PREFACE

The proceedings of the 2005 12th Annual CEGSS Conference contains eighteen abstracts covering a range of on-going research by engineering graduate students from universities across Quebec. The Civil Engineering Graduate Student Society (CEGSS) initiated the idea of such conference in September 1993 and held the first one in February 1994.

The conference has grown considerably, and the CEGSS are pleased to have the participation of students from other universities such as Concordia University and École de Technologie Supérieure in addition to the many students from the Department of Civil Engineering and Applied Mechanics at McGill University.

We would like to thank everyone who have helped put this conference together, CEGSS council, professors and staff members without their dedication and enthusiasm, this event would not have been possible. We would like to give a special "thank you" to the Department, the Faculty of Engineering, the McGill Alumni Association and the Post Graduate Student Society for their continued support and encouragement of student events such as this. Finally, we would like to thank all the graduate students whose abstracts are included in these proceedings for their continued desire to learn and who take this opportunity to share their research with other fellow graduate students.

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CEGSS Council, 2004-2005

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Denis Mitchell, Ph.D., ing.
James McGill Professor and Chair

March 31, 2005

Dear Graduate Student:

On behalf of the Department I would like to welcome you to the Twelfth Annual Conference organized by the Civil Engineering Graduate Student Society. As in previous Colloquia, the primary objective of this event is to provide the students with a forum for the discussion of the results of their research in a formal setting. The Department places a special emphasis on research activities; graduate teaching is one aspect and scholarly research is another aspect. The Colloquium enables you to inform the staff and your fellow students of your achievements during your graduate education and to identify strengths and weaknesses of the research work. The Department considers this Colloquium as an important vehicle for the dissemination of your research achievements in a collegial environment.

On behalf of the Department, I would like to thank the organizers of the Colloquium for their efforts and for ensuring the continued success of the event. I would also like to thank the supervisors for providing the guidance and encouragement to the students which enabled them to complete the research leading to these presentations.

Yours sincerely,

D. Mitchell
James McGill Professor
Chair, Civil Engineering

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SHEAR LAG IN TENSION MEMBER WELDED CONNECTIONS

By: Georges Abi-Saad[1] and Dominique Bauer[2]

The authors attempt to validate a rational method proposed recently for the calculation of the strength of tension member welded connections reduced due to shear lag effects. This rational method is based on an assumed distribution of forces along inclined lines in the member ends, somewhat similar to the Whitmore's concept used with gusset plates for bracing members. The stress distributions in the welded connection of a flat bar to gusset plate are examined at various load levels using non-linear finite element analyses. Three different values of the ratio of weld length to bar width are considered. The distribution of shear flow along the fillet weld lengths is examined. The predicted strengths of the connections using finite element models are compared to those obtained from the rational method and from current CAN/CSA-S16-01 design guidelines. Recommendations for further research work are stated.

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BEHAVIOUR AND ANALYSIS OF MULTI-STOREY STEEL FRAME / WOOD PANEL SHEAR WALLS

By: Caroline Blais[1] and Colin A. Rogers[2]

Due to the increasing cost of wood products, the use of light steel gauge framed walls in the residential and commercial domain is increasing in popularity. However, our knowledge on the performance and the behaviour of structures using such walls when subjected to lateral wind and seismic loads is limited. For this reason a research project on light gauge steel frame / wood panel shear walls was undertaken.

A database of monotonic and cyclic tests on shear walls made of a cold formed steel frame with wood panels was needed to obtain different wall characteristics such as stiffness, strength and ductility. For this particular project three wall configurations (18 specimens) composed of 1.1 mm thick 230 MPa grade steel and 9.0 mm thick OSB were tested; where the screw spacing along the perimeter of the wall was varied. From these tests design values, as well as force and overstrength modification factors were computed. Furthermore, the cyclic test data were used to create and calibrate hysteretic models later used in nonlinear time history dynamic analyses.

The Ruaumoko software was used for the modeling of representative buildings with ten earthquake records for the Vancouver region. A typical 2-storey house in Vancouver, BC, Canada was first designed for lateral loads and then modeled. The resulting shear deformations (rotations) obtained from the analyses were compared with the limiting parameters measured during the physical shear wall tests. The findings of the analyses are to be presented. Additional studies will include the design and the modeling of a commercial structure using the same type of wall.

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APPLICATION D'UN MODÈLE POUR L'EXPLOITATION D'UN PLAN D'EAU PAR UNE PLANTE AQUATIQUE

By: Ruben Bodo[1], Abdelkrim Azzouz[2], Robert Hausler[1].

