers of technology but all stakeholders, including the general public.

This paper outlines the possible transformations in terms of technology and management practices.

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**Keywords:** Municipal solid waste, MSW management, MSW technology, regulatory and economic instruments

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**Conference on Facilities Management – Strategic Facilities Management Towards Quality Environment, Kuala Lumpur, Malaysia, 18-19 August 2003**

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# NITRATE UTILIZATION RATE IN THE BULKWATER AND BIOFILM PHASES OF SEWER NETWORK

Noora Samsina Johari<sup>1</sup>  
Suhaimi Abdul-Talib<sup>2</sup>

## ABSTRACT

Significant progress has been made in developing fundamental knowledge on kinetics of microbial transformations during transport of wastewater in sewer networks. A model concept has been established for transformations occurring in sewer networks under aerobic and anaerobic conditions (Vollertsen *et al.*, 2001). Studies on in-sewer transformation processes under anoxic conditions have been initiated by Abdul-Talib *et al.* (2002). To date extensive investigations on kinetics of anoxic transformation processes have been conducted on the bulkwater phase. However, very limited information is currently available on kinetics of anoxic transformation in the biofilm phase. This study establishes a methodology for determining nitrate utilization rate (NUR) in bulkwater and biofilm phases. Tests were conducted using batch reactors with biofilm grown under sewer conditions. Raw municipal wastewater samples, taken directly from a sewer pipe or from the inlet of a wastewater treatment plant (WWTP), were used in this series of experiments. Nitrate utilization rate (NUR) in bulkwater phase was observed to be in the range of 0.39 to 1.07 gNO<sub>3</sub>-N m<sup>-3</sup>h<sup>-1</sup>, while NUR in the biofilm phase was found to be 0.04 to 0.10 gNO<sub>3</sub>-N m<sup>-2</sup>h<sup>-1</sup>.

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**Keywords:** Anoxic conditions, nitrate utilization rate, sewer biofilm

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**IWA Publishing, United Kingdom**

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# NITRATE UTILIZATION RATES DURING MICROBIAL TRANSFORMATION OF MUNICIPAL WASTEWATER UNDER ANOXIC CONDITIONS

Suhaimi Abdul Talib  
Mokhtar Shaharuddin

## ABSTRACT

The sewer is an integral part of the urban wastewater system: the sewer, the wastewater treatment plant and the local receiving water. The sewer is a reactor for microbial changes of the wastewater during transport, affecting the quality of the wastewater and thereby the successive treatment processes or receiving water impacts during combined sewer overflows. Significant breakthrough and progress have been made in the study on kinetics of microbial transformation in sewers under aerobic and under changing aerobic/anaerobic conditions. Fundamental knowledge on anoxic kinetics of wastewater is still lacking, that it is now not possible to apply an integrated approach of municipal wastewater treatment incorporating sewer networks as bio-chemical reactor. This paper presents the results of studies on anoxic processes, namely denitrification, in the bulk water phase of wastewater as it occurs in sewers. Experiments conducted on 12 different wastewater samples have shown that the denitrification process in the bulk wastewater can be simplified by the reduction of nitrate to nitrogen with significant accumulation of nitrite.

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**Keywords:** Anoxic processes, denitrification, in-sewer processes, nitrate utilization rate, nitrite utilization rate

## **PENDEFINISIAN DATARAN BANJIR SECARA TEPAT BAGI ANALISIS RISIKO BANJIR SECARA MAMPAN**

Shanker Kumar Sinnakaudan<sup>1</sup>

Aminuddin Ab Ghani<sup>2</sup>

Mohd. Sanusi S. Ahmad<sup>2</sup>

Nor Azazi Zakaria<sup>2</sup>

### **ABSTRAK**

Penentuan kawasan pembangunan di dataran banjir perlu dilakukan secara teliti supaya kejadian banjir dapat dielakkan pada masa hadapan. Terdapat banyak definisi dataran banjir yang berbeza dan mengikut kepentingan pembangunan disepanjang sungai. Kertas kerja ini mendedahkan pelbagai isu dan garis panduan yang digunakan dalam penentuan dataran banjir dan rizab sungai. Pemodelan dan analisis risiko banjir telah dilakukan bagi dataran banjir hidrologik untuk Sungai Pari di Ipoh, Perak dengan menggunakan model hidraulik/pengangkutan endapan (HEC-6) dan perisian GIS iaitu ArcView GIS 3.2, ArcView Spatial Analyst dan ArcView 3D Analyst. Keputusan awal kajian mendapati GIS mampu untuk berfungsi sebagai alat pemodelan ruangan dan analisis risiko banjir yang berkesan. Pendefinisian dataran banjir dalam model hidraulik mempengaruhi simulasi model hidraulik dan keputusan aras banjir yang dihasilkan. Hasil kajian juga menunjukkan pendefinisian dataran banjir dalam model hidraulik perlu meliputi skop topografik bagi memperoleh kesan risiko banjir yang lebih bersepadu dan praktikal. Cadangan penyelidikan pada masa hadapan diberikan bagi memantapkan penyelidikan yang telah dijalankan.

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**Kata Kunci :** Banjir, pemodelan hidraulik, pengintegrasian dalaman, GIS

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**Persidangan Kebangsaan Kedua Kejuruteraan Awam (AWAM 01),  
Star Cruises Superstar Gemini, 5-8 Februari 2002**

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# **PERFORMANCE INDICATORS FOR DRINKING WATER SUPPLY AND WASTEWATER SERVICES – THE MAKING OF AN INTERNATIONAL STANDARD**

Suhaimi Abdul Talib

## **ABSTRACT**

At the end of the Third World Water Forum in Kyoto held in March 2003, the international community had given the commitment to increase efforts to meet the world-wide challenge of providing improved drinking water supply and improved wastewater services. One of these efforts has taken the form of a series of International Standards related to the management and regulation of bodies involved in drinking water supply and wastewater services. This paper describes the development and the main contents of these standards focusing on service objectives, service assessment criteria and performance indicators.

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**Keywords:** Drinking water supply, international standards, performance indicators, service assessment criteria, wastewater services

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**Conference on Environmental Technology, ITS, Surabaya, Indonesia,  
6-7 October 2004**

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# **PRELIMINARIES STUDY ON RIVERBED CHANGES DUE TO SAND MINING ACTIVITY IN MUDA RIVER, KEDAH**

Sharifah Abdullah

## **ABSTRACT**

Natural river is a form of channel that easily changes in term of its physical shape such as width or depth as well as the changes in pollution and environmental level. Unplanned development couples with human and natural features are the biggest contributors to that change. Economic activities such as agriculture, urbanisation, fishery, sand mining, etc, should be controlled in ensuring the balance of river eco-system. Sand mining activities are concentrated at the sandy-bed in natural rivers. River sands are an important element in development factors, where its demand increases linearly with Malaysian infrastructure development.

The research was conducted to identify the changes of river bed due to sand mining activities. Muda River in Kedah was selected as the research location because of the currently active sand mining operations along the river. Base on JICA (1995) research, there are almost 100 sand mines along Muda River. Observation along Muda River, found that the river has experienced serious bank erosion, sedimentation at the river mouth and some damages on bridge structures. JICA (1995) showed that Muda River is having serious bed aggravation and degradation, rates about 2 m to 5 m in 10 years period. The consequences from bed degradation leads to unstable riverbank causing bank erosion. This research focuses on changes in riverbed due to sand mining operations using a mathematical model – FLUVIAL-12 (Mathematical Model for Erodible Channel, Chang, 1988) to forecast this changes.

The simulation carried out shown that The Manning Coefficient,  $n = 0.040$  is suitable for Muda River analysis. Yang Equation also gives almost an accurate result to the actual condition at research site. Conducted simulation cases have shown that there are a lot of changes at the riverbank and riverbed. Therefore, it is proven that the sedimentation and erosion had occurred at all considered cross-section. The conditions are inter-related to the activities along the channel. Simulation results had shown the needs of riverbank protection to avoid bank erosion along that river.

The extensive sand mining activities along the research area required closed supervision and control by related authority in ensuring that erosions are minimised. The mining depth need to be closely monitored so that sand miners did not exceed the permitted depth of Sand Mining Procedure established by JPS. The simulation analysis by FLUVIAL-12 has proved that the mining activities are changing the river morphology. Analysis also shown that sediment transport plays an important role in contributes the changes of riverbed.

# **REGIONAL FLOOD FREQUENCY ANALYSIS : REVISION AND DEVELOPMENT OF AN EXPERT SYSTEM FOR PENINSULAR MALAYSIA**

Wardah Tahir  
Zaidah Ibrahim

## **ABSTRACT**

Reliable estimates of the magnitude and frequency of floods are essential for the economical planning and safe design of any hydraulic structure. If a hydraulic structure is under designed, the results could be a disaster; the dam may break, the highway may flood or the bridge may collapse. On the other hand, if the structure is over designed and hence very safe, the cost involved could be unreasonably expensive. The Drainage and Irrigation Department of Malaysia has published the manuals on the estimation of design flood in the form of Hydrological Procedures. These procedures were developed around 10 to 20 years ago using the hydrological data from about 8 to 36 years of record (Pre-1960 to 1980). Since flood estimation involves the application of probability and statistical analysis for time series of data, the accuracy of the estimation would be improved if longer record of data were used. The first part of the paper discusses the revision of Regional Flood Frequency analysis using extended record of data and the following development of new Mean Annual Flood (MAF) equations for each frequency region in Peninsular Malaysia. The second part of this paper looks into the development of design flood estimation software.

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**Keywords :** Regional flood frequency analysis, mean annual flood, design flood estimation software

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Sarawak, Malaysia, June 2002**

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## **RIVER PROTECTION: ALTERNATIVE APPROACHES TO POLLUTION CONTROL**

Suhaimi Abdul Talib  
Junaidah Ariffin  
Bahardin Baharom

### **ABSTRACT**

Eventhough Malaysia is blessed with abundance supply of water resources, spatial and temporal variation of rainfall distribution and increasing incidences of river pollution have caused several crisis in water supply services. The regulatory approach which is based on Uniform Emission Standards concept is discussed in relation to the opposite concept of River Quality Objectives. It has been acknowledged that due to a number of constraints, the measures adopted by the Government have to some extent failed to safeguard the well-being of our natural water resources. The paper also proposes that, economic instruments should be used to compliment the existing regulatory instruments, so that more innovative and cost-effective pollution control measures will emerge that would be suited to specific industries.

