

1<sup>st</sup> International Conference on  
Sustainable Construction and project Management



29-31 March, 2016 Cairo, Egypt

**Preface:**

ICSCPM 2016, The First International Conference on Sustainable Construction Management in Cairo, Egypt aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results about all aspects of Sustainable Construction and Project Management. The conference also provides an interdisciplinary forum for researchers, practitioners and educators to present and discuss the most recent trends, innovations, concerns and best practices in managing construction portfolios, programs projects, challenges encountered and the solutions adopted in the field of sustainable Construction and Project Management.

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**Conference Themes:**

- 1- Portfolio, Program and Project Management
- 2- Sustainable Design & Construction Techniques
- 3- Claim, Dispute Resolution and Arbitration
- 4- Information Technology in Construction
- 5- Building Information Modeling ( BIM )
- 6- Facility Management
- 7- Building Design, Construction & Operation
- 8- Value Engineering
- 9- Supply Chain Management
- 10- Solid Waste Management
- 11- Green Road Management
- 12- Construction Engineering Education
- 13- Other Related Topics

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## **KEYNOTE SPEAKERS**

## **WIRELESS AND SMART SENSING TECHNOLOGIES FOR AUTOMATED TRACKING AND PROGRESS REPORTING OF CONSTRUCTION OPERATIONS**

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### **ABSTRACT**

Automated site data acquisition is critical for timely tracking and progress reporting, which in turn supports members of the project team in making needed management decisions. This lecture describes the essential requirements for integrated time and cost control and for reliable applications of the earned value method, also known as earned value management (EVM). The lecture will address two main issues; the establishment of realistic project baseline and the use of automated site data acquisition technologies for timely quantification of budgeted cost of work performed (BCWP). Technologies such as 3D imaging, 3D laser scanning, Global Positioning System (GPS), Radio Frequency Identification (RFID), Ultra-Wide Band (UWB) and wireless sensors networks (WSNs) are utilized, individually and in an integrated manner, to determine BCWP. As well, the lecture will describe briefly a newly developed material status index and recently developed self-adaptive methods for more accurate trending and forecasting of project cost and duration at completion or at any intermediate time horizon. Briefly described also is the use of building information modeling (BIM) for visualization of onsite progress.

## **SUSTAINABLE DEVELOPMENT AND ASSET MANAGEMENT**

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### **ABSTRACT**

Buildings and civil infrastructures are always in need for attention and infusion of funding to meet the required structural, functional, health, and environmental standards. Deteriorated buildings, poor road conditions and traffic congestions, corroded bridges, overflowing and aging sewers, and deficient drinking water systems are among some of the issues that can impact the economy, health, safety and quality of life in many communities and cities. This lecture will address some of the challenges associated with the decision-making processes in relation to sustainable development and asset management during design, construction and operation. This includes issues such as sustainable design, green construction, risk management and life cycle and user costs. Additionally, a discussion of sustainability rating systems such as LEED and Envision will be presented.

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## **GENERAL LECTURES**

## الكود المصرى لإدارة مشروعات التشييد

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### المخلص:

يتناول الكود المصرى لإدارة مشروعات التشييد تحديد وتوضيح المتطلبات الأساسية لإدارة المشروعات في مراحلها المختلفة من خلال سبعة مراحل: ١) مرحلة الدراسات والإستراتيجية العامة ، ٢) مرحلة التصميم ، ٣) مرحلة العطاءات والتعاقد ، ٤) مرحلة التشييد، ٥) مرحلة الاختبارات والتسليم الابتدائي وفترة الضمان ، ٦) مرحلة التسليم النهائي والضمان العشري ، ٧) التشغيل والصيانة. يستعرض الكود في محتواه النقاط الأساسية لكل مرحلة و تشمل: الأهداف الرئيسية للمرحلة ، الأطراف المشاركة بالمرحلة كل على حده ، عناصر ونطاق عمل المهام الرئيسية لكل مرحلة ، توضيح لبعض العناصر الرئيسية المرتبطة بالمرحلة. سيتم استعراض مكونات احد المراحل بشكل تفصيلي في هذه المحاضرة. سيتم أيضا استعراض الأعمال الجاري إعدادها بعد إصدار الكود بالقرار الوزارى رقم (٣٦٤) لسنة ٢٠٠٩ والخطط المستقبلية للتطوير وتحفيز أطراف الصناعة ( صناعة التشييد ) على استخدامه.

## **CONSTRUCTION & DEMOLITION WASTE MANAGEMENT & RECYCLING PROJECT CASE STUDY: NEW CAIRO CITY**

**Prof. Omima Salah Eldin**

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### **ABSTRACT**

The New Urban Communities Authority is keen on recycling construction & Demolition Waste (C&D). Consequently, a protocol was signed in December 2014, between The New Urban Communities Authority and The Housing & Building National Research Center (HBRC) to manage and recycle such waste, specifically, in New Cairo City. The work of HBRC was divided into two stages. Stage one contains the following processes :1) Proposing various management methods concerning the handling, and utilization of construction, renovation & Demolition Waste, 2) Specifying the qualifications and experiences of investors who will be in-charge of (C&D) waste, 3) Specifying the financial elements pertaining to recycling (C&D) waste commencing from collecting of waste till manufacturing products (such as kerbs, paving units, bricks, and hollow blocks) from the collected waste , and 4) Preparing the relevant technical specifications and conditions regarding the recycling process, in order to invite both local and international qualified investors to apply in the pre-qualification stage. The duration of the project is 10 to 15 years, as it will take into account, both the accumulated rubble and the expected waste which will be generated. Qualified investors were invited through an advertisement in both local and international newspapers, as well as, through the website of The New Urban Communities Authority. While, Stage two comprised mainly evaluating the obtained tenders according to the pre-qualification criteria. Six companies applied for the pre-qualification criteria. Four of the companies satisfied the stated criteria and were eligible to apply for the qualification stage. This is due to the fact that their presented documents proved that they have the capability of managing and utilizing such waste.

