BACHELORS'

THESIS ABSTRACTS BOOK 2022

DEPARTMENT OF CIVIL ENGINEERING
UNIVERSITY OF ENGINEERING & TECHNOLOGY LAHORE

PREFACE

The final year design project has been a vital component of the BSc degree program at the Civil Engineering Department. Every year students work on a variety of topics as their final year design projects; however, a summary of the final year project reports was not compiled, and the project reports were individually available in the departmental library. The idea of compiling the abstracts of the final year project (FYP) reports in the form of a booklet was conceived by Prof. Dr. Rashid Hameed. The idea was floated in the departmental meeting and Dr. Rizwan Azam as a Departmental Library director took the responsibility to make it a reality as a yearly item for the departmental library in addition to the yearbook for students. Every year, the departmental library will compile a booklet of the abstracts of FYP reports along with some featured graphical illustrations. This booklet of abstracts will be helpful for both the prospective students and the Alumni to give them an idea about the types of FYPs being offered at the department. It will also work as a directory for each year's FYP reports in library for easy access to the desired project reports.

The help of Engr. Muhammad Adil, the founding member of Library student advisory committee (LSAC), in compiling and formatting the abstracts in the form of booklet is greatly appreciated. In addition, the review of booklet by Dr. Muhammad Rizwan Riaz is greatly acknowledged.

Dr. Rizwan Azam
Director Departmental Library

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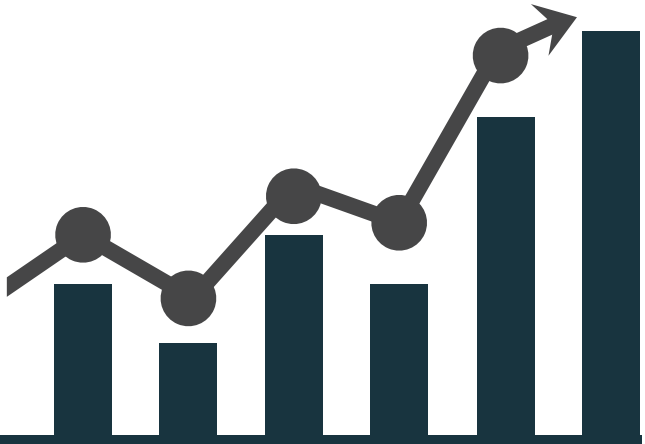

BACHELORS' THESIS

ABSTRACTS

APPLICATION OF MULTI-CRITERIA DECISION MAKING FOR SELECTION OF SUSTAINABLE CONSTRUCTION MATERIALS

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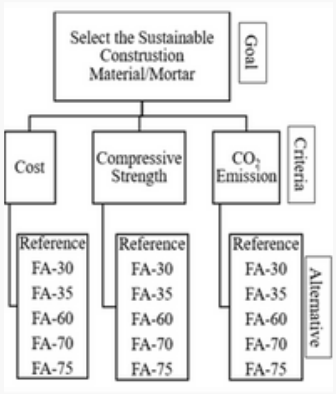
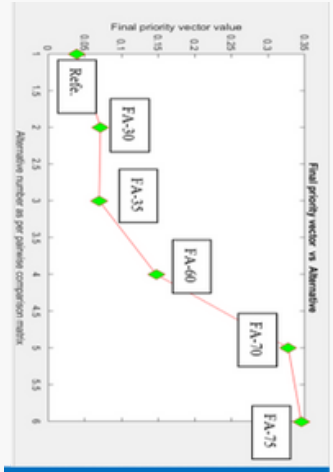


Development of hierarchy for AHP



Final priority vector vs alternatives

This work focuses on taking advantage of the Multi-Criteria Decision Making (MCDM) approach for the selection of sustainable construction materials. A detailed discussion about sustainability and its importance has been described. A detailed analysis about the significance of MCDM has been presented. Analytical Hierarchy Process (AHP) a technique of MCDM is being used on the already published data in order to select best possible sustainable construction materials. Detailed methodology to apply AHP has been discussed and the previous research have also been presented in this thesis. A MATLAB tool was developed in order to quickly apply the AHP method for a maximum limit of up to 10 alternatives and 10 criteria as recommended by the literature. Three examples have been solved by the AHP technique using data collected from the already published papers: 1. Replacement of natural aggregates by recycled aggregates in concrete with a range of 0-100%, 2. usage of natural aggregates in concrete along with recycled aggregate up to 100% along with some additives like fly ash, blast furnace slag, micro silica, steel fibers and super-plasticizers to get 30 MPa cylinder compressive strength at the end of 28 days and 3. production of mortar with ultra-high utilization of fly ash from 0-75% along with geo-polymerization. The whole methodology about how to set preferences and how to develop pairwise comparison matrices has been discussed; an explanation of the MATLAB tool in detail and a description of how to use it properly in order to get final priority vectors have been presented. As the project was the selection of sustainable construction materials so, a high priority was assigned to those parameters linked with sustainability and green construction like CO_2 footprint (sustainability factor) and volume of raw material used. The graphical presentation of the final priority vector was also provided along with a detailed discussion about the results. The Sustainable Development Goals (SDGs) which are incorporated in this work include SDG 11, 12 and 13 and these mainly deal with sustainable cities and communities, responsible production and consumption of materials and climate action. In the end, some conclusions are drawn, and some recommendations are presented for further improvements.

MECHANICAL PERFORMANCE OF RECYCLED AGGREGATE CONCRETE BRICKS

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Fig.1 RAC Brick

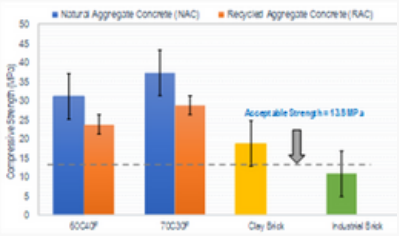

Fig.2 Compressive Strength

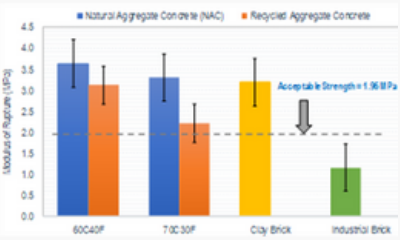

Fig.3 Modulus of Rupture

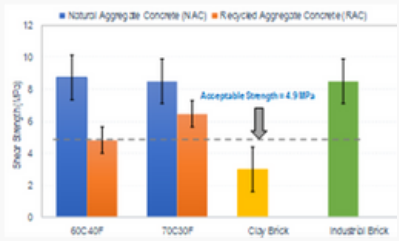

Fig.4 Shear Strength

The urbanization and modern development of the expanding infrastructure have resulted in large construction activities. With the expeditious growth in the construction industry, the rate of demolition has also increased and this is causing considerable increase in Construction and Demolition (C&D) waste all around the globe. Such solid wastes have resulted in increased cost of dumping and also have created critical environmental problems. In this regard, preventive measures are required to be taken to conserve the environment and for this reason construction industry has proposed the use of recycle aggregates in new concrete. Demolished concrete is crushed into recycled aggregates (Coarse & Fine) and their use in the new concrete has significant environmental and economic benefits. This study investigated the mechanical properties of masonry units (bricks of size and shape as per our local standard) manufactured by compression casting and using 100% RAC as shown in Figure 1. Initially different compositions of 100% RAC were tested to figure out the optimum phase of casting. Recycled aggregates were produced by crushing tested samples of concrete having compressive strength from 17 to 21 MPa. The experimental program included casting and testing of brick samples. To draft a comparison, Natural Aggregate Concrete (NAC) bricks, first class burnt clay bricks and industrial bricks were also tested. For the accurate interpretation of the mechanical properties both destructive (compressive strength, flexural strength, shear strength, impact and flexural impact) and non-destructive (rebound hammer and ultra-sonic pulse velocity) tests were performed. Based on experimental data, it was found from the results presented in Figure 2 to Figure 4 that RAC bricks satisfied the required strength values as stated by local and international standards. The compressive strength of RAC bricks (23.64 MPa) was higher than clay (18.64 MPa) and industrial bricks (10.76 MPa) but lower than NAC bricks (30.96 MPa). This study concluded that 100% RAC bricks could be efficient, eco-friendly and economical alternate to burnt clay bricks which consumes natural resources of clay. Use of RAC bricks will not only conserve the depleting natural resources of aggregates and clay but also help to protect environment from pollution.

DESIGN OF A MULTISTORY CONCRETE FRAME STRUCTURE

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The principal objective of this project is to design various components of a multi-story concrete frame structure using different commercially available software. This project relates to the UN sustainable development goal no. 9 pertaining to building resilient infrastructure. Structural design is a primary task in civil engineering projects. The steps involved in the design of a concrete frame structure include the development of structural model, application of different types of loads, analysis of the model, design of different members and finally preparation of structural drawings. Different software are used for the design of these members and their reinforcement detailing.

In this project, ETABS is utilized for the analysis and design of beams, columns and slabs. Design of foundation is done using SAFE. The design is performed according to ACI 318-19, ASCE 7-16 and IBC-2012. The number of stories is six including one basement. Different types of loads including self weight, live load, partition load, floor finishes, earthquake load and wind loads were applied on the model. Several different gravity and lateral load combinations were considered in order to make sure that the structure remain safe under the worst possible scenario. All the members were checked to ensure that none of them is overstresses and provide sufficient strength against the all the load combinations. Vertical deflections and lateral drifts limits are also satisfied. Mat foundation with enlarged thickness under some heavily loaded columns is provided as footing. Detailed drawings of structural layout, reinforcement detailing of beams, slabs and columns are prepared as final output of the project.

MULTI-SCALE INVESTIGATION FOR DEVELOPING SUSTAINABLE CONSTRUCTION MATERIALS:
APPLICATION TO BRICKS AND MORTARS

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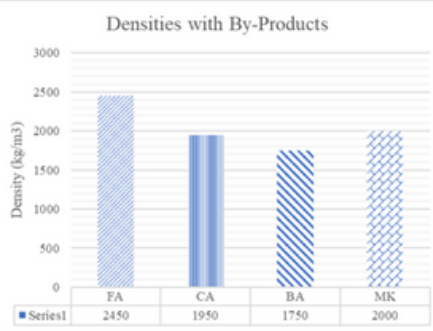

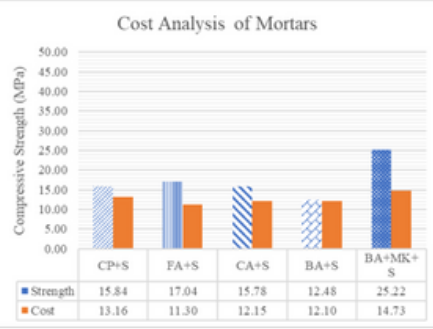

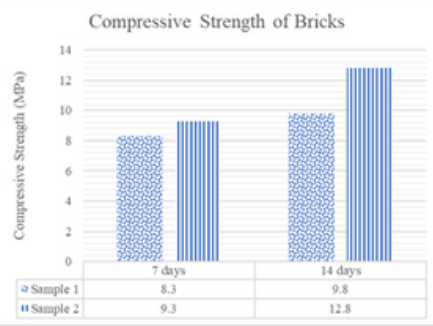

Concrete is one of the most important construction materials and it is extensively used throughout the world due to its strength, durability, and versatility during the construction of a structure. Consequently, its sustainability, economy and environment-friendliness must be ensured. Cement is the major constituent of concrete; its rapidly rising cost and contribution to global warming by emission of greenhouse gases prove detrimental to sustained use of concrete. Thus, the partial replacement of cement in concrete and mortar mixes by different industrial by-products has been the focus of many a research and researchers.