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**Keywords :** Economic instruments, regulatory instruments, river pollution control

## **SEDIMENT TRANSPORT MODELING AND FLOOD RISK MAPPING IN GEOGRAPHIC INFORMATION SYSTEM (GIS)**

Shanker Kumar Sinnakaudan<sup>1</sup>  
Dr. Aminuddin Ab Ghani<sup>2</sup>  
Dr. Mohd. Sanussi S. Ahmad<sup>2</sup>  
Dr. Nor Azazi Zakaria<sup>2</sup>

### **ABSTRACT**

Most computer models used in the flood risk analysis of rivers have inadequate functions in its spatial analytical capabilities and without sediment transport simulation capacity or suitable equations to represent correctly in-situ hydraulic processes. As a result, the current research presents the development of a new total bed material load equation using multiple linear regression analyses that is applicable for rivers in Malaysia. It was developed and embedded as a modified version of HEC-6 model and named SEDFlood model. The model is best suited for rivers having uniform sediment size distribution with a  $d_{50}$  value within the range 0.37 mm and 4.0 mm and performs better than the commonly used Yang, Graf and Ackers-White total bed material load equations. A user-friendly, menu-driven GUI for two and three-dimensional (2D & 3D) digital floodplain delineation was developed through ArcView GIS and SEDFlood tight coupling procedure. It is capable to produce quick analysis (snapshots) at any desired discharge time steps in flood risk mapping procedure. Field measurements were carried out to validate the hydraulic setting and the accuracy of model outputs. The feasibility of simulating a flood event along a river channel and floodplain was tested for Pari River catchment's area located in Perak, Malaysia. Flood risk analysis were conducted for the design flood events for 10, 50, 100-year Average Recurrence Interval (ARI). The design rainfall duration of 30, 60 and 120 minutes for the present and future land use conditions (year 2020) were considered in the simulation scenarios. The result of this research indicates that GIS is an effective environment for floodplain analysis and its integration with hydraulic model is not only feasible but also mutually beneficial for both GIS users and hydraulic modelers.

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# **SEWER NETWORKS AS BIO-REACTORS – ADVANCES TRANSFORMATION UNDER ANOXIC CONDITIONS**

Suhaimi Abdul Talib

## **ABSTRACT**

Evidence of microbial processes in sewer networks has been put forward by many researchers (Bjerre et al., 1997; Vollertsen, 1998; Tanaka, 1998). Intensive investigation of microbial processes under aerobic and anaerobic conditions have yielded better understanding wastewater transformation in sewer networks. Studies under anoxic conditions were initiated by Abdul-Talib *et al.* (2001). Experimental procedures for determining denitrification path and kinetics during the transformation processes were established. A model concept on anoxic transformation of municipal wastewater was proposed.

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**Keywords :** Anoxic transformation, denitrification, kinetics, sewer processes

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**Seminar on Waste Management UiTM-Kyoto University, Shah Alam, Selangor,  
Malaysia, 28 February 2003**

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# SEWER NETWORKS AS BIO-REACTORS – EXTENDING THE TRANSPORT FUNCTION OF SEWERS

Suhaimi Abdul-Talib<sup>1</sup>  
Zaini Ujang<sup>2</sup>  
Jes Vollertsen<sup>3</sup>  
Thorkild Hvitved-Jacobsen<sup>3</sup>

## ABSTRACT

The sewer is a complex system that comprises of the bulkwater phase, the biofilm phase, the sewer sediment and the sewer atmosphere. It is mainly dominated by heterotrophic biomass that is responsible for the microbial processes occurring in the sewer system. Microbial processes in sewer network may occur under aerobic, anoxic or anaerobic conditions depending on the electron acceptors present in the system. Significant breakthroughs have been achieved on the understanding of microbial processes occurring under sewer condition. This new understanding has made it possible to incorporate the process dimension in the design of sewer networks.

Conventional design of sewer networks considers only the hydraulic dimension. It is well known that more than half of the cost to provide a sewerage system is taken up by the sewer network. Therefore it will be a waste if the treatment capability of the sewer network is not fully utilized. Sewer networks can and should be designed to promote microbial processes that will deliver wastewater of quality that is suited to the receiving wastewater treatment plants.

This paper illustrates how model concepts describing microbial processes occurring during transport under aerobic, anoxic and anaerobic conditions could be utilized in designing sewer conditions that will enable the sewer network and the receiving wastewater treatment plants to function as an integrated wastewater treatment system.

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**Keywords :** In-sewer processes, integrated wastewater treatment, microbial transformations

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**Conference on Water and Drainage 2003, Kuala Lumpur, Malaysia,  
28-29 April 2003**

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# **SEWER NETWORKS AS BIO-REACTORS – INTEGRATED WASTEWATER TREATMENT SYSTEM**

Suhaimi Abdul-Talib

## **ABSTRACT**

The sewer is a complex system that comprises of the bulkwater phase, the biofilm phase, the sewer sediment and the sewer atmosphere. It is mainly dominated by heterotrophic biomass that is responsible for the microbial processes occurring in the sewer system. Microbial processes in sewer network may occur under aerobic, anoxic or anaerobic conditions depending on the electron acceptors present in the system. Significant breakthroughs have been achieved on the understanding of microbial processes occurring under sewer condition. This new understanding has made it possible to incorporate the process dimension in the design of sewer networks.

Conventional design of sewer networks considers only the hydraulic dimension. It is well known that more than half of the cost to provide a sewerage system is taken up by the sewer network. Therefore it will be a waste if the treatment capability of the sewer network is not fully utilized. Sewer networks can and should be design to promote microbial processes that will deliver wastewater of quality that is suited to the receiving wastewater treatment plants.

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**Conference on Environment Technology, ITS, Surabaya, Indonesia,  
6-7 October 2004**

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# **SIMULATION OF GROUNDWATER FLOW AND POLLUTANT TRANSPORT FOR ALLUVIAL AQUIFER IN KAMPUNG TEKEK, TIOMAN ISLAND**

Norhan Abd Rahman<sup>1</sup>  
Woei-Keong Kuan<sup>2</sup>

## **ABSTRACT**

Tioman Island is situated in the east coast of Peninsular Malaysia. With rapid growth in tourism industry, demand of water supply is expected to increase in this island. From previous studies, groundwater was found to be a potential water resource. A 3-dimensional numerical modelling software (Visual MODFLOW) is used to simulate the groundwater flow and pollutant transport of the aquifer in Kg. Tekek, for the prediction of available yield of groundwater, and also for studying the migration of potential contaminant source, i.e. nitrate due to withdrawal. The groundwater flow simulation results showed that the aquifer is capable of pumping 4000 m<sup>3</sup>/day. Results of pollutant transport modelling showed that the estimated concentration of nitrate in the pump well is generally low and complies with World Health Organisation (WHO) standard of drinking water.

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**Keywords:** Groundwater flow, pollutant transport, numerical model, Visual MODFLOW, island

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<sup>2</sup> Faculty of Civil Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia.

# **SPATIALLY INTEGRATED MODELING APPROACH USING MORGAN, MORGAN & FINNEY METHOD FOR PREDICTING SEDIMENT YIELD**

Shanker Kumar Sinnakaundan<sup>1</sup>

Ruslan Rainis<sup>2</sup>

Wan Ruslan Ismail<sup>2</sup>

## **ABSTRACT**

Morgan, Morgan & Finney (MMF) Method for predicting sediment yield has been successfully applied in various parts of Malaysia and Indonesia (Morgan, 1974, Morgan, 1979; Walsh, 1980; Morgan et al, 1982, Morgan, et al (1984), Besler, 1987, Brooks et al, 1993). However the spatial variability in the hydrological processes cannot be shown using these self structured procedures. To incorporate this spatial variation, a distributed NPP simulation model namely Ghydmod 1.0 that contains 3 major elements of the model (1: the mathematical equation that governs the hydrologic processes, 2: maps that define the study area, and 3: database tables that describes the information on a spatial variation and input parameters) integrated in one operating system. Arc View GIS 3.0a, ArcView Spatial Analyst, Avenue Scripting Language and Dialog Designer had been chosen to construct this model. Ghydmod 1.0 has been successfully used to estimate the impact of nine possible different land use development scenarios for existing and future conditions at three different locations in Kulim catchment area, Kedah, Peninsular Malaysia. The average discrepancy ratio between simulated and measured results is 1.1006, which falls within acceptable ratio range which is 0.5 to 2.0. Development on a newly cleared land was found to yield the highest sediment concentration (average 52.2% increase) however changes to urban areas do not have a significant increase in sediment yield (average 4.9 % increase). Introduction of the spatial element to the existing MMF method further enhance and provides a sustainable use for the existing procedure.

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**Keywords:** Morgan, Morgan Finney method, sediment yield, embedded model, GIS

<sup>1</sup> Water Resources Engineering and Management Research Centre (WAREM), Universiti Teknologi MARA

<sup>2</sup> School of Humanities, Universiti Sains Malaysia

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**Proceedings of XXX IAHR Congress: Water Engineering and Research in a  
Learning Society: Modern Developments and Traditional Concepts,  
Thessaloniki, Greece, 24-29 August 2003**

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# **SYNTHETIC UNIT HYDROGRAPH AND REGIONAL FLOOD FREQUENCY FOR PENINSULAR MALAYSIA**

Wardah Tahir  
Sahol Hamid Abu Bakar  
Zaidah Ibrahim

## **ABSTRACT**

The paper reports studies on two design flood estimation techniques namely, synthetic unit hydrograph and regional flood frequency analysis for Malaysian catchments. Five catchments were selected and observed storm hyetographs and their concurrent runoff hydrographs were studied to derive unit hydrographs. Then, comparisons were made between the NRCS and Snyder's synthetic unit hydrographs with the observed unit hydrographs. In another study, regional flood frequency procedures were updated using 40 year records of data from 146 river stations throughout Peninsular Malaysia. Seven mean annual flood regions and six flood frequency regions were delineated and corresponding equations were derived. The paper also looks into the development of a user-friendly web-based guidance system on design flood estimation for Peninsular Malaysia.