## **FUTURE OF DEVELOPING CITIES CHALLENGING AND OPPORTUNITIES**

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### **ABSTRACT**

Nowadays, the world is facing the biggest real estate opportunity in history .The main challenges is how to accommodate the enormous population growth in cities beside the three major needs (Power, Water & Food) .The solution is always “Technology” but the technology invoice could be more costly than the 3 main needs when we import it – besides it deep risk .The only solution is to create our own technology and solutions. Now cities are moving towards smart management for this big scale of complications. The international federation of Real Estate FIABCI is setting with the United Nation and the World Bank the definition and main indicators to measure the development of cities. The sustainability definition is now extended to measure more factors (Ecology, Economy, Political, culture) .At the end Egypt is plugged in the international platform as a member of FIABCI 2016. The Lecture is highlighting the urbanization scale

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## **SCIENTIFIC PAPERS**



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## **Portfolio, Program and Project Management**

## **IMPROVING THE MANAGEMENT OF PROJECTS AND PROGRAMS USING AGILE PRINCIPLES**

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### **ABSTRACT**

Historically, the traditional principles of project management were first applied in the defense and construction industries, and then propagated into the rest of industries that typically ran projects. In the 1990s, the application of these principles in the technology-driven industries, e.g. software and research and development (R&D), had encountered difficulties. This led to calls for adopting other means and more innovative paradigms for managing projects and programs in the latter industries. The paper reviews the agile principles that provided the basis for such new paradigm, which is characterized by continual change and uncertainty. The agile approach adopts incremental planning throughout the project/program execution stage. As such, the project/program plan evolves as project progresses further into execution. Afterwards, the paper introduces a popular application of the agile principle via the Scrum methodology. While agile and Scrum gained acceptance in a number of industries, the construction industry has been hesitant due to contractual constraints, amongst other reasons. Nonetheless, some of the more notable projects in the construction industry had practices that align with the known agile principles. The paper reviews Heathrow Airport Terminal 5 as an example of a project where some of the agile principles were employed. A discussion follows with the limitations of applying agile principles in construction projects and/or programs and instances where they can contribute to more efficient job delivery.

**Keywords:** Contemporary Project Management, Agile Project Management, Uncertainty, Change Management.

## CRITICAL CHIAN PROJECT MANAGEMENT- A CRITIQUE

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### ABSTRACT

Theory of Constraints in Goldratt's international best seller "The Goal" identified the Critical Chain as "The sequence of dependent events that prevents the project from completing in a shorter interval. Resource dependencies determine the critical chain as much as do task dependencies." Such a criterion derived the salient notion of the Critical Chain Project Management (CCM). This approach was advocated to compete with the Critical Path Method (CPM). In this paper, an in-depth review is performed to outline the main Pros and Cons of CCM and a comparative scheme is made among the refinements proposed by various investigators with a focus on buffer sizing. A light is then shed on such practice in Location-Based Scheduling (LBS) on the local region with emphasis to national projects. The New Suez Canal project is selected as a case study for applying CCM. Based on stochastic approach, the current study finally presumes the Best Unbiased Logical Estimate (BLUE) for buffer distribution in Location-Based Scheduling that provides a reliable guideline for sizing process with acceptable confidence level.

**Keywords:** Project management, Critical Chain; Critical Path Method, Time Buffers; Theory of Constraints; Location-Based Scheduling.

## **RISK ASSESSMENT AND MITIGATION FOR CONSTRUCTION PROJECTS IN EGYPT**

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### **ABSTRACT**

Due to the massive risk factors and the wide spread changes in the Egyptian construction sector over the last decade, risk in construction has been the object of great attention. The main objective of this paper is to identify and assess the significant risks in Egypt construction industry based on their risk rating (impact and probability). The paper also compares effective risk management techniques to cope with risks associated with construction activities and to implement the projects in accordance with project objectives. Using a carefully-selected set of 77 attributes, this research first identified the key factors impacting delay in Egyptian construction industry and then established the relationship between the critical attributes for developing prediction models for assessing the impacts of these factors. A questionnaire was spread then extensive personal interviews were conducted to form the basis of this research. Factor analysis technique is used to examine the significance of the risk factors. From the factor analysis, most critical factors of construction risk were identified as (1) lack of experience; (2) lack of owners' commitment; (3) lack of clarity in project scope; (4) Egyptian economic crises; (5) lack of contractor's commitment; and (6) Inefficient site management. These findings are expected to be significant contributions to the Egyptian construction industry in controlling the expected risks. The paper also suggests the risk response strategies appropriate for each type of identified risk.

**Keywords:** Risk Management, Construction Projects, Factor Analysis, Egypt

## MANAGEMENT AND ASSESSMENT MODEL FOR SUSTAINABLE CONSTRUCTION PROJECT DURING FEASIBILITY STAGE

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### ABSTRACT

Going towards sustainable construction (SC); the feasibility stage (FS) will be the initial gate where the project developers are going to identify the purposes of their project. At sustainable FS, the project developers are looking for achieving the clients' needs in sustainable method, to be accredited as sustainable project. Also, they are looking forward to enhancing their market reputation and attracting new clients who encourage this new trend. This paper proposed a model for managing the feasibility stage of sustainable construction project (MFSCP); based on comprehensive theoretical and field study. This model identifies the management processes of the sustainable feasibility stage of construction project, which justifying the potential increased of upfront costs because of sustainable practices; later it will help in controlling these costs when the project starts. There are two main goals of this model as following: 1) identifying the main enablers and drivers for managing sustainable FS to cover the sustainability gaps in traditional processes. And 2) Embedding the SC principles at the heart of decision making processes during the feasibility stage (FS); in order to cope with the Egyptian Green Pyramid Rating Systems (GPRS) criteria to pave the way for achieving the SC in Egypt as processes and final product. This model is designed to be used by project consultant / owner as a management and assessment tool.

**Keywords:** Sustainable Construction, Feasibility Stage, Project Management, Green Rating Systems, Models of Sustainable Construction Management.

## CONTRACT PRACTICES FOR SUSTAINABLE CONSTRUCTION PROJECTS

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### ABSTRACT

Over the last two decades, sustainability has risen up the social and political agenda. The demand of constructing green buildings is increasing. A lot of economic, environmental and social direct and indirect benefits are achieved by pursuing constructing sustainable projects. Developing sustainable project results in energy saving, waste reduction, noise control and air pollution control. Construction processes and practice are not sustainable by nature, due to the characteristics of construction industry. It is vital to investigate critical success factors to achieve sustainable construction projects. Construction contracts set the scope and liabilities of involved parties. Therefore, including green clauses in the contract is crucial to achieve sustainable project. This paper argues that identifying green clauses in the construction project contracts is necessary to achieve successful sustainable project. This research demonstrates the requirements of green contracts which is required to achieve sustainable construction projects. These aspects of Green contracts essential requirements are: 1) shareholders engagement to strength the concept of sharing common goal, 2) choosing the appropriate form of contract, 3) identifying sustainability targets, and 4) carefully considering sustainability concerns in the contract conditions (i.e., specifications, preliminaries and schedule).