For this replacement, the properties of industrial by-products and supplementary cementing materials must be understood first. Accordingly, a multi-scale approach is adopted to discern the behavior of such materials independently with cement as well as with the addition of sand. Fly ash, coal ash, bagasse ash and white metakaolin has been used as cement replacement materials in this research. Fly ash and coal ash were collected from coal power plant while bagasse ash was obtained from sugar Mills. Trial cubes of 2 inches by 2 inches dimensions were tested with 20% replacement of cement by fly ash & 10% replacement with coal ash as well as bagasse ash. The results indicated that bagasse ash mix was the most economical and it provided the required strength as well. Finally, brick samples were casted using the mix and an average strength of 11.3 MPa was obtained for bagasse ash mix at 14 days, with an average density of 1811 kg/m^3

The aim of the research is to utilize the pozzolan materials as cement replacement so that cement utilization can be reduced and also develop economical and eco-friendly bricks so that environmental balance can be maintained. Achieving Sustainable Development Goals 9, 11, and 13, which are focused on infrastructure, sustainable cities and communities, and climate action, respectively, was also one of the project's main goals.

DURABILITY PERFORMANCE OF RECYCLED AGGREGATE CONCRETE BRICKS

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Fig.1 100% RAC Brick

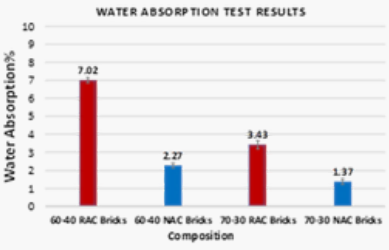

Fig.2 Water Absorption Test

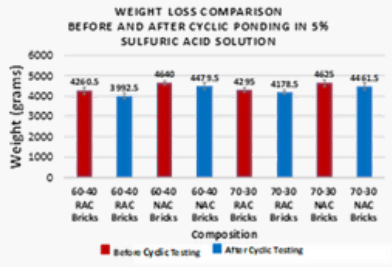

Fig.3 Durability Test

Fig.4 Durability Test

Recycled-aggregate concrete (RAC) production has proved to be an effective means of waste management as construction and demolition bulk proliferates each day. This study focused on investigating the durability performance of Recycled Aggregate Concrete bricks (Fig.1) in comparison with the Natural Aggregate Concrete (NAC) bricks for two compositions i.e., 60%C-40%F and 70%C-30%F, where C and F stands for coarse and fine aggregates, respectively. Other parameters like casting pressure and cement content were also different for each composition. Durability of bricks was investigated by performing different durability tests on the specimens. The experimental program included water absorption test, cyclic ponding test in 5% sulfuric acid solution, cyclic ponding test in 5% sodium hydroxide solution and efflorescence test. Non-destructive tests including Rebound hammer test and Ultrasonic pulse velocity test were also performed on each brick specimen to check the strength and quality of concrete. The results showed that NAC bricks have lesser water absorption than RAC bricks for each composition (Refer to Fig.2). 70C-30F composition bricks showed lesser water absorption than 60C-40F composition bricks. Compressive strength of bricks made using 70C-30F composition was found to be higher than bricks made using 60C-40F composition and natural aggregate concrete bricks exhibited more strength than recycled aggregate concrete bricks. Recycled aggregate concrete bricks of 70C-30F composition showed minimum weight loss under the influence of 5% sulfuric acid solution (Fig.3) and minimum loss in compressive strength. Recycled aggregate concrete bricks of 60C-40F composition showed minimum loss in weight under the influence of 5% sodium hydroxide solution (Fig.4) and was comparable with other compositions. Natural aggregate concrete bricks of 60C-40F composition showed minimum loss in compressive strength under influence of 5% sodium hydroxide solution. Efflorescence was not appeared on any composition of bricks. Based on the findings of this experimental study, recycled aggregate concrete bricks of 70C-30F composition appeared to be more durable than 60C-40F composition. Further, bricks prepared using 70C-30F composition also exhibited greater compressive strength.

ARTIFICIAL INTELLIGENCE
IN CIVIL ENGINEERING

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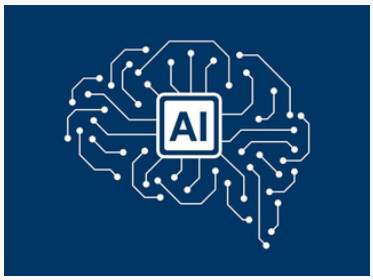

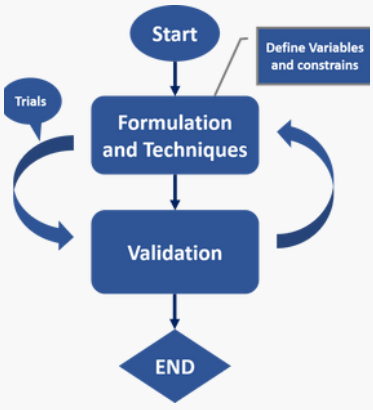

Nowadays, the use of artificial intelligence in civil engineering is extensive. Design engineers as well as field engineers are using artificial intelligence to solve a wide range of problems, such as construction management, hydraulic optimization, waste management, and planning. However, the use of artificial intelligence in the field of design optimization of steel structures is limited. This may be due to the difficulty in the application of optimization techniques. This study is intended to highlight the potential of the solver tool in excel to optimize the steel beams. Solver is an easy-to-use tool that allows using the evolutionary technique, through which design optimization can be done easily. An interface was developed in a spreadsheet in which all the steel beam parameters from an already designed beam can be entered and the most feasible yet economical solution (design) can be obtained within seconds. To express the potential of the developed optimization procedure, four examples taken from the literature have been optimized. The optimization procedure was applied to four different cases. The results depicted that a maximum optimization of 37%, 48%, 49%, and 37% were obtained for the four cases, respectively. Maximum optimization of up to 40% can be obtained by keeping the same material strengths that were used in the original design. However, up to 49% optimization is possible if we vary the material strengths. Optimization of up to 48% can be obtained by keeping the depth of the beam as a variable. A comprehensive study was also conducted to study the effect of different parameters on the optimization of steel beams. The results of the parametric study depicted that the optimization of steel beam improves with the increase in steel grade as the strength of steel directly affects the flexural strength of steel. An optimum range for the depth of the beam can be considered for the minimum cost that can help the designer in the selection of depth for a specific grade. A similar trend was observed for the flange slenderness ratio. The best choice for the selection of optimal solution is the one with a higher grade of steel, optimum depth, and lesser flange slenderness value.

ASSESSMENT OF VULNERABILITY AND FIRE RISK FOR HERITAGE STRUCTURES

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Heritage Building	FRI
Lahore fort	1.15
Badshahi Mosque	1.02
Shalimar Garden	1.07
Wazir Khan Mosque	1.22
Lahore Museum	1.35
Sheesh Mahal	1.36

Educational Building	FRI
Diyal Singh College	1.08
PU Old Campus	1.09
UVAS	1.05
UET	1.19
GCU	1.27
NCA	1.17

An uncontrollable fire can cause severe and deadly danger not only to human life but also serious consequences to the building structure. The framework and infrastructure to deal with fire is very miserable in our country, that is why fire hazard is a major threat in Pakistan. The main purpose of this project is to present the results derived from a survey that was conducted on both Heritage and old Educational Structures, to find out the scale and level of fire threat in these buildings. The technique or method that we used for the assessment of fire is Fire Risk Index (FRI) Method which is used to find out the fire rating of these structures. A total of twelve (12) old structures were visited and surveyed which included six (6) heritage structures and six (6) old educational institutions. All the aspects of these buildings which can contribute to fire were considered. Observations were noted and data was analyzed. Based upon these observations and data, a value of Fire Risk Index (FRI) was derived for each structure which exhibits its level of risk to catch fire. Furthermore, the characterization of the building is also carried out and in which classification of fire risk, it falls. The recent examples of fire incidents that we observed during the survey, indicated that most of the structures got fire due to carelessness, violation of building regulations, ignorance of safety measures, negligence and lack of combat against fire. A severe shortage of fire control equipment and infrastructure capability, which are necessary for fire prevention were also noted. It was also observed that there is a lack of focus and locally used methodology for the fire risk assessment of heritage structures. This suggested method i.e. Fire Risk Index Method can be used by the authorities as a recommendation to assess, mitigate and control the fire hazard in the heritage structures of Pakistan.

FLEXURE PERFORMANCE DETERMINATION OF FERROCEMENT PANELS USING SBR LATEX AND POLYPROPYLENE FIBERS AND MESHES

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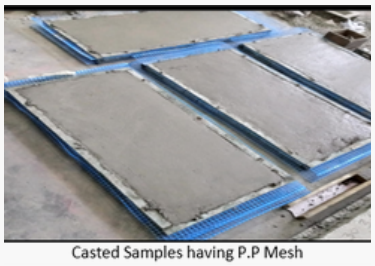
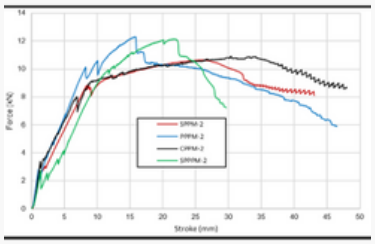
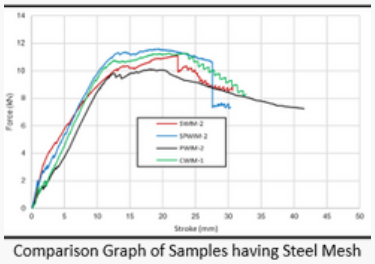


Casted Samples having P.P Mesh

Flexure Testing of a Specimen on Shimadzu UTM



Comparison Graph of Samples having P.P Mesh



Comparison Graph of Samples having Steel Mesh

Ferrocement panels are thin-section panels that are widely used in light weight construction. Due to lesser flexural stiffness, they are susceptible to surface cracking. The water may percolate through these cracks and may cause corrosion of steel wire mesh, which may further cause strength loss and durability issues. In the present experimental work, polypropylene wire mesh was employed to cater this problem. SBR Latex and Polypropylene Fibers are also utilized as admixtures to improve the flexural strength and energy absorption of panels. As a result, by making ferrocement panels load bearing, which may be useful in low-cost house construction. The ultimate flexure strength of ferrocement panels employing Polypropylene Wire Mesh, Welded Iron Mesh, SBR Latex, and Polypropylene Fibers is the subject of the research. Test variables are the Type of Mesh Layer, the dosage of Polypropylene Fiber, and SBR Latex. Experimental tests conducted on 16 square cementitious slabs of 1000 x 450 mm simply supported and subjected to four-point loading on 1000 kN fully computer-controlled Shimadzu UTM. Meshes are spaced 5mm apart on top and bottom, with a 6 mm diameter steel bar holding them in place. Sustainable development goal (SDG) of decent work and economic growth, sustainable infrastructure and of long-life construction is being met by providing low-cost housing with making ferrocement panels durable and ductile with addition of admixtures. Samples with polypropylene mesh (P.P mesh) exhibited smeared cracking pattern that showed that they are more ductile as compared to samples with iron mesh. The maximum peak value suggests that with the addition of Latex and Polypropylene Fibers we can make ferrocement a load-bearing member. The most suitable Specimen will be, sample having Polypropylene Fibers and Polypropylene Mesh as it's load bearing capacity is 14% more than a controlled sample. SBR Latex and Polypropylene Fibers are much beneficial in cases when Polypropylene Mesh is present. It is recommended that samples with P.P. Fibers and P.P Mesh are giving the best results. While the addition of SBR Latex is not causing many benefits as expected. So, the new research direction can be to use any other admixture in place of SBR Latex. In the case of Welded Steel Mesh, other admixtures are to be considered which can delay the initiation of the first crack and moisture entrance.