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**Keywords :** Design flood estimation, synthetic unit hydrograph, regional flood frequency analysis, NRCS, Snyder's synthetic unit hydrographs, web-based guidance system

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**Proceedings of International Conference on Water and Environment Bhopal,  
India, December 2003**

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# **URBAN DRAINAGE CATCHMENT MODELLING AND SIMULATION USING INFOWORKS CS**

**Marfiah Abdul Wahid  
Wardah Tahir  
Janmaizatulriah Jani  
Shafie Awang Semat**

## **ABSTRACT**

The paper presents a study on a new proposed urban drainage system at Mukim Setapak, Kuala Lumpur. The study models the storm water drainage catchments system and performs simulation for flood prediction by using InfoWorks CS software. The modeling process involves the study of the catchments, networks and nodes. At the modeling stage, the catchment characteristics data are entered and the rainfall design patterns are applied as input parameters for simulation. Simulations are done and analysed for difference rainfall events and difference conduit surface roughness given a duration of time. The surface roughness may be related to the maintenance and age factor of the drainage system. It can be assumed that less maintenance and ageing of the conduits are related to higher roughness value. The results shows that as roughness increases the possibility of flood increases. Recommendation will be made as to produce the optimum design of the storm water drainage system.

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**Keywords:** Urban drainage system, flood prediction, info works CS, optimum design

## WASTE MINIMIZATION AND THE ENVIRONMENT

Suhaimi Abdul Talib  
Fauzilah Ismail

### ABSTRACT

There is a genuine concern on problems related to municipal solid waste (MSW) management in Malaysia. With waste generation rates of 0.76 kg/person/day, Malaysia will soon face serious problems handling and disposing these wastes.

This paper focus on how the implementation of hierarchy of waste management options can improve the situation by reducing the amount of waste reaching the final disposal stage. The options include the well-known 5R principles –replace, reduce, re-use, recover and recycle. An integrated and comprehensive approach utilizing regulatory and economic instruments is also discussed.

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**Keywords:** Municipal solid waste, regulatory and economic instruments, waste minimization

# WASTEWATER CHARACTERIZATION FOR SEWER PROCESS MODELLING

Suhaimi Abdul Talib<sup>1</sup>  
Junaidah Ariffin<sup>1</sup>  
Jes Vollertsen<sup>2</sup>  
Thorkild Hvitved-Jacobsen<sup>2</sup>

## ABSTRACT

This paper introduces the concept of COD-fractions as a tool for characterizing municipal wastewater that takes into consideration the biodegradability of the wastewater organic matter and the associated microbial processes. The difference in approaches to modelling of microbial transformations in activated sludge processes and in sewer processes is discussed. Results of several studies on wastewater characterization based on COD-fractions conducted on municipal wastewater taken from Malaysia and Denmark were presented and compared. It was established that the heterotrophic active biomass accounts for 10 percent of the total COD while the biodegradable substrate (organic matter) account for 15-20 percent of the total COD.

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**Keywords:** Oxygen utilization rate, COD fractions, sewer process model, wastewater characterization

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**FKA-NASEC Joint Seminar on Research in Civil Engineering, Cameron Highlands, Pahang, Malaysia, 12-14 September 2003**

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**WATER QUALITY ISSUES IN DEVELOPING COUNTRIES  
- FOCUS ON WATER SUPPLY AND WASTEWATER SERVICES IN MALAYSIA**

Suhaimi Abdul Talib

**ABSTRACT**

This paper discusses the challenges in providing improved water supply and wastewater services in developing countries. The challenge of providing adequate and acceptable water supply and wastewater services must be addressed from institutional, socio-economical, technological and environmental perspectives.

Developments in Malaysia over the last twenty years were highlighted and ways forward were recommended

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**Keywords:** Institutional arrangement, water management, sustainable management

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**Seminar on Sustainable Water Resources Management, Shah Alam,  
Selangor, 25-26 August 2004**

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# **WATER SUPPLY AND WASTEWATER MANAGEMENT IN MALAYSIA: A COUNTRY REPORT**

Mohd Azrai Kassim<sup>1</sup>  
Azhani Sukimi<sup>2</sup>  
Sohaimi Kling<sup>3</sup>  
Ghufran Redzuan<sup>4</sup>  
Suhaimi Abdul-Talib<sup>5</sup>

## **ABSTRACT**

This paper presents the situation on water supply and wastewater services in Malaysia. The hydrological status is presented and main challenges facing the water supply and wastewater services in Malaysia are being highlighted.

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**Keywords:** Malaysia, water supply, wastewater

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**International Specialized Course on Water Supply, Sanitation and Treatment,  
Madrid, Spain, 13-23 October 2003**

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**Concrete Technology & Construction Materials**

## **A STUDY ON SELF COMPACTING CONCRETE MADE WITH LOCAL MATERIAL**

Ahmad Rasidi Osman<sup>1</sup>  
Mohd Syahrul Hisyam Mohd Sani<sup>1</sup>  
Wan Zukri Wan Abdullah<sup>1</sup>

### **ABSTRACT**

Recent remarkable changes in the construction environment are demanding improved technology for the production of high performance concrete with far greater workability, high strength and long durability. Therefore, a self-compacting concrete (SCC), which has excellent deformability and resistance to segregation and can be filled in heavily reinforced formwork without vibrators, was created. In order to verify the differences of the properties of hardened self-compacting concrete and normal vibrated concrete, various investigations have been carried out for establishing a rational mix-design and self-compactability testing method to make it a standard concrete. To achieve the performance goal, there are so many factors that have to be considered. It started from the application of local materials including the additive or admixture to enhance the flowability of concrete. It is followed by the concrete mix of varying design strength by using ordinary Portland cement (OPC) cement, aggregates of varying sizes, superplasticizers and fly ash which is expected to be effectively used for self-compacting concrete. The objective of this study is to find the local material that can be used as an admixture for self-compacting concrete (SCC). Local material that has been selected as an admixture is rubberwood ash. Ten different concrete mix designs are used as a mixture for sample of cube, cylinder and beam. Method that has been used to determine the self-compacting concrete (SCC) are U box/ U- flow test and slump flow test. Standard testing methods to determine the strength of concrete are cube test for compressive strength, cylinder splitting test for tensile strength and flexural beam test for flexural strength. Through U flow test and slump flow test, it was found that concrete mix with rubberwood ash as an admixture failed to be classified as a self-compacting concrete (SCC). It was also found that concrete mix with rubberwood ash will decrease in compressive strength, tensile strength and flexural strength. Strength of concrete decrease with the increasing of amount rubberwood ash added.

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## **BEHAVIOUR OF CALCIUM SILICATE AND SAND CEMENT BRICK WALLS UNDER COMPRESSIVE AXIAL LOAD**

Kartini Kamaruddin  
Siti Hawa Hamzah

### **ABSTRACT**

Conventional approach in design and construction of buildings are built based on frame structure using reinforced concrete, steel or timber as structural member for load transmittal to the foundation. Bricks are normally used as infill materials in such framed structures. However, research has shown that bricks can also be used as an external and internal load bearing walls. With the use of this structural masonry method of construction, cheaper and faster construction can be achieved. The savings in terms of using formwork and reinforcing steel can be made and the rate of construction can be reduced since less use of frame or not required at all and the waiting time for the structural concrete to cure or gain their strength can be eliminated. Kartini & Siti Hawa (1998) in the preliminary studies on identifying the suitability of locally produced bricks as load bearing walls, found calcium silicate bricks and sand cement bricks gave high compressive strength of 10.30 N/mm<sup>2</sup> and 8.59 N/mm<sup>2</sup> respectively. Further investigation was carried out by erecting three units of calcium silicate brick walls and three units of sand cement brick walls of the size 1000 mm x 1000 mm and half brick thick. The structural behaviors of these brick walls due to compressive axial load were investigated and from the studies it shows that both the calcium silicate and sand cement brick walls are suitable to be used as load bearing wall. However, the study concluded that sand cement brick wall showed better performance, with maximum lateral displacement of 3.81 mm, vertical deflection of 6.63 mm and ultimate load of 448.13 kN.

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**Keywords :** Calcium silicate brick, sand – cement brick, compressive axial load, lateral displacement vertical deflection and ultimate load

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Kuching, Sarawak, 19-21 May 2004**

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## **BENDING AND SHEAR STRENGTH OF LAMINATED VENEER LUMBER (LVL) MADE FROM RUBBERWOOD**

Ezahtul Shahreen Ab. Wahab  
Zakiah Ahmad  
Azmi Ibrahim

### **ABSTRACT**

This paper discusses the mechanical properties of Laminated Veneer Lumber (LVL) made from rubberwood (*Hevea brasiliensis*). The LVL panels were cut and dried dry in accordance to ASTM D198 (Flexural test). The properties evaluated include shear strength, modulus of rupture (MOR), modulus of elasticity (MOE), density and moisture content. The effects of timber species and veneer thickness on both properties were statistically analyzed. The LVL rubberwood showed an increment of 10.3% for MOR, 29% for MOE, and 15.5% for shear more than solid rubberwood.

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**Keywords:** Laminated Veneer Lumber (LVL), flexural test, modulus of rupture (MOR), modulus of elasticity (MOE), moisture content, density

## **BENDING STRENGTH OF GLASS FIBRE REINFORCED PLASTIC (GFRP) REINFORCED POLYMER CONCRETE**

Hamidah Mohd. Saman  
Azmi Ibrahim

### **ABSTRACT**

Polymer Concrete (PC) costs more than reinforced concrete but less than Fibre Reinforced Plastic (FRP). Combining or sandwiching PC with FRP sheet(s) would result in a FRP-PC composite with the core PC not only providing rigidity as in a conventional sandwiched system but also strength in addition to that provided by the skin(s). In the present investigation, core PCs of two ratios of ingredients consisted of sand:resin(polyester):filler(talcum) were cast and tested for their bending strengths. For each formulation, PC panels of 10 mm and 20 mm thick were prepared, some lined on one side (LPC) and others sandwiched (SPC) with laminated Glass Fibre Reinforced Plastic (GFRP). The core PC was also added with randomly distributed glass fibres and the performance of the resulting fibrous PC in bending was compared with those without glass fibres. The results showed that the use of higher resin content and distributed glass fibres did not significantly affect the performance in comparison to those prepared with a lower resin content and without fibres. Lining PCs with GFRP had increased the bending strength of the core PC by about 3 to 5 times.