**Keywords:** Construction Contracts, Sustainability, Green Contracts, NEC3

## COMPETITION ABILITY CRITERIA FOR EGYPTIAN CONSTRUCTION COMPANIES IN INFRASTRUCTURE PROJECTS

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### ABSTRACT

The Egyptian construction companies that work on infrastructure projects are facing increasing challenges due to the increasing competition from foreign contractors. These challenges urge the need for evaluation of the competition ability of Egyptian construction companies. Reviewing the literature we found that there are thirteen criteria that must be taken into consideration when evaluating the competition ability (i) Financial ;(ii) Health and Safety ;(iii) Technical; ;(iv) Quality;(v) Organization ;(vi) Relationship ;(vii) Past Experience ;(viii) Past Performance ;(ix) Resources ;(x) Environmental ;(xi) Management ; (xii) Present workload ;(xiii) Tendering price. The thirteen criteria have twenty seven sub-criteria that are collected from previous studies that influence the competition ability. This paper identifies the most important sub criteria such as the Size of past project completed, Type of past project completed ,Adequacy of labor resources ,QA/QC programs, Adequacy of plant &equipment's, Present workload, Construction program, Construction method and Environmental plan which affect the competition ability. The data applied in this study are collected through a survey distributed to 23 experts in construction industry to determine the score of each sub criteria, statistical analysis is carried out on respondents of the survey. By using SPSS software the mean score of each sub criteria and standard deviation were determined. Then a Framework for contractor selection was developed to evaluate and rank the bidders in infrastructure tenders based on sub criteria weights.

**Keywords:** Competition, Construction, Infrastructure, Egypt, Criteria, Companies.

## EFFICIENCY IMPROVEMENT OF CONSTRUCTION PROJECTS USING LEAN SIX SIGMA METHODOLOGY

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### ABSTRACT

Lean manufacturing is a well-known concept, which may be applied at any process for increasing the efficiency by eliminating non-added value (waste) activities.

On the other hand, Six Sigma is a process improvement methodology that aims to reduce defects to a rate of 3.4 defects per million defect opportunities. This study aims to apply Lean Six Sigma through the famous DMAIC approach to improve the efficiency of construction activities. Six ideas were proposed to improve the efficiency before the selection of "Reduce waste in reinforcement steel" to be the main objective of this study. Ten factors were considered as potential influencing factors affecting the high percentage of waste in reinforcement steel. Out of the ten proposed factors, "Engineers Experience" has the significant impact on "Percentage of Waste in Reinforcement Steel" at construction projects. After handling all reinforcement steel in the centralized steel workshop instead of processing at site, the following results were achieved:

- Waste percentage in reinforcement steel decreased from 16.73% to 5.64%.
- Process sigma level increased from 2.48 to 3.09.
- Average productivity rate increased from 54.6 to 78.7 (ton / hour)
- Average quality control comments reduced from 8.24 to 0.92 (comment / day).
- Process capability index decreased from 0.34 to 0.27, however long term process capability increased from -0.91 to 0.08.

**Keywords:** Construction Management, Waste Reduction, Lean, Six Sigma, Efficiency Improvement, DMAIC



## TOWARDS APPRISAL AND IMPROVEMENT OF MANAGEMENT PRACTICES FOR EGYPTIAN CONTRACTING ORGANIZATIONS

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### ABSTRACT

Project Management has evolved and emerged by several organizations not only to gain competitive advantage; but also as a crucial factor that determines the success of the organization. In this regard, there is a global growing interest and attention for organizations to evaluate and improve the level of their project management practices. The past decade has shown a dramatic increase in the attention, research and practice of the project management maturity and the maturity models. These models are used to evaluate the current project management capabilities of an organization and to ensure its efficiency and uniformity in delivering projects successfully. Moreover, these models are used to further enhance the performance of organizations. Although the maturity models has evolved during the last decade as one of the tools for achieving project management excellence on the organization level; however, the excessive variety of maturity models has made the choice between those models difficult and need careful attention and consideration in both the model choice and its practical implementation in the business. For developed countries (such as USA, Canada, UK, Europe, etc...) several maturity models have been proposed and commonly implemented successfully. In Egypt, there is a lack of documentation available on the current status and use of maturity models in the contracting organizations working in the construction industry. This paper constitutes a part of a larger research project aims to fill this gap. To achieve this, an extensive literature review has been conducted on the predominant existing maturity models, a market survey to assess the current status of maturity awareness in the construction contracting organizations has been developed and the basis of integrated framework for appraisal and improvement of project management practices for the contracting organizations working in the Egyptian construction industry have been proposed.

**Keywords:** Construction Industry, Egypt, Project Management.

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## **Sustainable Design and Construction Techniques**

## TOWARDS SUSTAINABLE BUILDINGS IN EGYPT

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### ABSTRACT

The energy consumption in construction sector consumes a large part of the total energy produced in Egypt. The energy is consumed into the material's manufacturing process, transportation of materials & construction of buildings and operation of buildings. The rise in energy prices and its impact on the environment increase the need to study how to save the consumed energy in the construction sector. To achieve such a purpose, new building techniques are used in order to save energy in material's manufacturing process by decreasing the weight of the construction materials and reducing energy for heating and air conditioning by using materials with high thermal insulation. Moreover, the energy can be saved through using local building materials to reduce the consumed energy of manufacturing and transporting. In this paper, the light is shed on the important types of sustainable building systems that are available recently in Egypt. In addition, it provides an evaluation of these systems in terms of their advantages and disadvantages in order to attain the suitable structural systems in Egypt.

**Keywords:** Sustainable, Green Reinforced, Concrete, Buildings, Bricks

## **APPLIED GREEN TECHNOLOGY FOR SUSTAINABLE DESERT BUILDINGS (CASE STUDY MASDAR CITY)**

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### **ABSTRACT**

Green technology or clean technology is the application of one or more of environmental sciences to conserve the natural environment and resources. It has been applied over the last years through many subject areas for instance: energy, green building, green nanotechnology, and green chemistry. This kind of technology has a great influence and constantly being developed to complement current practices in creating greener structures and to create distinction design for the buildings in the desert cities suitable to its sensitive condition. The application of "green technology" encompasses the choice of building, the location as well as a continuously evolving group of methods and materials, techniques for generating energy to non-toxic products. Green technology designed to reduce the overall impact of the built environment on human health and the natural environment by depending on utilization desert natural resources such as energy, wind, and water treatment. All this will provide good atmosphere protecting occupant health and improve employee productivity, also reducing waste, pollution, and environmental degradation. The present expectation is that this field will bring innovation and changes in daily life. This paper will illustrate the impact of using green technology through the desert building such as Masdar city.

**Keywords:** Green Building, Green Technology, Desert Buildings and Masdar City.

## **PASSIVE AND HYBRID TECHNIQUES FOR LOW COST ENERGY EFFICIENT HOUSING IN HOT DRY CLIMATE**

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### **ABSTRACT**

The main consumer of electricity in Egypt is the residential sector which accounts for 42% of the total consumption, followed by the industrial sector (28%). The consumption of the residential sector has been steadily increasing in the recent years. According to the Ministry of Electricity and Energy, this is due to two factors: the expansion of residential compounds and new communities as well as the use of domestic appliances, air conditioners in particular, during hot weather. Egypt is in a real need to change the "business-as-usual" approach in housing projects to overcome the major challenge of the hot dry climate while respecting the economic factors taking into consideration that increasing population and housing projects will affect negatively the energy demand in the coming few years. This paper will explore the main passive and hybrid design techniques for low cost energy efficient housing in hot arid climate. It will review six international case studies worldwide showing their energy efficiency practice and their methods to overcome climate and cost challenges using passive and hybrid techniques along with using local materials and renewable energy. The paper will recommend some of these techniques to be implemented in Egypt.