DEVELOPMENT OF ENVIRONMENTAL FRIENDLY CEMENT-LESS RECYCLED AGGREGATE CONCRETE MIXES IN PAKISTAN

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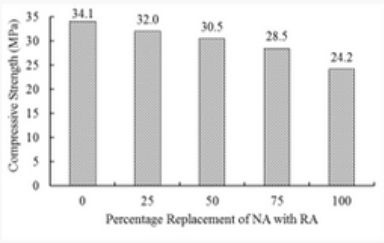

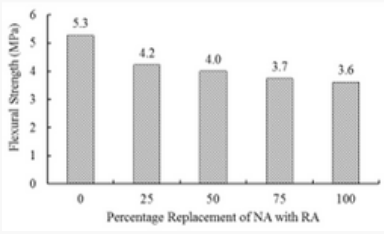

The Climate change due to global warming has become one of the major concerns in the world. The global warming is caused by the emission of greenhouse gases (GHG) particularly carbon dioxide (CO_2) gas in the atmosphere due to human activities. Amongst GHG, CO_2 gas contributes more than 50% of global warming. One of the challenges in fighting Climate change comes from the production of cement, as concrete is the second most used material and cement is the main constituent of concrete. Ordinary Portland cement (OPC) is conventionally used as a binder to develop OPC concrete. Pakistan is facing adverse impacts of climate change in the form of devastating floods, heat waves and rapidly melting glaciers. This proposed research addresses the challenge of Climate Action to reduce the use of OPC cement in the construction industry and hence reducing the CO_2 emissions and global warming.

In this research investigation, fly ash is used as an alternative of cement in concrete i.e., cement-less concrete, which will reduce the reliance of construction industry on the cement production and will help to reduce the adverse impacts of Climate change in Pakistan. In addition, recycled aggregates (RA) prepared from construction and demolition wastes (CDW) is used as a replacement of natural aggregates (NA) in cement-less recycled aggregate concrete (RAC), which will reduce the CO2 emissions and depletion of natural resources. This research work addresses three sustainable development goals (SDGs) i.e., SDG No.9 (Industry, Innovation and Infrastructure), SDG No. 11 (Sustainable Cites and Communities) and SDG No. 13 (Climate Action).

In this research investigation, cement-less RAC is developed using 100% fly ash, varying percentage replacements of NA with RA (0%, 25%, 50%, 75% and 100%) and varying molarities of sodium hydroxide (NaOH) solution (12 M, 14 M, 16 M). A ratio of sodium silicate (Na2SiO3) solution to NaOH solution of 1.5 is used in all mixes. A total of 15 mixes were prepared with each mix comprising three cube specimens of sizes 100 mm x 100 mm x 100 mm and three prism specimens of sizes 75 mm x 75 mm x 300 mm. All test specimens were ambient cured at room temperature i.e., 23 ± 2˚C.

The test results exhibited that both compressive and flexural strengths increased with increasing molarity of NaOH solution. Moreover, the compressive and flexural strengths decreased with increasing percentage replacement of NA with RA in cement-less RAC. The mixes prepared with 14 M and 16 M NaOH solutions and 100% replacement of NA with RA achieved the target compressive strength of 28 MPa.

MECHANICAL PERFORMANCE OF RECYCLED AGGREGATE CONCRETE PAVERS

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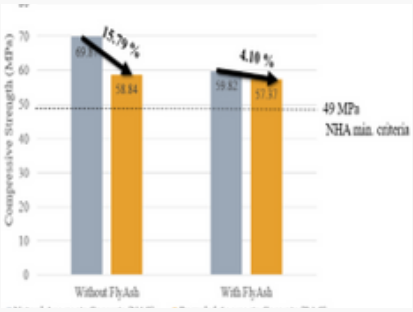

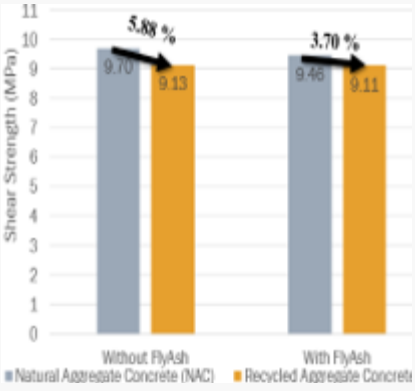

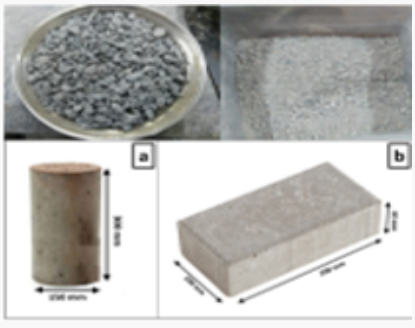

Concrete is the most commonly used construction material around the world. As the building and demolition industry grows, recycled-aggregate concrete (RAC) manufacturing has shown to be a cost-effective waste management solution. This waste aggregate can be utilized in other concrete structures which will have a positive impact on environment. The purpose of this study is to assess the mechanical characteristics of recycled aggregate concrete pavers.

In this study, the recycled aggregates was obtained by crushing tested concrete cylinders and cubes and sieve analysis was performed to separate coarse and fine aggregates. Different tests were conducted to determine the different physical properties of aggregates. On coarse aggregates moisture content, water absorption, loose bulk density, rodded bulk density, specific gravity, los angeles abrasion test, aggregate impact value test, aggregate crushing value test, ten percent fines value test, flakiness and elongation index test was conducted. On fine aggregates moisture content, water absorption, rodded bulk density, specific gravity and fineness modulus tests were conducted. Then these aggregates were used in different composition ratios for the manufacturing of concrete pavers. Four different compositions used for paver manufacturing are, Natural aggregate Concrete (NAC) without fly ash (60% fine, 40% coarse, 30% cement.), Natural aggregate Concrete with fly ash (60% fine, 40% coarse, 20% cement, 10 % fly ash), Recycled-aggregate concrete without fly ash (60% fine, 40% coarse, 30 % cement), Recycled-aggregate concrete with fly ash (60% fine, 40% coarse, 20% cement, 10 % fly ash). For mechanical characterization five different tests were performed i.e., Flexural impact test, rebound hammer test, Compression test, Flexure Test and shear test to assess the strength of the pavers made up of different compositions.

Results show, 100% RAC pavers manufactured under the scope of this study passed all the standard limits of compressive, flexural and shear strength as per local and international standards. It was also noticed that Natural aggregate concrete without fly ash is of superior quality and most inferior was Recycled aggregate with fly ash.

FEASIBILITY OF USING FLY ASH IN PRODUCTION OF ECO-FRIENDLY CLAY BRICKS

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In the last three decades, the production of burnt clay bricks has significantly increased due to rapid industrialization. The burning of bricks in a kiln at 900 ˚C to 970 ˚C emits carbon dioxide (CO_2), which increases the carbon footprint and hence negatively affects the environment. CO2 emission is one of the leading causes of the global warming and hence Climate change. In 2018, Pakistan has adopted the 2030 Agenda for Sustainable development by approving the National Framework of Sustainable Development Goals (SDGs) to prioritize set SDGs in long-term development perspective of country. The Climate Action is one such SDG, which target to reduce the emissions of greenhouse gases emissions about 20% by 2030.

In addition, an increasing production of burnt clay bricks is depleting the fertile agricultural soil at rapid pace. Research investigations are ongoing to use various industrial wastes as a replacement of clay in production of bricks. Fly ash (FA) is one such industrial waste which used in the production of clay bricks not only reduces environmental pollution but also reduces the burden on rapidly depleting natural resources. This study addresses three SDG i.e., SDG 9 (Sustainable development), SDG 11 (Sustainable cities and communities) and SDG 13 (Climate change) are primarily emphasized.

In this research study, influences of FA and the molarity of NaOH solution (alkaline activator) on the physical and mechanical properties of unburnt clay (CL) bricks are investigated. Six mixes of bricks with 15 bricks in each mix are prepared. Mix A comprises 70% FA, 30% CL and 12 M NaOH, Mix B comprises 80% FA, 20% CL and 14 M NaOH, Mix C comprises 80% FA, 20% CL and 16 M NaOH, Mix D comprises 60% FA, 40% CL and 12 M NaOH, Mix E comprises 70% FA, 30% CL and 12 M NaOH and Mix F comprises 60% FA, 40% CL and16 M NaOH. The unburnt bricks are cured for 28 days using wet hessian rugs.

The weight per unit area, water absorption, efflorescence, ultrasonic pulse velocity (UPV), compressive strength, and modulus of rupture tests were performed on the bricks. The test results exhibited that Mix C comprising 80% FA and 20% CL with 16 M NaOH solution attains the optimum physical and mechanical properties i.e., weight per unit area of 134 kg/m2, water absorption of 8.03%, slight efflorescence, UPV of 3.61 km/s, compressive strength of 43.28 MPa and modulus of rupture of 2.23 MPa. The compressive strength of unburnt bricks produced in all six mixes exceeded the minimum compressive strength requirement of 11 MPa as per ASTM C67-21 (ASTM 2021). Therefore, the use of FA in the production of unburnt CL bricks is feasible and an effective alternate for sustainable development.

