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LOCAL BUCKLING OF BURIED STEEL PIPELINES UNDER COMBINED AXIAL AND BENDING ACTIONS

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Keywords: steel thin, cylinder, numerical analyses, analytical calculations

ABSTRACT

Buried pipelines transporting oil products are structures of great financial, environmental and social importance. Such structures must adapt to eventual deformations of the surrounding soil, thus they may be severely damaged by large imposed permanent ground displacements triggered by landslides of seismic fault activation, causing combined axial and bending actions along the pipeline. Prevailing failure modes are tensile fracture at the welds between adjacent pipeline parts and local shell wall buckling in regions of high compressive stresses. The second issue is investigated here, numerically and analytically. The mathematical model used is that of a thin-walled cylindrical steel shell embedded in a uniform, infinitely elastic, continuous medium. Available analytical expressions for the buckling of bare cylinders under pure compression or bending are extended and simplifying expressions are proposed for cylinders embedded in a surrounding medium and subjected to combined loading. Numerical results from linearized buckling as well as nonlinear finite element analysis, modeling the pipeline and surrounding soil with shell and solid elements, respectively, and accounting for loss of contact between pipeline and soil, are used for comparison and calibration.
SYSTEMIC SEISMIC VULNERABILITY AND RISK ANALYSIS OF URBAN SYSTEMS, LIFELINES AND INFRASTRUCTURES TOWARDS SUSTAINABILITY AND RESILIENCE OF MODERN SOCIETIES AGAINST NATURAL DISASTERS

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Keywords: Systemic analysis, Earthquakes, Vulnerability, Risk, Socioeconomic loss, Buildings, Lifelines, Infrastructures, Interactions

ABSTRACT

The basic concepts and some representative results of the work carried out within the European collaborative research project SYNER-G (http://www.syner-g.eu) are presented. The overall goal is to develop an integrated methodology for systemic seismic vulnerability and risk analysis of urban systems, transportation and utility networks and critical facilities within the framework of sustainability and resilience of modern built environments against the natural disasters. SYNER-G developed an innovative methodological framework for the assessment of physical as well as socio-economic seismic vulnerability and loss assessment at urban and regional level. The built environment is modelled according to a detailed taxonomy into its components and sub-systems, grouped into the following categories: buildings, transportation and utility networks, and critical facilities. Each category may have several types of components.

The framework encompasses in an integrated way all aspects in the chain, from regional hazard to vulnerability assessment of components to the socioeconomic impacts of an earthquake, accounting for relevant uncertainties within an efficient quantitative simulation scheme, and modelling interactions between the multiple component systems in the taxonomy. The prototype software together with several complementary tools is implemented in the SYNER-G platform, which provides several pre and post-processing capabilities. In this way, valuable tools are provided to the engineering community, decision makers and authorities that cope with the risk assessment and management, contributing to the resilience and robustness of the modern society against natural hazards. The methodology and software tools are applied and validated in selected sites and systems in urban and regional scale. Representative results of the application in the city of Thessaloniki are presented here.
A TALE OF TWO CITIES: A STUDY OF THE ENERGY SYSTEMS IN BIRMINGHAM, AN INDUSTRIALISED CITY IN CENTRAL UK AND MASDAR CITY, A DEVELOPING CITY IN THE MIDDLE EAST

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Keywords: Liveable Cities, Energy, Sustainability, Resilience, Robustness

ABSTRACT

Energy is a vital component in the operation of modern day life. With increasingly limited availability of natural energy resources there is a raised awareness that energy needs to be used in a more efficient and sustainable way if we wish to maintain our current way of life without compromising our well-being or the carrying capacity of the planet.

The Liveable Cities Programme was established in 2012. Its aim is to quantify how a city operates, with a view to developing radical engineering solutions to deliver a resource secure, low carbon city which prioritises the well-being of its inhabitants. To do this, it is essential that lessons are learnt from the development of other cities.

Birmingham is a well-established post-industrial city that has evolved over the last fourteen hundred years. It was the fastest growing city in the 19th century. Masdar, founded in 2008, is a dynamic new city being built in a desert environment. Its aim is to be the most sustainable city in the world and offers an exciting opportunity to provide unique insights into the operating of different innovative technologies within an urban environment.

This paper demonstrates the differences and similarities between the two cities. It highlights the opportunities and mutual benefits that both cities will gain from the experiences of the other. This work shows how a greater understanding of common issues has the potential to lead to sustainable, resilient and robust cities able to face the challenges of the next 50 years.
NUMERICAL INVESTIGATION OF HIGH STRENGTH STEEL TUBULAR MEMBERS

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Keywords: High Strength Steel, Finite elements, Structural response, Tubular members

ABSTRACT

High strength steels are gaining increasing usage in construction, offering substantial potential benefits both in terms of economy and environmental performance. Although they are widely used in other industries, such as the automotive industry, and are catered for in a number of international structural design standards, further research is required to enhance these design provisions and promote more widespread use of high strength steel.

A comprehensive experimental and numerical investigation in the structural response of high strength steels has been undertaken by a consortium of universities and industrial partners as part of a European research project with the aim to enhance current understanding of their structural response and ultimately improve current design rules thereby leading to their more widespread usage in construction. This paper presents the development of efficient FE models for high strength steel tubular components failing by local buckling. Models for stub columns concentrically loaded and beams loaded in the three-point and four-point configuration are developed and validated against experimental results recently performed, which are also summarized herein. The investigated cross-sections include SHS and RHS whilst the material grades considered are S460 and S690. Issues such as the shape and magnitude of initial geometric imperfections, material modeling for high strength steels and magnitude and pattern of residuals stresses are discussed in detail and their importance on the structural performance of high strength steel tubular members is highlighted.
DESIGN OF A SMART STRUCTURAL HEALTH MONITORING SYSTEM FOR THE NEW I-10 TWIN SPAN BRIDGE OVER LAKE PONTCHARTRAIN

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Keywords: I-10 Twin Span Bridge, Structural health monitoring, Lateral load test, Instrumentation

ABSTRACT

A new Interstate 10 Twin Span Bridge over Lake Pontchartrain is being constructed to replace the existing Twin Span Bridge, which was heavily damaged by Hurricane Katrina in 2005. The new bridge consists of two 3-lane spans with 30 feet elevation above the surface of the Lake, 21 feet higher than the old bridge that makes it less vulnerable to high storm surge, and an 80-foot high rise near Slidell. The bridge will be supported by groups of battered pile foundations. In order to verify the analysis method used in the design and to address some concerns raised during the design phase, LA DOTD decided to install a health monitoring system on a selected M19 eastbound bridge pier of the main span. The pier consists of 24 square PPC battered piles (batter slope 1:6). The piles are 36 in wide and 110 ft. long. The system includes both sub-structure and super-structure instrumentations for use in the short-term monitoring during a static lateral load testing, and for long-term monitoring during selected events such as wave, wind and vessel impact. The sub-structure instrumentation includes strain gauges and MEMS In-Place Inclinometers (IPI) cast inside the foundation piles, triaxial accelerometers to measure lateral movements of pile cap, water pressure cells to measure wave forces, tiltmeters, and corrosion meters in the pile cap. The superstructure instrumentation includes strain gauges and corrosion meters inside the columns; strain gauges in the bent cap, three steel girders, three concrete girders, and one diaphragm; and installing a weigh in motion (WIM) system in the concrete bridge deck. A unique lateral load test was designed and conducted at M19 pier to assess the validity of the analysis method used to design the pile foundations. The test was conducted by pulling the M19 east and west bounds toward each other using two high strength steel strands that were run through the pile caps. A total of 1870 kips lateral load was applied in increments using two hydraulic jacks. This paper will present the design and development of the sub-structure instrumentation plan of I-10 Twin Span Bridge and its use during the lateral load test.
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Keywords: identification, mode shapes, ambient loading, seismic loading, wind loading

ABSTRACT

In the present article, the point of the identification of vibration mode shapes of a double-asymmetric multi-storey reinforced concrete (r/c) building due to a strong wind loading is presented. A seven-storey (plus a basement) r/c building, which is located at Kalamata town in Greece, was instrumented by a local multi-channel network of accelerometers in July 2009. Twelve 24bit-nominal resolution digital uniaxial wirable accelerometers by GeoSIG Ltd -with a “common time” and “common start”- were installed on the above-mentioned building. On September 14, 2009, a severe windstorm took place in Kalamata town of Greece, causing significant vibration to the instrumented building. The above-mentioned installed multi-channel system recorded the response acceleration time-histories of the building. Applying the newly methodology that is called “modal response acceleration time-histories”[1-3], the main vibration mode shapes of the building are computed. Moreover, very useful information about the theoretical procedure for the identification of vibration mode shapes is given in the paper.

ON THE SUSTAINABLE RESTORATION DESIGN OF A HISTORICAL STEEL RAILWAY BRIDGE

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Jordan University of Science and Technology (JUST)  Aristotle University of Thessaloniki (AUTH)  University of Birmingham (UoB)
This paper presents a methodology applied for the restoration design of the old steel truss Echedoros River Railway Bridge. Such an intervention can be characterized as sustainable if the design considerations include the assessment of the remaining fatigue life, the estimation of the future traffic demands and the evaluation of the total cost of the project. The certification of the design criteria used in the present study, i.e. loads and resistance assessments is mainly based on the Guidelines entitled ‘Sustainable Bridges’, which have been recently produced by the European Commission. The Echedoros River Railway Bridge due to its position used for decades to be one of the most important structures of the railway network in the northern part of Greece. The bridge been classified as a historic structure, was completely reconstructed in 1946 after the 2nd World War in its present form that consists of two spans with one concrete support in the middle of the river and two main truss girders with riveted connections for each opening. In the present work a finite element analysis model of the whole bridge and several partial finite element analysis models of critical details have been studied using ANSYS software including solutions for critical traffic, earthquake and fatigue loading combinations. With this framework the field conditions of the most representative details have been simulated taking into consideration different local deficiencies and possible failures. As result an evaluation of extreme stress areas on gusset plates and a more representative stress distribution among the connecting rivets has been obtained. The restoration of the old steel-truss railway bridge with riveted connections is mainly limited by its strength against fatigue and influenced by the ultimate strength of its structural members. So, the proposed methodology leads to a more accurate and robust restoration design.
ABSTRACT

Glass curtain-wall systems are nowadays extensively used in modern construction due to the fact that they can be manufactured as building façades to possess all those high efficiency properties prescribed by the designer; among these properties predominant role play the high strength-to-self-weight ratio, the serviceability requirements, the recyclability of the constituting parts, as well as transparency and the overall aesthetics characteristics. From a structural engineering standpoint, although usually curtain-wall systems are considered as secondary structural systems, their structural performance has to be meticulously analyzed and designed to fulfill modern Structural Codes requirements because they are in most cases subjected to strong environmental actions.

The structural response of standard curtain-wall systems subjected to normative load combinations is numerically investigated within the Euro codes framework. In addition, an optimal structural design of the glass curtain-wall system is carried out by applying advanced finite element analysis schemes and taking into account structural design principal criteria. The proposed optimal structural design approach leads to useful conclusive remarks for the selection of the basic structural members as well as the anchor details and the glass panels with reference to the dominating actions being the wind and the earthquake action. The proposed methodology is illustrated by means of a numerical application on a typical building façade case study.