Résumé : Les plantes envahissantes peuvent devenir une source renouvelable de biomasse (sous produit) et d'énergie permettant de combler certaines demandes grandissantes dans le monde. Cela n'est possible que si ces plantes sont parfaitement contrôlées dans leur croissance et leur propagation. Cette étude vise à prédire la quantité de plantes qui peut être exploitées de manière rationnelle dans un écosystème lacustre et la quantité de sous- produits extraites de ces plantes lorsque l'optimisation de l'extraction de son jus (des feuilles) est appliquée. Dans ce contexte, la jacinthe d'eau constitue une des plantes aquatiques de choix à cause la diversité ses voies de valorisation : protéines, antioxydants, épuration des eaux usées, etc. Cette plante flottante possède des atouts intéressants en ce qui concerne l'absorption de matière organique et inorganique et a aussi un taux de croissance phénoménal qu'il faut contrôler adéquatement. Ces atouts surclassent la jacinthe d'eau par rapport aux autres macrophytes du même ordre comme *Lemna minor* ou *Pistia stratiotes*. Le traitement des eaux usées de cette façon semble être une méthode efficace et très économique, basée sur la capacité de cette plante aquatique à absorber les éléments polluants se trouvant dans l'eau. Cela dit, l'option de cultiver cette plante à des fins de valorisation à peu de coût serait intéressante. Dans la mesure où les protéines et autres agents antioxydants extraits permettraient de résorber les dépenses engagées en terme d'achats de réactifs, d'appareils de cueillette, de récolte, de transformation et de salaires du personnel engagé dans un tel projet de mise en valeur des plante dans un lac donné. Une telle démarche va faciliter la réhabilitation du lac et la reprise des activités récréatives génératrices de devises puisque la qualité des eaux sera améliorée. Cette méthode cadre mieux aux réalités des pays de l'hémisphère sud où les conditions climatiques y sont favorables et permettent une culture de plantes aquatiques, pour valoriser doublement ces plantes sur le plan de la dépollution et sur le plan de la production des matières à valeur ajoutée. Une étude de bilan d'optimisation du procédé d'extraction de protéines et de glutathion à partir de la jacinthe d'eau a permis d'entrevoir son exploitation rationnelle dans le cadre d'un lac défini dont la faisabilité sera explorée lors cette recherche.

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L'objectif de cette étude est de ressortir à travers un modèle mathématique la meilleure façon de récolter et de valoriser la jacinthe d'eau d'un lac d'une certaine superficie connaissant la pollution. Ce genre de modèle permet non seulement de simuler la quantité de protéines antioxydantes produites mais également de prévoir la qualité des plantes qui peut rester à la surface des eaux sans nuire à l'usage du cours d'eau par les riverains en matière de navigation, de pêche, d'irrigation, de tourisme, etc. L'optimisation appliquée permet de son coté d'économiser l'argent et le matériel (énergie solaire, plan expérimental, solvants moins toxiques, etc.).

Mots clés : jacinthe, modèle mathématique, lac, biomasse, pollution, optimisation.

FLOW DYNAMICS AND SEDIMENT TRANSPORT AROUND PAIRED DEFLECTORS FOR FISH HABITAT ENHANCEMENT

By: David M. Carré[1], Pascale M. Biron[2] and Susan J. Gaskin[1]

Schemes to restore fish habitat in rivers often involve installing instream structures such as current deflectors to create and maintain riffle-pool sequences. The presence of deep pools is a critical component of a high-quality physical habitat for fish as it provides sheltering and cool temperatures during the summer months. Recently, some laboratory studies have shed more light on the complex flow dynamics and resultant bed topography around deflectors. However, no field study has been carried out so far. Natural rivers, unlike laboratory flows, exhibit many additional complexities, which need to be taken into account when implementing instream structures. Many schemes to restore fish habitat experience low success rates or require costly maintenance after only a few years. To improve the success rate, we need to develop tools such as numerical modeling to test scenarios prior to the implementation of structures.

The objective of this research is to characterize flow dynamics and sediment transport around paired deflectors used to enhance fish habitat in a natural river. The studied reach is in the Nicolet River (Qc), where several paired deflectors and dug pools have been implemented between 1995 and 1999 to improve fish habitat. Calibrating and validating such a model requires accurate measurements of these parameters in the natural river. Repeated detailed bed and bank topography surveys were taken with a total station to monitor bed morphology changes and the dynamics of the riffle-pool sequences. Bed shear stress estimates were obtained from an Acoustic Doppler Velocimeter at several locations. Bedload sediment transport was assessed by two methods: tracer rocks and sediment traps. Two hundred painted particles were deployed at two cross-sections divided in five zones in order to investigate the sorting of sediment, thickness of the active layer and distance moved. Three sediment traps were installed downstream of the deflector in the riffle cross section to obtain bedload transport rates and the size of moved particles. Results show marked differences in flow dynamics and bedload sediment transport patterns between the left and the right bank downstream of the deflectors. This is surprising considering that paired deflectors should, in theory, produce a relatively symmetrical disruption to the flow field on each side. The percentage of recovery of tracer particles became increasingly lower during the field monitoring season due to factors such as sediment and algae deposition on the painted rocks. It therefore became difficult to relate accurately individual particle movement to flood events. To solve these problems, tracer alternatives such as Passive Integrated Transponder (PIT) tag will be used during the next field seasons.