DURABILITY PERFORMANCE ON RECYCLED AGGREGATE CONCRETE PAVERS

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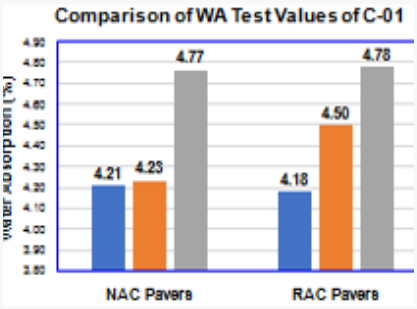

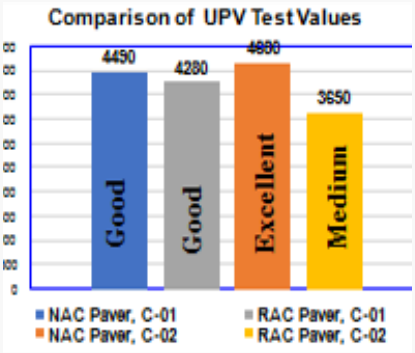

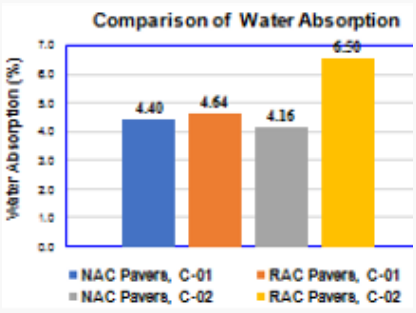

The demand of today's world market is to manufacture eco-friendly construction products such as pavers and masonry units for the consumers with minimum cost and to save economy. Demolition of old structures creates a lot of waste concrete which is harmful to the environment and construction site. The recycling of aggregate from demolished concrete is the best method to eliminate the waste concrete from the environment and eco-friendly disposal of concrete waste. Recycle aggregate concrete (RAC) can be used to prepare bricks, pavers, masonry blocks, etc. The purpose of this research is to find the durability performance of recycled aggregate concrete pavers and compare that with the NAC pavers. For this purpose, firstly waste concrete cylinders were collected from concrete laboratory of civil engineering department of UET Lahore. Then crushing was done into the required size of recycled aggregate and standard tests were performed to determine physical properties. These recycled aggregates were used for the casting of pavers. Two compositions were cast: first with 30% Portland cement and the second with 20% Portland cement and 10% Fly Ash. For comparison, NAC pavers were also cast. To check the durability of these pavers three tests were conducted that includes: Water Absorption test, Ultra-Sonic Pulse Velocity Test and Efflorescence tests. The results of these tests show that WA of RAC pavers were more than NAC pavers and UPV values of RAC pavers were less than NAC pavers. Also, a comparison is made between pavers manufactured with and without Flyash. Results show concrete pavers without Flyash is better than pavers With Flyash. Overall, it can be concluded that one can use recycled aggregate to cast concrete pavers as it gives comparable results to Natural aggregate concrete pavers. This research can be used to prepare the RAC pavers.

COMPUTER AIDED DESIGN OF AN OFFICE BUILDING

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This project covers the computer-aided analysis & design of an office building and addresses the UN's Sustainable Development Goal number 9 of building resilient infrastructure, promoting sustainable industrialization and bringing foster innovation. The building is a multi-story reinforced concrete frame structure with four floors in the superstructure, and a basement as a substructure. The superstructure is modeled and analyzed using ETABS while for modeling and design of the foundation, SAFE is used. Further, the detailed drawings including the longitudinal and cross-sectional details of structural components are drawn using AutoCAD. ACI 318-19 (Building Code Requirements for Structural Concrete), ASCE 7-16 (Minimum Design Loads and Associated Criteria for Buildings and Other Structures), International Building Code, 2012 and Building Code of Pakistan, 2021 are used for identifying load magnitudes, their severity, and various load determination parameters. The model is analyzed for all possible kinds of loading like; wind load, seismic load, partition load, live load, self-weight, superimposed dead load, and is designed for critical design load combinations. For columns, reinforcement is kept around 1%. Other checks such as beam-capacity ratios, drift ratios, and permissible deflections are also satisfied. Considering the ease of construction and safe design, mat footing has been provided underneath. The soil bearing capacity is taken as 1.5 tons per square feet. The mat slab is checked against soil pressures, maximum allowable settlement, and punching shears. Hence, the provided design is safe to implement. Through this project, we not only got familiar with the engineering codes and practices being followed for carrying out the structural design of a building but, also got to know the use of the latest computer-aided tools developed to ensure design accuracy.

ANALYSIS OF CONCRETE BUILDINGS HAVING VERTICAL IRREGULARITIES

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It is a big challenge that tall buildings must withstand the various forces acting along different directions under seismic and wind forces. Present study deals with the seismic performance of irregular RC buildings with different types of vertical irregularities. The analysis of irregular buildings was carried out using ETABS software for various irregularities given in UBC 97. The response spectrum analysis was used for performing the dynamic analysis of the structures. Seismic analysis as per UBC 97 was followed. This study meets one of the SDGs (Industry Innovation and Infrastructure) announced by UN. The main purpose of our analysis is to build quality, reliable and resilient infrastructure to support sustainable development. Four vertical irregularities were investigated. a) Stiffness irregularity-soft storey, b) Weight (mass) irregularity, c) Vertical geometric irregularity, and d) In-plane discontinuity in vertical lateral-force resisting element. Results are compared with and without dynamic analysis recommended for the irregularities in buildings. It is found that maximum increase in moment by incorporating the analysis guidelines for vertical irregularities is 10%, 15%, 47% and 48% for Type-1, 2 ,3 and 4 respectively than moments for analysis without incorporating the recommendations for vertical irregularities.

FEASIBILITY OF USING WATER TREATMENT SLUDGE IN MANUFACTURING OF ECOFRIENDLY BRICKS

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Sludge is a by-product of water treatment plants and dumping it has always been an issue of concern. In some countries, it is dumped in rivers and used in landfills as well. Studies are being conducted in many countries for incorporating WTP sludge in different construction materials like concrete and bricks. The aim of this study, is to determine the feasibility of using WTP sludge as a main ingredient in the manufacture of eco-friendly bricks.

Clay has been used for preparing bricks for centuries in almost every part of world especially in the Sub-Continent. As the time is passing, the demand of bricks is increasing since more housing is required to accommodate the rising masses of people. However, conventional clay brick manufacturing has a lot of drawbacks including its adverse effects on the environment. To cope with this situation, new resources have to be introduced for manufacturing of non-conventional bricks. The main purpose of this study is to assess the effects of using water treatment plant sludge of French WASA Treatment Plant Faisalabad in the manufacturing of ecofriendly sludge bricks along with fly ash and cement. This proposal aims to use vibratory table for vibration and normal curing methods for preparing construction bricks instead of burning (which is one of the causes of environmental pollution) or applying hydraulic pressure by means of compression machine i.e., an uneconomical approach for preparation of bricks. Different samples were casted by changing the compositions of cement and fly ash while keeping the sludge content constant at 50%. Bricks manufactured yielded satisfactory results for compressive strength test, water absorption test and efflorescence test.

DEVELOPMENT AND FEASIBILITY ANALYSIS OF ENVIRONMENTAL-FRIENDLY ASH BRICKS

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This project comprises making eco-friendly bricks out of ashes of raw materials. Raw materials that we used are Fly ash, Cement, Sand, and Gypsum. The feasibility of making bricks from ashes is studied and the optimum ratio and water content for making bricks are finalized. The compressive strength of bricks is examined by changing the composition of the mix to make them compatible with the standard strength of bricks. Tests like water absorption are also done to check the durability of bricks. The research concluded with the remarks that un-burnt Fly ash bricks are an alternative material to existing burnt clay bricks as it shows comparable mechanical and durability properties when compared to existing burnt clay bricks. The purpose of the project was to achieve United Nations' sustainable development goals. Climate change is one of the most important problems on earth. By making fly ash bricks, we can save the earth and also can save the energy consumption that is used in the production of burnt clay bricks.

APPLICATIONS OF WEB-BASED TECHNOLOGIES IN CIVIL ENGINEERING

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This piece of work deals with the applications of web-based technologies in civil engineering. Web-based technologies are internet based interfaces that can be accessed by anyone anywhere in the world having a device with internet connection. Web-based interfaces use as simple as an excel spreadsheet or a programming language to make computations and solve any kind of problem. In civil engineering, web-based technologies help in automating the time consuming analysis and design processes. Once a web-based interface is ready, it is just needed to input the required parameters, the output would be generated in no time. In this project, a web-based interface is prepared for concrete mix design using ACI 211.1-1991. Once the required input parameters are inserted in this web-based interface, it will automatically generate the concrete mix design ratio as the output. The formulated interface also generates a concrete mix ratio from the analytical data of concrete laboratory of civil engineering department UET Lahore. In the end few mix design problems are solved both manually and using the interface and it is verified that mix design ratio is same for both.

NUMERICAL SIMULATION OF PRECAST CONCRETE PIPES

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Concrete pipes are used for carrying sewage, storm water and as culverts for the water mains. They can be cast in-situ with different design mixes providing for the required strength, serviceability and durability meeting the desired purposes. Numerical Simulation has the wide range of significance regarding the comparison with the experimental analysis. It is an effective approach to deal the elastic as well as plastic assessment of concrete pipes using finite element analysis (FEA). The consideration of economy, time factor, extensive labor and the use of resources are enormous in case of experimental testing for concrete pipes which has been compensated by the numerical simulation techniques.

In this study, ABAQUS was used for the modelling of different concrete pipes aligning with the objectives of the project. The simulation of Reinforced Concrete Pipe was carried out by modeling it in ABAQUS for the vertical displacement at crown and it was compared with the analysis done for the concrete pipe experimentally, having the same material and physical properties. Three more RCC pipes were modelled with the change of steel grade for vertical displacements and stresses at the crown and were compared to determine the variations because of the different grade of steel.

For the creation of models, the reinforcing bars were selected 3D wire planner with truss section. The reinforcing bars and concrete interaction was carried by embedding the bars into the concrete. The lower bearings were defined 3D solid deformable and it constituted rectangles and quarter circles. The upper wooden beam was defined for 3D solid deformable and assigned with the required material properties. The loading applied to the model was pressure loading and three edge bearing test was performed for the designed model.

After the modelling, as required, the results were computed for the defined objectives. The results gathered the knowledge of the variation of the vertical displacements value between the simulation and experimental analysis of the concrete pipes. The comparison of the three concrete pipes with different grades were also determined on the basis of vertical displacements and stresses at the crown. Conclusions and discussions were made to concise the objectives required with the project and the percentage of accuracy we obtained with the analysis.

This project will be significant on a national and international scale since the latest generation is centered on more precise, cost-effective, time-friendly, and accurate methods of computing results achieved using simulation techniques. Also, it will enable a medium to be easily assessed by the designer for optimizing various designs with both accuracy and precision.