THE SYNERGY PROJECT:
A STUDY OF HIGH ENERGY-EFFICIENT BUILDING ELEMENTS ASSESSED UNDER

CESARE’14 – An International Conference coorganised by the Schools of Civil Engineering of

Jordan University of Science and Technology (JUST)  Aristotle University of Thessaloniki (AUTH)  University of Birmingham (UoB)
INTEGRATED PROTECTION CRITERIA AND LIFE CYCLE DESIGN ASPECTS

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Keywords: energy efficiency, linear thermal transmittance, hygrothermal performance

ABSTRACT

This paper presents the first steps of a project that focuses on the research and development of high energy efficient building elements, assessed under integrated protection criteria and life cycle design aspects. More specifically, it concerns a holistic approach in designing and evaluating the building elements of new and existing constructions in Greece, with regard to their energy, hygrothermal, fire and environmental performances. Apart from the knowledge and the theoretical results that will derive during the project, there are also more practical products, such as a catalogue and computational tools with numerous constructional details and information regarding their thermophysical, hygrothermal, fire resistance and environmental properties. These tools are very useful for all engineers, especially during the design and the decision-making phases of a new building or a renovation project. The expected products of the proposed project will not only act as a guideline for the technical community, but it will promote the use of building materials, which are efficient from every aspect of view.
THERMAL BRIDGING ANALYSIS ON CLADDING SYSTEMS FOR BUILDING FACADES

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Keywords: point thermal bridge, external cladding systems, heat transfer

ABSTRACT

In the contemporary architecture, cladding is widely used as the outer skin of new and retrofitted buildings. Among its most important advantages are the flexibility in developing interesting aesthetic effects due to the numerous alternatives of cladding materials, as well as its ability to outline efficient multi-layered building elements, providing thus the necessary protection against the ambient environment and contributing to the formation of comfortable indoor conditions. In most façade cladding systems, self-weight and wind loading are normally transferred to the building structure with the use of a metallic frame and steel brackets, which penetrate the thermal insulation layer. In terms of thermal performance, the area of the bracket’s anchorage is the weakest, due to the point thermal bridging effect occurring at the junction of the metal brackets and the external solid wall. The objectives of the proposed paper are to define the magnitude of this thermal bridging effect and its interrelation with the bracket’s characteristics, the thermal resistance of the solid wall behind the external cladding, as well as with the ventilation rate of the air cavity formed between the two elements (the external cladding and the solid wall). The analysis is conducted under steady state conditions as a multi-parameter study through the use of specialized software for thermal modelling, which enable the calculation of the point thermal transmittance $x$ (W/K) and its visualization through isothermal images for every case. Although heat transfer through the cladding elements is very complex and depends highly on the final choices of the façade engineer, the derived quantitative information regarding the extent of the thermal bridging effect for the alternative scenarios of cladding characteristics is still very essential, especially in cases where a high energy performance is required.
Polymer Adhesives with Enhanced Properties Suitable for Assembling of Structural Glass

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Keywords: Steel-Glass Structures, Glued Joint, Polymer Adhesives, FE Modelling

ABSTRACT

Polymer adhesives designed for structural use is becoming more and more favourable and feasible for steel-glass load bearing connections since their properties were improved according to requirements of engineering point of view. Assembling of glass elements, or bonding of glass to steel members brings significant advantage in many factors like uniformly distributed stress contraction, low self-weight, absence of holes in glass etc. Every adhesive, given to be used in a joint with real load bearing role, has to be carefully tested and investigated before its practical use and safe static evaluation of overall structure with load bearing semi-rigid adhesively bonded joint. Main interest of civil engineers is focused on strength and stiffness, particularly on possible elongation of tested polymer. Reputable adhesive producers are familiar with these required properties and their own research and development do the best to produce adhesives, with improved material properties in every new generation of adhesive. There is a new generation of acrylic adhesive on the market, which shows significantly better properties in comparison with previous one. 5 years ago, material tests of previous generation of the same adhesive were performed. Main problems for modelling of the older version were the changeability of the stiffness during the range of load and relatively low possible elongation at break. New technology shows nearly bi-lingual stress-strain diagram with stiffer initial part (close to elastic behaviour), achieves higher strength and possible elongation at break. These characteristics bring save and economic design of adhesively bonded connection closer to civil engineers without advanced knowledge of finite element software. The paper deals with the explanation of polymer adhesive behaviour, describes structural interaction between assembled members and provides theories for hand calculation of bonded joint between steel and glass, which shows real load bearing role and transfer internal forces between connected members.
TOWARDS A SUSTAINABLE PRESERVATION
OF THE POST-BYZANTINE MONUMENTS OF CAPPADOCIA

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Keywords: Sustainability, monuments, stone masonry

Abstract

Cappadocia is worldwide known for its Byzantine monuments. However its Post-Byzantine monuments, dating from the 18th and 19th centuries, are also equally interesting. These are the churches built by the Greeks and left behind when they were forced to leave in the 1924 population exchange between Greece and Turkey.

These monuments possess a wealth of architectural features and artistic elements unique in Asia Minor. Their architectural style is an interesting and fascinating mixture of Western and Oriental elements that express the position of Cappadocia on a cross road. Most of them are three-aisled basilicas with an open arcaded portico. Their exquisite construction reveals the survival of Early-Christian building techniques. They are built with a thick volcanic stone masonry, whose both sides are riveted with well-dressed stone masonry, and are reinforced with iron beams. An important feature is the wide use of the pointed arch, also for cross-vaults and barrel vaults.

These churches are endangered by abandonment and inappropriate use. They should be preserved, restored and made accessible to visitors. To this purpose the following process should be followed. Location of the churches and documentation (detailed photographing, 3D scanning and visualization, surveying and drawing). Documentation of the frescoes, analysis and interpretation. Study of the architectural typology and morphology and comparison to the Greek religious architecture of the same era.

For their restoration needed are: Complete architectural drawings. Documentation of the load bearing structural elements and their condition. Study of the composition of the materials (stone, mortar and iron). Geological and geotechnical study of the ground. The seismicity of the region. Simulation of each monument in order that the stresses and the deformations under different conditions can be calculated.

These process will demonstrate the artistic and historic value of these monuments and help their restoration.
THINKING “INSIDE” THE BOX (AND BUDGET): ALTERNATIVE WAYS TO PRESERVE THE BYZANTINE ANTIQUITIES WHILE RETAINING THE OPERABILITY OF THE VENIZELOU - THESSALONIKI METRO STATION

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Keywords: Sustainability, Cultural Heritage, Thessaloniki Metro

ABSTRACT

The new Thessaloniki Metropolitan Railway infrastructure is a challenging engineering project of 1.1 billion € investment, in a difficult engineering environment due to the proximity with the sea side and the exposure to a considerable level of seismic hazard. Above all, the construction of the main Metro line is faced with the challenge to accommodate the fact the city has been historically built over different layers, each one corresponding to a different era: Macedonian (Hellenistic), Roman, Byzantine, Ottoman and modern Greek. Recently, significant archeological findings were revealed at the Venizelou Metro station involving the 75m long and 5.5m wide, Byzantine Decumanous road, also called Middle Road (Μέση Οδός) of Thessaloniki built by the Roman emperor Galerius in the 4th Century and reconstructed two centuries later. Next to it, the four pillars of the most important crossroad of the city at the time, this of the Middle Road with another significant pathway, Cardo were also discovered; This spot essentially marked the commercial heart of the ancient city right below the commercial heart of the today’s one. The historical and cultural significance of these findings raised the question of whether the construction of the Metro station was indeed feasible without detaching and transferring the archeological findings elsewhere. The necessity to keep the construction within the limits of the initial design and the already constructed perimeter diaphragm walls, posed an additional constraint to the engineering problem on top of the tight already limiting budget and time constraints. This paper reviews the engineering problem and describes the proposal made by the Department of Civil Engineering when it was assigned by the Aristotle University of Thessaloniki the task to investigate alternative solutions on the basis of their feasibility, cost over and respective benefit. It was shown that, it is indeed feasible from both a technical and a financial view point to preserve the vast majority of the findings while keeping the construction within the topological and budget limits, by detaching the antiquities, proceeding to the construction of the lower layers up to the level of -6m and then placing back more than 70% of the findings to their original position. It is deemed that this proposal contributed significantly to the ongoing public discussion between the local and governmental authorities as it demonstrates feasible solutions towards the remarkable coupling of the modern city with its own past.
ASSESSMENT OF WALLS’ THERMAL RESPONSE FROM A PROPORTIONAL AND A RELATIVE POINT OF VIEW

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Keywords: for instance Sustainability, Resilience, Robustness

ABSTRACT

In this work the variations of concrete thermophysical properties for various wall configurations are considered to assess their influence on the dynamic thermal characteristics, such as the decrement factor and time lag. The examined assemblies refer to insulated walls with variable concrete thickness and the concrete placement in one or two layers. The insulation is also placed as one or two equivalent layers (constant thicknesses) giving rise to a total of six representative wall formations. The thermal response is determined by employing the thermal-circuit modelling approach and the analysis is based on the nodal solution method. Variations on the geometrical characteristics and the thermophysical properties of concrete layers are seen to interrelate non-linearly with the walls’ RC-sections corresponding parameters with consequences on its dynamic thermal characteristics. As such variations, together with the studied insulation placements, affect the decrement factor and time lag in a disparate way, metrics for assessing the walls’ thermal behaviour from a proportional (PDM, PTM) and a relative (RDM, RTM) viewpoint are introduced. Computer results, revealing the influence of the assumed wall attributes on the decrement factor, time lag and the proposed metrics are shown for all the studied wall assemblies.
TWO- AND THREE-DIMENSIONAL NUMERICAL ANALYSIS OF SOIL NAIL SUPPORT SYSTEMS

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Keywords: Slope stability, Soil nails, numerical analysis, finite element method, three-dimensional effects

ABSTRACT

It is common practice in the geotechnical analysis of excavations and soil slopes to ignore three-dimensional effects and perform plane strain calculations (numerical and/or analytical) on typical cross-sections of the geometry of the problem under investigation. In such analyses, one-dimensional support elements, such as ground anchors and soil nails, are modelled as two-dimensional elements using equivalent stiffness and strength properties. This paper investigates the validity of this approximation through an extensive series of two- and three-dimensional finite element analyses of excavations supported with soil nails. In all cases considered, the excavation is assumed to be infinitely long, and therefore three-dimensional effects are only limited to the performance of the soil nail support system. In the two-dimensional (plane strain) analyses the soil nails are modelled using plate elements, while beam elements are adopted in the three-dimensional analyses. The effect of the conventional plane strain simplification on the calculated factors of safety and structural forces is first investigated through comparisons of two- and three-dimensional analysis results for the case of a soil nail – supported vertical cut. Subsequently, several cut slope inclinations and various soil and groundwater conditions are considered. Based on the numerical results and comparisons, practical guidelines are proposed for the approximate plane strain analysis of soil nail support systems.
Factors and issues related to the environmental impact caused by the life cycle of timber building construction projects

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Keywords: environmental impact; life cycle; timber construction; timber buildings; environmental sustainability

ABSTRACT

Timber construction offers a number of advantages in terms of environmental sustainability particularly in comparison to other construction technologies such as Concrete construction. Although the calculation of the environmental impact caused by the life cycle of a timber construction project provides results that display some of these advantages, it is also necessary to examine the manner in which timber construction should move forward in order to maximize its sustainability potential. The aim of the current research is to determine the key factors and issues that are related to the environmental impact caused by timber construction and thus provide the basis for future considerations regarding the optimal delivery of such projects. A timber building is used as the basis for the calculations that are used to quantify the influence of the issues examined. Furthermore, the conclusions that are derived highlight recommendations intended for application in similar projects, while also providing suggestions for the way forward regarding sustainable practice within the timber building sector.
A NEW STEEL ANTI-SEISMIC DEVICE FOR REINFORCED CONCRETE BUILDINGS

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Keywords: anti-seismic device, seismic energy absorption system, seismic non-linear response history analysis

ABSTRACT

In the present paper, a new metal anti-seismic device is presented from the theoretical point of view. In order to increase the seismic capacity of multi-storey reinforced concrete (r/c) building, a new metal anti-seismic device is invented that has been covered recently by a diploma of invention by the Greek Industrial Property Organization. The proposed anti-seismic device is located into the r/c beams, near the two ends of each beam, and in combination with the longitudinal steel bars of the section, a plastic hinge is developing there. The plastic hinge possesses a fully plastic part of his available Moment-Rotation diagram. Using the above-mentioned anti-seismic device at the two ends of each r/c beam, the ultimate plastic mechanism of the r/c building due to strong earthquakes is setting under control since it is developing on the beams, mainly.
Experimental investigation on opposite patch loading of beams

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Keywords: opposite patch loading, experimental investigation, failure load, analytical formulae.