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A DATABASE MANAGEMENT SYSTEM FOR GROUNDWATER MODELING IN THE BASIN OF MEXICO

By: Carrera-Hernández, J. J.[1] and Gaskin, S.[2]

The concept of water management evolved from a piece meal approach to a Basin level management after the International Conference on Water and Environment in 1992. This concept shifted to Integrated Water Management in Rio, later in that same year. Behind this idea was the introduction of land and water related aspects in water management at the Basin level. However, this seldom occurs in practice, mainly due to a lack of proper tools to achieve an integrated river basin and sustainable approach. These tools should help to simulate, visualize and compare different water management scenarios.

In an Integrated Water Management approach, the development of Regional Groundwater Models should be used. Groundwater Flow Models are required in order to predict the impact of different management policies in the future and all data required should be easily accessible to decision makers and modelers. Data accessibility to several users can be provided by a Relational Database Management System (RDBMS) which can integrate both qualitative and quantitative data without the need of a GIS. The RDBMS can incorporate data such as location of wells, pumping rates, groundwater level depth and elevation, rainfall depth as well as temperature and pan evaporation data.

In this presentation, the development of a database for groundwater in the Basin of Mexico is shown, as it encloses one of the biggest cities in the world: Mexico City and its Metropolitan Area (MCMA). The Basin's aquifer system comprises the most important part of the water supply system for the MCMA; the heavy dependence on this system has taken its toll and a decline in the potentiometric level of up to 80 meters was recorded by 2002 in some areas (Edmunds et al., 2002).

The database comprises rainfall depths, monitoring wells, extraction wells and lithology records in the Basin of Mexico, as well as topography as a Digital Elevation Model (DEM). In order to build this database, the authors have gathered all the information which is currently spread through the existing water supply agencies and previous studies realized in other areas of the Basin. In order to show the usefulness of this database, the evolution of the groundwater level in the Basin of Mexico is studied from 1984 to 1997 using the proposed database and compared with maps obtained in previous studies (DGCOH, 2000).

This database is being used to develop the first comprehensive groundwater flow model through the use of the *r.gmtg* module (Carrera-Hernández and Gaskin, 2004) which integrates the finite difference groundwater flow MODFLOW and the GRASS GIS.

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References:

Carrera-Hernández, J. J. and Gaskin, S. J. (2004). GMT: A groundwater modelling tool for integrated water management. In: Proceedings of the International conference on Finite Elements Models, MODFLOW and more: Solving groundwater problems.

DGCOH (2000). Piezometría del Valle de México. Technical report, Lesser y asociados, S.A. de C.V.

Edmunds, W. M., Carrillo-Rivera, J. J. and Cardona, A. (2002). Geochemical evolution of groundwater beneath Mexico City. *J. of Hydrology*, 254:1-24.

Ortega, A. and Farvolden, R. N. (1989). Computer Analysis of regional groundwater flow and boundary conditions in the Basin of Mexico. *J. of Hydrology*, 110:271-294

BUCKLING BEHAVOIUR AND NONLINEARITY OF FRP COMPOSITE SHEET PILES

By: Yi Chen [1] and Prof. Yixin Shao [2]

The FPR composite shape can exhibit complex behaviour. Local buckling frequently occurs due to the low modulus and thin wall nature of the composite section. The local buckling stress of the FRP composite sheet pile panel is investigated by two methods. One is solving the governing differential equation directly and the other is applying explicit expressions. The buckling flange is considered as a plate elastically restrained by the webs. These two methods give comparable results.

The sheet pile panel is tested as a beam by lateral uniformly distributed load. The experiment shows nonlinearity behaviour of the section with the increasing load. The neutral axis shifted away from the compressive flange. This shifting can be caused by the reduction in elastic modulus. The rigidity of the section is investigated. With the neutral axis position, the flexure rigidity (*EI*) and shear rigidity (*KAG*) are achieved based on the properties of layers in each member of the section. The results show that when the section reaches its failure, there is a non negligible reduction of the flexure rigidity (*EI*), which cause larger deflection of the beam, and it is always the deflection, other than strength that controls in design.