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**Keywords :** Polymer Concrete (PC), Fibre Reinforced Plastic (FRP), bending strength, laminating, sandwiching, skin(s) and distributed glass fibres

## **CIRI-CIRI KONKRIT SEGAR DAN KERAS UNTUK PENGHASILAN KONKRIT BERMUTU**

Ahmad Ruslan Mohd. Ridzuan  
Mohd Ali Jelani  
Abu Bakar Mohamad Diah

### **ABSTRAK**

Kertas kerja ini membincangkan secara terperinci mengenai penghasilan konkrit bermutu yang dapat digunakan mengikut spesifikasi. Oleh itu, perhatian serta pengetahuan yang sempurna dalam penghasilan konkrit adalah perlu bagi menghasilkan konkrit yang berkualiti serta tahan lama. Walaupun telah banyak di perkatakan terhadap aspek ini tetapi masih terdapat masalah yang berkaitan dengan struktur konkrit itu sendiri. Oleh itu tidak keterlaluan jika aspek-aspek ini sentiasa di tonjolkan agar ianya menjadi satu natijah atau dorongan serta mengenalpasti semula aspek-aspek atau ciri-ciri yang di anggap penting dalam penghasilan konkrit. Untuk menghasilkan konkrit yang dapat berfungsi dengan cemerlang serta tahan lama ia perlulah diteliti daripada peringkat awal seperti pemilihan bahan komponen yang berkualiti serta pada peringkat konkrit basah dan pembancuhan konkrit sehingga ke peringkat perletakan ke dalam acuan dan sehingga keras dan boleh digunakan. Pemantauan ciri-ciri konkrit segar serta yang terkeras dengan itu adalah amat penting bagi memastikan konkrit yang dihasilkan mencapai tahap kualiti yang di perlukan serta mengikut spesifikasi yang ditetapkan dalam spesifikasi pembinaan.

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**Keywords :** Konkrit bermutu, konkrit segar, konkrit keras, pembinaan

# CONCRETE IN MALAYSIA : ISSUES AND CHALLENGES

Kartini Kamaruddin

## ABSTRACT

Looking into the vision of our Prime Minister for Malaysia to be a fully developed country in the year 2020, we as the industries player have to address some of the objectives and problems faced by the industries today in order to achieve the Vision. Government has allocated large sum of money for projects, such as infrastructure, housing and education for both public and private for the purpose of a better quality of life for all. Most of these projects involve construction and as the most widely used construction material in the worlds, concrete, like flour in making cake, is the major and essential ingredient for any construction project. Past experience has shown that the materials used in structural concrete today are fundamentally no different than those that were used or available years ago. However, there have been major improvements of concrete today together with other innovations in the industry in methods of production of concrete- much more sophisticated, more versatile, better understood and offer much improved quality and consistency than in those early years. Mechanization and mechanical handling are becoming common with most major sites having their own batching plant or in smaller sites particularly in urban sites where space is limited, mixing of concrete on site are slowly being replaced by ready-mixed concrete. The technical developments in the form of producing higher strength of concrete, the use of concrete pumps and formwork systems, production of pre-cast and pre-stressed on sites and at factories have enabled some of the benefits of the modern concrete construction. These developments will meet the challenges imposed provided that education and training aspects are handled in a competent manner and this is a continual challenge for the concrete industry.

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**Keywords :** Concrete, ready-mixed concrete, concrete production, modern concrete construction, construction industries, construction players, education and training.

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**Seminar on Construction Waste Management, Putrajaya, 26 March 2003**

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# **DESIGN AND DEVELOPMENT FOR FIBRE REINFORCED LIGHTWEIGHT CONCRETE FOR BUILDING STRUCTURAL COMPONENTS**

Hamidah Mohd. Saman  
Azmi Ibrahim  
Abdul Manaff Ismail,  
Ahmad Ruslan Mohd.Ridzuan,  
Kartini Kamaruddin

## **ABSTRACT**

Concrete density can be reduced in several ways, and these include by using lightweight aggregates, cellular, foams, high air contents, no fines mixes and others. In this project, the use of foaming agent to produce lightweight concrete, hence the term foamed concrete will be explored. Foamed concrete is a cement based slurry in to which a stable and homogeneous foam is mechanically blended, either by mixing or by injecting. The project is divided into three (3) main phases. Phase 1 involves the study on the optimisation of foamed concrete incorporating different types of sand, sand-cement ratios, water-cement ratios and curing methods and regimes; Phase 2, the investigation into enhancement properties by adding silica fume and glass fibres and finally Phase 3 focuses on the application of foamed concrete as building structural components such as masonry and panels/walls where strength as well as thermal and acoustic properties would be of concern. Nineteen series of foamed concrete of densities ranging from 300 to 1600 kg/m<sup>3</sup> have been successfully produced in the laboratory using the mix proportions designed. The mechanical properties, namely the compressive strength, the modulus of elasticity and the flexural strength at the age of 3, 7, 28 and 60 days have been under close monitoring. However, only the results from Phase 1 and a few from Phase 2 will be presented in this progress report. From Phase 1, the preliminary results compiled so far showed that the compressive strength of foamed concrete for all of the density investigated is significantly dependent on the sand-cement ratio and the particle size distribution of sand. The compressive strength has been shown to improve not only with reducing sand-cement ratios but also reducing sand content. On the contrary, a cheaper mix of foamed concrete would only be possible through maximising the sand content. For a lower density foamed concrete, the amount of sand that could be incorporated is also limited due to the problems related to mix segregation and stability. Therefore, the sand content in foamed concrete requires comprehensive optimisation for the purpose of producing a sufficiently strong mix for the intended purposes without sacrificing both the economics of the production and practicality in the mixing and placing of such concrete. A series of sand-cement ratios for different types of sand will be attempted and the resulting fresh mix, if stable, will be placed in appropriate moulds and subsequently tested in compression following different curing periods and regimes. Charts of compressive strength versus densities for different sand-cement ratios and different types of sand (characterised by its particle size distribution) will be established. These charts would be



able to provide estimates of the compressive strength of foamed concrete of any densities for an arbitrarily chosen sand-cement ratio and particle size distribution of sand.

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**Keywords :** Lightweight concrete, foamed concrete, portaf foam, mechanical properties, and-cement ratios, particle size distribution, compressive strength.

## **DETERMINATION OF AIR VOID PARAMETERS OF CONCRETE MATERIALS USING IMAGE PROCESSING TECHNIQUES**

Hashem Mohd Ali Al-Mattarneh  
Sulaiman Abdul Malik  
Rohana Hassan

### **ABSTRACT**

Results obtained from many experimental studies proved that concrete air void parameters play an important role in protecting concrete from freeze – thaw damage. The ASTM C457 test has long been a standard used to obtain the air void parameters of concrete materials. The standard test procedure involves linearly traversing a cut and polished section of a concrete specimen. The polished section then observed under a microscope. Chord lengths of material constituents along the linear transverse are recorded and later used to calculate air void parameters statically. This procedure is long and tedious, which make it susceptible to human error due to operator's fatigue. This study was conducted to develop a new test method for evaluating concrete air void parameters using an image analysis method. A polishing procedure along with a microscope, video camera, image analysis software and computer are used to obtain high contrast image of concrete material. Because of the high contrast that can be obtained, cement paste, air void in the cement paste, and aggregate materials in the concrete can be distinguished from one another based on these images. An image analysis program has been prepared for this study which is a similar way to standard ASTM C457 test. Cube specimens were prepared from three concrete mixes with w/c ratios 0.35, 0.45 and 0.55. Cubes specimens which have been previously tested using the standard ASTM C457 method are used and tested using the image processing method. Statistical comparisons indicate that the results of the new test are indeed significant. The new test appears to have excellent potential for practical application. Further study on a variety of other concrete materials would be required for implementation in a standard procedure.

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**Keywords :** Concrete, air void, image analysis

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29 November - 1 December 2003**

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## **ENHANCEMENT OF MALAYSIAN STRUCTURAL TIMBER GRADING USING DIELECTRIC SENSOR**

Hashem Al-Mattarneh  
Rohana Hassan  
Khafilah Din  
Zakiah Ahmad

### **ABSTRACT**

Strength grading of structural timber is important to enhance the value of the timber. This circumstance conveys that demands of non-destructive testing and evaluation techniques to estimate the physical and mechanical properties of timber structures need to be enhanced. In this paper, research work focuses on the development of dielectric sensor to measure electromagnetic properties (dielectric constant) of timber in low frequency range 1 kHz to 100 kHz. A mobile dielectric sensor has been developed. One hundred and fifty nine (159) timber samples were graded using Malaysian visual grading standard. These samples were chosen from six different Malaysian timber types representing three selected strength grade. The experimental results for dielectric properties, bending strength, compressive strength and modulus of elasticity of timber samples were reported. The effects of frequency, timber type and timber grade on timber dielectric properties were discussed. The use of the measured dielectric constant shows the ability of the sensor which has been developed in this study to enhance the visual grading of timber material.

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**Keywords:** Timber grading, non-destructive technique, dielectric properties

## **FAILURE MECHANISM OF SAND CEMENT BRICK WALL**

Siti Hawa Hamzah  
Kartini Kamaruddin

### **ABSTRACT**

Bricks are normally used as infill materials in framed structures. Kartini & Siti Hawa (2001, 2003, 2004a, 2004b) in their studies determined the physical properties of locally produced sand cement bricks and its potential as structural carrying capacity member in building construction. The failure mechanism of sand cement brick walls in all tested four (4) samples fell in the splitting mode category. Average ultimate load of 476 kN and cracks were seen to propagate from under the load level throughout the wall to the 8<sup>th</sup> layer and some to the 13<sup>th</sup> layer from a total of 14 layers of bricks i.e almost the lowest end of the brick wall.