ABSTRACT

An experimental study was carried out on sections of welded beams subject to opposite patch loading. The objective of the study is to analyze the behavior of sections subject to opposite patch loading by considering webs with two different slenderness ratios and loadings distributed along different lengths at different positions relative to the stiffeners. Thus, 18 tests were carried out and the load-displacement curves were recorded by integrating the failure and post failure phases. These results, relative to slender webs, should enrich the existing results associated with low slenderness webs. The failures are visually characterized by the different buckling mode shapes and the possible appearance of plastic deformation observed at the end of the experiment. These failures appear to be influenced by the shape of the initial geometrical imperfections which are inevitably present in each beam. In parallel with the experimental study, existing analytical formulas for calculating the failure load are identified and their results compared with the test results to assess their accuracy. Thus, four analytical formulas [1-5] are selected and their predictions are confronted with test results. These analytical formulas take into account the variation of the yield resistance and the critical load of elastic instability with respect to the slenderness of the web. They are calibrated on the basis of test results and finite element modeling. Their application to the geometries tested in this study shows that the results they give are conservative but their accuracy is to be improved.
Advanced FEM Models for Wind Turbine Towers to Optimise their Structural Design

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Keywords: wind turbine tower; wind loads; tower shell; finite element analysis

ABSTRACT

In the present paper, the structural behaviour of typical steel tubular wind turbine towers under wind loads are simulated and analysed. In particular, towers of heights of 50m, 150m and 250m are considered and numerically investigated with three different design approaches being the following: (i) the support tower appropriately designed with internal horizontal stiffening rings, (ii) the tower without stiffening rings and (iii) thin tower with strong stiffening rings. As the steel structure’s weight is directly related to the project’s cost, weight reduction ratios are compared to the displacement and stress increase ratios in order to estimate the optimal tower design by reducing the cost meeting and satisfying stiffness and strength Structural Codes requirements.
A New Modelling Approach of a Multizone Building in Saharan Climate

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Keywords: Multizone Model – Temperature – Nodal Method.

Abstract

This paper introduces a new approach to the description and modelling of multizone buildings in Saharan climate. Therefore, thermal nodal method was used to apprehend thermal behavior of air subjected to varied solicitations. A coupling was made between equations proposed by P. Rumianowski and some equations of a building thermal energy model found in the TRNSYS user manual. Runge-Kutta fourth order numerical method was used to solve the obtained system of differential equations.

The comparison shows that the found results are to some extent satisfactory. This new multizone model can be widely used to study the energy performance of large scale buildings and succeeds in the prediction and simplification of the physical phenomena with acceptable accuracy. In these situations, building simulation is a cross-disciplinary subject between building physics, mathematics and computer science.
Keywords: wind turbine, stiffening ring, numerical simulation, finite element analysis, buckling

ABSTRACT

Recent environmental phenomena along with the upcoming fossil fuel shortage make the use of renewable sources of energy imperative for the near future. Wind energy as a rather promising renewable energy source has advanced and is expanding rapidly. To this end, the improvement of the structural detailing of steel wind turbine towers is critical for the improvement of their performance thus resulting to more efficient, durable and robust structures facilitating their wider application and consequently the expansion of wind energy production. The present study identifies the contribution of steel internal circumferential stiffening rings placed along the tower height, to the overall structural behavior of the tower. The stiffening rings are suggested as a mean to reduce local buckling phenomena, increasing the buckling capacity of these slender steel structures. The beneficial role of the rings is established by the utilization of finite element model of the wind tower. Different distributions and locations of the rings are parametrically analyzed.
BEHAVIOR OF STEEL-FRAMED BUILDING ELEMENTS IN FIRE UNDER INTEGRATED PROTECTION CRITERIA

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Keywords: Fire insulation materials; Fire resistance; Thermal analysis; Heat transfer; Sustainability

ABSTRACT

This paper develops recommendations for the determination of the efficient use of fire insulation materials and the benefits that can be obtained in comparison to non-insulated structural elements. The study focuses on the thermal analysis of structural members which consist of reinforced concrete or steel, various types of fire insulation and other layers. Thermal analysis can be divided into two parts: The first part is focused on the heat transfer from the fire to the boundaries of the component through convection and radiation whereas the second part concerns the temperature evolution inside the member through conduction. Because of the complexity that governs the equations describing the phenomena, the structural detail models have been studied using finite element models.

The aim of this work is to study various constructional configurations of structural elements including insulating materials in order to determine the evolution of temperature profiles and to assess the benefits that can be gained from the use of such constructional components. The analysis will be parametric with the aid of finite element analysis software. Results will be performed and delivered through tabulated data and summarized tables and figures. Professionals will have the chance to quantify the response of the structural elements in terms of temperature and time. Results of this study can be used as input data for the estimation of the maximum load capacity of a structural member under fire conditions.
The effect of RC slab on progressive collapse resistance of steel frames

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Keywords: progressive collapse, steel structures, concrete slabs, column removal

ABSTRACT

The resistance of steel frames to progressive collapse is a problem which has been analyzed using many different approaches. The dominating methodology in progressive collapse has been the alternate load path method described in the DoD [1] which involves the loss of one of the columns of the structure. For steel frames this methodology can be used to evaluate the resistance of a system to damage progression. Recent advances in the field of steel frames progressive collapse resistance [2]-[5] have shown that the collapse of a structure after a column loss can happen through more than one mechanism. Although most of the research attention has been focused on yielding type collapse mechanisms, for steel structures loss-of-stability-induced mechanisms have been identified for commonly used type of frames. For steel buildings, the latter mechanisms are potentially more catastrophic than the former since the progression of damage occurs in a brittle and sudden fashion. This paper is extending the work presented in [3] by investigating the effect of the inclusion of the RC slab in the progressive collapse analysis of steel moment frames. It is shown that depending on the governing collapse mechanism, the effect of including the RC slab in the analysis could be either conservative or un-conservative. The work applies the analytical methodology of [3] extending it with the inclusion of the RC slab and also presents validating computational analysis results.
3D Global loss of stability progressive collapse mechanisms of steel high-rise buildings

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Keywords: progressive collapse, steel structures, concrete slabs, column removal

ABSTRACT

The progressive collapse phenomenon of buildings has gained great attention from the structural engineering community since the collapses of the World Trade Center in New York in 2011. The response of structural systems, such as high-rise buildings, to local (extended or not) damage is in the core of this attention. The available methods for the analysis of such phenomena are described in [1] which is the dominating code for progressive collapse today. The current work extends the analysis included in [4] by using techniques able to identify global loss of stability phenomena. As presented in recent publications [2]-[5], these loss-of-stability phenomena (local or global) are usually more critical for the integrity of the structure than others (e.g. yielding-type of failures). Through a 3D FEM analysis of steel high-rise buildings, the potential of global loss of stability is investigated, a collapse mode which is not usually considered by the codes or by structural engineers mainly due to its complexity.
Dynamic buckling modes of progressive collapse of steel frames

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Keywords: progressive collapse, steel structures, dynamic buckling, column removal

ABSTRACT

The complexity of the progressive collapse phenomenon demands from the structural engineer to consider features which are not usually considered in common analysis and design. In this environment, the work recently published in [1]-[3] has identified a progressive collapse mode for steel frames which involves the sudden/brittle buckling failures of columns adjacent to the removed one. Although this mode is a relatively newly identified mode, the method of analysis so far applied was a static nonlinear FEM analysis, as allowed and described in [4]. However, the dynamic nature of progressive collapse phenomena, along with the new buckling collapse mode, constitutes a dynamic nonlinear analysis necessary. The objective of the current work is to identify buckling phenomena following the event of column removal in a steel frame, by applying a FEM dynamic nonlinear analysis.
ENVIRONMENTAL SUSTAINABILITY ASSESSMENT METHODOLOGY PROPOSAL FOR HERITAGE BUILDINGS’ RESTORATION

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Keywords: Heritage building; Restoration; Environmental sustainability; Environmental sustainability assessment

ABSTRACT

Sustainable construction is seen as a way for the building industry to respond towards achieving sustainable development on the various environmental, socio-economic and cultural facets’. [1] The herein presented study sets heritage buildings and their restoration activities as a focal interest in achieving sustainability through construction sector. Restoration projects primarily aim for the conservation of the heritage buildings and preferably for the restoration of these buildings for a specific use. Thus, the best scenario for a heritage building’s participation in sustainability is its physical continuity with an actively participating role in the life of its context where is responds to all: environmental economic, social and cultural, credentials of sustainability.

As the interest of the study, the environmental sustainability of heritage buildings can be achieved through continuity of the building with its apparent heritage values and alteration of its life time performance. Accordingly, the assessment of the environmental sustainability of heritage buildings shall base on understanding how and with what environmental impacts the laterally mentioned criteria are achieved.

It is the aim of this paper to present a specifically developed methodology to assess the environmental sustainability performance of heritage buildings’ restoration projects in correlation with other assets of sustainability. Methodology is set as a structure that classifies, integrates and quantifies different groups of numeric and written information to assess the environmental sustainability of heritage buildings’, specific to, adaptive reuse projects. It is developed as a comprehensive scheme that utilizes LCA as a backbone for delivering environmental sustainability performance values.
DUCTILITY SPECTRUM METHOD TO ESTIMATE SEISMIC DEMANDS FOR STRUCTURES

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Keywords: Ductility, spectrum, demand and structure.

ABSTRACT

Forces and displacements induced by major seismic effects can go beyond the elasticity range in structural elements. In current designs, the traditional way to take into account the nonlinearity of the structure is the non-linearity of structure is taken into account in association with the reduction of level forces with an indirect elastic analysis. The movements are then verified in an approximate way. This is the design method based on strengths. Design with direct coverage of travel and accurate evaluation of the nonlinear behavior expected of each structural element is, however, a more exact approach. This is the design method based on performance.