**Keywords:** Low cost Housing, Sustainable Design, Passive Design and Hybrid Techniques.

## **PERFORMANCE CRITERIA EVALUATION FOR SUSTAINABILITY PLANS OF HERITAGE PRESERVATION PROJECTS**

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### **Abstract**

Architectural heritage is all that man built: towns, neighborhoods and buildings with the Provisions of the spaces and facilities have architectural or historic or scientific or cultural or national value. As the architecture heritage is a the product of civilization and the pot of the nations cultures and the experience which accumulated through the ages and distinguished its identity, Therefore it is necessary to enhance heritage reservation programs which can grantee sustainability plans adding more decades to the long age of the heritage. This paper aims to evaluate the performance criteria of the sustainability plans for the architecture heritage reservation by studying different Egyptian and Arabic reservation projects and comparing sustainable plans designed at the beginning of the reservation project and the current situation to extrapolate the positives and the negatives at the sustainable plans which can be useful to plan for another reservation projects.

**Keywords:** Reservation Programs, Sustainability Plans, Performance Criteria, and Efficiency

## SYSTEMS ENGINEERING APPROACH TO MEASURING THE ENVIRONMENTAL IMPACTS OF OPEN TRENCHING CONSTRUCTION OPERATIONS

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### ABSTRACT

Open trenching is still common in various construction projects that involve underground utility lines. Due to the disturbance of the soil and the use of heavy machinery, environmental impacts can be of a concern. The paper introduces a holistic systems engineering approach to measuring the environmental impacts of open trenching operations. Exemplification is carried out for pipe laying activities. The systems engineering approach employs the Systems Modeling Language (SysML) for the abstraction of the open trenching construction operation and its various environmental impacts. SysML is utilized in this context to depict the environment, the construction product, and the construction technique as three interacting systems that exchange key system flows of materials and energy. The building blocks of the systems are presented using block definition diagrams (BDDs) whereas the flow of materials and energy is presented via internal block diagrams. The system is illustrated using an example pipe laying job that was part of the New Cairo Water Pipeline Project. Example shows how the various environmental impacts can be measured.

**Keywords:** Systems Engineering, Sustainability, Environmental Impact Assessment, Pipeline Construction, Open Trenching, SysML

## THE EFFECT OF SUSTAINABLE PRACTICES ON THE ECONOMIC PERFORMANCE OF CONSTRUCTION FIRMS

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### ABSTRACT

Construction activities generate large amounts of waste and use lots of energy, both of which have caused significant impacts on the environment and created growing pressure to implement sustainable practices in this sector. The present study aims to determine empirically the effect of sustainable practices at firm level (firm integrative practices, supplier management, and subcontractor management) and project level (project integrative practices, waste reduction, and waste management) on economic performance of construction firms from members of construction firms' point of view. Data were gathered through a survey involving 210 firms in the Malaysian construction industry. The partial least squares (PLS) technique was used to analyse the data. The results show that, although sustainable practices at both firm and project level have a positive effect on the economic performance of construction firms, the effects of project sustainable practices are higher. This study extends our knowledge of the outcome of sustainable practices. This information may motivate managers of construction firms to implement sustainable practices.

**Keywords:** Sustainable Practices; Construction Industry; Economic Performance; Malaysia



## **EFFICIENCY PROJECTS IN EGYPT: A COMPARATIVE ANALYSIS BETWEEN LEED AND GPRS**

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### **ABSTRACT**

The construction industry is a complex and rapidly evolving environment. However, with this complexity, there is a much needed emphasis for contractors to have a cutting edge and pioneering efforts in new business sectors. The U.S. Bureau of Economic Analysis estimates that 3.4% and 3.73% of the U.S. gross domestic product (GDP) was generated by the construction industry in 2011 and 2013 respectively. Despite this contribution, the world as a whole, and the construction industry in specific, face multitude of challenges to cope with energy and resource scarcity. In an effort to alleviate the effects of such dilemma, governmental funds in energy efficiency projects has been estimated, by the US Department of Energy, to have reached \$34.3 billion in 2014. Specific to the construction industry, building high performance projects has become of great importance in an effort to mitigate such problem. Consequently, over the years multitude of green construction rating systems have evolved. These include the International Green Construction Code, LEED for Homes, and the Green Pyramid Rating System (GPRS) among others. To that end, the purpose of this paper is to provide a comparative assessment between LEED and GPRS in regards to their focus, comprehensiveness, development, and applicability to the Egyptian market. The outcomes of this research will provide decision and policy makers with better understanding of the outcomes of their decisions.

**Keywords:** Efficiency Projects, Green Construction, LEED, GPRS, Construction Rating Systems.

## **TOWARD SUSTAINABLE BRIDGES: GEOTECHNICAL ASPECTS REGARDING DESIGN OF JOINTLESS BRIDGES**

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### **ABSTRACT**

In Egypt, designing bridges with expansion joints is a common practice. In most cases, the performance of these expansion joints is unsatisfactory, and therefore substantial maintenance works are frequently required. This makes jointless bridges an attractive option since they represent a more sustainable construction technique. Although construction of these bridges might be slightly costly, their life cycle costs are dramatically reduced by eliminating the maintenance costs. This paper introduces a finite-element (FE) investigation into the behavior of bridge integral abutments under alternate cycles of expansion and contraction of the bridge due to seasonal temperature variations. An example multiple-span reinforced concrete solid-slab bridge is proposed and analyzed using an elasto-plastic two-dimensional FE model. The bridge abutment is supported on steel H-piles. The proposed FE model has the capability of simulating both the construction of the bridge, and backfilling process using a multi-stage numerical technique. The mobilized earth pressures and the changes in these pressures due to the thermal effects are predicted for different bridge lengths. The results of analyses have shown that the design earth pressures are notably affected by the bridge length, the number of temperature increase cycles, and stiffness of the backfill material relative to that of the abutment.