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SIMPLIFIED NON-LINEAR ANALYSIS OF NEGATIVE SKIN FRICTION ON PILES AND PILE GROUPS

By: Md Ahsan Habib [1] and Prof. A M Hanna [2]

A simplified method is proposed for analysis of the negative skin friction on piles and pile groups, which uses conventional soil test data. The procedure can be used for friction and end-bearing piles in consolidating soil under vertical surcharge loads.

In the proposed method, soil is represented by a finite number of independent horizontal layers and each pile is modeled by a series of the same number of rod elements with axial mode of deformation. An iterative framework using finite element method is established to perform the analysis, where the response of the soil consolidation at each layer is attributed to the corresponding pile nodes. Whenever the surrounding soil consolidates or settles more than the pile(s), negative skin friction develops and shear stress is mobilized to the pile shaft in the form of dragload. The net soil displacement at a pile node is composed of i) the mobilized shear displacement caused by the soil settlement in corresponding layer and, ii) the displacements induced by the displacement fields of the neighbouring piles. The relation between the mobilized shear and the corresponding shear displacement at each pile node is considered nonlinear and a hyperbolic load-transfer approach is adopted to model this nonlinearity. Thus, the soil stiffness matrix is updated with the successive increase in soil consolidation in order to ensure that the complex load response and the changing soil characteristics with the increase of soil consolidation implicitly govern the hyperbolic parameters. The interaction induced due to the displacement fields of neighbouring piles, on the other hand, are considered linear.

The results of the proposed procedure compare well with the recent studies and a number of field observations in homogeneous or multilayered soil deposits. It is concluded that the proposed approach is capable of predicting the dragload on frictional or end-bearing piles or pile groups with reasonable accuracy.

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FATE AND TRANSPORT OF RESIDUAL PETROLEUM OILS UNDER FREEZE-THAW TEMPERATURE CYCLES USING X-RAY COMPUTED TOMOGRAPHY

By: Sormeh Kashef Haghighi[1] and Subhasis Ghoshal[2]

In the past decade, petroleum hydrocarbon pollution of land sites has becoming an increasingly serious problem in the Canadian North. The study of contaminant migration in this region is more complicated due to the presence of permafrost and active layer zones. The active layer is the top layer of saturated soil in which temperature fluctuates above and below 0°C during a freezing period and in some places this fluctuation maybe during a day. The objective of this research is to determine the effect of these freeze-thaw cycles on the displacement and migration of trapped petroleum oils. The migration of residual contaminant may alter the microbial availability, dissolution and volatilization of entrapped oil phases. Different porous media show different effects on the migration of residual non-aqueous phase liquids (NAPLs) due to their various pore size distributions. Experiments were conducted where columns of sand contaminated with petroleum oils were subject to freezing at a constant temperature as well as at variable temperatures. The migration of oil in the column, the changes in porosity and the oil saturation in entire column were nondestructively characterized using X-ray Computed Tomography (CT) scanning. X-ray CT scanning has been recently used to non-destructively characterize and visualize the distribution of various solid and fluid phases in porous media. A third generation high-resolution CT scanner at McGill University was used in this research. An image subtraction methodology was developed to quantify the movement of NAPLs under freeze-thaw cycles.

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THREE-DIMENSIONAL NUMERICAL MODELING OF FLOW AROUND 90◦ OPEN-CHANNEL BENDS

By: Sangsoo Han[1], Pascale M. Biron[2], and Amruthur S. Ramamurthy[2]

Flow in 90-degree bends of rectangular channels is commonly encountered in hydraulic engineering. Control and regulation of the flow around bends is also equally important in characterizing natural meandering rivers with sharp bends. In the past, head loss attributed to the bend and the nature of the flow in the downstream section of the bend were the main flow characteristics studied in detail. The disturbance in the form of secondary flows caused by the bend may persist for considerable distances in the section downstream of the bend. The simplest way of reducing the disturbance caused by the bend is to modify the bend geometry. For instance, super elevation at the floor level in the bend section has been attempted to even out the flow. In natural meandering rivers, the cross-sectional geometry in bends is clearly asymmetrical shape, with a shallow zone on the inner bank due to the presence of a point bar and a deep pool close to the outer bank. Topographic steering generated by the point bar restricts the helix secondary flow to the outer part of the channel, whereas the helix occupies the full width of artificial symmetrical channels. The objective of this research is to use a three-dimensional numerical model to examine the influence of modified bed geometries on the flow characteristics of flow around artificial bends.