In this paper an improved procedure, applicable to evaluation and design of structures has been developed and illustrated by examples for Multi-Degree-of-Freedom Systems. This procedure uses inelastic spectra and gives peak responses consistent with those obtained when using the nonlinear time history analysis.
Estimation of Urban Wind Energy - Equiterre Building Case in Montreal

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Keywords: Urban Wind Turbine, Urban Energy, Wind Tunnel, Wind Speed Estimation

ABSTRACT

Urban energy generation such as that produced by small scale wind turbines installed on or around buildings can be defined as micro-generation. In the last few decades, there is a growing interest in the use of wind power in buildings. Given that the wind speed varies significantly at different locations over buildings’ roofs in the urban environment, the generated power, which is a function of the cube of the wind speed, will be very sensitive to the location of wind turbine above the roof.

The prediction of the wind speed in the built environment is difficult, due to the large roughness and the frictional effects, which reduce the wind speed close to the ground. The most dependable method for the wind assessment in the urban environment is to directly measure the wind speed, ideally at the position (location and height) of the proposed wind turbine. However, measuring the wind speed at a site is both time consuming and expensive i.e. normally not appropriate for the early stages of wind power development.

However, there are several methods available for the initial assessment of wind resource in the urban area, with varying degrees of resolution and accuracy. In order of increasing accuracy, such methods include wind atlases, wind tunnel modelling and the direct wind recourse measurement, if our interest lies on existing buildings. A variety of wind atlases are available at continental and national level. For instance, the Canadian wind energy atlas – http://www.windatlas.ca – covers a wide area but its low resolution can only provide a general picture of the wind resource, let alone that wind atlases cannot take into account local variations and their effect in the wind distribution.

On a more refined scale, wind speeds can be implemented using wind tunnel models. These models must be primed with data at a known location, usually local meteorological stations or airports. Wind tunnel tests may give a more accurate estimate of the wind regime without actually undertaking field wind measurements. The paper discusses the methodology of estimating wind speeds for urban power generation. A case study for one building in Montreal, the Equiterre building, will be discussed in detail. Field wind measurements from an anemometer on Equiterre building are compared with Trudeau airport corrected data. Wind tunnel test results provide the expected wind speed over this building and are compared with the field measurements. The correlation and the discrepancy of these comparisons are discussed in the paper.
Effect of Partially Through Crack Size on Strength of Shell Structures

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ABSTRACT

The analysis of numerous cases of failure in shell structures has found to occur at stresses lower than the design stresses. The origins of these failures have been due to flaws or cracks. In order to determine which size of crack is admissible, one must study how the structural strength is affected by cracks.

In this paper the analysis is done using finite Element program developed by the author. The stress Intensity factor $K_s$ of the shell structure is calculated and compared with that of theoretical one and excellent results were achieved as shown in the figures and tables of the results. The load carrying capacity of cracked shell structures were also evaluated and compared with that of the uncracked shell structures capacity to determine the crack size that is admissible. The results obtained were also compared with that of theoretical solutions and excellent results were achieved. The elements used in this program are 8-nodes shell element; 6-nodes singular triangular shell element and 8-nodes transition singular shell element, all elements with 5-degrees of freedom per node.
FLEXIBILITY ASSESSMENT AND CONVERSION POTENTIAL OF BUILDING STRUCTURES IN RELATION TO SERVICE LIFE ESTIMATION

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Keywords: Sustainability, Building Structures, Flexibility, Conversion, Refurbishment, Service Life Estimation

ABSTRACT

The Estimated Service Life, ESL, is of a major influence in many building assessments. The comparison and optimization of design alternatives but also the outcome of LCA calculations depend directly on the accuracy of this ESL [1]. Up till now building engineers have focused on Technical Service Life, but more and more the Functional Service Life is decisive in how long a building can be used. It can be expected that the Functional Service Life of a building structure is influenced by the ability of the building to accommodate changes during its Service Life: Conversion Potential. Flexibility is here seen as a property of the building that represents the building's ability to change and adapt to new requirements and upgrades, for example the possibility to replace and upgrade the building's façade or its service installations [2] [3].

To study Flexibility in more detail, it is necessary to qualify and quantify this property. This paper discusses the way in which Structural Flexibility and Conversion Potential can be defined using so-called Flexibility indicators. With this a methodology was developed to assess Structural Flexibility in buildings. The method was applied in a research on 18 different buildings in Eindhoven, Netherlands. Half of the buildings were buildings to be demolished, the other half have been, or shortly will be, refurbished.

The measured Flexibility results of the 18 buildings have been linked to each of the buildings achieved Service Life in order to find a relation between the buildings Flexibility properties and the Service Life. The first preliminary results indicate that buildings with an above average Structural Flexibility showed a higher survival probability (an increased chance of a longer Service Life) compared to the buildings with a below average Structural Flexibility.
SLS-BASED PERFORMANCE OF RC: BOND MODELLING STRATEGY

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**Keywords:** reinforced concrete, bond model, cracking, deformation, tension-stiffening

**ABSTRACT**

It is well known that interaction between rebars and concrete, often referred as bond, has a crucial effect on performance of RC structures, both in the serviceability (SLS) and the ultimate limit states (ULS). Although the existed practice in design of RC is often related to the bond model of Model Code [1], many other bond models have been proposed. The main source of variation in the proposed models arises from differences in the constitutive testing procedures, boundary and confining conditions, stress state and interpretation of the obtained data. Moreover, the bond zone undergoes complex physical and mechanical actions such as formation of secondary and splitting microcracks, local crashing and shearing concrete in front of the ribs. Due to this, sometimes it is even stated that practically it is impossible to obtain local bond-slip relationship supported by the common testing methodologies. Focusing investigation on development of the discrete cracks in bond zone around a rebar embedded in concrete, present study proposes an alternative numerical strategy for deriving bond stress-slip relationship. This strategy is based not on the local concrete to reinforcement interaction tests, but on the cracking and deformation behaviour of full-scale RC members. The approach, in an integral manner reflecting the bond phenomenon allows significantly reduce scatter of bond modelling results.

Main principles of the novel approach are formulated and implemented on RC ties. Brief comparative analysis of the currently used bond models (including the Model Code 2010) substantiates applicability of the proposed strategy. Validation using experimental data of RC tie elements with different reinforcement ratios has indicated that the bond-slip relationships obtained by the proposed technique can be successfully used in the serviceability analysis of RC members.
SAFETY AND REDUNDANCY OF ADAPTIVE BUILDINGS STRUCTURES

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Keywords: Adaptive Structures, Safety, Redundancy, Fail-Safe-Concept, Load Path Management

ABSTRACT

The last three decades there has been extensive pioneering research done on adaptive structures. Studies on buildings and civil structures that are able to adapt to different environmental conditions. The focus of the presented study is the safety and redundancy of adaptive building structures.

Safety is the state of being “safe”, the condition of being protected against types or consequences of failure, damage, accidents or any other event which could be considered non-desirable. The application of an adaptive structure gives new elements in the design of a structure compared to a traditional structure that has to be elaborated. There are additional components added that must be checked on safety and reliability, but at the same time can these additional elements also provide an additional safety option. In this paper is the failure of the active elements considered as the possibility of extra redundancy because of the active elements.

A fail-safe concept for a structure means that a structure must not fail due to the failure of single elements and alternative load transfer mechanisms are available. For adaptive structure this means in addition to the individual structural elements also the active system must be fail-safe. This means that even if it loses the active control, the stability must be ensured. The first considered additional safety issue is the possibility that all the active elements do not function correctly at the time that the actuations are required.

The second additional safety consideration is according to the NEN-EN 1991. On buildings in consequences class CC3, a risk analysis must be performed in the design process. This analysis must consider the probability and consequences of any unfortunate event. Design analysis is made to avoid disproportionate damage to the structure from an accidental cause. Within the analysis of unfortunate events, the active frame can contribute in dealing with exceptional load cases.

These considerations will be discussed and presented with a case study of a high-rise building.
Influence of the supplementary cementitious materials on the dynamic properties of concrete

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Keywords: Concrete, Non-destructive test, Dynamic elasticity modulus crushed limestone, Résistance, natural pozzolana.

ABSTRACT

The Frequency of resonance method is one of many non-destructives tests witch allow us to evaluate construction materials. It was used to determine the dynamic properties of concrete, required in structures design and control and considered to be the key elements of materials dynamics.

In this study, we chose a non-destructive approach to quantify -in laboratory-, the influence of adding “crushed limestone” and “natural pozzolana” on local concrete’s dynamic characteristics. However, several concrete mixtures have been prepared with limestone aggregates. The experimental plan used, allowed us to determine the dynamic elasticity modulus, the dynamic rigidity modulus and the Poisson's ratio of different formulated concretes.
INVERSE TECHNIQUE FOR INVESTIGATION OF THE POST-CRACKING BEHAVIOUR OF SFRC MEMBERS IN FLEXURE

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Keywords: Residual stresses, Steel fibre reinforced concrete, Flexural members, Crack width.

ABSTRACT

Steel fibre reinforced concrete (SFRC) is a cement-based material reinforced with randomly distributed fibres. The addition of fibres into the concrete matrix counteracts its brittleness, producing material with increased ductility, toughness and post-cracking stiffness as well. Due to the ability of fibres to transfer stresses through the crack plane, cracked SFRC is able to carry a certain portion of tensile stresses. Therefore post-cracking strength can be considered as the main parameter describing the effectiveness of fibres and concrete interaction. Stresses resisted by cracked SFRC are known as residual and can vary significantly depending on the fibre amount and mechanical properties of fibres and concrete \cite{1}.

The paper deals with experimental and theoretical investigation of the post-cracking behaviour of SFRC. Experimental results of six notched beams with fibre contents of 0.5 and 1.0\% by volume subjected to three-point loading scheme are presented. Considering SFRC as a homogeneous material, the inverse analysis technique is proposed for determination of the residual stresses of SFRC in tension. To verify the calculated results a numerical modelling is utilized employing a nonlinear finite element analysis program ATENA. Simulated load-crack width curves were compared with the experimental data validating adequacy of the proposed model.
ANALYSIS OF TEST RESULTS OF RC TIES SUBJECTED TO STATIC AND CYCLIC LOADING

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Keywords: Reinforced concrete, Deformations, Cyclic loading, Shrinkage

ABSTRACT

Due to increased computational efforts, the adequate modelling of repeated loading has become relevant in the last decades from the point of view of the structural design and safety assessment. Increased deformability of structural elements subjected to cyclic loading becomes an important issue that should not be neglected in design of roads, wind power plants, offshore structures, different types of machinery foundations, etc. Moreover, the deformational response of RC members is often complicated by long-term effects like shrinkage and creep of concrete [1]. The shrinkage effect is proportional to sectional stiffness of concrete, decreasing with increased number of load cycles, but still remains significant for adequate deformations prediction of RC elements in serviceability loading state.