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## **FATIGUE PERFORMANCE OF POLYPROPYLENE FIBRE HIGH STRENGTH REINFORCED CONCRETE**

Khafilah Din  
Afidah Abu Bakar  
Yong Chua Boon

### **ABSTRACT**

This paper presents experimental results on the performance of high strength concrete of grade 60 containing polypropylene fibre subjected to repeated constant amplitude load. The fibre is having a mix length of not more than 50 mm. The mean load applied to the concrete prism specimen is one half of its yield load. Results from third-point bending test of prism are investigated. This paper discusses on fatigue performance of three different composite concrete mixes i.e. high strength, fibre reinforced and high strength fibre reinforced concrete in terms of crack propagation; namely material constants  $m$  and  $C$  which is required in assessing fatigue life of this composite concrete. This work provides a good understanding and benefit gained on concrete technology on fatigue crack behaviour of composite concrete properties.

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**Keywords:** Polypropylene fibre, high strength, fatigue cracking, constant, amplitude load, tensile loading mode

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Developing Countries, Kuala Lumpur, 5 October 2004**

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## **FLEXURAL BEHAVIOUR OF COMPOSITE POLYMER CONCRETE AND GFRP SHEET**

Siti Rashidah Mohd. Nasir  
Hamidah Mohd. Saman  
Azmi Ibrahim  
Mohd. Faisal Mohd. Jaafar

### **ABSTRACT**

A composite of Polymer Concrete (PC) and Glass Fibre Reinforced Plastic (GFRP) sheet(s) was investigated in terms of its bending strength. Variations in the composite system included PC lined on one surface with GFRP sheet (LPC) and PC sandwiched between GFRP sheets (SPC). In this study, two series of formulations with ratios of 55:35:10 and 60:30:10 of sand, resin and talcum were used. Two different types of sand were employed which were silica and mining sand. Bending strengths of PC alone as well as LPC and SPC were tested. In this investigation, a thickness of 10 mm was adopted for the PC. The results showed that the bending strength of PC made with silica sand performed better than that of mining sand, and that the strength was improved when the layer of excess resin was positioned at the extreme tensile fibre. Laminating the PC with GFRP sheet(s) as in LPC and SPC increased the strength by up to 3 times. The performance of PC, LPC and SPC were greatly dependent on the particle size distribution of the aggregates.

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**Keywords :** Polymer concrete, Glass Fibre Reinforced Plastic (GFRP), flexural strength, laminating and sandwiching.

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**Proceedings of the 3<sup>rd</sup> International Conference on Recent Advances in Materials, Minerals and Environment (RAMM 2003), Penang, Malaysia, 20-22 October 2003**

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## **FLEXURAL TOUGHNESS OF OIL PALM TRUNK FIBRE REINFORCED CONCRETE**

Khafilah Din  
Zakiah Ahmad

### **ABSTRACT**

This paper describes flexural behaviour of normal concrete of grade 30 N/mm<sup>2</sup> strengthening by natural fibre from oil palm trunk (OPT). Two fibre lengths i.e. 25 and 50 mm were chosen with 3 different low fibre volume fractions i.e. 1%, 2% and 3% and water cement ratio 0.5. Toughness index was obtained by using a new procedure stipulated in ASTM C1018. Three types of strength test were conducted such as compressive, tensile and flexural at 28-day subjected to monotonic loading.

Results indicate adding the OPT fibre into concrete matrix would not significantly improved the compressive strength of concrete, but it will prolong the capability to resist bending. Concrete having 1% fibre provides excellent ductility either in terms of compressive or tensile strength compared with concrete without fibre. Fibre length of 50 mm improved the tensile strength and vice versa for the compressive strength. Concrete composite with 25 mm fibre length is better to be used for compression member. Toughness index of  $I_g$  increases as volume fraction of fibre increases and this is consistent with steel fibre under the same new measurement technique of deflection.

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**Keywords:** Normal concrete, natural fibre, load-deflection measurement, toughness index

## **IMAGE PROCESSING APPLICATION TO DETERMINE THE AIR VOID PARAMETERS OF CONCRETE**

Hashem Al-Mattarneh  
Sulaiman Abdul Malik  
Rohana Hassan

### **ABSTRACT**

Many experimental studies have proven that concrete air void parameters played an important role in protecting concrete from freeze-thaw damage. The ASTM C457 test has long been a standard used to obtain the air void parameters of concrete materials. The standard test procedure involves a linearly traversing cut and polished section of a concrete specimen. The polished section is then observed under a microscope. Chord lengths of material constituents along the linear traverse are recorded and later used to calculate air void parameters statistically. This procedure which is long and tedious makes it susceptible to human error due to operator fatigue. This study was conducted to develop a new test method for evaluating concrete air void parameters using an image analysis method. The concrete surface will undergo a polishing procedure. A microscope, video camera, image analysis software and computer are used to obtain high contrast images of concrete surface. A high contrast images can be obtained where cement paste, air voids and aggregates in the concrete can be distinguished based on these images. An image analysis program has been prepared for this study which linearly traverses these images and records the chord length of material constituents in a similar way to the standard ASTM C457 test. Statistical comparisons indicate that the results of the new test are indeed significant. The new test appears to have an excellent potential for practical application. Further study on a variety of other concrete materials would be required for implementation in a standard procedure.

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**Keywords:** Concrete, air-void, image processing, freeze-thaw



## INDICATIVE BEHAVIOUR OF PROFILED STEEL SHEETING DRY BOARD WALL SYSTEM STIFFENED WITH STEEL PLATES

Wan Hamidon Wan Badaruzzaman<sup>1</sup>  
Wan Hanna Melini Wan Mohtar<sup>1</sup>  
N. Hamzah<sup>1</sup>  
Abdul Khalim Abdul Rashid<sup>1</sup>  
Siti Hawa Hamzah<sup>2</sup>

### ABSTRACT

The presence of steel plates in Profiled Steel Sheeting Dry Board (PSSDB) wall system is expected to increase the ability of the system in withstanding loading. Therefore, the investigation into the behaviour of the PSSDB wall with the presence of steel plates at specific positions was conducted. Three full scale samples were prepared to investigate specifically the effect of the placement of steel plates, i) sample without steel plate, ii) sample stiffened with steel plates on both sides at mid-height, iii) sample stiffened with steel plates on both sides at top and bottom ends, and at mid-height. The samples were 3 m high and were tested under axial loading. It was found that all samples failed at almost the same ultimate load at about 162 kN/m run. It seemed that the steel plates introduced were not able to improve the load resistance capacity of the PSSDB wall samples. This could be due to few reasons, firstly, the amount of steel plates used were relatively very small compared to the whole PSSDB wall section, and secondly, the screwed attachment between the steel plates and the PSSDB wall samples was not functioning properly as it was observed that the steel plates were detached from the PSSDB wall at failure. The load bearing capacity of the samples was found to be capable of taking up normal loading onto walls in residential buildings, which is about 40 kN/m run. The predicted critical load  $P_{cr}$ , calculated from Euler equation is 242 kN/m run which is higher by about 50% than the actual value. Overall buckling was observed to be the mode of failure in all cases. The higher predicted value was mainly due to the full interaction assumption made by the theory. However, in reality, partial interaction took place, hence, resulting in lower stiffness values. Further studies should be made to improve the theoretical prediction by taking into account the partial interaction behaviour of the wall samples.

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**Keywords:** Cemboard, profiled steel sheet, steel plates, failure behaviour

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# **INFLUENCE OF RECYCLED AGGREGATES ON THE PERFORMANCE AND DURABILITY OF OPC CONCRETE**

Ahmad Ruslan Mohd Ridzuan  
Azmi Ibrahim  
Abdul Manaff Mohd Ismail

## **ABSTRACT**

The effects of using crushed waste concrete as coarse aggregates upon compressive strength, drying shrinkage and air permeability of concrete were investigated. Waste concrete cubes, which had been tested for compressive strength in compliance with construction specification, were crushed and utilized as coarse recycled aggregates in new concrete. It is important to mention that, in order to simulate the real life conditions, waste concrete with very minimal information about its originality was used in its natural moisture condition. Tests on the aggregates showed that the recycled concrete aggregates have lower specific gravity and bulk density but have higher water absorption capacity than the natural aggregates. The resistance to mechanical actions such as impact and crushing for recycled concrete aggregates is also lower. Concrete mixes with design strength of 30 N/mm<sup>2</sup>, 35 N/mm<sup>2</sup> and 40 N/mm<sup>2</sup> were prepared using this recycled aggregates as coarse aggregates and tested. From the strength point of view the recycled aggregate concrete compared well with natural aggregate concrete. Therefore it could be considered for various potential applications. With respect to air permeability the recycled aggregate concrete shows higher permeability compared to corresponding natural aggregate concrete and comparable shrinkage.

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**Keywords :** Recycled aggregate, strength, permeability, durability, concrete

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**Seminar Penyelidikan Kejuruteraan Awam (SEPKA 2003),  
Cameron Highland, 11-13 September 2003**

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# **INFLUENCE OF SILICA FUME ON FLEXURAL STRENGTH OF FIBRE-REINFORCED CONCRETE**

Afidah Abu Bakar  
Khafilah Din  
Norisham Ibrahim

## **ABSTRACT**

This paper presents the results of an experimental study on the influence of silica fume as partial replacement of Portland cement (at 0, 10, 12 and 16%) on the performance of fibre-reinforced high strength concrete. The fibres are polypropylene and polyester-based types and a comparative evaluation on flexural strength and toughness properties is also presented. The results indicate that suitable SF content could lead to effective enhancement of strength.

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**Keywords:** High strength concrete, polymeric fibres, flexural strength and toughness

## **INFLUENCE OF WASTE CONCRETE AGGREGATES ON THE PERFORMANCE AND DURABILITY OF OPC CONCRETE**

Ahmad Ruslan Mohd Ridzuan  
Azmi Ibrahim  
Abdul Manaff Mohd Ismail

### **ABSTRACT**

The effects of using crushed waste concrete as coarse aggregates upon compressive strength and carbonation were investigated. Waste concrete cubes, which had been tested for compressive strength in compliance with construction specification, were crushed and utilized as coarse recycled aggregates in new concrete. Tests on the aggregates showed that the recycled concrete aggregates have lower specific gravity and bulk density but have higher water absorption capacity than the natural aggregates. The resistance to mechanical actions such as impact and crushing for recycled concrete aggregates is also lower. Concrete mixes with design strength of 30 N/mm<sup>2</sup>, 35 N/mm<sup>2</sup> and 40 N/mm<sup>2</sup> were prepared using this recycled aggregates as coarse aggregates and tested. From the strength point of view the recycled aggregate concrete compared well with natural aggregate concrete. Therefore it could be considered for various potential applications. With respect to resistances to carbonation the recycled aggregate concrete show comparable performance.