**Keywords:** Integral Bridge, Soil-Structure interaction, Elasto-plastic analysis, Temperature

## **REDUCE ENERGY DEMAND FOR COOLING A NEW OFFICE BUILDING THROUGH THE DESIGN RENOVATION**

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### **ABSTRACT**

The growth in energy consumption and the rise in fuel price are critical issues in Egypt. Buildings are one of the most energy consumers and significant contributors to greenhouse gas emissions. In Egypt, more than 60% of the total electricity consumption is attributed to residential, commercial, and institutional buildings. Artificial lighting is estimated to account for 36% of the electricity used in the nonresidential sector and 35% of the electricity used for HVAC system. A significant increase in electricity demand is expected over the next few years with a growth rate of 8%. This paper aims to explore sustainable measures to improving energy efficiency for buildings. The objective is to reduce energy demand for cooling a new office building through efficient thermal protection measures, taken into consideration the technical, economic and environmental aspects. Data was gathered through studying the drawings of the new building, previous studies and the applications which were concerned with the energy efficiency. In this research studies the effect of using double glazing windows instead of single glazing windows, external double walls instead of single walls, external shading for windows and improvement of roof insulation. The proposed measures reduce the annual electricity requirements and the CO<sub>2</sub> emissions by more than 53%. The optimization costs payback period is 5 years.

**Keywords:** Optimization Measures, U-Value Calculation, Heat Load, Thermal Insulation, Solar Gains, and Energy Saving.

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## **Information Technology In Construction**

## RISK AND UNCERTAINTY ASSESSMENT MODEL IN CONSTRUCTION PROJECTS USING FUZZY LOGIC

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### ABSTRACT

In the global construction market, most construction companies are willing to undertake international projects in order to maximize their profitability by taking advantage of attractive emerging markets and minimize dependence on local market. Due to the nature of construction works, there are lots of risks and uncertainties associated with the company and project conditions. Therefore, how the profitability of the project changes with occurrence of various risk events, in other words, the sensitivity of project costs to risk events, should be estimated realistically. This paper offers a comprehensive risk assessment methodology that provides a decision support tool, which can be utilized through the bidding decisions for international construction projects introducing a risk model that facilitates this assessment procedure, prioritize these projects and evaluates risk contingency value. The risk models is developed using the analytic hierarchy process (AHP) to evaluate risk factors weights (likelihood) and FUZZY LOGIC approach to evaluate risk factors impact (Risk consequences) using software aids such as EXCEL and MATLAB software. The reliability of the developed software has been tested by applications on a real construction projects. The proposed methodology and decision support tool have been proved to be reliable for the estimation of cost overrun due to risk while giving bidding decisions in international markets. Therefore, the developed model can be used to sort projects based upon risk, which facilitates company's decision of which project can be pursued. The developed risk model is validated, which prove its robustness in risk assessment (97%) in company level and (105%) in project level. It can also be used to sort construction projects based upon risk. The developed contingency risk model demonstrates the ability to evaluate risk contingency value by aggregating rules combining company risk index and project risk index using fuzzy logic approach and MATLAB software.

**Keywords:** Risk Management, International construction, Risk Factors, Analytic Hierarchy Process (AHP), FUZZY LOGIC Approach, MATLAB software and Validation process

## A FUZZY RATING METHOD FOR THE BID/NO-BID DECISION IN ROAD CONSTRUCTION PROJECTS

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### ABSTRACT

Contractors realize the importance of making the right decisions during the tendering stage. Failing to be clear about project suitability at this stage could lead to significant monetary losses in the future or losing good opportunities when contractor retreats from bidding on one of the better projects. The literature has investigated the bidding decision-making process; however a gap is frequently pointed out in regards to having an easy-to-use rating scheme that can measure project suitability/attractiveness and help with the final bid/no-bid decision. The paper attempts to provide such facility for the road construction sector in Egypt. Based on an in-depth study of this sector and a survey of the most critical factors that are typically accounted for in the bid/no-bid decision, a modified version of a fuzzy linguistic rating model that was previously presented in the literature is utilized. The fuzzy approach was adopted due to the uncertainty that characterizes the bid/no-bid decision problem. Through these critical factors, the model determines the level of attractiveness of the bid opportunity and helps with recommending the bid/no bid decision. A large road construction company – classified as First Class in the category Roads, Bridges, Railways, Airports and Tunnels by the Egyptian Federation for Construction and Building Contractors (EFCBC) – was chosen for demonstrating system usage as well as validation. The results show the potential of this model in determining the level of attractiveness of bid opportunities of road projects and recommending the bid/ no bid decisions as well.

**Keywords:** Road construction, Bidding, Decision-making, Fuzzy models.

## DEVELOPMENT OF FUND ALLOCATION OPTIMIZATION MODEL FOR PAVEMENT MAINTENANCE MANAGEMENT FOR EGYPTIAN HIGHWAY NETWORK

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### ABSTRACT

Available funds are, typically, not adequate to satisfy all the required maintenance projects for highways and roads networks in most countries, including Egypt. Under current policies and funding levels, further deterioration in pavement conditions can be expected, since the budget needed for highway maintenance is greater than the funding levels available. As a result, highway agencies must seek more cost effective methods for highway network preservation. The development of fund allocation optimization model of pavement management is essential to manage and allocate the available budget for maintenance of highways and roads networks in Egypt. In this paper, a Fund Allocation Optimization Model (FAOM) for highways in Egypt is developed using a genetic algorithms optimization application, designed as an add-in for MS Excel™. Markov chain theory is used to generate the Transition Probability Matrices (TPM) for each type of maintenance activities. The models used in FAOM are developed using the available data at the General Authority for Road Bridges and Land Transport (GARBLT) in Egypt for two major highways, which are Cairo-Alexandria agricultural highway and Alexandria-Matrouh north coast highway, representing the agricultural roads and coastal roads conditions in Egypt, respectively. FAOM was developed for a planning horizon of 5 years. Seven optimization budget and performance constraint scenarios were demonstrated in this paper. The results show that the model is sensitive enough to allocate the available fund for different maintenance strategies, and to reflect the differences of optimization analysis constraints on the analysis results, also can provide an effective tool for planning maintenance activities under different budget and/or performance optimization constraints.

**Keywords:** Pavement Management, Optimization Model, Markov Chains, Transition Probability Matrix, Pavement Condition, Fund Allocation.

## DECISION SUPPORTING SYSTEM FOR RISK ASSESSMENT IN CONSTRUCTION PROJECTS: AHP-SIMULATION BASED TECHNIQUE

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### ABSTRACT

Unpredicted risk factors may occur through project execution, which lead to increase in the overall budget and duration. These risk factors may be due to site conditions, resources, project parties...etc. Some researchers developed their researches concerning the time contingency or cost contingency or both of them. This paper presents a model for assessing cost and time contingencies. The model presented here depends on Analytical Hierarchy Process (AHP). In the new formulation both cost and schedule overruns, and risk response will be taken into consideration simultaneously to decrease cost and time contingency. Results showed that cost and schedule overruns can be defined as normal probability distribution with a mean value of 34.5% and 37.9%, respectively. On the other hand, if risk response taken into consideration these values are reduced to 15.4% and 9.1%, respectively. A Sensitivity analysis was carried out to investigate the impact of changing input: attributes and sub-criteria on the model output values (% change in schedule and cost overruns). The main contributions were: the two attributes, management strategy and unexpected surface conditions have 16.51%, and 13.83% impact on cost overrun and schedule overrun for best case scenario when risk response considered. On the other hand, for sub-criteria: owner, and site location these values are 9.86% and -9.47% on cost overrun for best case scenario and on schedule overrun for worst case scenario when risk response considered. Validation of the developed model using three case study projects revealed that the model assess cost and schedule overruns with an accuracy of 91%. This value demonstrates that the obtained results are fairly good and acceptable.