This paper analyses deformations of experimental RC ties subjected to static and cyclic loading. Three RC ties were subjected to static loading and 9 were cyclically loaded (up to 66 repetitions). Unlike the common practice, shrinkage of concrete was taken into account in the analysis of the RC ties. Modified (by eliminating the shrinkage effect) load-deformation diagrams were compared to the experimental relationships. It is shown, that the shrinkage effect can significantly distort experimental results and, therefore, lead to inaccurate predictions of structural responses based on corrupted material models. To verify the obtained results, numerical simulation of the experimental specimens was performed. The study concludes that computer simulations should introduce the shrinkage effect as a separate parameter of the numerical model that is not a common practice in the serviceability analysis of RC sections subjected to cyclic loading.
EXPERIMENTAL INVESTIGATION ON LONG-TERM DEFORMATIONS OF TENSILE RC MEMBERS

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Keywords: Reinforced concrete, Time-dependent deformations, Creep, Shrinkage, Tension-stiffening

ABSTRACT

Structural engineers for the analysis of concrete structures most often choose design code methods. Although the design code methods are simple and ensure safe design, they have significant shortcomings. These methods cannot include all important material and geometrical parameters and, therefore, are not accurate enough. Numerical techniques, as an alternative to the design code methods, are based on universal mechanical principles, but their adequacy depends on the correct assumption of constitutive laws.

Modelling of cracking behaviour and the tension stiffening effect is considered to be one of the most complex and challenging issues in the constitutive simulation of reinforced concrete structures. After cracking, due to bond with reinforcement, concrete between cracks carries a certain amount of tension stresses normal to the cracked plane. The concrete adheres to the reinforcement bars and contributes to the overall stiffness of the structure. The phenomenon is called tension-stiffening. Based on various assumptions, a number of tension-stiffening models have been proposed for the case of short-term loading. However, a very limited number of studies have been devoted to the investigation of tension-stiffening for the case of long-term loading [1-3].

Current study aims at assessment of long-term degradation of tensile stiffness in RC elements. Five similar RC ties have been tested under sustained loading with load duration varying from 18 to 105 days. The finite element program ATENA and the experimentally derived tension-stiffening relations were used for modelling of the ties. Good agreement of simulation results with the test measurements has been stated. Furthermore, comparative analysis of average strains obtained from elongation of reinforcement and measured at the concrete surface was conducted. Noticeable differences in stiffness assessed using these two approaches were found.
CURVED GLASS IN REALIZED PROJECTS

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Keywords: curved glass, curved insulated glass

ABSTRACT

In the last years a tendency of an increasing of the number of in building project built-in curved glass could be observed. In a lot of realized projects around the whole world one can find such glass in many different applications with a big number of different geometries. These applications can principally be curved monolithic glass, laminated safety glass or insulated glass. This fact makes it absolute of interest to make much more investigations in this field. The investigations in this field could be focused on e.g. the process of the bending of the glass to bring it into the right shape, or the very difficult topic of pre-stressing of such glasses. How to design curved insulated glass is a big issue too. In comparison to flat insulated glass the internal pressure in the space between the glass layers due to the so called climatic loads is much higher.
INNOVATIVE MATERIAL FOR SEGMENT TUNNELS

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Keywords: FGM, SCC, structural elements, sustainable concrete, shield-tunnel segments

ABSTRACT

Self-Consolidating Cement Composites (SCCC) is nowadays a matured technology, adapted to many different structural applications. Indeed recently its possibilities by including fiber cocktails are broadened, hence allowing serving incompatible functions concerning the most complex engineering environments. Moreover, concrete industry needs to meet the important issues of cost-efficiency and environment impact by accurately assessing the use of resources also.

The Functionally Graded Material (FGM) concept introduced in Japan in the early 1970s, when applied to SCCC certainly helps to produce customized concrete elements (spatially tailored) in a more cost-efficient way. On the other hand unlike SCCC due to its rheological characteristics, it allows an effortlessly casting of robust FG segments while reducing the design complexity.

In the light of the synergy, a FGSCCC concept is presented and the feasibility of producing linearly compositional gradients applicable to tunnel segments located under sea water areas demonstrated. Equally, the highly-optimized performance of the graded solution has been experimentally proved. Thus, the main paper objective is to introduce the deployed hybrid concept and to illustrate its feasibility for producing FG tunnel segments.
Updating A High Building's Finite Element Model based on the Experimental Modal Parameters

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Keywords: finite element updating, optimization, genetic algorithm, modal system identification.

Abstract

Ambient vibration testing is the most economical non-destructive testing method to acquire vibration data from large civil engineering structures. Using the modal identification techniques the modal parameters can be determined which are effectively used as validation criteria in the context of finite element model updating to develop reliable finite element models of large engineering structures. These updated models will be useful both for predicting the dynamic behaviour and for assisting in the identification of structural damage.

In this paper, the finite element model updating of a case study (a twelve story reinforced concrete building) is presented. The modal identification results obtained from ambient vibration measurements of the building are the natural frequencies and the mode shapes of the first lateral and torsional modes which are the dynamic characteristics of interest of this study. The finite element model of the building is developed from the information provided in the design documentation. A sensitivity analysis is carried out to determine the most sensitive parameters for FE model. The updating is performed using the genetic algorithm. As results, a good correlation between measured and calculated modal parameters is obtained with parameters updated.
ANALYTICAL EVALUATION OF TIE FORCE METHODS FOR PROGRESSIVE COLLAPSE RESISTANCE OF PRECAST CONCRETE CROSS WALL STRUCTURES USING REINFORCEMENT BAR

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Keywords: Cross wall, progressive collapse, analytical, ties force method, pullout, catenary action

ABSTRACT

This is the first of a research program involving a fundamental study of an analytical method for progressive collapse resistance design of floor-to-floor joint in precast cross wall structures using reinforcement bars into keyways. The tensile tie force (TF) method is one of the main design approaches for progressive collapse. As this method does not take into account the effect of steel-concrete interfacial properties, or the size and embedment length of tie bars on bond behaviour, it can be considered as a simplified method, hence further investigations on the reliability of the method would become necessary. This study aims to evaluate current TF method developed by British Standard or BS EN1991-1-7 using full scale test and analytical approach. To this end, comprehensive analytical model of the pullout behaviour of reinforcement bars in grout considering post-bond-failure is firstly developed; and then, by considering the tie force-slip relationship together with the catenary action mechanism, for the first time, an analytical method to analysis and design of floor-to-floor joint in cross wall structures is established. The pullout model developed in the first part was calibrated using experimental results of precast concrete block pullout tests based on reinforcement bars embedded in grout. The theory derived in this paper is verified using experimental results of full scale floor-to-floor joints tests. The results indicate significant discrepancy between analytical and full scale tests with current TF method; hence an improved model based on the analytical results has been proposed to address this concern.
SEISMIC VULNERABILITY ASSESSMENT OF THE OLD HISTORIC CENTRE OF POGGIO PICENZE DAMAGED BY THE 2009 L’AQUILA EARTHQUAKE

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Keywords: Historic Centres, Seismic Vulnerability Assessment, Risk Mitigation, Resilient Cities.

ABSTRACT

This paper deals with the seismic vulnerability assessment of the old historical centre of Poggio Picenze, in Abruzzi, which was severely damaged after the 2009 L’Aquila earthquake. In particular, a predictive model able to retrieve probable damage scenarios, calibrated on the basis of empirical observations on similar historical centre of the inner Abruzzi stricken by the 2009 seismic event, is applied in order to provide fragility curves. Then, the obtained results are compared with the observed damages, so to confirm ex-post the reliability of the proposed methodologies. The used predictive model, based on the determination of a limited numbers of structural parameters that can be obtained by simple and quick inspections [1-2-3], is conceived in order to provide useful information on the most effective antiseismic strategies to be implemented on regional scale in order to pursue a global mitigation of the seismic risk associated to the analysed population of building. From this point of view, the representation of the obtain results on a GIS platform, allows to appreciate the attitude of the proposed predictive tool in giving useful and powerful information for decision and policy makers.
DISPLACEMENT BASED DESIGN, (DBD), NONLINEAR STATIC PUSHOVER ANALYSIS TO VERIFY THE PROPER COLLAPSE MECHANISM OF STRUCTURES

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ABSTRACT

Under the pressure of recent developments, seismic codes have begun to explicitly require the identification of sources of inelasticity in structural response, together with the quantification of their energy absorption capacity. In the pushover procedure, a static lateral load, which is distributed approximately equivalent to seismic loads generated by an earthquake, is applied to the structure, which is then displaced (pushed over) incrementally to the level of deformation expected during the earthquake (target displacement) while keeping the applied load distribution pattern. Base shear and corresponding displacement at each stage are used to build the pushover curve, following which the seismic structural deformations and the performance level of the structure are estimated. The nonlinear load-deformation characteristics of individual components and elements of the structure are considered in the model to account for the possibility of exceeding elastic limits.
PERFORMANCE OF DIFFERENT TYPES OF CEMENTS IN MARINE ENVIRONMENT

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Keywords: Performance, Marine Environment, Blended Cements, Strength Reduction, Permeability

ABSTRACT

Cement based materials when exposed to aggressive environments like the one near shore deteriorate due to ingress of moisture and other harmful chemicals. This study presents the performance of different kinds of cements in extreme marine environment. An experimental study was conducted for this purpose in which mortar cubes of different cements including OPC, Slag cement and Blended cements (varying percentages of 10%, 20%, 30% Fly Ash and 10%, 20%, 30% Silica Fume) were cast. Compressive strength of each was measured in at 7 days and 28 days initially. Samples were then immersed in sea water for 180 days to observe the impact of marine environment. Testing was done to determine the strength of the immersed samples after 90 days and 180 days. OPC samples showed the highest compressive strength initially but when exposed to extreme environment, strength degradation was observed and reduction was more as compared to slag cement and 10% Silica Fume samples. The increased percentages of Fly Ash and Silica Fume resulted in significant decrease of strength in mortar samples at both initial and final stages. Slag Cement samples showed the least change in strength of mortar after 180 days exposure to sea water. In addition to that concrete cylinders and cubes were also prepared from all the cement types mentioned above to compare the properties of each. Compressive strength and permeability of these concrete samples were measured to evaluate the performance of each cement type. The results of OPC and Slag cement samples were not found significantly different in terms of strength. Increased percentages of Silica Fume and Fly ash again resulted in reduction in concrete strength. When permeability was compared, Slag cement samples showed better resistance as compared to rest of the cements.
PREDICTIVE METHODS FOR THE SEISMIC VULNERABILITY ASSESSMENT OF MINOR CHURCHES

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**Keywords:** Churches, Seismic risk, Damage observation, Vulnerability assessment, Predictive methods, Fragility curves

**ABSTRACT**

Seismic protection of monumental buildings, in particular of churches, is one of the most important issues in Italy, the religious heritages being a cultural and historical resource in the whole national architectural scenario.

An homogeneous distribution of religious buildings is recognizable in the Abruzzi region (Italy), where many churches have been built or rebuilt, according to common techniques, in the immediate aftermath of the earthquakes occurred throughout the eighteenth century. These buildings, characterized by some similarities in terms of geometric features and architectonic elements, are significantly vulnerable, due to the poorness of the masonry properties and the absence of effective ante-seismic structural measures. All these vulnerabilities have been highlighted during the L’Aquila earthquake 2009, which caused a significant and widespread state of damage, putting in evidence, once again, that a proper preventive fragility assessment of the performances of these structures, through suitable procedures and predictive methods, would have lead to minimize the consequent losses.

In view of this demand, this paper presents a study on the seismic vulnerability of the churches of the Sulmona-Valva Diocese, a territorial zone at the boundary of L’Aquila district, whose churches undertook only slight damages during the seismic events of 2009.