DESIGN OF STEEL INDUSTRIAL BUILDING WITH CRANE RUNWAY GIRDERS IN LAHORE REGION

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Since the steel structures is an important division of structural engineering, the study implies all the advancements in the respective division. The design of steel industrial building is integral to understand most of the complexities and technicalities that the very branch inculcate. This design not only encompasses the detailed structural calculations done manually in case of foundation design but also the use of the latest computer-aided software. The study elaborates the application of moving load analysis that is included in the chapter of Design, done to investigate the reactions as a result of moving crane. It also details non-linear analysis to study the behavior of bracings under tensile stress. Detailed model development is also described in the thesis with the aid of AutoCAD. AISC code ASTM 7-05 is applied for wind load analysis. Universal building code 97 has been applied for seismic analysis. Readers can understand the design of connections also as the contemporary computer-aided program Ideastatica has been used to design bolted connections and in the design of gusset plates. Furthermore, the design of pedestals is also encompassed and has been done on SPcolumns. Keeping in view the implications of differential settlement plinth beam is also designed using SAP-2000. Evidently, the writer has endeavored to compose a thesis that incorporates not only the use of software but is also backed by solid manual calculations and detailed flow charts for the service of discipline.

DURABILITY PERFORMANCE OF PRE-CAST CONCRETE PIPES

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Water sewer line and water distribution system is one of the major infrastructure asset for sustainable community. Durability of precast water sewer network is key parameter to ensure continuous facility to end users. Therefore, it is utmost important to develop durable sewer concrete pipelines to ensure the reliable, sustainable, and cost-efficient transport of water and sewerage for safety of society. This project investigates the effects of sulfuric acid attack on the concrete samples prepared with different concrete mixture proportions incorporating fibers. Different mechanical and durability tests were performed to evaluate the performance of precast concrete pipes. Sample were exposed to different concentrations of acid attack and normal water up to 28 days. The mass loss and strength loss caused by acid attacks and under normal curing was evaluated. In addition to the compressive strength test, the UPV test and rebound hammer test was also performed on the concrete samples, which were cast using different concrete mixes. Four sulfuric acid solutions with different percentages of 1, 3, 5, and 7% sulphuric acid were used to cure the samples. The samples were cured in these solutions and tested at the age of one day, three days, fourteen days, and twenty-eight days. The change in mass and the loss in strength in the samples were observed. The loss in these parameters was found to be increasing with the exposure time the samples to the sulphuric acid. Furthermore, the results showed that the compressive strength is increased with the addition of fibers. More dosage of fibers leads to more strength. The non-destructive tests like rebound hammer and ultrasonic pulse velocity also strengthened the findings of mass loss and strength loss. Hence, it can be argued that durability of precast concrete pipes with durable concrete material ensures the development of sustainable community. Out of all the sustainable development goals (SDG) of the UN, our research targets “Clean Water and Sanitation” (6), “Decent Work and Economic Growth” (8), and “Industry, Innovation and Infrastructure” (9).

INVESTIGATION OF MECHANICAL CHARACTERIZATION OF FIBER REINFORCED POLYMERS (FRP) PIPES

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Parallel Plate Load Test

Tension Test

A fiber-reinforced polymer, or FRP for short, is a composite material made of fibers, resins, fillers, and additives. FRP's mechanical properties are enhanced by the high elastic modulus of the fibers. FRP offers excellent mechanical qualities that improve stiffness, strength, pressure capacity, durability, cost-benefit, and environmental impact. They are widely used among the work in many chemicals , petrochemicals, and refining industries and due to its reliability and structural properties it can be used in water supply and sewerage industry in Civil Engineering. Following experimental research, several specimens for compression, tension, flexural, and stiffness testing were prepared in accordance with standards. Although they lack the quality assurance to be utilized reliably in either buried or open situations, they are nevertheless in use in our nation. More and more pipelines are being deployed globally to address rising transportation needs for strategic fluids while also reducing prices. However, due to a lack of research, quality assurance is not concentrated in this area.

Two distinct specimen types with different cores were tested. It is more dependable to utilize the specimen that depicts greater stiffness since the specimen with a core strength of 410 kPa exhibits less stiffness than the specimen with a core strength of 2010 kPa. The specimens underwent tests for tension, compression, and flexural tests. In the event that data on the pipe's pressure is available, the computed values can be applied to the pipe. If information for ensuring the quality of fiber-reinforced pipes (FRP) based on the body of existing literature was accessible. It might be used to establish a trustworthy orientation for the pipe's starting.

The experimental outcome of the study reveals the mechanical significance of the FRP pipes and data for quality assurance.

INVESTIGATION OF MECHANICAL PROPERTIES OF CNT-PPF REINFORCED SCBA BLENDED CEMENTITIOUS COMPOSITES

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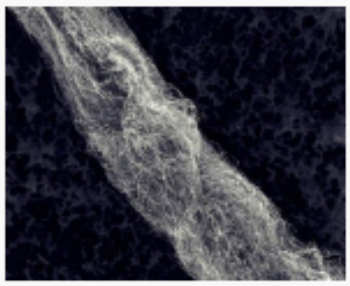

During the past decade, research has been carried out on the incorporation of carbon nanotubes as reinforcements in cementitious composites to achieve improvement in performance at a nano level, where the cracks begin to initiate. However, the mechanism by which the CNTs reinforce and impart their properties to the cementitious composites remains incomprehensible due to flexibility in its dispersion, bonding, and manufacturing process. The primary goal of this research study was the development of CNT reinforced cementitious composites incorporating supplementary cementitious materials as partial cement replacement along with microfibers as reinforcements to produce strong, sustainable, and eco-friendly composites. Furthermore, the effect of variation in concentration of CNTs while keeping the SCMs and microfibers constant was studied. Our research used sugarcane bagasse ash as a partial replacement and polypropylene fibers as microfibers. Five different design mixes were developed keeping cement replacement and fiber content constant while varying the CNTs concentrations. The samples were tested for various mechanical and durability properties i.e., compressive strength, flexural strength, impact strength, water absorption, and ultrasonic pulse velocity. The findings of our research work stated that the mix with optimum compressive strength incorporated 15% SCBA as partial cement replacement, 1.5% PPF by weight of cement, and 0.08% CNTs by weight of cement. The compressive strength and flexure strength decreased with the initial incorporation of CNTs i.e., 0.04% by weight of cement and then it increased with the increase in CNTs content to 0.08% by weight of cement. The impact strength results stated that the control mix had the optimum strength, however, the strength increased with the increase in CNT concentration which should be further investigated. Water absorption and UPV results in turn supported the findings of mechanical strength tests on our specimens. This study proved that with the incorporation of CNTs, SCBA, and PPF, without any compromise on compressive strength, sustainable and eco-friendly cementitious composites can be developed.

EFFECT OF DIFFERENT CURING TECHNIQUE ON THE STRENGTH OF CONCRETE

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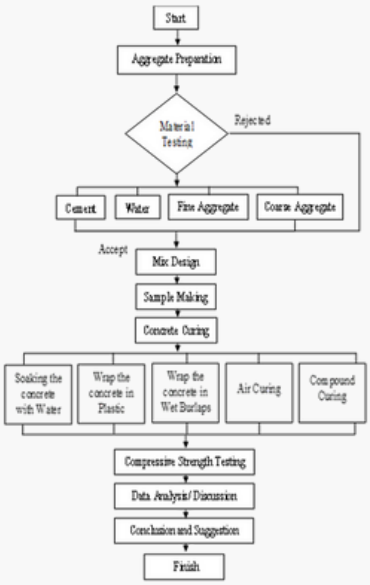

Concrete is a mixture of coarse and fine aggregates bonded together with cement paste. Concrete is the cheapest construction material known for its strength and durability all over the world. Concrete gains its strength due to the process of hydration which is accelerated by proper curing of concrete.

This study reports the effect of different curing techniques on compressive strength. A total of 20 cylinders of mix ratio 1:1.5:2.84 with a slump of 75-100mm were casted at an average temperature of 25 ˚C (77 ˚F). The cylinders were subjected to different curing techniques such as water ponding, wet burlap, plastic bags, chemical curing, and air curing.

The results revealed that other than water curing chemical curing and wet burlaps bag curing provide satisfactory curing when compared with water cured samples using ponding technique. Air and plastic sheet curing did not provide satisfactory results and hence not recommended

PERFORMANCE EVALUATION OF GROUNDWATER RECHARGING WELLS IN LAHORE

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Lahore is second largest city of Pakistan mainly rely on groundwater reserves for domestic, commercial & industrial purposes. Higher abstraction rates to meet increasing demands are continuously depleting the ground water table. The abstraction rate of groundwater in Lahore has increased to 540 MGD (2.45 MCM) in 2018 from 44.6 MGD (0.2 MCM) in 1960. Now a days, many Managed Aquifer Recharge (MAR) techniques are being used to decrease the groundwater depletion rates like infiltration galleries, and recharging wells etc. Different agencies have installed recharging wells at various locations in Lahore whose inflows and piezometric data are being collected by flowmeter and piezometer installed by various agencies. Some of these agencies include World Wild Life Fund (WWF) Pakistan, Punjab Irrigation Department, Environmental Sciences Department, Punjab University, Lahore, PCRWR Lahore, and CEWRE UET Lahore. This research aims identifying the locations where these recharging wells have been installed in Lahore, investigating their working condition, assessing their recharging volume and proposing measures to restore the inactive recharging wells. The difference in groundwater table depths with and without recharging well situation was predicted. The study shows that if the same urban development trends prolong, it will render groundwater system unsustainable as the groundwater recharging sources more or less remain at the same level while the abstraction rates continue to increase day by day.
The gap between inflow and outflow is continuously increasing which is resulting in the depletion of groundwater storage. To overcome such rapid decline of water table, there should be rain water harvesting through recharging wells in Lahore city. The current study highlights the importance of groundwater refueling by series of recharging wells in order to minimize Lahore's water depletion rate.

DESIGN OF PAVEMENTS INCORPORATING A STABILIZED SUBGRADE

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Constructing structures over soils possessing poor geotechnical characteristics is a challenging task for civil engineers. The present research work evaluates the effect of Brick Kiln Waste on the poor subgrade soil properties and the thickness of pavements. Sample of soil was collected from Quaid e Azam Business Park Lahore-Islamabad Motorway (M-2) Sheikhupura, Punjab. Laboratory tests were carried out to evaluate and classify the collected soil sample. According to experimental results, the sample showed the soaked CBR value less than 7%, thus it has been used in this research as a poor subgrade. Brick Kiln Waste has been used to stabilize the soil and geotechnical properties of stabilized soil were studied in detail. For this purpose, an experimental program was carried out to stabilize clayey soil with the Brick Kiln Waste ranging from 10 to 30% of dry weight of the soil and its effect on the soil strength has been analyzed. Laboratory testing involving sieve analysis, hydrometer analysis, liquid limit and plastic limit, modified Proctor test and California bearing ratio test were carried out on the soil. The results showed that the clayey soil became coarser and more suitable as a subgrade material with the addition of the Brick Kiln Waste. California bearing ratios of untreated and treated soil have been compared to check the effect of Brick Kiln Waste on soil properties of the stabilized soil.