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**Keywords:** Recycled aggregate, strength, carbonation, durability, concrete

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**Conference on Scientific & Social Research (CSSR 2004),  
Kuching, Sarawak, 19–21 May 2004**

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# MEASUREMENT OF DIELECTRIC CONSTANT USING CAPACITOR PROBE FOR TIMBER GRADING

Rohana Hassan  
Hashem Al-Mattarneh  
Khafilah Din  
Zakiah Ahmad

## ABSTRACT

Visual grading for timber is vastly known in Malaysia and even in the worldwide. However, is it accurate enough to be the only method practically used in timber grading? This question shall always be a question mark as only fewer studies have been done to solve these common phenomena. In this paper, research work focuses on the development of Capacitor Probe as equipment to measure dielectric constant of timber in low frequency range within 1 kHz, 10 kHz and 100 kHz. Samples were taken from 14 selected Malaysian timber types representing four strength grade. The experimental results, dielectric properties with different frequencies in respect with different strength grade were presented and discussed. The measured dielectric constant shows the ability of the Capacitor Probe as one of the Non-destructive test method in enhancement of timber grading.

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**Keywords :** Dielectric constant, low frequency, non-destructive, timber grading

## **MECHANICAL PROPERTIES OF HIGH STRENGTH CONCRETE CONTAINING POLYMERIC FIBRES**

Afidah Abu Bakar  
Khafilah Din  
Siti Hawa Hamzah

### **ABSTRACT**

A laboratory assessment was made on high strength concrete (HSC) of Grade 60 generated from cement replacement material, i.e. silica fume and low water-cement ratio. Since HSC is usually brittle in nature, addition of polymeric fibres is intended to improve ductility of the composites. Two types of fibres, namely polypropylene of fibrillated form and wasted-short polyester fibres, are compared in the concrete mix at volume fractions of 0.5 % and 1 %. The influences of these fibres on the compressive, splitting tensile and flexural strengths are also comparable with controlled HSC mix without fibres.

From the experimental investigation, each fibre type seemed to have its own significant contribution in the mechanical strength properties. It was found that polypropylene fibres improved splitting tensile and bending strengths. However, polyester fibres seemed to react well with cementitious materials and resisted better in compression. Quantification of these properties will help to identify specific application of fibres in structures using high strength concrete.

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**Keywords:** High strength concrete, polymeric fibres, mechanical strength properties

# **MICROWAVE COMPLEX PERMITIVITY AND SCATTERING PARAMETERS FOR DETERMINATION OF MOISTURE CONTENT IN TIMBER MATERIAL**

Hashem Al-Mattarneh<sup>1</sup>  
Sulaiman A. Malik<sup>1</sup>  
Zakiah Ahmad<sup>1</sup>  
Deepak K. Ghodgaonkar<sup>2</sup>

## **ABSTRACT**

The experimental results for moisture measurement of several Malaysian timbers using in microwave free-space technique are presented. The method is based on the measurement of the reflection and transmission of microwave in the X-band frequency range. The complex permittivity of timber were deduced from the scattering parameters for timber material at different moisture content ranging from saturated to oven dry. The results show that the microwave scattering parameters and complex permittivity (dielectric constant and loss factor) of timber material can be used to determine the moisture content.

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**Keywords :** Timber, microwave, moisture content, dielectric properties, scattering parameters

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4-7 November 2003**

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## **NON-DESTRUCTIVE TECHNIQUE FOR ASSESSING MOE OF LAMINATED VENEER LUMBER (LVL): VIBRATION METHOD**

Kohei Komatsu<sup>1</sup>  
Mori Takuro<sup>1</sup>  
Paridah Md.Tahir<sup>2</sup>  
Zakiah Ahmad<sup>3</sup>  
Azmi Ibrahim<sup>3</sup>

### **ABSTRACT**

A variety of non-destructive evaluation (NDE) techniques are used to assess the engineering properties of structural lumber. Static bending, longitudinal-vibration and longitudinal stress wave NDE techniques are frequently used to assessing the modulus of elasticity (MOE) of lumber. Excellent correlation between MOE values obtained from these techniques has shown to exist.

In this study, an investigation was made on the stiffness and MOE of LVL manufactured from Malaysian Rubberwood and Japanese Sugi. The test specimens were prepared according to ASTM D198. The beams were assessed in the laboratory using vibration nondestructive evaluation (NDE) and also static bending for comparison purposes. The test results are presented in terms of modulus of rupture and modulus of elasticity and the data was analysed statistically. The results of this study reveal that the LVL has relatively reliable strength properties. The application of vibration nondestructive technique can be used as a tool to predict or estimate the strength of LVL.

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**Keywords:** LVL, modulus of elasticity, rubberwood, sugi, NDE

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Daejeon, Korea, 21-24 April 2003**

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## PENGHASILAN KONKRIT BERMUTU

Kartini Kamaruddin

### ABSTRAK

Secara ringkasnya konkrit boleh didefinisikan sebagai bahan yang dihasilkan daripada campuran simen, batu baur kasar, batu baur halus (pasir) dan air mengikut kadar campuran (nisbah) yang tertentu. Campuran ini akan dibiarkan mengeras didalam kotak acuan supaya membentuk satu anggota struktur. Selain daripada bahan-bahan asas yang disebut diatas, kadang-kadang sejenis bahan tambah dicampurkan untuk menghasilkan konkrit yang bersifat tertentu.

Di dalam setiap projek pembinaan tidak kira kecil atau besar, konkrit merupakan satu daripada bahan-bahan binaan yang banyak digunakan. Oleh kerana itu, teknik membuat konkrit yang berkualiti tinggi hendaklah difahami dan diperhatikan dengan teliti.

Untuk menghasilkan konkrit yang bermutu ataupun berkualiti, bahan-bahan mentah yang digunakan seperti simen, batu baur dan air mestilah berkualiti. Manakala kadar campuran, jumlah air digunakan, cara menggaul, cara mengangkut, cara menempatkan atau menuang, cara memadatkan konkrit, kualiti acuan dan cara pengawetan mestilah mengikut tatacara kerja yang betul, peraturan, piawaian atau spesifikasi yang telah ditetapkan. Jika bahan-bahan mentah yang digunakan berkualiti rendah atau kerja-kerja penyediaan tidak mengikut peraturan yang telah ditetapkan, maka sudah pasti konkrit yang terhasil akan mempunyai kualiti yang rendah, dan ini mungkin akan mengakibatkan struktur konkrit tersebut tidak dapat menanggung beban seperti yang diharapkan. Untuk memastikan hanya bahan yang baik kualitasnya sahaja digunakan di tapak bina, maka pengawasan lanjut hendaklah juga dilakukan semasa menyimpan, menggaul dan peringkat binaan. Ujian-ujian di tapak bina perlu juga dilakukan untuk menentukan atau memperolehi binaan konkrit yang baik. Rajah 1.0 menunjukkan carta aliran faktor-faktor yang akan mempengaruhi mutu kualiti konkrit.

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**Keywords :** Konkrit, tapak bina, kualiti konkrit, bahan konkrit, bancuhan konkrit, penuangan konkrit, piawaian dan spesifikasi konkrit.

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**Seminar Penghasilan Konkrit Bermutu, Melaka, 29-30 Ogos 2003**

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## **PERFORMANCE OF FOAMED CONCRETE INCORPORATING SILICA FUME AND DISTRIBUTED GLASS FIBRES**

Hamidah Mohd. Saman  
Azmi Ibrahim  
Kartini Kamaruddin

### **ABSTRACT**

In this preliminary investigation, an attempt was made to enhance the strength and the absorption characteristic of 1000 kg/m<sup>3</sup> density foamed concrete. A series of two replacement levels of silica fume namely 2% and 5% of an equal mass of cement and for each level, two levels of randomly distributed short glass fibres content namely 0% and 2% of an equal mass of binder was employed. Compressive and tensile strengths were assessed on moulded specimens after 3, 7 and 28 days of water-cure. Chloride penetration depths were also monitored on moulded specimens immersed in a 5% chloride solution for 3, 7, 28 and 56 days. An Initial Surface Absorption Test (ISAT) was also carried out after 28 days of water-cure. Preliminary results compiled thus far showed that the addition of silica fume and glass fibres did not contribute to any significant improvement in either the strength or the absorption of the foamed concrete investigated and hence possess no property-enhancing characteristic.

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**Keywords :** Foamed concrete, strength, absorption, silica fume and glass fibres

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**Prosiding Persidangan Kebangsaan Ketiga Kejuruteraan Awam (AWAM 2004),  
Penang, Malaysia, 20-22 Julai 2004**

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## **PLASTIC SHRINKAGE CHARACTERISTIC OF CEMENT MORTAR REINFORCED WITH OIL PALM TRUNK FIBER**

Zakiah Ahmad<sup>1</sup>  
Azmi Ibrahim<sup>1</sup>  
Paridah Md Tahir<sup>2</sup>

### **ABSTRACT**

The purpose of this research is to investigate the contribution of fibers to the reduction of shrinkage cracks during the initial setting stage of concrete. The fiber used is oil palm trunk fiber. The fiber lengths are in the range of 25 mm until 50 mm. The fiber content varies from 0 to 4 percent of total mortar volume. The tests are conducted by using 600 mm x 900 mm rectangular slabs with 19 mm thick. The slabs are subjected to rapid drying right after casting. Shrinkage test was carried out by measuring the weighted average. The castings of fiber-reinforced mortar followed the ASTM C 270-97 d. The contributions of fibers are evaluated by using the crack area. In all cases, the crack area of unreinforced matrix is compared with the crack area of reinforced matrix. From this investigation it was found that the fiber improved shrinkage problem of the mortar. The 4 percent of fiber content shown to have the highest weighted average and 3 percent of fiber improves the compressive strength.