A sample of thirty three-naves churches has been considered to this purpose. In a first stage, a damage survey has been performed, based on the observations carried out in the immediate aftermath of the 2009 seismic event. This allowed to evaluate the global response of the structures, which, at a later stage, has been interpreted by means of linear and nonlinear kinematic analyses implemented on the weakest macro-elements.

On the basis of the obtained results, a predictive model based on simple “fragilities indicators” has been set-up, so to provide a powerful tool that could be taken in consideration for future risk mitigation analyses to be carried out at regional level.
SHEAR RESISTANCE OF INTERFACES BETWEEN EXISTING AND NEW RC ELEMENTS

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Keywords: Interface, Shear resistance, Aggregate interlock, Dowels, Embedment length, Relative slip

ABSTRACT

Estimation of the shear resistance of interfaces between old and new concrete is essential in the design of strengthening of existing RC structures, especially when the interfaces are designed against seismic actions. The interface should not fail when subjected to the maximum expected forces. Shear resistance of an interface depends on various parameters, more important of which are the preparation of the interfaces and the quality of execution of works. The magnitude of relative slip of the two sides of the interface is essential for the assessment of the resistance of an interface, but it is difficult to predict at the phase of design.

In this work the main existing analytical models for estimation of the shear interface transfer are briefly reviewed and are applied to predict the experimental resistance of specimens tested in the literature. The adequacy of the models is discussed in relation to their predictive power and the different assumptions of the models. Code provisions of MC2010, ACI and KAN.EPE for the design of interfaces are discussed and applied to predict the shear resistance of the test specimens. Some observations on the behavior of the interfaces of RC in filled frames tested in relation to the analytical predictions of the methods discussed are also presented.
BEHAVIOR OF CONCRETE CONFINED BY GLASS AND CARBON FIBERS

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**Keywords:** fiber reinforced polymers, concrete, reinforcement, stress-strain relationship, ductility

**ABSTRACT**

Fiber-reinforced polymer (FRP) composites are widely applied for strength and ductility enhancement of reinforced concrete members. Ease of application as well as the non-increase of stiffness characteristics of the bearing members are important factors for opting for this method. Many empirical and analytical models have been proposed to calculate the increased compressive concrete strength and strain characteristics. However, there is still no model capable of describing the enhanced concrete characteristics equally well for all the parameters involved, e.g. concrete strength, amount of confinement. In this work, some models found in the literature have been selected owing to the accuracy of their predictions compared to experimental results. Furthermore, results of tests on plain concrete cylinders that have been reinforced by glass and carbon fibers are presented. The behavior of the specimens tested is compared to the predictions of the models and the observations are discussed.
Shear Strength of Steel Beams with Trapezoidal Corrugated Webs Using Regression Analysis

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Keywords : Shear strength, Steel Beams, Trapezoidal Corrugated Web, Regression

ABSTRACT

It was recognized from theoretical and experimental results that the shear buckling strength of a steel beam with corrugated web is complicated and affected by several parameters. A model that predicts the shear strength of a steel beam with corrugated web with reasonable accuracy was sought. To that end, multiple regression analysis (MRA) with a total of 93 collected experimental data points were used for modeling and predicting the shear buckling strength of a steel beam with corrugated web. Then mathematical models for the key response parameter (shear buckling strength of a steel beam with corrugated web) were established via MRA in terms of different input geometric, loading and materials parameters. MRA model having an $R^2$ value of 0.93 and passing the F- and t-tests were selected. Results indicate that, MRA could accurately predict the shear buckling strength of a steel beam with corrugated web with a minimal processing of data.
EXPERIMENTAL INVESTIGATION AND PREDICTION OF PUNCHING SHEAR STRENGTH OF HIGH STRENGTH CONCRETE SLABS

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ABSTRACT
This research presents an experimental program for investigating punching shear strength of slabs, consisting of 27 high and normal strength concrete slabs. The test data from the experiment are analyzed and divided into three series primarily concerned with the effects of three variables on the punching strength of high-strength (HS) concrete slabs: the concrete strength, the slab depth and the column size and shape. The ACI 318-11 approach is considered along with the approaches developed by Moe, Yitzaki, Herzog, Regan, and Rankin. All approaches are compared with the experimental results.

The experimental results indicated that shear strength for HS concrete slabs is proportional to $f_{c'}^n$ where the power (n) had been found to be in the range of (0.5 to 0.33). The assumption that the critical perimeter is at a distance (1.5d) from the load area is found to be reasonable and the reinforcement ratio has a considerable effect on the shear strength especially when the slab depth is high. A modified approach, modelled after the Rankin’s approach, is proposed and verified by this experiment and other tests.
ASEISMIC DESIGN OF BEAM-TO-COLUMN STEEL CONNECTIONS USING PERFORATED BEAMS

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Keywords: beam-to-column connections, seismic-resistance design, perforated beams, novel web opening shapes, cyclic loading, hysteretic behaviour, RWS connections, ductility

ABSTRACT

This study presents an overview on the behaviour of seismic-resistant beam-to-column connections using the design concept of Reduced Web Sections (RWS) and replacing the solid steel beams with perforated beams. The effect of using non-standard novel web opening configurations is comprehensively investigated for both bolted and welded connections. The ease of manufacturing process for such perforated beams together with the improvements on the structural behaviour (Vierendeel and web-post buckling capacity) foreshadows the enhancements gained.

Three-dimensional finite element models, which incorporate the contact interactions and the non-linear material characteristics, are employed to investigate the moment-rotation capacity of the connections as well as the prying effects of the bolts for the particular cases. The models of the beam-to-column sub-assemble are initially calibrated against experimental results; it is found capable to trace the non-linear cyclic behaviour of the connection and to capture all possible local failure modes. The elaborated finite element model is then used to conduct a series of simulations in order to examine the effects of various geometric parameters on the connections’ behaviour such as the distance between the endplate and the first perforation as well as the size and the shape of the opening.

The stress distribution in the vicinity of the connections and the web openings is thoroughly investigated. Research results show that the plastic hinge of the connection with the elliptically-based web openings can be now effectively controlled, hence the degradation in the capacity of the connection is minimised. The connections with novel openings outperform the conventional ones; hence they can be suitably used in the aseismic design of steel frames. Ultimately, it is concluded that using large perforations is an effective way of improving the behaviour of connections enhancing their ductility and their energy dissipation capacity.
PUNCHING SHEAR STRENGTH OF FIBROUS HIGH STRENGTH REINFORCED CONCRETE FLAT PLATE SLABS WITH ECCENTRIC LOADING

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Keywords: High strength concrete, Slabs, Punching shear, Eccentric Slab Column Loading, Steel Fibers.

ABSTRACT

This research, based on the experimental program conducted, discusses the punching shear strength of high strength concrete slabs and the influence of the main variables including the effect of concrete compressive strength, effect of steel fiber reinforcement, and effect of load eccentricity on the performance of slab-column connections. The specimens were tested under monotonic loading to failure. In addition, some specimens were tested to include the influence of reversed cyclic loading.

The behaviour is established by a study of deflections, crack pattern, rotations, strains, and ultimate loads.
Applications of Topology Optimization in Structural Engineering

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Keywords: Topology Optimisation, Structural Optimisation, Architecture, Conceptual Design, Perforated Beams

ABSTRACT

This study introduces applications of structural topology optimization to buildings and civil engineering structures. Topology optimization problems utilize the firmest mathematical basis, to account for improved weight-to-stiffness ratio and perceived aesthetic appeal of specific structural forms, enabling the solid isotropic material with penalization (SIMP) technique. Structural topology optimization is a technique for finding the optimum number, location and shape of “openings” within a given continua subject to a series of loads and boundary conditions (Bendsoe and Sigmund, 2003). Aerospace and automotive engineers routinely employ topology optimization and have reported significant structural performance gains as a result. Recently designers of buildings and structures have also started investigating the use of topology optimization, for the design of efficient and aesthetically pleasing developments. This paper examines two examples of where topology optimization may be a useful design tool in civil/structural engineering in order to overcome the frontiers between civil engineers and engineers from other disciplines. The first example presents the optimized structural design of a geometrically complex high-rise structure and the optimal design of its architectural building shape. The second one focuses on the optimization and design of a perforated steel I-section beam, since such members are widely used nowadays in the vast majority of steel buildings and structures while they provide a number of advances. Conclusions are drawn regarding the potential benefits and barriers to the more widespread implementation of topology optimization within the civil/structural engineering industry.
Flexural behaviour of reinforced beams by using corrosive rebar

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Keywords: corrosion, beams, rebar, flexural behaviour

Abstract

At this research, the effect of pre corrosion rebar on the flexure behaviour of beams is investigated. The corrosion is induced at rebar, before using for reinforcing beams, by two methods. The first method is putting rebar in water with 10% salt concentration inside lab. The second method is surrounding rebars by salt outside the lab and leaving them to weather changing, like rain and different relative humidity. The second method is given more corrosion rate compared to first method. The beam are subjected to four loading test. Three ages of beams are investigated which are 30, 90 and 120 days. Two size of rebars (10 mm, 12 mm) are exposed to corrosion and used at this research. The results are shown that high corrosion rebar of 10mm carried maximum load with maximum deflection at mid span for all ages. The percentage of increasing load for this corrosion bar is 144.3%, 141.7%, 124.3% for 30 days, 90 days and 120 days respectively compared with low corrosion of same bar size. This percentage is 126.1%, 127% for 30 days and 120 days respectively compared with no corrosion of same bar size.
EXPERIMENTAL STUDY ON THE AGING PERFORMANCE OF SECONDARY SILICONE SEALANT OF INSULATING GLASS UNITS

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Keywords: silicone sealant, IGUs, edge seal, aging tests, cross-bonded method, durability

ABSTRACT

Insulating glass units (IGUs) have been widely used as an energy saving building product. The air/water tightness performance of the edge seal system is the key to achieve the durability of IGUs. Nowadays, most edge seal consists of a dual sealant system, in which the secondary sealant is to retain the integrity of IGU. High temperature/relative humidity conditions and UV-exposure are the two most common factors that cause the detrimental aging effects upon the secondary sealant. In this paper, the cross-bonded test method is employed to examine the aging effects on the mechanical performance of silicone specimens. The tensile strength, shear strength, elongate rate at break and Shore hardness are measured for different aging periods. Aging rates are also calculated to investigate the aging sensitivity. It is found that most aging actions occur at the early age. The aging mechanisms are also discussed: excessive cross linking formation and the Si-O bond oxidation on the interface are deemed as two major reasons that attribute to the different aging behaviours of silicone sealants.
BUCKLING AND POST-BUCKLING BEHAVIOR OF BEAMS ON ELASTIC FOUNDATION MODELING BURIED PIPELINES

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Keywords: Winkler beam, buried pipeline, upheaval buckling, buckling mode cross-over, buckling mode interaction, nonlinear analysis

ABSTRACT

Buried pipelines transporting oil products are structures of great financial, environmental and social importance. Such structures must adapt to eventual deformations of the surrounding soil, thus they may be severely damaged by large imposed permanent ground displacements triggered by landslides or seismic fault activation, causing combined axial and bending actions along the pipeline. Possible failure modes are tensile fracture at the welds between adjacent pipeline parts, local shell wall buckling in regions of high compressive stresses and upheaval buckling, which may be critical for relatively shallowly buried underground pipelines with low diameter to thickness ratio.