One of the main characteristics of the flow around bend is the water surface variation in vicinity of the bend driven by a centrifugal force. The water surface elevation observed from the experiment showed that the water surface geometry near the bend can have up to a forty percent depth difference between the inner and outer radius of the bend. The rigid-lid assumption in the numerical model failed to produce reasonably accurate flow field predictions. Hence, a Volume of Fluid (VOF) simulation, which is a two-phase flow simulation, was carried out to predict the water surface level and the flow field with the three dimensional numerical model. The predicted flow field is in good agreement with 2D laboratory measurements of velocity.

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ANALYSIS OF SIMPLY-SUPPORTED SINGLE CELL PRISMATIC BOX SECTIONS

By: Sk. Amjad Hossain[1] and Prof. M.S.Mirza [2]

This research extends Maisel's (1982) methodology, the generalization of Vlasov's, simple beam theory, and its extension to evaluate torsion, distortion and shear lag effect in simply-supported single cell uniform box section. The computer program developed can work with any geometry and loading conditions, and analyse simply supported box sections with any(trapezoidal and rectangular) geometry , material properties and loading conditions, formulate the bending, shear, torsion ,distortion and warping stress with respect to incremental loading, variable span, torsional moment at different location of the section. It can be used as a useful design manual, so that one designer can find significant stresses for design of a single cell box girder bridge. It has been developed into two separate computer programs, the first dealing with shear flow, shear stresses, combined shearing stress, torsional warping stress, distortional warping stress, maximum transverse bending stress, etc. The second program includes shear lag only. Torsional warping is treated using the method of Kollbrunner and Hajdin and Heilig (1966), while Sedlacek's (1971) method is used to account for the distortional effects.

Keywords: Box section, simply-supported, bending, shear, torsion, distortion, warping, shear lag, stress.

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PEROXIDASE-CATALYZED OXIDATION OF STEROID ESTROGENS

By: U.Khan[1], C. Cardinal-Watkins, A. Wojtowicz, and J. Nicell

Effluents from sewage treatment plants (STPs) tend to be the single most important point source for the introduction of endocrine disrupting compounds into the environment. Recently, it has been reported that most of the estrogenic activity associated with such effluents can be attributed to the presence of synthetic (ethynylestradiol, EE2) and natural hormones (estradiol, E2; estrone, E1; estriol, E3). Data to date suggests that such compounds are present in the environment in the ng/L range. Such trace quantities may seem to be of minor importance; however, these compounds have been found to be biologically active at concentrations as low as 0.01 ng/L. Furthermore, due to the continuous natural excretion of E1, E2, and E3, and due to the wide scale social implications of limiting the use of oral contraceptives (i.e., the dominant source of EE2), source control does not appear to be a viable solution. Hence, innovative treatment methods must be considered. As one of these, enzymatic treatment of recalcitrant aromatic compounds holds considerable promise.

Among the numerous advantages offered by enzymatic treatment, the most important ones include: inherent selectivity; lack of susceptibility to changing operating conditions; high reaction rates; and, most importantly, effective treatment at trace levels. The treatment of phenolic compounds has been extensively characterized with various enzymatic systems. Of the various enzymes, a number of peroxidases (horseradish peroxidase, HRP; soybean peroxidase, SBP, and Arthromyces ramosus peroxidase, ARP) have probably undergone the most in-depth characterization. HRP is the classical enzyme in the field, while SBP and ARP hold considerable promise due to their amenability to economic mass production. Hence, the treatment of estrogens, all of which are phenolic compounds, with peroxidases offers an exciting possibility.

Even though peroxidase-catalyzed removal of estrogens may be an emerging research area in the field of enzymatic wastewater treatment, reports as early as 1950's can be found in medical literature regarding the transformation of such compounds using HRP. This research was initiated under the premise that peroxidase induction upon the administration of estradiol was one of the body's self-regulating mechanisms. Although these studies established the notion of using enzymes for the transformation of such compounds, results obtained cannot be directly used for treatment applications due to their medical orientation. Furthermore, nothing to date has been reported regarding the removal of steroid estrogens using either SBP or ARP.

Hence, the primary objective of our research was to characterize and establish the technical feasibility of using the aforementioned peroxidases for the removal of estrogens. Experiments were conducted at concentrations higher than those found in STP effluents and drinking water sources in order to characterize the reactivity of the enzymes toward these compounds without being hampered by analytical difficulties. Studies were conducted to quantify the stoichiometry of the catalytic reaction between hydrogen peroxide and the steroids. In addition, the abilities of the enzymes to treat the compounds over a range of pHs was studied.

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Based on these results, the quantities of the peroxidases that were required to achieve a target level of treatment within a selected timeframe was determined. The results demonstrate that, over a wide pH range, the compounds are surprisingly good substrates of HRP, SBP, and ARP. When compared to typical catalyst concentrations that had been used in previous studies to accomplish the treatment of various phenols, the quantities of enzymes required for the treatment of the steroids in the present study were typically several orders of magnitude smaller. These results have rather profound implications in regards to the feasibility of enzymatic treatment where the cost of the enzymes has often been cited as the limiting factor.