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**Keywords :** Plastic shrinkage, oil palm trunk, fiber, crack area

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**Proceedings of 3<sup>rd</sup> International Conference on Recent Advances in Materials,  
Minerals and Environment 2003, Penang, Malaysia, 20–22 October 2003**

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## **SAND CEMENT BRICKS AS LOAD BEARING WALLS**

Kartini Kamaruddin  
Siti Hawa Hamzah

### **ABSTRACT**

Conventional approach in design and construction of buildings are built based on frame structure using reinforced concrete, steel or timber as structural member for load transmittal to the foundation. Bricks are normally used as infill materials in such framed structures. However, research has shown that bricks can also be used as an external and internal load bearing walls. With the use of this structural masonry method of construction, cheaper and faster construction can be achieved. The savings in terms of using formwork and reinforcing steel can be made and the rate of construction can be reduced since frames are less or not required at all and the waiting time for the structural concrete to cure or gain their strength can be eliminated. Kartini & Siti Hawa (2001, 2003) in their preliminary studies to determine the physical properties of a brick and a structural behaviour as a wall of sand cement brick found out that the locally produced sand cement bricks are suitable to be used as load bearing wall. It also shows a better performance, with maximum lateral displacement of 3.81 mm, vertical deflection of 6.63 mm and ultimate load of 448.13 kN.

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**Keywords :** Sand-cement brick, load bearing wall, lateral displacement, vertical deflection and structural masonry

## SAWDUST ASH (SDA) : A NEW CEMENT SUBSTITUTE

Kartini Kamaruddin  
Hamidah Mohd Saman

### ABSTRACT

With the “Dasar Pertanian Negara-1984” to look into the alternative use of the waste material and worries on the limited disposal area, therefore the search into the use of organic waste material as cement replacement is timely and fulfills the government strive to sustain the development environmentally. Many of waste materials, i.e saw dust ash (SDA), rice husk ash (RHA) and the rattan dust ash (RDA) to name a few were industrial by-products which can be considered as waste material and normally thrown away without any commercial value. The opportunities in discovering the maximum value from the waste materials should be taken up and used as a useful resource. One of the potential organic waste or by product that has been identified is sawdust.

Wood industry is one of Malaysia’s major contributors to our economic growth. According to report in Second Industrial Master Plan (IMP2) (MITI, 1996) the wood based exports in Malaysia increased from RM 4.3 billion in year 1985 to RM 12.3 billion in year 1995 and indicated that by year 1995, there was about more than 5,000 factories in wood based sector in Malaysia. Furthermore, the furniture, sub-sector of wood based industries exports increased by 21.0 percent from RM 1.4 billion in year 1994 to RM 1.7 billion in year 1995 (MITI, 1996). This means that there are large supplies of wood to cater for the industry needs. When this wood is processed, the large amounts of sawdust are inevitably thrown away or it will be burnt at the back of the factory without any commercial value. It is the intention of this preliminary research to find out whether this sawdust ash obtained from the burning of the sawdust can be used as a new cement substitute in making concrete. The chemical analysis of the sawdust ash, the compressive strength test and durability test on the concrete cubes are conducted. The concrete cubes are made of various proportion of ordinary Portland cement (OPC) and sawdust ash (SDA) such as 0% (as control mix), 10%, 20%, 30%, 40% and 50% cement replacement with 0.5 water cement ratio. Grade 30 concrete was used throughout the test. From the results obtained, it shows that the concrete with 30% replacement of SDA is acceptable and the compressive strength is within the specified strength required in design mix. In terms of durability, concrete with up to 20% SDA by weight of cement possess ability to resist acid attack as good as that of control. The concrete containing SDA shows improved permeability in terms of chloride penetration depth. Therefore, SDA has the potential usage as a new cement substitute.

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**Keywords:** Compressive strength, durability, saw dust ash, cement replacement

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**Seminar on Engineering Research (SEPKA 2003), Cameron Highland,  
12-14 September 2003**

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# **SHRINKAGE PROPERTIES OF CONCRETE REINFORCED WITH OIL PALM TRUNK FIBER**

Zakiah Ahmad<sup>1</sup>  
Azmi Ibrahim<sup>1</sup>  
Paridah Md Tahir<sup>2</sup>

## **ABSTRACT**

In hot climate countries like Malaysia, shrinkage of concrete is one of the major characteristics influencing its durability. Incorrect specification and handling of this characteristic affects concrete durability and/or increases costs of construction.

This paper reports on the results of an investigation on the drying shrinkage of concrete reinforced with oil palm trunk fibers. It deals with the contribution of oil palm trunk fibers to the reduction of shrinkage cracks in concrete. The length of fibers used is in the range of 25 mm to 50 mm. The content of fibers varied at 0%, 1%, 2%, 3% and 4% of the total concrete volume. A total of 45 specimens were tested representing sections of square columns 400 x 400 mm with height of specimen 150 mm. Thick PVC pipe with different diameters were cast at the centre of the specimens to act as stiff cores which provide the internal restraint so that the cracking tendency in the thin shell at the surface of the column can be observed.

The contributions of fibers are evaluated by using crack width and length. In all cases, the crack area of unreinforced matrix is compared with the crack area of reinforced matrix. It was found that the fiber content plays an important role in reducing the cracks.

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**Keywords:** Oil palm trunk fiber, drying shrinkage, crack width, restrained shrinkage

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**STRENGTH DEVELOPMENT OF REACTIVE POWDER CONCRETE (RPC)  
REINFORCED WITH STEEL AND POLYPROPYLENE FIBRES AND CURED  
UNDER DIFFERENT CONDITIONS**

M. Fadhli Ahmad  
Hamidah Mohd. Saman  
Azmi Ibrahim  
Hanizah Abdul Hamid

**ABSTRACT**

In this study, a series of twelve Reactive Powder Concrete (RPC) with different volume fractions of steel and polypropylene fibres cured under different curing conditions was investigated. The mix design was adopted from earlier studies conducted by Richard and Cheyrezy, and modified to suit the availability and condition of local resources. The RPC specimens with fibres were steam cured at 90°C for 3 days, followed by air before their compressive and tensile strengths being assessed at the age of 3, 7 and 28 days. For the RPC specimens without fibres, a series of four RPC was cured under four different conditions namely air, 44 and 68 hours of steam, and hot water. The results showed that at up to a fibre volume fraction of 3%, the RPC with steel fibres recorded an increase in the compressive and tensile strengths with the fibre contents, and those with polypropylene fibres did not respond to the distributed reinforcement. The RPC cured under hot water recorded the highest compressive and tensile strength.

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**Keywords :** Reactive Powder Concrete (RPC), steel fibre, polypropylene fibre, curing, compressive and tensile strength.

**STRENGTH DEVELOPMENT OF REACTIVE POWDER CONCRETE (RPC)  
USING DIFFERENT CURING CONDITION AND CYCLES OF  
STEAM-CURING**

Hamidah Mohd. Saman  
Azmi Ibrahim  
Rozita Aris  
Hanizah Abdul Hamid

**ABSTRACT**

Firstly developed in 1990s, Reactive Powder Concrete (RPC) is an ultrahigh-strength cement-based composite with excellent mechanical properties, superior physical characteristics, considerably high ductility and extremely low porosity or permeability. It represents a new class of Portland-cement-based material with compressive strength well in excess of 100 MPa. Its superior compressive strength combined with high shear and tensile strengths result in significantly smaller structural elements for a given service and environmental loads hence a dramatic reduction in the total dead weight of the structure. In an original RPC, the absence of coarse aggregates is a key-aspect for the microstructure and the performance of the RPC. In this preliminary investigation, the utilisation of available resources in Malaysia to replace the relatively more expensive and generally unavailable ingredients in original RPC mix were explored. The effect of partly substituting cement and sand with coarse aggregates referred to as a modified RPC on the compressive strength of the resulting hardened concrete compared to that of the original RPC was investigated. The effects of using different types of sand and variations in the curing conditions and durations were also examined. At shorter steam-curing time, the results showed that the compressive strength of RPC in its modified form is lower than that of the original, which is attributed to the higher water-to-binder ratio. Additionally, RPC specimens made of river sand of medium grading performed better than that of fine and uniform size silica sand. It appeared that modified RPC attained compressive strength similar to that of original RPC when steam-cured for 7 day, with hot water cured modified RPC at 90°C recorded a compressive strength of 100 MPa.

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**Keywords :** Reactive Powder Concrete (RPC), modified RPC, silica sand, steam-curing, hot water-curing and compressive strength.

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## **STRENGTH AND ABSORPTION CHARACTERISTICS OF SAWDUST (SDA) BRICKS**

Kartini Kamaruddin,  
Hamidah Mohd. Saman

### **ABSTRACT**

This investigation was intended to look into the possibility of using sawdust ash (SDA) as a replacement material in making bricks. Five (5) series of brick specimens were prepared which comprised of 0% (as reference), 10%, 20%, 30% and 40% of SDA replacement level to cement. The performance assessment of SDA brick specimens are by determining their compressive strength, flexural strength and absorption characteristics. Comparisons are made of these values and those of reference (without SDA). Determination of physical properties of the brick specimens using non-destructive technique (NDT) namely rebound hammer and ultrasonic pulse velocity (UPV) were also tested and correlation are made of the results obtained to the compressive strength obtained by destructive technique (DT). The results compiled so far indicated that the compressive and flexural strength decreased as the SDA replacement level increased. In terms of initial surface absorption (ISAT) and water absorption, the findings showed that SDA brick specimens recorded higher absorptivity compared to those obtained from reference brick specimens.

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**Keywords :** Sawdust, sand-cement brick, rebound hammer, ultrasonic pulse, compressive strength, flexural strength, water absorption

## TENSILE PROPERTIES OF LAMINATED VENEER LUMBER MANUFACTURED FROM TROPICAL HARDWOOD SPECIES

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Wong Ee Ding<sup>1</sup>  
Zakiah Ahmad<sup>2</sup>

### ABSTRACT

This paper presents the results of a study on tensile properties of Laminated Veneer Lumber manufactured from selected Malaysian tropical hardwoods species. The 50 mm thick Laminated Veneer Lumber panels were manufactured using 13 and 17 layers veneers. A special grips and support was fabricated for the test, which was conducted according to ASTM D198 (static Test of Lumber in Structural Size). The Laminated Veneer Lumber comprised Kedondong (*Canarium, spp*), Keruing (*Dipterocarpus, spp*) and Bintagor (*Calophyllum, spp*). The properties evaluated include tensile strength and modulus of elasticity. The effects of timber species and the veneer thickness on the tensile strength properties were statistically analysed. The results show that timber species have more dominant effects on the tensile strength of tropical hardwood Laminated Veneer Lumber.