The latter issue is investigated here, both analytically and numerically. The mathematical model used is that of a beam on elastic foundation, commonly referred to as Winkler beam. The case of a simply-supported beam with uniformly distributed transverse springs subjected to constant axial force over its length is addressed, as a first step towards more realistic modeling of actual buried pipelines crossing active faults. Linear buckling analysis is first carried out analytically, yielding critical buckling loads and corresponding buckling modes. The results are verified by means of comparison to finite element results, and indicate buckling mode cross-over depending on the stiffness of soil springs. Then, geometrically nonlinear analyses with imperfections (GNIA) are performed, indicating buckling mode interaction and descending post-buckling paths, thus unstable post-buckling behavior. The effects of material nonlinearity of both pipeline steel and soil springs are evaluated. Subsequent steps of this investigation will include more realistic boundary conditions, different soil resistance for upwards and downwards motion of the pipeline, as well as axial force distribution representative of the one along buried pipelines subjected to fault activation and corresponding bending moments.
SENSITIVITY OF A STEEL ARCH ROAD BRIDGE TO IMPOSED FOUNDATION DISPLACEMENTS AND ROTATIONS

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Keywords: steel arch bridge, imposed foundation settlements, liquefaction, nonlinear analysis

ABSTRACT

It is common practice to prohibit the use of shallow foundation for bridges in areas prone to seismic liquefaction. Hence, deep foundations (piles) are exclusively used, transferring loads to deeper, non-liquefiable soil layers. Nevertheless, recent studies regarding the seismic response of shallow foundations on liquefiable soils suggest that the aforementioned conventional design philosophy may be drastically changed in order to reduce the overall cost, while maintaining acceptable performance and safety levels. Namely, the existence of a surface “crust” of non-liquefiable soil with sufficient thickness and shear strength may mitigate the consequences of liquefaction in the subsoil, so that the use of shallow foundations becomes permissible. Moreover, this new design concept has the additional advantage of reducing the inertia forces acting on the superstructure, as the part of the subsoil, which will be intentionally allowed to liquefy, will lose its shear resistance and may consequently act as a “natural” system of seismic isolation.

However, there are also some potentially detrimental effects from this new design concept. One of them is that shallow foundations are admittedly more sensitive to differential settlements, which are likely to create additional actions to the bridge superstructure. This issue is investigated in the present paper for the case of a steel arch road bridge consisting of two simply supported spans with composite deck. Each span of the bridge under consideration is 42m long and the deck’s width is 15m. The effect of large displacements and rotations induced at the level of the foundation of the intermediate pier on the structural efficiency of the superstructure is investigated by means of nonlinear analyses. The results show that the bridge under consideration can sustain large displacements at the base of the pier without significant damage. However, the superstructure is quite vulnerable to imposed rotations of the foundation, especially about the longitudinal axis of the bridge.
EVALUATION OF GEOSYNTHETICS IN PAVEMENTS BUILT OVER NATURAL SOFT SUBGRADE USING FULL-SCALE ACCELERATED LOAD TESTING

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Keywords: Soft soil, Geosynthetic, Instrumentation, Accelerated load testing, Permanent deformation

ABSTRACT

In the state of Louisiana, pavements often have to be built over a weak subgrade due to the soft nature of Louisiana soil, which generates many design and construction difficulties. As an alternative to the traditional method of treating the soft soil with lime or cement, geosynthetics, mainly geogrids and geotextiles were evaluated in reinforcing pavements constructed over soft natural subgrade. A total of six full-scale test sections were constructed, among which two sections were reinforced by one and two layers of triaxial geogrids, respectively; while high strength geotextiles were used to reinforce two of other sections with different base thicknesses. The rest of the two sections were left as control sections, of which one section was constructed over geotextile-wrapped sand embankment as the common practice in Southern Louisiana. The test sections were subjected to a full-scale moving wheel load applied by the Accelerated Loading Facility (ALF). A variety of instrumentations were used to measure the load-associated and environment-associated pavement responses and performances. Important design parameters such as the resilient deformations and stresses in the subgrade and the strains in the base were measured. The permanent deformations at the surface and in the subgrade of the test sections were measured at the select intervals of traffic load applications. Influential environmental factors such as moisture contents and temperatures were also monitored throughout the testing. Results of the full-scale tests demonstrate the effects of geosynthetics on the performance of pavements and quantify the benefits of different geosynthetics in stabilizing/reinforcing the subgrade/base in pavements. In addition to evaluating the pavement performance, the instrumentation measurements of pavement responses under dynamic moving wheel load provide the important information on geosynthetics’ effects on the resilient behavior of pavements.
INFLUENCE OF THE NATURE OF THE AGGREGATES ON THE STABILITY OF BITUMINOUS MIXTURES

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Keywords: aggregate, stability, bituminous mixtures, mineralogy

ABSTRACT

Extending the service life of asphalt pavements is a function of the stability of the various constituent material mixtures prepared to make the pavement structure. The methods of pavement do not take into account the nature of the aggregates, although the characteristics of the aggregates have an influence on the behavior of bituminous materials by their mineralogical nature, their mechanical properties and their geometrical characteristics. Bituminous mixtures used in this study are made with aggregates from several deposits at different quarries. The different samples of bituminous mixtures with different aggregates are submitted to a series of laboratory dry and wet tests. This study allowed us to observe and determine the influence of each of the intrinsic properties of aggregates on the strength and stability of asphalt studied.
The quality of the materials and techniques used to achieve the Roman roads in Algeria

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Keywords: Roman routes, Materials, Heritage Valuation

ABSTRACT

The channels offer a very interesting archaeological material, because they give us opportunity to understand the history of history besides this, they are also factors that increase membership and territorial identity. Roman roads are one of the hallmarks of the Roman Empire, which extends to North Africa. The realization of these pathways aimed to facilitate trade between the Roman provinces, and also to allow quick movement of armies. Roman roads are characterized by a very straight up avoiding swampy areas and the immediate vicinity of watercourses. This research on paths and Roman roads that are in Algeria is the result of a study on the quality of the materials and techniques used at that period of our history to build these roads.
ESTIMATION OF ASPHALT PAVEMENT SURFACE CHARACTERISTICS USING IMAGE ANALYSIS TECHNIQUE

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Keywords: image analysis, friction, texture, surface, asphalt, polishing

ABSTRACT

Asphalt concrete pavements gradually lose their skid resistance causing safety problems especially under wet conditions and high driving speeds that represent the worst possible scenario for the driving activity. It has been proven that pavement skid resistance is controlled by many factors, among which aggregate and mixture properties are the most important. To mimic the actual process, friction and texture measuring devices are needed to quantify surface deterioration at different polishing intervals that reflect different stages of the pavement life. Therefore, there is a need to come up with another method that can assist in investigating the bituminous pavement surface characteristics in a practical and time-efficient test procedure. The purpose of this paper is to utilize a well-developed image analysis technique to characterize asphalt pavement surfaces without the need to use conventional friction and texture measuring devices in an attempt to shorten and simplify the polishing procedure in the lab. Promising findings showed the possibility of using image analysis in lieu of the labor-sensitive-variable-in-nature friction and texture measurements. It was found that the exposed aggregate surface area of asphalt specimens made from limestone and gravel aggregates produced solid evidence of the validity of this method in describing asphalt pavement surfaces. Image analysis results correlated well with the British Pendulum Numbers (BPN), Polish Values (PV) and Mean Texture Depth (MTD) values.
EVALUATING THE PERFORMANCE OF GEOSYNTHETIC-REINFORCED AGGREGATE OVER WEAK SUBGRADE

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Keywords: Geosynthetic reinforcement, Plate load test, Bearing Capacity

ABSTRACT

The objective of this study was to evaluate the performance of geosynthetic-reinforced unpaved road sections with aggregate bases over soft subgrade using laboratory plate load test. The model tests were conducted in a 1.5 m long, 0.91 m wide, and 0.91 m deep steel test box. The load was applied through a 190.5-mm diameter steel plate. The parameters evaluated in this study included the location and tensile modulus of geosynthetics, and the number of geosynthetic reinforcement layers. The stress distribution on top of the subgrade layer and the strain distribution along the geosynthetic reinforcements were also investigated in this study. Test results indicated that the geosynthetic reinforcement resulted in appreciable reduction of surface deformation and increase of bearing capacity for unpaved aggregate base over soft subgrade. The test results also showed obvious effects of the geogrid arrangement/location on the unpaved test section’s performance, with the double reinforcement location consistently yielding the largest improvement. The definite trend of increasing BCR and reloading elastic modulus with increasing tensile modulus of geosynthetics was observed when geosynthetics are grouped according to the aperture shape and polymer type. Finally, the results of model tests were compared with the modified Meyerhof and Hanna’s solution developed by the authors in a previous study; and the analytical solution gave a good prediction of the experimental results of the model tests on geosynthetic reinforced unpaved sections.
EVALUATING SET-UP PHENOMENON FOR FULL-SCALE INSTRUMENTED TEST PILES

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Keywords: Test pile; Static Load Test; Dynamic Load Test; Pile Set-up; Excess Pore Water Pressure.

ABSTRACT

Piles driven in cohesive soils usually experience a large increase in resistance over time, known as set-up or freeze. Dynamic load tests (DLT) and Static load tests (SLT) are usually performed to verify the axial resistances of piles at specific times after end of driving (EOD) and to quantify these resistances. An extensive field testing program was performed on full-scale instrumented precast prestressed concrete (PSC) piles driven in cohesive soils at the Bayou Lacassine Bridge, Louisiana, to evaluate the pile set-up phenomenon. The testing program includes instrumenting two full-scale test piles with a network of vibrating wire strain gages, pressure cells, and piezometers, and instrumenting the surrounding soils with multilevel piezometers. Five SLTs and three DLTs were conducted on each test pile at different times after EOD in order to quantify the magnitude of set-up. Measurements from the load tests on both piles confirmed that the pile set-up after EOD follows a logarithmic linear rate with time. An increase in piles’ total resistances (or set-up) of 1.60 to 1.77 times the EOD resistances were observed after the final restrikes. Piezometers data demonstrated close relationship between the dissipation of excess pore water pressures that were generated during pile driving, following EOD, and pile set-up. The load transfer curves derived from the strain gage measurements were used to separate the side and tip resistance profiles from the total resistance. Piezometers installed in the ground showed that the influence zone, caused by pile driving, extends beyond the 3B distance (B: Pile width).
CEMENTITIOUSLY STABILIZED VERY WEAK SUBGRADE SOIL FOR SUSTAINABLE PAVEMENT

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Keywords: Treated/stabilized soil, Weak subgrade, Resilient modulus, Permanent deformation

ABSTRACT

This research study was performed to evaluate the performance of cement treated/stabilized very weak subgrade soil specimens molded at high water content condition. Three soil types of different plasticity indices were considered in this research study. Three different wet of optimum moisture contents producing raw soil strength of 172 kPa (25 psi) or less were chosen for treatment/stabilization. The percentages of cement content were determined to achieve target 7-day strength values of 345 kPa (50 psi), treatment for working table application, and 1,034 kPa (150 psi), stabilization for subbase application. The repeated load triaxial (RLT) tests were performed on the laboratory molded treated/stabilized specimens in order to evaluate their resilient modulus and to study their deformation behavior under cyclic loading. The test results indicated that the proper selection of cement content for very weak and wet subgrade soil can substantially improve their performance in terms of resilient modulus and permanent deformation for working table and subbase applications. A good correlation was observed between the water/cement ratio and the resilient modulus/permanent deformation, with the soil specimens compacted at low water/cement ratios showed better performance than those compacted at high water/cement ratios. For heavily stabilized subgrade soils for subbase application, the permanent deformation of the stabilized layer can be neglected in the pavement design.
CONTRIBUTION TO THE EXPERIMENTAL IDENTIFICATION OF THE COLLAPSE POTENTIAL OF SOILS