PHOTOREACTIVATION FOLLOWING COMBINED PERACETIC ACID-UV DISINFECTION OF A PHYSICOCHEMICAL EFFLUENT

By: Nicolas Martin[1] and Prof. Ronald Gehr[2]

Photoreactivation of microorganisms following UV inactivation is a well-known but complex phenomenon. It is affected by several factors, including UV fluence (the effect is diminished at higher fluences), wavelength, light intensity, and exposure time to photoreactivating light. The effect on photoreactivation of a combined peracetic acid (PAA)/UV process has not been investigated. Accordingly, the primary objective of the current study is to assess the degree of photoreactivation, under both sunlight and artificial lights (laboratory fluorescent grow-lamps), following UV and PAA/UV inactivation of fecal coliforms (FC). In October and November ("Fall"), experiments have shown that average log increase of FC due to photoreactivation after the combined PAA/UV treatment is 0.54 and 0.01 for artificial lights and sunlight respectively, compared with 1.29 and 1.36 after UV treatment alone under artificial lights and sunlight respectively. In January ("Winter"), results for artificial lights show an average log photoreactivation after PAA/UV treatment of 0.10, and 0.70 after UV treatment alone. These photoreactivation figures include the effects of dark repair. Controls assessing reactivation of raw samples in the dark and under lights have yielded negligible growth. Hence the use of PAA in combination with UV has been shown to reduce the potential for photoreactivation.

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CONTRIBUTION OF NON-STRUCTURAL ELEMENTS IN ROOF DIAPHRAGM OF SINGLE STOREY STEEL BUILDINGS

By: Simon Mastrogiuseppe[1] and Colin Rogers[2]

Dynamic analysis programs are often used to compute the period of vibration of single-storey steel buildings. It is common to find that the predicted period of vibration is much longer than that measured in-situ testing. Dynamic analysis programs do not usually take into account the stiffening effects of the non-structural components: this could be the source of the divergence between the results in the field and the results obtained by computational methods.

This research project concentrates on the roof diaphragm system and the contribution of the non-structural components to diaphragm stiffness. It is believed that the non-structural components – roofing materials such as insulation board and gypsum board – add to the overall stiffness of the system on a non-negligible scale.

The physical properties of these non-structural components are determined through laboratory testing. The effect of these components is then incorporated into the non-linear time history analyses of single storey steel buildings that will be performed with Ruaumoko.

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ASSESSING THE CARBONATION BEHAVIOUR OF CEMENTITIOUS MATERIALS FOR CO_2 SEQUESTRATION PURPOSES

By: Sean Monkman[1] and Prof. Yixin Shao[2]

Carbon dioxide is the dominant greenhouse gas resulting from human activities. A significant fraction of the CO_2 discharged to the atmosphere comes from point sources, such as thermal power plants and cement plants. Electricity generation is responsible for 30% of the total carbon dioxide emissions, while cement production accounts for 7%. The carbon dioxide content of a flue gas is about 12% for power plants and 20% for cement kilns.

Previous efforts have established, in an industrial context, that carbonation curing of cement products is an alternative to hydration. The contemporary emphasis on the environmental impact of CO_2 emissions suggest that it is time to revisit the idea and investigate the possibility of using carbonation curing as a carbon dioxide sequestration methodology. The use of CO_2 extracted from or contained in flue gas is one way to address the significant carbon dioxide emissions by the cement industry - one tonne of carbon dioxide is emitted for each of the 1.56 billion tonnes of clinker produced annually. Development of this strategy must start with the determination of appropriate and advantageous materials for utilisation in such a procedure.

The carbonation behaviour of six cementitious materials was examined (two cements, fly ash, blast furnace slag, electric arc furnace slag and lime) for applicability to CO_2 sequestration applications. No-slump press formed compacts and loose powders were subjected to 100% CO_2 at a constant pressure of 5 bar for two hours. The CO_2 contents of the as-received and the carbonated materials were measured. It was found that the cements could each show CO_2 uptake on the order of 12%, while the lime achieved nearly 40%. Fly ash and electric arc furnace slag had uptakes of 30% and 12% respectively. The carbonation uptakes achieved were significantly lower than the theoretical maximum as determined by chemistry. The strength achieved after two hours of carbonation exceeded the strength displayed by comparable samples hydrated for seven days. XRD analysis determined that the primary carbonation product formed was calcite, while C_3S, C_2S, CSH and CH were the phases consumed.