This study showed that clayey soil stabilized with Brick Kiln Waste could be used as a good subgrade for pavements, highway embankments, and foundations of buildings. For this purpose, flexible and rigid pavements design on untreated and treated subgrade have been carried out according to AASHTO guidelines.

This research encompasses Sustainable Development Goal (SDG) No. 9 (Industry, Innovation and Infrastructure).

DESIGN OF ROOFTOP RAINWATER HARVESTING SYSTEM FOR 5, 10 AND 20 MARLA HOUSES IN LAHORE

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Pakistan is facing serious water issues. It is currently classified as water scarce country as the annual per capita availability of water has fallen below 1000 m^3/capita. The groundwater resources are experiencing a high level of stress due to growing population. Groundwater levels have been declined up to 40 m below the earth's surface in the study area (WASA, 2011). Ground water pumping has been increased substantially and due to improper sewerage system of cities, flood inundation has also been increased. Considerable amount of rainfall (mean annual rainfall > 60 mm) makes rainwater harvesting a logical solution to reduce pumping of ground water and flood inundation.

Data from various sources was used for this study, which aims to "Design of Rooftop Rainwater Harvesting System for 5, 10 and 20 Marla Houses in Lahore" which includes the calculation of; (1) annual rooftop rainwater harvesting potential, (2) rooftop runoff, (3) number and diameter rooftop rainwater discharge pipes, (4) flushing tank volume, (5) storage tank volume and (6) storage capacity in terms of days for specific number of person in house having specific amount of Mean water consumption.

The analysis of rainfall data showed that pattern of rainfall in Lahore is of erratic nature but there is significant potential for implementation of rooftop rainwater harvesting systems in Lahore. The results of analysis of rainfall data from 1991 to 2020 shows that; Mean annual precipitation in Lahore is 687.2 mm, maximum daily precipitation in Lahore is 189.7 mm which occurred on 23rd August 1996, Mean maximum daily precipitation is 93.7 mm and maximum daily intensity of rainfall was observed 70.71 mm/hr. in Lahore on 23rd August 1996.

The results of "Design of Rooftop Rainwater Harvesting System for 5, 10 and 20 Marla Houses in Lahore" gives; mean annual rainwater harvesting potential of 65.181 m^3, 121.672 m^3 and 225.962 m^3, number and diameter of rainwater pipes are 2 (100 mm), 4 (100 mm) and 3 (150 mm), volume of storage tank as 17 m^3, 31 m^3 and 56 m^3, volume of flushing tank as 0.095 m^3, 0.177 m^3 and 0.329 m^3 for 5, 10 and 20 Marla houses respectively.

This study falls under United Nation's standard development goal (SDG) no. 06 Ensure availability and sustainable management of water and sanitation for all.

DESIGN OF FOUNDATION SYSTEM OF SELECTED MULTISTOREY BUILDING FOR MULTIPLE LOADING UNDER DIFFERENT SOIL CONDITIONS

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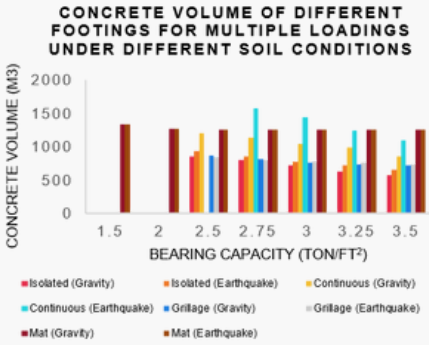

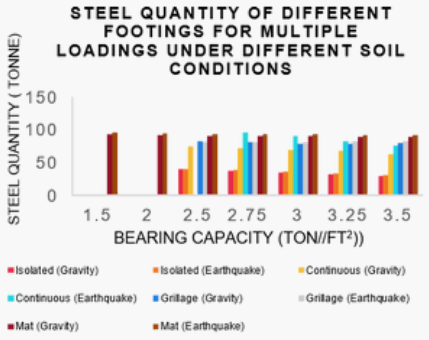

In this era of inflation, everyone wants to reduce the overall cost of building as much as possible. As, the Foundation is an essential part of building which covers the most part of overall cost. It should be design in such a way that it must provide full stability and costs minimum. In this project, different types of foundations are designed under different conditions, so that a stable and economical type of foundation can be selected. Although a substantial work being done on foundations over the years, the uncertainty in the knowledge and information in the fieldof economical design of foundations still exists. In this study, both manual and computer aided analysis and designs were performed on different foundations to see which foundation system provides economical results under specific conditions. the results of both manual and computer aided design are compared with each other for accuracy and precision. On the basis of these design, steel quantity and concrete volume are estimated for different types of foundation and a comparison of different footings is made that shows us that at certain value of bearing capacity, which foundation system should be preferable and how much material can we save which will ultimately reduce the cost of construction. This compiled information would be used as a reference and will help a lot the designers to produce economical and very efficient design of foundation of multistory buildings for various conditions.

INVESTIGATION OF THE CAUSES AND IMPACT OF REWORK ON PERFORMANCE OF PROJECTS OF PAKISTAN

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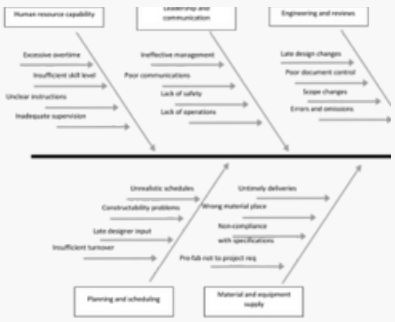

The construction industry plays a major role in the development of a developing nation like Pakistan. Ineffective construction management practices at the site obstruct the process of development by resulting in severe direct and indirect damages experienced due to rework. Thus, the purpose of this file is to identify the critical factors causing rework and their impact on project performance in terms of time, cost, and quality. Through extensive literature review, the authors selected potential factors causing rework in the construction environment such as that of a developing nation like Pakistan. Data is collected through an extensive questionnaire and the Likert scale is used for the analyses of the factors. Significance and Ranking of each factor have been assigned through the Relative Importance Index and t-test, and statistical difference between factor category groups is analyzed. Frequent changes during construction come out to be the most critical factor causing rework as given by the Relative Importance Index (RII) among 30 factors derived from the literature review while wrong information provided by the client is the most critical factor based on impact on time and cost. Recommendations are given in the end based on the results of the data analysis techniques. Skilled workers for construction and proper planning and scheduling of project activities before the execution of the project are highly ranked strategies for mitigation of rework. The findings of this study may contribute toward reducing rework and improving project performance in the construction industry of Pakistan and other developing nations of the world. In September 2015, the General Assembly adopted the 2030 Agenda for Sustainable Development which includes 17 Sustainable Development Goals (SDGs). Building on the principle of “leaving no one behind”, the new Agenda emphasizes a holistic approach to achieving sustainable development for all. Through a broad study on rework, we have achieved some sustainable development goals like Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Sustainable Cities and Communities, and Climate Action.

STRENGTHENING OF CLAY USING INDUSTRIAL WASTE

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It is necessary to use strong soil in civil engineering projects to enhance the response of the soil. The goal of this study was to use industrial wastes such as Bottom Ash and Fly Ash to strengthen cohesive soil. Geotechnical parameters of the soil samples were compared to those of the soils that had been strengthened by the addition of bottom ash and fly ash to examine the influence of these wastes on the soil. On the native and stabilized soil samples, the following tests were carried out; Sieve analysis, hydrometer analysis, the Atterberg limits tests, modified Proctor test, unconfined compressive strength (UCS) test and California Bearing Ratio (CBR) test. Soil strength was boosted by the addition of industrial wastes such as bottom and fly ashes. This means that bottom or fly ash may be utilized to strengthen cohesive soil. On the basis of the results which are obtained during this research, it is recommended for the future studies that bottom ash should be preferred as a strengthening agent for the clays. Overall, as well as meeting some of the standards set for road pavement applications, the results obtained from this research are very promising for the ongoing discussions on the assessment of weak subgrade using different stabilizing agents.

DEVOLPMENT OF ROCKFALL HAZARD FOR KARAKORAM HIGHWAY (KKH) ASSESSMENT FROM THAKOT TO PATTAN

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All developed countries like USA, Europe and developing countries like India have developed a rockfall hazard rating system for their region. Pakistan is lagging behind in this respect. Pakistan has not developed a rockfall hazard rating system so far. As an initiation for this effort of developing a rockfall hazard rating system for Pakistan, a certain length of Karakoram Highway (KKH) is selected for current research. Poor geology of the area combined with sever rainfall makes it prone to rockfall around the year since its completion. Current study deals with the rockfall hazard analysis for existing route based on Pearson's RHRS method, eventually identifying the areas of high hazard. The main aim is to develop a rockfall hazard rating program tailored for KKH from Thakot to Pattan bridge. In this terrain, high hazard areas are mostly morainic deposits and brecciated rocks, and areas near seismic structures zones.

STRUCTURAL PERFORMANCE OF PRECAST CONCRETE PIPES

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Concrete pipe is the essential component in the sewerage system for transfer of sewage to disposal point without any leakages. This study was aimed to access the structural performance of full-scale precast pipes manufactured at local industrial plant. The manufacturing of these full-scale pipes was through spinning method. Three edge bearing load test was performed on 450 mm diameter pipe. Steel fibers were also utilized along with conventional rebar cage. Rebound hammer test was also performed on inner and outer surface of the pipe to evaluate the strength variation in the casted pipes. It was observed that strength was varied along the length of the tested pipe and also at the inner and outer surface due to casting methodology adopted and workmanship issues. It can be argued that the use of steel fibers along with conventional rebar cage improved the cracking behavior and ultimate load carrying capacity of the pipes.

CONCRETE MIXTURE DESIGN FOR PRECAST CONCRETE PIPES

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Spun casting is the oldest method of manufacturing precast concrete pipes among all existing methods. While improved concrete mixtures incorporating fibers for other methods of concrete pipe manufacturing, such as vibration method and roller compaction method, have been developed, no such concrete mixture has yet been developed for the spun-cast concrete pipes. This study was planned to explore the potential of incorporating locally manufactured steel fibers and commercially available polypropylene fibers to develop an improved concrete mixture for use in the manufacturing of full-scale spun cast concrete pipes. Various dosages of steel fibers and polypropylene fibers were used The flexural performance of the fiber-reinforced concrete mixtures was superior to the control mixture without fibers in terms of flexural strength, toughness, ductility, and crack control. The addition of fibers resulted in reduced water absorption and sorptivity, potentially enhancing the durability of the concrete.