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Keywords: collapse potential, initial moisture content, energy of compaction, fine particles

ABSTRACT

The soils of arid and semi-arid regions are metastable, of a weak opened structure, unsaturated nature, being in the deposits form. In the dry state, a natural cementation between grains confers them an important intergranular liaison and can support very high loads. However, the saturation, even without an additional load provokes the liaisons disintegration, giving a dense structure followed by a sudden collapse of the soil particles. Among the saturation causes, there is the groundwater level rising, the water infiltration and leaks in pipes. Because of the important collapse potential and critical consequences that can occur in the constructions, this type of soils is considered as unstable foundations seat. Experimental and theoretical studies aiming to understanding the great number of uncertainties implied in the phenomenon of collapse are currently undertaken. The literature revealed that the majority of research was devoted to the collapse mechanisms and the identification methods, of treatment and prediction. Because of the structural composition of these soils, reconstituted samples, made up of various proportions of sand and fine particles were tested. The first phase of the present investigation concerns the experimental determination of the geotechnical characteristics. A comprehensive testing program using the ultrasonic apparatus and the cone penetrometer was carried out, in order to identify the factors which control the collapse mechanism. The results obtained clearly show the influence of certain parameters such as; initial moisture content, the energy of compaction and the quantity of fine particles, on the collapse potential, limit penetration and the ultrasonic.
Behaviour of Soils after stabilization with Lime

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Keywords: clayey soils, lime, parameters, Behaviour

ABSTRACT

The treatment of clayey soils by the addition of lime is an old and a recognised technique that is applied in the construction of embankments and subgrades related mainly to road projects. The mixing procedure causes immediate reduction of water content in the soil and thus reduces the plasticity index, causes a flattening of the Proctor curve and an increase in CBR value. This experimental laboratory investigation aims to explore the effect of some parameters such as the particle size distribution, plasticity index, the moistening and flocculation of the lime upon the behaviour of the resulted mixed soils.
THE EFFECT OF WETTING AND DRYING ON RESILIENT MODULUS BEHAVIOUR AND PAVEMENT RESPONSES OF LIME-CEMENT STABILISED SUBGRADE SOILS

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Key words: lime-cement stabilisation, resilient modulus, wetting and drying, repeated load triaxial test, analytical Pavement design, Kenlayer program.

ABSTRACT

Stabilization of subgrade soils significantly improves their strength and mechanical properties. However, the moisture changes from environmental conditions cause deterioration to the stabilized subgrade soils by continuous cycles of wetting and drying. This paper demonstrates the changes to the resilient modulus of the stabilized subgrade soils after cycles of wetting and drying, as it is a key mechanical property and element in analytical pavement design procedures. A series of tests were conducted on three types of subgrade soils that were stabilized to varying degrees with combination of lime and cement. The tests carried out were soil classification, unconfined compressive strength and resilient modulus. The results show a decrease in resilient modulus values after cycles of wetting and drying. Furthermore pavement responses to the applied load have changed for changes of moisture for untreated and treated soils.
DYNAMIC RESPONSE OF FLOATING PILE MACHINE FOUNDATION

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Keywords: Dynamic, Finite elements, Machine foundation, liquefaction.

ABSTRACT

Machine foundations are unique, because they may be subjected to significant dynamic loads during operation in addition to normal design loads of gravity, wind, and earthquake. The magnitude and characteristics of the operating loads depend on the type, size, speed, and layout of the machine. The foundation has to guarantee smooth running during normal operation, and foundation integrity for possible accidental loading situations. Dynamic effects of the machines play a major role on sizing of the foundation where conditions, like resonance is avoided by varying the stiffness and the mass of the structure which leads to modifications in foundation sizes. For carrying out these studies, a detailed 3D finite element analysis approach is considered.

Herein, a finite element software (ANSYS.11) is adopted which provides an efficient tool for dynamic analysis and structural design of machine foundations. As a case study, piled machine foundation in sandy soil is analyzed. Machine foundations resting on end bearing and floating piles are introduced. Harmonic dynamic load is chosen. A parametric study is carried out to investigate the effect of several parameters including: geometry of the piled machine foundation, the amplitude of the dynamic load, frequency of the dynamic load and damping ratio. Linear elastic model is adopted for modeling the piles and their cap for machine foundation using eight node isoparametric (solid 65) element, while elastic model is adopted to model the soil behavior and eight node isoparametric elements are used to model the soil through (solid 45) element.

It is concluded that as the pile cap thickness increases, the oscillation of displacement decreases due to material damping inherent in the concrete of the cap. There is a limit of pile cap size at which its stiffness governs its dynamic response, above this size, the weight of the cap overrides its stiffness effect, and the additional weight by cap leads to increase the pile foundation displacement. When the pile diameter of the group increases, the frequency, at which the maximum displacement occurs increases hence the system becomes more stable against resonance condition. In the case of changing spacing between piles, the maximum moment factor (IM) is always at the pile cap center where the load is applied. This factor increases when the pile spacing increases. The dimensionless displacement factor (IZ) decreases markedly as the pile cap length increases, reflecting the increase in displacement with pile cap length. The increase of the normalized moment (IM) with pile cap length can be attributed to the increase of the unsupported length within the cap which leads to increase in the moment. The increase in size of pile cap for machine foundation increases the geometrical damping of the structure, and the increase in spacing between piles causes an increase in geometrical damping.
RESONANCE FREQUENCY OF MACHINE FOUNDATIONS RESTING ON SATURATED SANDS

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ABSTRACT

Liquefaction is the rapid loss of shear strength in cohesionless soils subjected to dynamic loading, that it is a state of saturated cohesionless soil when its entire shear strength is reduced to zero due to pore water pressure caused by vibration. Liquefaction depends on the nature, magnitude and type of dynamic loading. An entire stratum may be liquefied at the same time under shock loading, or liquefaction may start at the top and proceed downward with steady-state vibrations.

The present research is concerned with predicting liquefaction potential and the pore water pressure under the dynamic loading in the dynamic analysis of foundations based on the fully saturated sandy soil using the finite element method by QUAKE/W computer program.

As a case study, machine foundations on fully saturated sandy soil in different cases of soil densification (loose, medium and dense sand) are analyzed. Two types of dynamic loads are chosen, these are harmonic and pulse loading. A parametric study is carried out to investigate the effect of several parameters including: the amplitude of the dynamic load, the frequency of the dynamic load and damping ratio. The equivalent linear elastic model is adopted to model the soil behaviour. Emphasis was made on zones at which liquefaction takes place, the pore water pressure and vertical displacements.

The results showed that liquefaction and deformation develop fast with the increase of loading amplitude and frequency. Liquefaction zones increases with the increase of load frequency and amplitude. Tracing the propagation of liquefaction zones, one can notice that, liquefaction occurs first near the loading end and then develops faraway. The soil overburden pressure affects the soil liquefaction resistance at large depths. When the foundation is constructed over loose saturated sand, liquefaction may take place at a frequency ratio equals 1.0. This finding highlights the importance of studying the liquefaction potential when analyzing machine foundations on such soils. When the soil beneath the machine foundation is medium or dense, the frequency ratio at which liquefaction may occur is greater than 1.0. It can be noticed that the time of initial liquefaction decrease as the frequency of dynamic load increases.
THREE DIMENSIONAL MODELING OF DAM-RESERVOIR-FOUNDATION SYSTEM

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Keywords: Interaction foundation-fluid-dam, Ansys, concrete dam

ABSTRACT

Most civil engineering structures are elements of much larger systems, called the overall system, containing several other system components. When subjected to transient loads, these structures interact with the other components of the overall system such that a continuous transfer of energy is established between them. The effects of interaction on the dynamic behavior of these structures are determined by the mechanical properties of all the components of the overall system, the interaction mechanism and the type of dynamic loading. Dams belong exactly to this category of structures. It is obvious that the foundation soil and water reservoir affect the dynamic response of gravity dams during earthquakes. A three dimensional parametric study was performed in this article to view the combined effect of soil foundation, water reservoir presence and fluid-dam and fluid-soil interfaces modeling on the modal behaviour of “Brezina” concrete dam situated at Algeria.

Two assumptions were adopted to model the dam-fluid and soil-fluid interfaces using Ansys finite element code: the contact elements and the coupling equation. Also three approaches are adopted to investigate the soil-structure interaction phenomenon: the fixed support foundation, the massless soil foundation and the mass soil foundation. Conclusions were made via the dam-reservoir-foundation interaction phenomenon applied for the dam object of this study. It was shown that modeling the interfaces by contact elements or by coupling equations gives the same results and that water reservoir presence and the soil foundation modeling produce a decrease of the modal system frequencies.
Pressure Distribution on the Upstream Face of Tunnel Gate with Different Lip Shapes

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Keywords: Lift gate, down pull force, lip shapes

ABSTRACT

The lift gate which installed at specified position of the dam tunnel facing a great pressure according to the high water storage level in the reservoir of dam, and this is the reason behind the need for choosing the suitable gate specifications withstand of such pressures. The one of important factors that affected the stability and bearing of gate is the pressure resulting from pressurized flow established along the tunnel which exerted on the upstream face of gate. The present research included the analyses of experimental measurements of pressure heads distribution indicated by fifteen peizometric holes located on upstream face of tunnel gate model as five holes on each of three vertical lines. The pressure heads have been obtained for many values of gate opening ratios and different shape of gate lips. These measurements were analyzed in details by using the surfer software program in addition of applying the equations based upon the principles of momentum. The relation among the of down pull forces and pressures on the gate upstream face were also studied.

The analysis include some graphs which have been provided to present the relationship among pressure heads and gate opening, coefficients of down pull forces against pressures on the gate upstream face. The results revealed that pressure head are mostly concentrated at the upper portion of gate for all values of gate openings which indicate the need of make this part to be supported by steel beams or any other shapes and materials more than other parts of gate in order to satisfy the economical and safety requirements of gate design.
Investigating Dahr El Baidar slope using geological, geotechnical and geophysical tools


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ABSTRACT

A Research Unit on Mass Movement Hazard Assessment and Risk Evaluation (RUMMARE) is grouping major university researchers and Research Centers across Lebanon aiming at developing the Hazard Zonation Mapping of Lebanon. This unit started investigating one slope failure located at Dahr El Baydar Mount Lebanon, due to its relevance in hosting a major infrastructural project: The Arab Highway. This paper includes geological, geophysical and geotechnical soil characterization of the study area, to identify the causes of failure. The geological analysis reveals the presence of faults in the vicinity in addition to a layer of weak clay. The geotechnical investigation is based on the interpretation of 9 boreholes for which quality assessment is carried out using in-situ sampling and lab tests. Geophysical tests are performed using ambient noise vibration technique with the Horizontal to Vertical Spectrum Ratio HVSR method to show the resonant frequency and the thickness of the subgrade material. The above data are used towards modeling the slope in order to better understand the risk factors of failure affecting the area. This work is an initial step for the assessment and prediction of the behavior of various critical slopes in Lebanon.