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DEPTH-AVERAGED TWO DIMENSIONAL MODELING OF A MODIFIED RIVER

By: Karen Ng [1] and Prof. Susan Gaskin [2]

Due to the increased concern for the consequences of river modification from a biological and ecological standpoint, there is a need for human intervention to prevent further degradation of the environment from occurring. In particular, dwindling fish populations are a concern, due to both environmental and economic reasons. Instream structures are often employed to increase the amount of suitable fish habitat. However, a way to quantify and qualify suitable fish habitat is necessary. An important part of assessing fish habitat suitability is hydraulic modeling. A hydraulic model is useful in determining the discharges required to maintain a certain level of fish habitat; since data is often not available for a whole range of flows, particularly high flows, hydraulic models are used to determine the flow characteristics. A two-dimensional depth-averaged model, River2D, is being used to determine its ability to model a modified river. The river being studied is the Nicolet River, located in south-eastern Quebec, which is a popular fishing area. The river has been rehabilitated to increase fish populations by installing double-wing current deflectors that will help form deep pools that are necessary for protection for mature fish and riffles that provide oxygen and nutrients for the younger life stages of fish in the river.

The model River2D requires topographic data as input as well as velocity sets for the calibration and validation of the model. The sensitivity of the model results were investigated as well as the model's ability to cope with sudden changes in topography. Challenges encountered while using River2D include roughness characterization of a natural river.

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DEVELOPMENT OF STATISTICAL DOWNSCALING METHODS FOR SIMULATING THE DAILY PRECIPITATION AT A LOCAL SITE

By: Siddharth Pharasi [1] and Prof. V.T.V. Nguyen [2]

Studies of climate change impact at a local site usually require daily time series of surface weather variables, such as precipitation, for future climate scenarios. Recently, Global Climate Models (GCMs) have been widely used to simulate present climate and project future climate with forcing by greenhouse gases and aerosols. The spatial resolution of these models, however, remains quite coarse and do not permit a good estimation of surface weather variables at a small local scale. Statistical downscaling (SD) has recently emerged as a widely used technique that establishes relationships between local weather variables and large-scale GCM results.[1] Several SD methods have been proposed in recent years.[2] The main objective of this research is therefore to develop statistical models that could accurately describe the relationships between the climate variables at the regional scale and the precipitation characteristics at a local site.

At present, multiple regression methodology has been applied to meteorological data at the Dorval Station. 26 CGCM variables obtained via the NCEP Quebec grid were used as predictors in a stepwise regression algorithm, with the normalized daily precipitation values as the response variable. This yielded 22 significant predictor variables with an R-square of 0.3. When a weighted least squares methodology was employed, 15 predictors resulted with an R-square of 0.8. At this preliminary stage of the research, the fit in either approach is far from accurate, because the residuals are not randomly distributed. For the validation phase, the distribution of residuals has to be determined. Furthermore, the correlations between the predictors themselves have to be assessed, either via physical knowledge, or statistical techniques such as ridge regression and generalized least squares. The next stage of this research will attempt to incorporate the advanced methodologies of generalized linear modeling, particularly truncated Poisson regression, in order to extend a validated statistical model to other local sites in the Quebec region.

References:

[1] Wilby et.al. Statistical Downscaling of general circulation model output: A comparison of models. Water Resources Reasearch. Vol. 34, #11, November 1998: pp 2995-3008.

[2] Hewitson, B.C. and Crane, R.G. Climate downscaling: techniques and applications. Climate Research. Vol. 7, 1996: pp 85-95.

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COUNTER FLOWING WALL JETS FOR MIXING AND DILUTION

By: Magdalena Tudor [1], A.S. Ramamurthy[2], and Diep Vo[3]

Wastewater plant effluents discharged into a stream should undergo dilution in a short reach of the stream. The devices used to discharge the effluents should ensure its rapid mixing in the stream. Jets are simple and efficient devices that accomplish this purpose. In closed conduits, counter flowing wall jets can be used also for efficient mixing of chemicals. The increased interest in the use of cross jets and counter flowing jets to ensure proper mixing of effluents in a stream can be traced to the large scales of mixing achieved by these devices, as compared to traditional co-flowing jet devices.

In the present study, the mixing characteristics of the counter flowing wall jets were determined experimentally. Salt solution was injected into the pipeline carrying the jet flow. A conductivity meter was used to find the salt concentration. The parameter denoting the ratio of the jet velocity to the main velocity was in the range of 5 to 15. The concentration distribution of the salt was determined at several cross sections of the jet wake to determine the mixing characteristic of the counter jet

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CO2 UPTAKE THROUGH CARBONATION OF CONCRETE USING SIMULATED AND REAL FLUE GAS

By: Xudong (Arthur) Zhou[1] and Prof. Yixin Shao[2]

Carbon dioxide (CO2) is one of the major greenhouse gases, whose significantly increasing emission may lead to higher temperatures and cause climate change. The objectives of this research are to examine the feasibility of using calcium silicate concrete to absorb CO2 in flue gas collected from cement plant and to investigate the effects of material compositions and process conditions on the CO2 uptake.

