THESIS ABSTRACTS OF CEE STUDENTS

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COMPARISON OF BNBC EARTHQUAKE PROVISIONS WITH STRUCTURAL DYNAMIC ANALYSIS

Investigator: Khandkar Mahbubur Rahman
Supervisor: Dr. Iftekhar Anam

The validity of conventional seismic analysis by the 'Equivalent Static Force Method' (ESFM) has been studied by comparing the results with dynamic analyses of two dimensional reinforced concrete buildings for the recorded data of two major earthquakes of the past; i.e., the El Centro earthquake in USA (1940) and the Kobe earthquake in Japan (1995).

The studies done for typical 1, 2, 5 and 10-storied Reinforced Concrete (RCC) buildings indicate significant underestimation of seismic forces (i.e., shear forces and bending moments) by the conventional method in all the cases studied. For example, the maximum shear forces (in kips) in the first floor beams obtained by the Equivalent Static Force Method and the structural dynamic analyses (for El Centro and Kobe data) are as follows

Stories	Max SF for ESFM	Max SF for El Centro	Max SF for Kobe
1	0.70	5.91	7.60
2	2.22	14.33	18.06
5	4.49	9.86	34.79
10	6.54	9.35	23.01

The results obtained by the time domain linear dynamic analysis are explained by corresponding frequency domain analyses, which are based on the concepts of dynamic magnification factor and resonance.

In the studies performed here, the model 2-storied building proves most vulnerable in El Centro earthquake while the model 5-storied building is at maximum risk in Kobe, both due to resonance of the structure with the recorded data. Thus the effect of resonance is highlighted and the common belief that taller structures always provide more critical seismic design criteria is refuted. The results from these studies demonstrate the importance of dynamic seismic analysis.

THE EFFECT OF SOIL CONDITION IN EARTHQUAKE RESPONSE

Investigator: Muhammad Shydul Alam
Supervisor: Dr. Iftekhar Anam

The effect of soil condition on earthquake response has been studied by considering the effects of soil-structure interaction and soil amplification. In this study, idealized Reinforced Concrete buildings (1, 2, 5 and 10-storied) are subjected to ground vibrations recorded during the Northridge earthquake in 1994.

Surface foundations on soils of shear wave velocity c_s = 300 ft/sec, 1000ft/sec and 10000ft/sec (representing soft, medium and hard soil respectively) are used as the substructure. The maximum forces (shear force and bending moment) are compared for different conditions of the foundation and the subsoil.

The results from soil-structure interaction show that the maximum bending moment occurs for the 5-storied building. The soil-structure interaction does not significantly modify the bending moments for any of the structures. This is because the considered foundations are surface foundations and are quite stiff compared to the structures themselves.

However, the maximum forces are significantly affected if the effect of soil amplification is also taken into account. For structures built on soft soils the maximum bending moment occurs for the 2-storied building instead of the 5-storied building. This is because the natural frequency of the soil layer nearly coincides with the natural frequency of the 2-storied building, thereby amplifying the energy content of the earthquake at those frequencies.

Therefore in assessing the possible impact of an earthquake on a particular structure, it is important to know the main energy content of the vibration and the natural frequencies of the structure, and to avoid resonance.

ASSESSMENT OF WORKING ENVIRONMENT OF GARMENTS INDUSTRIES

Investigators:
Mohammad Habibur Rahman
Muhammad Rubaiyat Zaman
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Supervisor: Md. Hasanuzzaman

Investigation of occupational health and safety problem in four selected garment industries has been carried out in this study. A working method has been developed to carry out this investigation, based on the Work Environmental Theory, Local Theory, Theory about Implementation Processes and National Factory Acts and Regulation. According to the working method four factories were investigated. The management and workers at different locations of four factories were interviewed and some people from other organizations, working with garment industries and having some role on occupational health and safety issues in the garment industries were also interviewed. After investigation it was found that these factories suffer work related problems like dust (55%), high and uncomfortable temperature (50%), chemical exposure from fabrics (30%), high noise level (25%), poor ventilation system and repetitive work. It was also noticed that the workers and management were afraid of fire in the work place. Beside the occupational health and safety problems the workers complained about low wages, abuse of labor rights and uncertainty of the job as well. It was observed that the occupational health and safety conditions of a factory depended not only on the internal factors like workers behavior (understanding and reactions about the work related problems), management behavior, stability of business (agreement with the buyers) and economical situation of the factory, but also on the external factors like work environment regulation, practical condition of enforcement of work environment regulation, behavior of street level bureaucrat, government attitude in relation to enforcement of the working environment regulation and socioeconomic situation of the country.