**Keywords:** Cost Overrun, Schedule Overrun, Probability, AHP, Analytic Hierarchy Process, Score, Weight.



## PLANNING OF HUMAN RESOURCES IN CONSTRUCTION COMPANIES IN EGYPT

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### ABSTRACT

The Egyptian construction industry is facing increasing challenges due to privatization and increasing competition from foreign contractors. These challenges imply the need to control costs and make more precise estimates. Labor costs are main cost items that should be accurately estimated during the initial project phases and controlled during construction. Currently, there is no formal method to estimate the required supervision and service work force in construction project in Egypt. This leads to inaccurate estimates of project costs in addition to understaffing or overstaffing during construction. The main objective of this study is to put standard rates of the most suitable size of both supervision and service work force in different construction project types (such as bridges, water treatment plants, power stations and buildings). Average production rates for productive workers are common and documented in different sources. Therefore, the scope of work on this study is to consider only the supervision and service work force. Data from 34 recent construction projects of various types for public and private sectors was collected to evaluate the average rates of supervision work force (engineers, foremen) and service work force (technical office, surveying staff, accountant, storekeeper, safety staff and quality staff) for project types and Predict supervision work force (engineers, foremen) and service work force (technical office staff, surveying staff, accountant, storekeeper, safety staff, quality staff) for projects of a given type and cost. Egyptian construction companies can use these results as a base for human resources planning in different types of projects.

**Keywords:** Planning; Human Resources; Construction Companies; Egypt.

## **ADAPTIVE OPTIMIZATION OF BRIDGES MAINTENANCE UNDER BUDGET CONSTRAINTS IN EGYPT**

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### **ABSTRACT**

The traditional approaches for bridges maintenance is proven to be inefficient as they lead to random way of spending maintenance budget and deteriorating bridge conditions. In many cases, maintenance activities are performed due to user complaints. The objective of this paper is to develop a practical and reliable framework to manage the rehabilitation activities of Bridges network and could be operated within the available data in Egypt. The model solves an optimization problem that maximizes the average condition of the network given the limited budget using Genetic Algorithm (GA). The system provides bridge inventory, condition assessment, repair cost calculation, deterioration prediction, and budget optimization. The developed model takes into account multiple parameters including serviceability requirements, budget allocation, element importance on structural safety and serviceability, bridge impact on network, and traffic. A questionnaire is conducted to complete the research scope. The proposed model is implemented in software. The results of the framework are multi – year maintenance plan for the entire network for up to five years. A case study is presented for validating and testing the model with Data collected from “General Authority for Roads, Bridges and Land Transport” in Egypt.

**Keywords:** Bridge Management Systems (BMS), condition assessment, deterioration, cost optimization, fund allocation.

## **A FRAMEWORK FOR MANUAL LIGHTING CONTROL IN COMMERCIAL BUILDINGS USING FUZZY HIERARCHICAL EXPERT APPROACH**

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### **ABSTRACT**

Lighting energy consumption accounts for one of the largest energy users in the US commercial buildings. In this context, most research works in simulating energy consumption in buildings have been developed focused on predicting personal action of artificial lighting. However, most of these models were limited to few factors, such as illuminance, time of arrivals, and user attitudes. The objective of this paper is to develop a model that predicts the lighting intensity depending on the environmental, and the physical factors in the workplace. Furthermore, this model predicts the manual switching patterns of the artificial lighting that influenced by different user attitudes, High, medium and low artificial lighting consumer. A new methodology is developed based on hierarchical fuzzy expert system approach. The data was collected from using a questionnaire sent to occupants in different institutional buildings. The model starts with valuating the performance of various factors; environmental, physical, and users' attitudes. Afterwards, the fuzzy expert system determines weight for each factor, and aggregate all the previous factors into one single crisp output. Finally, fuzzy logic technique allows the aggregation of all previous indicators into one lighting performance scale that depict the personal action of the lighting switching patterns. Occupants' presence and behavior in buildings as well as environmental, physical, have large impact on electric lighting usage. The developed research/model will help architects and practitioners to design an efficient workplace day lighting, and reduce artificial lighting energy use.

**Keywords:** occupant preferences, lighting manual control model, lighting electricity consumption fuzzy Logic, institutional buildings

## **QUANTIFICATION OF RISKS: COMPARISON BASED ON AHP/ ANP –SIMULATION TEQNIQUES**

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### **ABSTRCT**

Cost saving and time performance are usually essential to all parties who are involved in a construction project, i.e. owner, contractor, subcontractor, etc. The main causes of disputes in construction projects involve delay and failure to complete the work in the specified cost and period. An effective risk management process encourages the construction companies to identify and quantify risks. Construction companies that manage risk effectively and efficiently realizes financial stability, greater productivity and higher performance rates. This work aims at comparing two decision-supporting systems for quantifying the risk especially for construction projects in Egypt.

**Keywords:** Risk Assessment; Cost Overrun; Probability; AHP; ANP

## UNCERTAINTY AND RISK FACTORS ASSESSMENT FOR CROSS-COUNTRY PIPELINES PROJECTS USING AHP

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### ABSTRACT

Infrastructure cross-country pipelines projects carry out higher risk than traditional because they entail high capital outlays and intricate site conditions. The high-risk exposure associated with infrastructure cross-country pipelines projects needs special attention from contractors to analyze and manage their risks. They cannot be eliminated but can be minimized or transferred from one project stakeholder to another. Therefore, current research aims for identifying the risk factors that affect infrastructure cross-country pipelines projects based on experts experience and company's point of view which participated in similar projects. The risk factors classified under two categories to company level risks and project level risks. The risk factors were assessed using risk assessment models that facilitate this assessment procedure, prioritize these projects based upon its risk indexes and evaluate risk contingency value. Analytical hierarchy process (AHP) used to evaluate risk factors weights (likelihood) and FUZZY LOGIC approach to evaluate risk factors impact (Risk consequences) using software aids such as EXCEL and MATLAB software, accordingly risk indexes for both company level and project level evaluated and overall project risk index determined . Five case studies in different countries were selected to determine the highest risk factors and to implement the designed models and test its results. Results show that project no 3 in Iraq conquer the highest risk index (39.75 %); however, project 5 in Egypt has the lowest risk index (5.24%). Results of risk factors in other countries are (32.81%) in Emirates, (17.27%) in Saudi Arabia and (11.67%) in Libya. Therefore, the developed model can be used to sort projects based upon risk, which facilitate company's decision of which project can be pursued.