DVELEOPMENT OF ROCKFALL HAZARD RATING SYSTEM FORM PATTAN TO DASSU

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Rockfall hazard maps are essential to avoid and reduce rockfall hazards in the area. Karakorum Highway is one of the essential economic routes in the Northern areas of Pakistan. Rockfall happens regularly in the area and can damage local livelihoods and living conditions. Therefore, the problem of rockfall hazard and its reduction for the sustainable development of this area is significant. The finding of hazard assessment in this region is essential to face this development challenge. This thesis shows the applying of geographical information systems (GIS) and methods to find rockfall hazards in the rough Mountainous region of Pattan TO Dassu. The study area is located along Karakorum highway KKH where severe rockfalls take place regularly and provide a serious threat to local living conditions. The rockfall is mainly caused by torrential rain during Monsoon and Western spells, leading to the Highway barricade. Two 10 days site visits were conducted to collect data and make observations. The first visit was divided into 14 sections based on changing the geology. In the next visit, values of all parameters were noted at the site. Also, samples were collected from high hazard areas and tested in the laboratory. In the end hazard for each section was calculated based on Pierson RHRS. Then hazard maps were developed for the study area.

CRITICAL SUCCESS FACTORS FOR STAKEHOLDERS' MANAGEMENT IN CONSTRUCTION PROJECTS OF PAKISTAN

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A stakeholder is someone who cares about how a project goes or what happens at the end of it. Construction project management usually includes any or all of the following people as stakeholders: the client, contractors, designers, subcontractors, and people who work on the project. Construction project management in Pakistan seems to be one of the main issues. If stakeholders aren't good at managing the project, the chances of it working out are much lower than they should be. People who are involved in a construction project have a big impact on how well the project works and successfully ends as they communicate and work together. In a country like Pakistan, where the economy is still in its infancy, the construction industry is critical. The failure of construction projects can be caused by ineffective stakeholder management techniques at the construction site. Thus, the purpose of this study is to identify the most important aspects influencing Stakeholder Management in the construction business. The authors conducted a thorough literature analysis to identify elements that could affect stakeholder management in a developing country like Pakistan. A thorough questionnaire is employed to gather data, and a Likert Scale is then used to analyze the various elements. Additionally, data about the organization's current stakeholder management practices are gathered. The Relative Importance Index and One-Way ANOVA tests are used to determine the significance and ranking of each element, and the statistical differences between the three groups are examined. Stakeholder management is influenced by 70 factors listed in a literature analysis, and project mission formulation is the most important of these. Using Factor Analysis, four categories of factors have been found, and the most important one is Stakeholders' interests and relationships. Ultimately, recommendations are made based on data analysis techniques and current Stakeholder Management practices in the firm. To improve the building sector in Pakistan and other developing countries, the findings of this study may be useful.

ANALYTICAL COMPUTATIONS USING MATLAB FOR GEOPOLYMER CONCRETE BEAMS WITH STEEL FIBERS UNDER FLEXURAL LOADING

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The aim of the study is to analytically investigate the mechanical behavior of beams under flexural loading. For this purpose fiber-reinforced fly ash geopolymer concrete (GPC) has been investigated and the effect of different percentages of fiber by volume mixtures like 0.25, 0.5, 0.75, and 1% on the compressive strength and flexural strength has been studied. When considering material non-linearity failure of the specimen make hand calculations too lengthy. Hence Matlab code has been developed. In total, one ordinary Portland cement beam and five geopolymer concrete beams with different percentages of steel fibers are under investigation. Beams are analyzed with varying diameters of steel fibers and varying lengths to get the maximum strength. Moment and curvatures at different stages like cracking point, yielding point, and ultimate point are noted. The moment-curvature curves are prepared using Matlab code and then load-deflection curves are obtained from moment-curvature curves. Comparison is made with experimental curves from a reference research paper. Using moment-curvature curves obtained theoretically it is concluded that, a geopolymer concrete beam with 0.375% fiber gives maximum strength, as it shows maximum moment capacity.

DEVELOPMENT OF MACHINE LEARNING MODELS FOR APPLICATIONS IN CIVIL ENGINEERING

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Concrete is most widely used construction material and requires extensive laboratory testing to ascertain its field properties. This is laborious, time consuming and costly practice. Machine learning and other artificially intelligent methodologies have made many things simpler by using past data to predict future outcomes. A model on machine learning using python is made using multi-linear regression using extensive past data set of compressive strength laboratory tests on concrete specimens against proportions of mix design. 80% of the data set is used for model training and 20% data set is used to test the model. The model makes prediction of the actual compressive strength of concrete with varying proportions of mix design. This model is quite accurate as the accuracy of the results predicted and those found from the laboratory tests ranges from 88% to 98%. The R2 value is 88%. This model paves way to use machine learning models to ascertain other material related properties for use in civil engineering projects when sufficient data is available to train the model. To use ML models on commercial scale, one first needs to have the sufficient data of past experiments to render the model accuracy acceptable.

EXPERIMENTAL INVESTIGATION OF PERMEABLE PAVEMENTS

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Lahore is facing great environmental challenge in respect of its groundwater table level, which is declining at an alarming rate of 2-3 ft per year. One of the major reasons for the groundwater level decline is increased impervious surfaces in the city (because of pavements, houses, industries, etc.) that reduce the groundwater recharge. Pervious (or porous) pavements are gaining importance as a low-impact-development (LID) alternatives in developed countries. Such pavements differ from traditional pavements in respect of strength and permeability. Usually, pervious pavements have relatively less strength, and as such are only recommended for light traffic or for shoulders of the highways. Their use is recommended at places where groundwater recharge need to be enhanced. Pervious pavement can be made through variety of materials, such as cement-based materials and/or bituminous materials. This study aims to carryout physical testing for various combinations of cement and bituminous materials and to recommend suitable mix to be used for pervious pavements in Lahore climatological conditions. Literature review reveals that the strength and permeability of porous concrete depend on aggregate to cement (A/C) ratio, water to cement (w/c) ratio, aggregate size, type and compaction efforts on concrete. The strength of composite pervious pavement is not just based on concrete, it also depends upon the soil (base or sub-base) underneath the pavement layer. This research concludes that for a target strength of 14 MPa and infiltration rate of 20 mm/hr (corresponding to maximum rainfall intensity of 50 years return storm), an aggregate to cement (A/C) ratio of 4:1 with water to cement (w/c) ratio of 0.36 yields sufficient strength with satisfactory permeability. Cost of such mix is estimated to be Rs. 11,000/ m^3 at market rates of May 2022. The study will help the developers enhancing the use of the pervious pavements, for shoulders, parking places, paths ways etc.

APPLICATION OF COMPUTATIONAL FLUID DYNAMICS FOR MODELLING HYDRAULIC STRUCTURES

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Flows around hydraulic structures are multifaced. To understand the flow phenomenon taking place around hydraulic structures scientists and engineers have relied on physical modelling in which a replica of original structure is prepared and observations are collected form that model. Presently also physical modelling is considered as a reliable method of understanding and predicting flow behaviors. Among drawbacks of physical modelling are its cost, requirement of ample space and scale effects etc.

Computational fluid dynamics also popularly abbreviated as CFD is relatively a newer technique for flow modelling. It has developed with the advancements in computational power after the invention of computers. Almost all the CFD codes are based on the solution of Reynold's averaged Navier Strokes (RANS) equations. Navier strokes equations are differential equations which are derived based on continuity and conservation momentum. Time averaging the instantaneous velocities gives the RANS equations. These equations based on physics of flow phenomenon can be applied for modelling fluid flow behaviors. Earlier the CFD gained popularity in aerospace industry in 1960s and later on in other fields including hydraulic engineering.

Various solvers are available commercially to solve the RANS equations. In this project components of ANSYS® is utilized for modelling. ANSYS® is a commercially available software of which a student version is available as an open source program.

Flow over a reduced scale physical model of Terbela dam spillway is observed and recorded. Geometry and flow domain as in lab is transferred to ANSYS® to solve it. Results obtained in lab and CFD model were almost similar. This show CFD can be reliably used for modeling hydraulic structures. It can replace the physical modelling technique which is relatively expensive technique.

EFFECT OF MICRO PLASTIC & METAL WASTE ON MECHANICAL PROPERTIES OF CONCRETE

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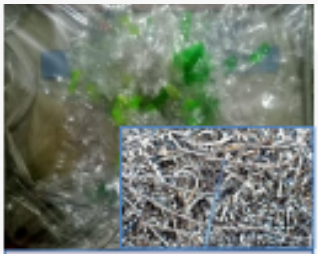

Plastic & Industrial wastes

Wastes in concrete mixer

Curing of Concrete Test Samples

Flexural test in progress

Disposal of the waste materials has always been a problem in industry as well as at common level. The best way seems that such materials be utilized in a useful way. The basic purpose of this research lies in the utilization of these hazardous wastes and also it can benefit to increase the strength of concrete. In this context, the following research is done to study the effect of steel scraps and plastic waste on the mechanical properties of concrete. PET (Poly Ethylene Terephthalate) bottles and cans are mostly discarded after a single use, creating disposal issues. Same is the case with industrial metal wastes that creates the same problem causing serious environmental impacts; too. This study reports an experimental work in which PET bottles were shredded and used as additives in concrete at various replacement percentages by weight of cement and also the industrial wastes obtained from the lathe machine were utilized to be used in concrete; each waste in isolation and in combination . Plastic waste was obtained from plastic PET bottles and the steel scraps was obtained from the Lathe Machine present in the workshop of the University of Engineering and Technology, Lahore. Plastic bottles were cut into small pieces of different sizes ranging from 10mm to 30mm in length and 5mm in width. The target strength was 15MPa. These wastes were mixed in the concrete mixture in varying proportions of 3%, 5%, 7%, and 10% by weight. The same approach was adopted for industrial waste. These tests were carried out at different percentages of wastes for 7 days, 14 days and 28 days. It was observed that addition of plastic and steel scrap increase the strength of concrete but up to a certain limit. Further addition of these additives makes concrete less durable and workable. Optimum range of plastic is between 0% and 3%. However according to previous research on this project, the most feasible plastic content is 1%. Addition of steel scrap increase concrete's strength. Strength is increased till 7% and then decreases, which shows that changing point is 7%. When both steel and plastic are added, max. strength was shown by those samples having equal percentage of steel and plastic, however the recommended range is between 0% to 5%, as below this range strength reduces significantly. Based on the observations made and experimental results, following

CONDITION ASSESSMENT OF EXISTING PRE-CAST CONCRETE PIPES

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One of the most significant and critical urban asset for a sustainable community is sewer pipeline network and water distribution system. Water sewer network and distribution systems have a definite service life span to provide continuous facility to end users. Therefore, it is pertinent to continuously evaluate the condition of water and sewer concrete pipelines to ensure the reliable, sustainable, and cost-efficient transport of water and sewerage for safety of society. The condition assessment commonly carried out by visual observations followed by some destructive or non-destructive testing methods. However, it is need of the hour to shift our assessment method to advance assessment techniques to save time and money for our community. Currently, in this project, the condition assessment of concrete pipes was carried out through trivial methods (destructive and non-destructive). Various test i.e., ultra-sonic pulse velocity, rebound hammer test, visual inspection, three edge bearing test, and core cutting test on the old buried and new pipes were performed. It was observed that concrete used for construction in existing precast concrete pipes still has better quality after a span of 20 years. However, steel has deteriorated with the passage of time and clear corrosion of steel was identified in existing pre-cast concrete pipes. At the same time, it was observed that there should be an automated mechanism to continuously asses the condition of pre-cast existing pipes which will address the sustainable development goals (SDG 6, 9, 11). It was suggested to develop an innovative automated method (i.e. automated scanner test, robotic sensor test) to assess the condition of pre-cast pipes. Hence, it can be concluded that condition assessment of pre-cast concrete pipes will lead towards sustainable societies and infrastructure.