ASSESSMENT OF WATER SUPPLY, SANITATION AND SOLID WASTE MANAGEMENT OF A SLUM AREA IN DHAKA CITY

Investigators:
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Abul Quasem Tawasin
Mohammad Muyeenuzzaman
Supervisor: Md. Hasanuzzaman

Nowadays slums are an integral part of Dhaka city. At present 19.4% of the total population of Dhaka city live in slums (CUS, 1996). Due to poverty of the slum dwellers, they are unable to maintain the minimum standard of living. The environmental conditions of the slums are not good as well.

Based on the information of DSK (secondary data), the existing situation reflects that the coverage of the water supply is 99% from DWASA and 1% from the tube well; sanitary latrine practice is 40% and pit latrine 60% in the selected slum. The solid wastes are collected and disposed in the traditional way, which is not satisfactory. This is an innovative observation that reflects the water supply, solid waste management and sanitation of an old and well-established slum in Dhaka city.

Various technical and socioeconomic parameters, which are related to the situations, are used for this study. On the basis of technical analysis & questionnaire survey it was found that the overall environmental situation is very poor in this slum. To improve the present situation, slum dwellers participation should be ensured with initiatives for the development of the existing water supply & sanitation. Number of water points with desired quality and sanitary latrine should be increased. For the solid wastes that are generated by the slum, the BIOGAS PLANT can be a useful solution for the dwellers. Moreover the health and hygiene practices and the environmental pollution, extensive educational programs and publicity through mass media, poster and motivational lectures should be arranged so as to increase the awareness of the slum dwellers.

PERFORMANCE OF RUBBER DAM PROJECTS IN BANGLADESH

Investigators:
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Suprvisor: Dr. M R Kabir

Bangladesh is a land of rivers. There are hundreds of big and small rivers crisscrossed in the delta shape low land area. Though Bangladesh is a low land area, water from the neighboring countries flow over the land towards the Bay of Bengal each year. Different types of hydraulic structures are installed for the utilization of the water for various purposes such as irrigation, hydro-electricity etc, for a long time. Among them rubber dam structure is newly introduced for specific location.
The implementation period of rubber dam is short due to simplicity in the construction work. Its development cost is low compared to traditional water retention structures and it also does not have adverse environmental impacts.

This study is concerned with the feasibility and performance of rubber dam projects implemented in specific locations of Bangladesh. For achieving this goal, the performance of three rubber dams namely Idgaon, Bakkhali and Bhogai rubber dam project have been evaluated.

The evaluation includes all the engineering, agricultural, environmental and organizational functions. Engineering evaluation involved identification of construction, operation and maintenance problems and mitigation measures. Agricultural evaluation involved assessment of impacts on irrigated area, cropping intensity and yield. Environmental evaluation involved evaluation of impacts on fisheries, drought, water logging, and ground water table and boat communication. Organizational evaluation involved evaluation of organizational set-up including peoples participation and operation and mainline cost recovery of the projects.

The study was carried out through collection of both primary and secondary data and information from the project beneficiaries, adversely affected local people and the service givers.

The cost-benefit results of the three rubber dam projects are quite satisfactory. The major findings of this research work are the rubber dam projects are facing problems in design, site selection, sedimentation and operational and that should be mitigated by careful monitoring. Such as, in the Bakkhali Rubber Dam project design and site selection are two crucial sectors for which the project is not in action at present. The operation and maintenance committee of this project work gently and the rubber bags needed some repair. The Idgaon Rubber Dam Project is working efficiently. It may be considered as the most ideal project among the rubber dam projects till now. No problem found in the O & M sector. There is some sedimentation in the rubber dam site but most of it washes away by the flash flood. In Bhogai Rubber Dam Project, political interference and lack of motivation of the local beneficiaries make the project's OMC inactive. Moreover in the project site sedimentation is huge which is not desirable. But all the projects have positive agricultural impact. They increase the irrigated area and yield of crops. Necessary action and more motivation to local people under guidance of LGED will make the entire rubber dam projects much productive in the economy of this country.

SEISMIC ANALYSIS OF THREE-DIMENSIONAL OFFSHORE STRUCTURE AND ELECTRIC TOWER

Investigator: Muhammod Delwar Hossain
Supervisor: Dr. Iftekhar Anam

There is no established building code in Bangladesh for the seismic (static or dynamic) analyses of trusses, and in most cases trusses are not designed against earthquakes. With this view, the primary objective of this study is to analyze the behavior of different trusses under seismic vibrations.