**Keywords:** Risk Management, International Construction, Risk Factors, Optimization Model, Analytic Hierarchy Process (AHP), FUZZY LOGIC Approach, MATLAB Software and Validation Process.

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**Building Design, Construction  
& Operation, and Solid Waste Management**

## INTEGRATING SOLAR THERMAL TECHNOLOGIES WITH GREEN BUILDINGS IN BIRMINGHAM, ALABAMA

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### ABSTRACT

Birmingham, Alabama has a humid subtropical climate with a mean annual temperature of 17.35°C, and receives annual total radiation exceeding 10,900 MJ/m<sup>2</sup> with approximately 2660 hours of sunshine. An experimental approach will be described to assess the effect of integrating a solar energy system with green buildings in Birmingham. Besides its advantages of providing natural ventilation, cooling, heating, and hot water supply, solar panels may increase the plant diversity instead of solely relying on drought tolerant species, which enables the use of a mixture of other plant species. The solar panels on rooftops can also be used to power the rooftop irrigation systems. The integrated solar energy system normally consists of two solar collecting pumps, two silica gel-water adsorption chillers, a hot water pump, a cooling tower, a cooling water pump, finned tube heat exchangers, floor heating pipes, and circulating pumps. A hot water storage tank can be used to collect solar heat and provide hot water to the solar energy system. This presentation addresses the runtime of the solar floor heating system, the average supply and return water temperature, and the average heating capacity. The normal floor and air temperature for a non-heating room will also be addressed. In this research, some energy savings features, such as air conditioners with water-cooled condensers, energy saving lights, high performance windows, high R-value attic, highly-insulated roofs, and the photovoltaic (PV) tiles, will also be addressed.

**Keywords:** Green Building, Solar Energy, Solar Thermal Technology, Natural Ventilation, Heating, Air-Conditioning.

## **‘MICRO-COMMUNITIES’ INITIATIVE EGYPT’S WINNING CARD TOWARDS DEVELOPMENT AND AGAINST DISASTERS**

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### **ABSTRACT**

At this critical moment in Egypt’s history, micro-communities (based on small and interrelated populations’ clusters) present themselves as an efficient counteraction to the myriad of challenges facing the country. The catastrophic urban sprawl and probable disastrous events fuel the search for better organizational initiatives that enable Egyptians to achieve and sustain high quality of living standards and, in doing so, enhance the capacity to resist and overcome the aftermath of disasters. The aim of this paper is to investigate possible routes to the successful implementation of a ‘micro-communities’ initiative in Egypt. The paper follows an investigatory research methodology in order to examine the logic and benefits attributed to the initiative. Urban and architectural considerations are discussed and references to relevant development initiatives are made. The paper’s ultimate goal is to recommend a series of steps that bring the whole ‘micro-communities’ initiative from theory to application.

**Keywords:** Micro-communities, Taskforces, Disaster Preparedness, Urban Patterns, Archetypes



## **SUSTAINABLE CONSTRUCTION WASTE MANAGEMENT FOR SUSTAINABLE BUILDINGS**

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### **ABSTRACT**

One of the main modules in any sustainable building rating system is recycling of construction waste. Construction waste constitutes a huge part of the solid waste management system and is continuously on the rise because of the booming housing and building industry. Construction waste accumulation has numerous adverse environmental effects, is considered a burden on the economy and fosters the depletion of natural resources. Researches have been ongoing worldwide to try to reduce as well as mitigate the effects of construction waste accumulation and there has been numerous efforts done in this regard. Green buildings is one of the methods used to incorporate the concept of sustainability in construction industry, it promotes the practice of building in an environmentally responsible way by minimizing waste, decreasing pollution and preventing the depletion of natural resources throughout the building life-cycle. Green buildings efforts add to the contemporary building practice of design for utility, durability, budget and comfort. The study incorporates deeper understanding of construction waste, its classification methods, key components, as well as the end life of each of the components and their reuse or recycling option. Most of construction wastes are being sent to landfills causing health problems as a result of the biodegradation of wastes in the landfill, moreover, it allows for the depletion of natural resources and does not account for energy conservation. Recycling of construction waste is still a costly process in contrast to the cheap price of many of the raw materials used in construction. The objective of the paper is to develop a sustainable construction waste management system as one of the key modules in green buildings.

**Keywords:** Sustainability, Landfill, Green Buildings, Construction waste, Recycling, Waste Management

## **SUSTAINABLE WASTE MANAGEMENT FOR CAMPUS CONSTRUCTION PROJECTS - CASE OF UMASS, AMHERST, USA**

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### **ABSTRACT**

The optimum use of resources and the efficient management of waste are the most vital principles of sustainable building, which significantly reduces the negative impacts of construction on the environment and preserves its natural resources. Several institutions supported by local governments in the United States have acquired the experience and the methodology to develop policies, guides, and demonstration projects to enhance construction waste management of building projects in a sustainable way. Massachusetts has specifically presented several green building initiatives with particular regard to construction waste management. The University of Massachusetts (UMass- Amherst) is a prominent state institution with a campus classified as "Green". Thus, this study addresses the management of construction waste at UMass as a model by exploring the governing framework, and highlighting the measures that define the process of construction waste management for campus projects. Throughout the study, waste management considerations, guidelines, and policies are reviewed, field visits are conducted, and conclusions are derived in order to improve the management performance of campus construction waste, thereby advising other institutions on better management practices.

**Keywords:** Sustainable Building, Construction Waste Management, University Campus Projects.

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## **Other Related Topics**

## A NOVEL METHOD TO PRODUCE DRY GEOPOLYMER CEMENT POWDER

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### ABSTRACT

Geopolymer cement is the result of reaction of two materials containing aluminosilicate and concentrated alkaline solution to produce an inorganic polymer binder. The alkali solutions are corrosive and often viscous which are not user friendly, and would be difficult to use for bulk production. This work aims to produce one-mix geopolymer (just added water) that could be an alternative to Portland cement by blending with dry activator. Sodium hydroxide (SH) was dissolved in water and added to calcium carbonate (CC) then dried at 80°C for 8 hours followed by pulverization to a fixed particle size to produce the dry activator consisting of calcium hydroxide (CH), sodium carbonate (SC) and pirssonite (P). This increases their commercial availability. The dry activator was blended with granulated blast-furnace slag (GBFS) to produce geopolymer cement powder and by addition of water; the geopolymerization process is started. The effect of W/C and SH/CC ratio on the physico-mechanical properties of slag pastes was studied. The results showed that the optimum percent of activator and CC content are 4 % SH and 5 % CC, by the weight of slag, which give the highest physico-mechanical properties of GBFS. The characterization of the activated slag pastes was carried out using TGA, DTG, IR spectroscopy and SEM techniques.