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**Keywords:** Tensile strength, Laminated Veneer Lumber, modulus of elasticity, Poisson's ratio, Malaysian Tropical Timber.

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# **TENSILE STRENGTH CHARACTERISTICS OF STRUCTURAL SIZE TIMBER**

Yong Chua Bon  
Zakiah Ahmad  
Mohd Salleh Mohd Noh

## **ABSTRACT**

In Malaysia, there is no research done on the tensile strength of structural size timber. The tension stress found in the Malaysian code of practice, MS 544: Part 2: 2001, was not determined directly. This paper discusses the behaviour of solid timber in structural size from selected Malaysian hardwoods under tensile loading. The solid timber specimens, comprising Kedondong (*Canarium spp*), Keruing (*Dipterocarpus spp*) and Bintangor (*Calophyllum spp*). The tensile strength tests were carried out using structural size specimens. A special tensile grip was fabricated using the model suggested in ASTM D198 and the tests were also conducted according to ASTM D198 (Static Test of Lumber in Structural Size). The tensile strength characteristics evaluated include tensile strength, modulus of elasticity and Poisson's ratio, and the data were analyzed statistically. In this study it was found that the grade stresses for structural size specimens were higher than that published in the Malaysian code of practice.

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**Keywords:** Timber, tensile strength, modulus of elasticity, Poisson's ratio

## **TENSILE STRENGTH OF POLYMER CONCRETE WITH GLASS FIBRE REINFORCED PLASTIC (GFRP) SHEETS**

Azmi Ibrahim  
Hamidah Mohd. Saman  
Hanizah Abdul Hamid

### **ABSTRACT**

The cost of polymer concrete (PC) is higher than reinforced concrete but less than Fibre Reinforced Plastic (FRP). Combining or sandwiching PC with FRP sheet(s) would result in a FRP-PC composite with the core PC not only providing rigidity as in a conventional but also strength in addition to that provided by the skin(s). In the present investigation, core PCs of two ratios of ingredients consisted of sand:resin (polyester):filler(talcum) were cast. For each formulation, PC panels of 10 mm and 20 mm thick were prepared, some lined on one side (LPC) and the other is sandwiched (SPC) with laminated glass fibre reinforced plastic (GFRP). The core PC was also added with randomly distributed glass fibres and the performance of the resulting fibrous PC in direct tension was compared with those without glass fibres. The results showed that the use of higher resin content and distributed glass fibres did not significantly affect the performance compared to those with a lower resin content and without fibres. Lining and sandwiching PC with GFRP had increased the tensile strength of the core PC by about 2 and 3.5, times respectively. In all cases, mining and silica sands were used as aggregates.

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**Keywords :** Fibre Reinforced Plastic (FRP), polymer concrete, laminating, tensile strength, mining and silica sand.

# **TENSILE STRENGTH PROPERTIES OF CONCRETE REINFORCED WITH KENAF FIBERS (*Hibiscus cannabinus*)**

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Paridah Md Tahir<sup>2</sup>  
Abdul Rahman Mahmood<sup>1</sup>

## **ABSTRACT**

Short discrete fibers have been extensively used in cement mortar and concrete to obtain certain favorable properties in composite. Generally, the addition of such fiber will cause higher impact and fracture toughness, improved ductility, and wear resistance properties of the composite. In particular, the addition of fibers into cement-based matrix is known to improve the post cracking tensile strength of the concrete.

This paper reports the result of an experimental investigation on the tensile strength behavior of concrete reinforced with kenaf fiber. Fiber length is 25 mm and fiber varies at 0%, 1%, 2%, 3% and 4% of the total volume of concrete material content. Grade 30 concrete with constant w/c, cement: aggregate ratio was employed. The Modulus of Elasticity was determined by using conventional stress-strain method according to BS standard. Concrete with 3% fiber showed marked improvement in first crack load and ultimate tensile strength.

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**Keywords:** Kenaf, fiber, tensile strength, reinforced concrete

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# TENSILE STRENGTH PROPERTIES OF FULL SCALE STRUCTURAL LUMBER FROM SELECTED MALAYSIAN TROPICAL TIMBER

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Yong Chua Bon<sup>1</sup>  
Mohd Salleh Mohd Noh<sup>1</sup>  
Azmi Ibrahim<sup>1</sup>  
Paridah Md Tahir<sup>2</sup>

## ABSTRACT

The need for precise design criteria for the tensile strength of structural timber is attaining increasing importance for the effective design and utilization of wood. Currently the information on the in-grade tensile strength properties of Malaysian tropical timber is based on small clear specimen and is taken to be numerically equal 0.6 times to the bending strength. Therefore in this investigation, the tensile strength test was carried out using in-grade structural size specimens. In order to carry out this test, a special tensile grip was fabricated using the model suggested in ASTM D198. The species used are Kedondong (*Canarium spp*), Keruing (*Dipterocarpus spp*) and Bintangor (*Calophyllum spp*). Tests were conducted according to ASTM D198 (Static Test of Lumber in Structural Size). The tensile strength properties evaluated include tensile strength, modulus of elasticity and Poisson's ratio. Comparisons were made between tensile properties of the structural size specimen and that given in Malaysian standard MS 544 Part 2: 2001. There was significant difference between the tensile strength for structural size and those stipulated in MS 544 Part 2, and the later was found to be more conservative. Structural size testing therefore provides the true value of tensile strength.

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**Keywords:** Tensile strength, modulus of elasticity, Poisson's ratio, Malaysian tropical timber

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# THE INFLUENCE OF SUPERPLASTICIZER ON THE WORKABILITY AND STRENGTH OF RICE HUSK ASH CONCRETE

Kartini Kamaruddin<sup>1</sup>  
Hamidah Mohd Saman<sup>1</sup>  
Hilmi Mahmud<sup>2</sup>

## ABSTRACT

With the society becoming more energy and environmentally conscientious, therefore it forced to the development of new construction materials, which must be of both inexpensive and require very little energy to produce. Such material is the by-products of industrial processes. Rice husk ash having the pozzolanic properties would reduce the demand of Portland cement and thus it should theoretically reduce the cost of cement. Adding the correct amount of rice husk ash (RHA) is important for achieving high strength, however being very fine particle with high specific surface, the use of RHA tends to increase the water requirement. To overcome these, proper dosage of superplasticizer need to be incorporated.

This paper presents a preliminary study on the influence of superplasticizer on the workability and strength performance of normal strength concrete incorporating different replacement level of RHA to ordinary Portland cement (OPC). In this study, seven series of concrete mixtures were prepared, including the control mix and incorporating different proportions of RHA with constant water to cementitious material ratio of 0.63. The superplasticizer dosage was tailored in each mixture to achieve a slump in a range between 100 mm to 150 mm. The results of this study show that the partial replacement of OPC with RHA can increase the fluidity, thus improve the compressive strength.

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**Keywords :** Superplasticizer, rice husk ash, ordinary portland cement, cementitious, workability, strength, normal strength concrete

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## **THE PERFORMANCE OF CONCRETE WITH SAWDUST ASH (SDA) AS PARTIAL CEMENT REPLACEMENT**

Kartini Kamaruddin  
Hamidah Mohd Saman

### **ABSTRACT**

Developing countries like Malaysia has the most fast growing construction industries, thus making the construction material such as cement in great demand. The search for alternative binders or cement replacement materials have thus become a challenge for national development and forward planning. From the economic, technological and ecological points of view, cement replacement materials have an undisputed role to play in the future of the construction industry. Small amounts of inert filler have always been acceptable as cement replacements, what more if the fillers have the pozzolanic properties, in which it will not only impart technical advantages to the resulting concrete but also enable larger quantities of cement replacement to be achieved. Many of these filler materials are industrial by-products and correctly considered as waste, so the resulting benefits in terms of energy savings, economy, environmental protection and conservation of resources are substantial.

Wood industry is one of Malaysia's major contributors to our economic growth. This means that there are large supplies of wood to cater for the industry needs. When this wood is processed, the large amounts of sawdust are inevitably thrown away or it will be burnt at the back of the factory without any commercial value. It is the intention of this preliminary research to find out whether this sawdust ash obtained from the burning of the sawdust can be used as cement replacement in making concrete. The chemical analysis of the sawdust ash, the compressive strength test and durability test on the concrete cubes are conducted. The concrete cubes are made of various proportion of ordinary Portland cement (OPC) and sawdust ash (SDA) such as 0% (as control mix), 10%, 20%, 30%, 40% and 50% cement replacement with 0.5 water cement ratio. Grade 30 concrete was used throughout the test.

For each series of mix, the workability test, the compressive strength test at age of 3, 7, 14 and 28 days and durability test in terms of weight loss under acid attack and chloride penetration depth were conducted. From the results obtained, it shows that the concrete with 30% replacement of SDA is acceptable and the compressive strength is within the specified strength required in design mix. In terms of durability, concrete with up to 20% SDA by weight of cement possess ability to resist acid attack as good as that of control. The concrete containing SDA shows improved permeability in terms of chloride penetration depth. Therefore, SDA has the potential usage as partial cement replacement.

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**Keywords :** Compressive strength, durability, saw dust ash, cement replacement

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## UTILIZATION OF WASTE IN CONCRETE

Ahmad Ruslan Mohd Ridzuan

### ABSTRACT

Although recycling of waste materials has started in the last decades, recycling as means of sustainable use of materials did not actually start until fairly recently. Recycling of waste concrete is no exception. Basically there are two main reasons to the rationale underlying recycling concrete as source of aggregates; the need to conserve natural resources and the need to manage waste amicably. As societies progress one of the problem arising from continuous technological and industrial development is the disposal of waste materials. Concrete being the most widely used constructional material contributed one of the largest proportions of construction and demolition waste. Environmental and economic considerations encourage the recycling of waste concrete. In Malaysia, very little is known about the use of recycled aggregate in manufacture of new concrete. Therefore it is timely in this part of the region to seek better understanding of the potentials and limitations of recycled concrete. However to make the acceptances of recycled aggregate concrete feasible its strength and durability must also be assured.

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**Keywords :** Waste, recycling, aggregate, concrete, strength

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