Three offshore structures (200′, 400′ and 600′) proposed for construction in the Gulf of Mexico and also an existing electric tower are considered in this study. These structures are subjected to ground motions from two major earthquakes of the recent past; i.e., the Kobe earthquake in Japan (1995) and the Northridge earthquake in USA (1994). The earthquake data are used with a computer program written for the linear dynamic analysis of 3-dimensional trusses to analyze the structures and perform parametric studies. Different structural behaviors are comprehensively analyzed showing time series results of various member forces of the trusses as well as the Fourier spectra of the maximum forces. A study is performed on the behavior of common steel structures of different heights in these earthquakes. It is found that the maximum axial forces in the offshore structures are almost proportional to their heights.

The stresses for the Kobe data are found to be greater than the Northridge stresses in most of the cases. The allowable tensile stress is assumed to be 18 ksi for all the members. From dynamic analyses, the maximum

tensile stresses in all the members are found to be below 18 ksi. However, the compressive stresses often exceed the allowable compressive stresses in the members, which are lower than allowable tensile stresses due to geometric nonlinearity. This indicates that earthquake may present a critical design condition for trusses.

SEISMIC ANALYSIS OF TWO AND THREE-DIMENSIONAL R.C.C. FRAMES

Investigator: Md. Atikur Rahman Talukder
Supervisor: Dr. Iftekhar Anam

Under strong earthquake vibrations, Reinforced Concrete (R. C. C.) structures have often behaved unsatisfactorily in recent earthquakes in USA, Japan, Taiwan, Turkey, India and many other countries. Results of two-dimensional linear dynamic analyses of R. C. C. structures have shown that the 'equivalent' static forces predicted by the existing building codes are often much smaller than the dynamic forces. Two-dimensional nonlinear dynamic analyses have shown that the static forces may not be adequate for a safe design against severe earthquakes. Therefore, this work is conducted with a view towards extending the studies to nonlinear three-dimensional analysis. The linear three-dimensional analysis of R. C. C. frames performed in this study is a step in that direction.

Recorded ground motion data from the Kobe earthquake (Japan, 1995) and the Northridge earthquake (USA, 1994) are used to conduct structural dynamic analyses.

Three-dimensional linear dynamic analyses are conducted on 2, 5 and 10 storied buildings with 'adequate' structural dimensions from static point of view. The results indicate that the maximum shear forces in the 'critical' beams and columns of these buildings predicted by the 2-dimensional and 3-dimensional analyses are often quite different and may be significant from design point of view. Also the shear forces predicted by the static analyses are found to be much smaller than the earthquake-induced forces in all the cases studied here.

NON LINEAR SEISMIC ANALYSIS OF RCC BUILDING

Investigator: Zebun Nessa Shoma
Supervisor: Dr. Iftekhar Anam

Reinforced Cement Concrete (commonly known as Reinforced Concrete and referred to as R.C.C., RCC or RC) is a complex composite material that provides a unique coupling of two materials (concrete and steel). When subjected to high stresses, it behaves like an elasto-plastic material. This behavior is particularly observed when the structure is subjected to dynamic loads. Considering the nonlinear behavior of R.C.C., parametric studies are performed in this thesis to investigate some important details of the behavior of R.C.C. Simple two-dimensional frames are taken for static structural analysis under increasing vertical load and nonlinear dynamic analysis under combined vertical load and seismic vibrations. Three known earthquake data (El Centro, Kobe and Northridge) are applied in the long and short directions of a number of buildings (2, 5, 10 storied) to study their responses. Various aspects of the nonlinear response of R.C.C. are studied. These include the effect of axial force on the Moment-Curvature (M-ϕ) relationship, the mode of failure and the importance of increasing shear strength. From the analysis it is found that the failure of all the structures are due to excessive shear force in beam or column. In case of Kobe earthquake all the buildings taken into consideration failed (both long and short direction) and no failure occurred in the short direction due to El Centro earthquake. For Northridge earthquake, low rise (2 storied) building frames failed due to excessive shear in the columns. But results of 5 and 10 storied frames showed that shear failure of beams occurs rather than the columns. Finally a study is carried out which include increasing the shear strength of beam, column and footing (1.7, 2 and 2.5 times) in order to improve the shear capacity of the structure.