In this study, the factors that control carbonate cement-based materials have been examined and several hypotheses involved explaining their interaction. The factors include porosity, the components of binders, pre-setting and post-curing, gas concentration, moisture, carbonation time, injection and releasing procedure as well as the thickness of the compact.

The limitation of CO2 uptake of cement-based materials is related to the diffusion of simulated and real flue gas for the specific reaction conditions. A diffusion control model has been used to predict the possible CO2 uptake and the matrix of the cement-based materials has been examined by infrared CO2 analyzer, XRD and SEM. These analysis results have shown that, in general, the matrix is composed of mostly amorphous or very poor crystalline forms of calcium carbonate that condense the surface of particles and block the gas for further penetration into the core of particles.

Some possible mixture proportions of mortar and concrete using in construction field as masonry blocks have been suggested for cleaning the flue gas and hope to achieve social and economical benefits.

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08:30 ***Conference Registration, Breakfast***

09:00 CONFERENCE OPENING
Prof. D. Mitchell (Department Chair)

09:10 Three-Dimensional Numerical Modeling of Flow Around 90º Open-Channel Bends
Sangsoo Han, Pascale M. Biron, and Amruthur S. Ramamurthy

09:30 Flow Dynamics And Sediment Transport Around Paired Deflectors For Fish Habitat Enhancement
David M. Carré, Prof. Pascale M. Biron and Prof. Susan J. Gaskin

09:50 Photoreactivation Following Combined Peracetic Acid-UV Disinfection of a Physicochemical Effluent
Nicolas Martin and Prof. Ronald Gehr

10:10 Application d'un modèle pour l'exploitation d'un plan d'eau par une plante aquatique
Ruben Bodo, Abdelkrim Azzouz, Robert Hausler

10:30 – 10:50 ***Refreshments***

10:50 Peroxidase-Catalyzed Oxidation of Steroid Estrogens
U.Khan, C. Cardinal-Watkins, A. Wojtowicz, and J. Nicell

11:10 Depth-Averaged Two Dimensional Modeling of a Modified River
Karen Ng and Prof.Susan J. Gaskin

11:30 Fate and Transport of Residual Petroleum Oils under Freeze-Thaw Temperature Cycles using X-Ray Computed Tomography
Sormeh Kashef Haghighi and Subhasis Ghoshal

11:50 A database management system for groundwater modeling in the Basin of Mexico
Jaime Carrera-Hernández, and Prof. Susan J. Gaskin

12:10 – 13:00 ***Lunch Break***

13:00 Counter Flowing Wall Jets for Mixing And Dilution
Magdalena Tudor, A.S. Ramamurthy, and Diep Vo

13:20 Assessing the Carbonation Behaviour of Cementitious Materials for CO_2 Sequestration Purposes
Sean Monkman and Prof. Yixin Shao

13:40 Buckling Behavoiur and Nonlinearity of FRP Composite Sheet Piles
Yi Chen and Prof. Yixin Shao

14:00 CO_2 Uptake Through Carbonation of Concrete Using Simulated And Real Flue Gas
Xudong (Arthur) Zhou and Prof. Yixin Shao

14:20 – 14:40 ***Refreshments***

14:40 Simplified Non-Linear Analysis of Negative Skin Friction On Piles And Pile Groups
Md Ahsan Habib and Prof. A M Hanna

15:00 Analysis of Simply-Supported Single Cell Prismatic Box Sections
Sk. Amjad Hossain and Prof. M.S.Mirza

15:20 Behaviour and Analysis of Multi-Storey Steel Frame / Wood Panel Shear Walls
Caroline Blais and Colin A. Rogers

15:40 Contribution of Non-Structural Elements in Roof Diaphragm of Single Storey Steel Buildings
Simon Mastrogiuseppe and Colin A. Rogers

16:00 Shear Lag In Tension Member Welded Connections
Georges Abi-Saad and Dominique Bauer

16:20 Development of Statistical Downscaling Methods for Simulating the Daily Precipitation at a Local Site
Siddharth Pharasi and Prof. V.T.V. Nguyen

16:40 CONFERENCE CLOSING
David Carré (President of the CEGSS)

16:50 ***Wine and Cheese***

Special Tanks to:

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McGill Alumni Association

Faculty of Engineering

Post Graduate Student Society (PGSS)

Mr. Joseph Kristof, Health Safety Course Instructor

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