LABORATORY EVALUATION OF GEOMECHANICAL PROPERTIES OF GRANULAR SOIL STABILIZED WITH SHREDDED RUBBER

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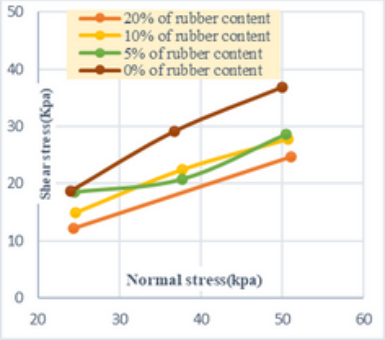

The increased amount of scrap tires is becoming an enormous concern. The large stockpiles cause environmental, contamination, and health issues due to their non-biodegradable nature. Therefore, effective use of scrap tires is the need of the hour to minimize the severity of these issues. Several studies have been carried out in order to ascertain if tire shreds can be used to improve the strength of granular soils, which can be helpful in used in mechanically stabilized earth walls (MSE), earth embankments, and landfills. But using scrap tires for increasing the shear strength of sand requires a sound knowledge of the size of tire shred and mixing the appropriate ratio of tire shred with sand. This research presents several standard proctor compaction tests results performed on sand samples mixed in different proportions with tire shreds from which various geotechnical properties like optimum moisture content, maximum dry density were determined. The results indicated that shredded rubber tires did not effectively play its role in increasing the shear strength of sand. For further conformation, direct shear tests were conducted on mixtures of dry sand and shredded rubber with different proportions of shredded rubber. It has been observed that adding elastic materials like small pieces of scrap tires in sand will increase the cohesion by a negligible amount but overall shear strength of sand reduces. The reason for this reduction in strength is due to the fact that rubber particles reduces friction between sand particles.

CONCRETE MIXTURE OPTIMIZATION FOR SPUN-CAST CONCRETE PIPES

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The use of proper storm sewers and culverts is essential to keep our cities functioning, clean, and safe. Reinforced pre-cast spun concrete pipes play a major role in it.Locally the range of different mixtures that companies follow gives an output with low strength concrete mix design which will shorter the life span of Spun Concrete pipes. This study aims to optimize the water-cement ratios using a super-plasticizer which reduces the use of water and adds fiber to come up with the best Concrete mix design for RCC spun pipes. Using ACI guidelines, the mix proportions of various factories manufacturing spun cast concrete pipes locally will be explored to study the mechanical and absorption properties of various concrete mixes suitable for Spun cast concrete pipes. The addition of super-plasticizer improves the workability of concrete and fiber helps the concrete to obtain higher strength. Results will investigate different concrete mixes with various water-cement ratios, sources of sand & gradation of coarse aggregates.

In September 2015, the General Assembly adopted the 2030 agenda for sustainable development that includes 17 Sustainable Development Goals (SDGs). Building on the principle of “leaving no one behind”, the new agenda emphasis a holistic approach to achieving sustainable development for all. Through broad study on rework, we have achieved SDGs those are decent work and economic growth, Industry, Innovation and Infrastructure, Sustainable cities and Climate action.

EXPERIMENTAL DETERMINATION OF LATERAL STRENGTH OF CONFINED MASONRY WALL WITH OPENINGS

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Masonry construction plays a vital role in routine construction. This type of construction is used in vast type of buildings whether it is house or a multi-storey building construction.In multi-storey building especially in frame structures walls are built in between frames to restrict inside area of the building from outside space often known as boundary walls. These types of walls are usually infill masonry walls which are built after the construction of frame. Just filling of the bricks in that open space between the columns doesn't make that wall to bear any loads whether it is the gravity load or seismic load or wind load. That infill masonry is there just to fill up the vacant space.The best method to make that walls bear loads is to make them confined with the columns usually known as confined masonry wall. Through confinement we can expect the walls to give some strength when subjected to gravity or lateral loads. Therefore, this study is enlightened towards how much seismic strength will these sorts of construction would give to overcome earthquake or wind loads. The purpose of this study is to evaluate the lateral stiffness of confined masonry panels: One wall panel is without any opening the other panel is having a opening. The effect of opening has been studied and the results have been compared. Lateral force was applied using hydraulic jack. The change in stiffness was evaluated and compared. Pakistan Building Code has been followed while designing the confined masonry panels. The findings of this study are very much beneficial for the seismic prone regions of Pakistan making it an applied research.

MONITORING AND ANALYSIS OF CONSTRUCTION SITE ACCIDENTS IN PAKISTAN

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During construction projects, most of the construction site accidents occur due to various causes related to Site Conditions, Design of structure, Materials of Construction, Consultant, Contractor, Equipment and Machinery, Management, External Factors. Due to the high probability of accidents in Pakistan construction sites it is highly needed to identify the causes and the types of these accidents. The reason behind this research was to assess the construction site accidents in Pakistan construction industry and provide solution for the industry. For the preparation of survey instrument literature review is performed to extract the reasons and types of accidents. Top ten causes of accident include, collapse of building or part of it collapse of scaffold, electrocution accidents, fall and slips from height, elevator shaft, machinery accidents, gas leaks, fire and explosion accidents, struck by moving objects. Construction Site Accidents in the construction project can be reduced by improving planning, management, site coordination, and by increasing safety resources, capacity of safety parameter. This study is conducted to analyze causes and results of occupational accidents at a construction site in Pakistan. Research data consists of the accident statistics of a construction site in Pakistan, which is obtained by using “mixed research approach” method which includes both retrospective cohort and questionnaire survey. In this study, causes and types of construction accidents, which occurred in the construction site, are investigated.

MECHANICAL PERFORMANCE OF INDUSTRIAL CONCRETE BRICKS

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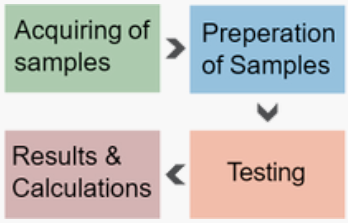

Nowadays, there is an increased use of concrete bricks in local construction industry due to high cost and environmental issues related to the production of clay bricks. This study focuses on the testing of industrial bricks which includes portland cement, water, fine aggregate, and a foaming agent. Weight of the brick is light due to presence of air holes in the specimen. Specifically, the purpose of this study was to investigate the mechanical properties of concrete bricks, like: compressive strength, bending strength, and water absorption capacity. The strength of a brick may be improved by increasing the amount of cement content in the mix. As a result, it's important to figure out how to mix sand and cement to increase the quality of the bricks. Strengthening bricks with diverse material qualities and discovering their reference properties are the main goals in this work. Concrete bricks were tested under standard code to test their mechanical performance. Use of mixed cement can reduce the porosity of the sample, and the sample strength will be improved.

AN ANALYTICAL STUDY OF CONSTRUCTION EQUIPMENT MANAGEMENT IN PAKISTAN

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Construction companies largely depend on the use of construction equipment throughout the course of their work. Pakistan's Analytical study of construction equipment management is the focus of this research. There are several aspects that might affect Pakistan's construction equipment management practice that are being examined in this research, including the absence of clear policy and rules and the availability of the spear component. Primary sources such as structured questionnaires completed by company executives, project managers, site engineers, and senior technicians were utilized to help answer the study's research questions. Questionnaire survey was used to conduct the survey. Because of this, data from the surveys was compiled and organized using an SPSS statistical application to create a table for easy viewing and reporting of the study's results. As a basis of the results, recommendations are made to management bodies in the company, to project managers in the company, and proposals are made for additional researchers.

STUDY OF THE EFFECT OF DIFFERENT SELF HEALING TECHNIQUES ON MECHANICAL PROPERTIES OF CEMENT-BASED COMPOSITES

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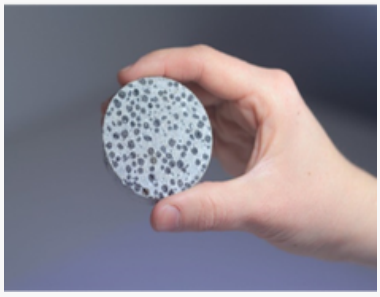

Due of its availability and cost, concrete is widely utilized in the construction industry around the world, yet it is prone to cracking. Concrete's durability is reduced as a result of cracking due to the entry of chloride and water, which corrodes rebars in reinforced concrete. Self-healing procedures are well-known strategies for preventing concrete cracking and restoring its strength and durability. Generally the compressive strength of concrete increases with the use of Bacteria in concrete and improves many physical and structural properties. Several types of bacteria along with their impacts on the physical and mechanical properties on concrete are discussed. Bacillus sp. CT-5 is proposed bacterial type of concrete to be used in the design mix

STABILISATION OF SOIL CONTAMINATED WITH PHARMACEUTICAL WASTE

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Solid waste and fluid effluent from pharmaceutical factories and laboratories, called pharmaceutical waste, pose significant potentials to contaminate natural soils. As a result, geotechnical engineering characteristics of soils such as shear strength and permeability deteriorate markedly that may compromise structural serviceability leading to foundation failures. This study reports on an experimental campaign involving geotechnical laboratory assessments of a soil contaminated with pharmaceutical waste (PW) and that treated with lime. Preliminary tests conducted on the contaminated soil indicated that it could not be recommended for use as a construction material because its bearing capacity failed to meet the recommendations of International Building Code. For completeness, tests were carried out to determine the compaction and strength characteristics of the stabilized soil using an optimum 4% lime content based on the plasticity index value, with various percentages of pharmaceutical waste (3%,5%,8%,10%). After the stabilization an optimal value of 4% lime and 10 % Pharmaceutical waste, added by weight of the air-dried soil showed that compaction and strength characteristics of the soil improved significantly due to the chemical actions experienced b/w the admixtures and the soil. In essence, this project has successfully demonstrated that the pharmaceutical waste exhibits significant risk of soil contamination that warrants specific treatment. Furthermore, the study also implements an economical and eco-friendly technique of using lime to sufficiently improve geotechnical engineering characteristics of soils contaminated with pharmaceutical waste.

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