GROUND WATER PUMPING AND ITS IMPACT ON DHAKA CITY

Investigators:
S M Sorowar Jahan Haroon
R K M Shamsul Haque
Supervisor: Syed Mahabubul Haque

Dhaka as the capital of Bangladesh has grown into a busy city of about ten million people. Having a sweet blending of the old and new architectural trends, Dhaka has been developing fast as a modern city since independence in 1971 and is throbbing with multidimensional activities, be it industrial, commercial or political. Area of Dhaka is 303 sq. km. (approx.).

Water has primarily two major sources. They are ground water and surface water. DWASA is primarily responsible for the supply for all domestic and commercial water to the city dwellers. Besides this many private organizations have their own deep tube wells to abstract ground water for their own uses. The water supply system of Dhaka city is dependent on mainly ground water source. Around 97% supply of DWASA comes from ground water and only 3% comes from surface water. At present DWASA are operating 287 plus deep tube wells in its service areas and is able to supply the city dwellers only about 60 percent of their total water demand. Although DWASA has surface water based water treatment

plant at Saidabad, which will be operative very soon, but an appreciable amount of total water demand would be mitigated from the ground water source due to the various limitations of the surface water source.
Dhaka's present population is 10 million and total water demand 1600 million liter per day (mld). This water demand is increasing at a rate of 11% each year. This is due to the rapid population growth in the Dhaka city. Dhaka is now growing in a very unplanned way, so a large number of high-rise buildings has been constructed in some areas like Motijheel, Panthapath, Mohakhali areas of Dhaka city. The high-rise building creates local pressure on DWASA distribution system. To meet the future water demand more ground water will require to be pumped by deep tube wells.

The most important problems related to the ground water abstraction in Dhaka city are as follows:
1. If the water is continued to be withdrawn at the present rate, then the total draw down will cause many of existing DWASA tube wells inoperative in future.
2. Degradation of ground water quality.
3. Ground water with drawl can lead to accelerated consolidation of sub-surface material and hence increase subsidence. The land subsidence then may manage public and government buildings, roads, bridges, railways, swear system and water distribution system.

ENVIRONMENTAL IMPACT ASSESSMENT OF A CEMENT FACTORY

Investigators:
Shah Mahmud Muktadir
M M Al-Mamun Haque
Supervisor: Md. Hasanuzzaman

Environmental Impact Assessment is done based on the physio-chemical environment like land, hydrography and water quality, air quality, meterological, socioeconomic environment, checklists and graded matrix methods issued to identification of potential impact and evaluation of their consequences to the possible extent.

The EIA suggests that the project under study involves potential environmental impacts to which further careful attention must be given in construction, operation and maintenance of the project in order to minimize and offset the adverse effects. The negative impacts are not severe and the potential adverse impacts if addressed properly could be minimized without much effort, though they would require careful attention.

The location of the cement plant is environmentally acceptable. However, adequate and effective pollution prevention, abatement and control measure, proper and careful operations and maintenance, regular and effective environmental monitoring with adequate staff and budgetary provision, periodic reporting to DOE, creation of an environmental cell, ensuring preventive management practices, adoption of the Disaster management Plan should be ensured.

SURFACE WATER QUALITY MONITORING IN PERIPHERY RIVER OF DHAKA CITY

Investigators:
Taibur Rahman
C M Mirfaque Bin Zahid
Supervisor: Md. Hasanuzzaman

The river Turag, Balu and Shitalakhya are situated in the periphery of Dhaka City. At present these are the most polluted rivers in Bangladesh. Dhaka City is very densely populated and will be one of the ten "Mega Cities" in the near future. The amount of untreated wastes, both domestic and industrial, being released into the rivers is tremendous and is increasing day by day. Therefore, the objectives of this study were to investigate the condition of the river water quality in terms of some important water quality parameters (pH, turbidity, conductivity, DO, BOD, COD). After investigation it was found that these parameters specially DO and BOD is far above the acceptable limits, which is a threat to the aquatic environment.

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PROBLEMS OF WATER SUPPLY IN DHAKA CITY AND POSSIBLE SOLUTION

Investigators:
Md. Abdus Sattar Khan
Mominul Aziz
Supervisor: Dr. M R Kabir

The biggest challenge for the next decade or so will be supplying potable water to the growing population of the world, the Johannesburg Earth Summit stated this year. This study is based on the analysis of water supply system of Dhaka city as a case study and tried to find out a solution to meet the demand for potable water.

Water supply in Dhaka city is based on surface and groundwater sources. Dhaka Water and Sewage Authority (DWASA) has been supplying water to the city dwellers using these sources however, the growing population of the city is steadily making the supply of water inadequate. Dhaka city's water supply system has to seek an alternative to meet the growing demand for potable water.