**Keywords:** Geopolymer Cement Powder, Dry Activator, Granulated Blast-Furnace Slag, Calcite.

## **STRENGTHENING OF REINFORCED CONCRETE COLUMNS USING ADVANCED COMPOSITE MATERIALS TO RESIST SEISMIC LOADS**

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### **ABSTRACT**

Recent earthquakes have demonstrated the vulnerability of older reinforced concrete building to fail under the imposed seismic loads. Accordingly, the need to strengthen existing reinforced concrete structures, mainly columns, to resist high seismic loads have increased. Conventional strengthening techniques such as using steel plates, steel angles and concrete overlay are used to achieve the required increase in strength or ductility. However new techniques using advanced composite materials are established. Column's splice zone is the most critical zone failed under seismic loads. There are three types of splice zone failure can be observed under seismic action namely; Failure of flexural plastic hinge region, shear failure and failure due to short lap splice. A lapped splice transfers the force from one bar to another through the concrete surrounding both bars. At any point along splice force are being transfer from one bar by bond to surrounding concrete and also by bond to the other bar of the pair forming the splice. The integrity of lap splice depends on the development of adequate bond length. The R.C columns built in seismically regions are expected to undergo a large number of inelastic deformation cycles while maintaining overall strength and stability of the structure. This can be ensured by proper confinement of the concrete core. The last type of failure is focused in this research. There are insufficient studies which address the problem of strengthen existing reinforced concrete columns at splice zone through the confinement with "advanced composite materials". Accordingly, more investigation regarding the seismic behavior of strengthened reinforced concrete columns using the new generation of composite materials such as (Carbon fiber polymer), (Glass fiber polymer), (Armiad fiber polymer).

**Keywords:** Confined Concrete, Seismic Loads,(FRP),Computer Program (Atena).

## PROPERTIES AND FIELDS OF APPLICATION OF CELLULAR CONCRETE

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### ABSTRACT

Cellular Concrete is a porous lightweight type of concrete which can be composed of cement, lime, aluminum powder, fly ash (or sand) and water. The aluminum powder produces the porous structure in the concrete mass. The final product is obtained as a result of the reactions that occur between the binder containing calcium oxide, the siliceous component, and the cellular structure producing ingredient. This research was conducted to find out the physical and the mechanical properties of the mixes which included different percentages of the different constituents. The physical properties investigated included the unit weight and water absorption. The mechanical properties tested included the compressive strength, the splitting tensile strength, the flexural strength, and the impact resistance. The thermal conductivity, high temperature resistance and sulfate resistance were also investigated. The fields of application were suggested including concrete building bricks and blocks, lightweight non structural units and usage for thermal isolating.

**Keywords:** Cellular concrete, unite weight, compressive strength, thermal conductivity.

## RESPONSE OF RETAINING WALL DUE TO EMBANKMENT CONSTRUCTION ON SOFT GROUND

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### ABSTRACT

Construction on soft ground is considered a challenge for geotechnical engineers due to its low shear strength and high compressibility. As known, retaining walls are subjected to lateral loading from soil pressure. In some places in a road or highway, construction of embankments on soft soil retained by a wall should be necessary. This study case needs to be investigated. Hence, in this paper the influence of an embankment construction directly on retaining wall is studied numerically by using Plaxis FEM program. Full scale of an embankment and two diaphragm retaining walls tied with struts are utilized. The Soft Soil Model is used to simulate soft soil. The consolidation analysis is applied to investigate the long term behavior of the soft soil. The stability of the retaining wall is evaluated at different stages of the embankment construction process. The results show that the retaining wall is subjected to significant increases in the lateral displacement, lateral soil pressure and bending moment during and after construction of the embankment. The lateral displacement and the bending moment increase with increasing embankment height due to increasing embankment spreading. As well as the forces in the strut increase with developing embankment. The lateral displacement and the bending moment of the wall, and the strut forces depend on the embankment height and the rate of the embankment construction which should be considered in the design of the retaining wall.

**Keywords:** Soft soil, Consolidation, Lateral displacement, Finite element, Embankment

## **EXPERIMENTAL AND NUMERICAL ANALYSIS OF RC BEAMS CAST USING BOTH CONVENTIONAL VIBRATED AND SELF- COMPACTING CONCRETES**

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### **ABSTRACT**

Self-compacting concrete SCC is the sufficient solution to overcome the disadvantages of conventional vibrated concrete CVC fresh and hardened properties. An experimental program contains six reinforced concrete beams was carried out to investigate the effects of using self-compacting concrete on the structural behavior of beams. Three specimens of reinforced concrete beams were cast using conventional vibrated concrete and the other three specimens were cast using self-compacting concrete. All specimens have the same dimensions and reinforcements. Tested specimens were analyzed using three-dimensional finite element program considering hardened properties of each concrete type. A comparative study was carried out between the experimental results of both types to investigate the advantages of using self-compacting concrete. The results of the experimental and the numerical analysis using three-dimensional finite element method were also compared to verify the methods of simulation.

**Keywords:** RC Beams, Self-compacting concrete, Conventional vibrated concrete, Finite Element Method, Tension stiffening.



## **STRENGTH AND DURABILITY CHARACTERISTICS OF GROUND GRANULATED BLAST FURNACE SLAG (GGBFS) CONCRETE MIX**

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### **ABSTRACT**

Environmentally viable alternative to cement is using ground granulated blast furnace slag (GGBFS). It is used as partial replacement of cement. Ground granulated blast-furnace slag (GGBFS) is a by-product of the metallurgical industry. The aim of this work was to investigate the effects of partially replaced Ordinary Portland Cement (OPC) by ground granulated blast furnace slag (GGBS) on fresh and hardened concrete properties. Durability of concrete was investigated through the exposure of test specimens to sulfuric acid solution. Reinforced beams were cast and tested to study their behavior under different stages of loading. The main variables taken into consideration in concrete mixes were the percentage of cement, GGBS, Silica Fume, Limestone powder, gypsum and age of testing. Five mixes were cast. Increasing the percentage of GGBS; setting time and consistency increases but strength decreases using same water content. The concrete containing GGBFS usually has low early-ages strength, but shows high later strength at 90 days. After exposure of test specimens to sulfuric acid solution control mix had higher degradation percent in compressive strength after 28 day and mass loss was higher than GGBFS mixes.

**Keywords:** Durability, Ground Granulated Blast Furnace Slag (GGBFS), Silica Fume.