Groundwater source supply system of the city, supplies the major share of water and surface water is abstracted from the neighboring rivers of Dhaka city. The ground water source is unlikely to have an increase in supply of water as interference of wells will deny further installation of wells and Arsenic intrusion is quite probable. Whereas surface water source has limited prospect in supplying water as pollution is increasing in the rivers (Buriganga's chemical health is the greatest example). An alternative should be sought to solve the problem.

The study analyzed the population trend of the city and drawn a population projection till 2020. The growing demand is hence calculated. Review of existing water supply system showed that DWASA is lacking in meeting the current demand for potable water. The grown future demand will have a severe water crisis in the city and alternative must be sought for that reason.

The study also showed rainwater as a highly prospective alternative, which will be able to serve as an alternative source to meet the growing demand of Dhaka's population. The study has started the hunt for alternative sources of water supply and has opened the door for further research in this area exploring storage and supply prospects of rainwater as a possible further development.

DYNAMIC ANALYSIS OF THREE-DIMENSIONAL FRAMES DUE TO EARTHQUAKE AND WIND LOAD

Investigator: Md. Monjurul Islam
Supervisor: Dr. Iftekhar Anam

In this work, three-dimensional RCC frames have been analyzed for earthquake and wind loads using the concepts of Structural Dynamics, with the purpose of observing the qualitative and quantitative differences between their effects on the structural response of 2, 3, 4 and 5-storied buildings. Both the maximum bending moments and maximum torsional moments are compared for the ground motion of El Centro earthquake (1940) and a sustained wind speed of 100 mph.

The results show that the internal forces (moments and torsions) due to the earthquake motion are much greater than the maximum forces due to wind loads for all the cases under study. In fact, the wind forces will remain smaller even if the wind velocity is doubled. Moreover, for the buildings under study (symmetric about one axis), the flexural moments are found to be much greater than the torsional moments induced by these loads. However, the torsional moments due to earthquake motion are also found to be significant from design point of view and should not be neglected for the design of the RCC sections under earthquake.

The study shows the qualitative differences of the effects of wind and earthquake loads on structures. Whereas the forces due to earthquake tend to diminish totally within 30-40 seconds, the wind forces tend to reach steady values (corresponding to the static forces) after a while. Moreover, whereas the forces due to wind load tend to increase with the height of the building, the variation of the seismic forces depend on resonance and continue to increase only up to a structural height when the structure's natural frequency matches with the frequency of the major energy content of the earthquake. Therefore, although the 'equivalent' static analysis method is not appropriate for earthquakes, it is suitable for wind load analysis if an appropriate dynamic magnification factor is also used.

A study on the variation of torsional moments over the building heights show that these moments tend to decrease along the height of the structures, and this decrease is almost linear for wind loads.

CAUSES AND PREVENTION OF CRACKS IN BUILDINGS

Investigators:
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Alauddin Ahmed
Supervisor: Syed Mahabubul Haque

Majority of cracks occur when the building or its components or the material of which the building is made up of is subjected to forces that are greater than those it can withstand. Cracks may also occur if the materials used in the building is of poor quality and the construction is not carried out in accordance with relevant drawings, prescribed job specifications and in a workmanlike manner.

Cracks can be broadly classified in two categories; i.e., structural cracks and non-structural cracks.
There are various reasons for developing these cracks. Such as cracks due to

- excessive shear force
- excessive moment
- tension force
- thermal stresses
- temperature variations
- elastic deformation and creep
- effect of chemical reaction
- movement of ground
- excessive axial force
- vegetation
- the effect of adjacent construction

Much of these cracks are developed due to faulty design, overloading or other similar fractures. Cracks in a structure give an impression that the structure is getting unsafe.

ACI Code includes some safety factors to eliminate cracks. Some precautionary measures need to be taken to eliminate cracks. Causes and prevention of cracks in structures have been described in this thesis.

IDENTIFICATION OF HAZARDS AND SAFETY FACTORS DURING THE CONSTRUCTION OF A HIGH RISE BUILDING

Investigators: Ranjan Kumar Banik
Supervisor: Md. Hasanuzzaman

Hazard identification is done through physical investigation, interview of the personnel involved in the construction process and data collection. It has been found different types of hazards like physical, chemical, biological, social and safety issues are involved in excavations, scaffolds, roof work, maintenance and cleaning works. Most of these are ignored during construction.

ANALYSIS OF EXISTING SOLID WASTE MANAGEMENT SITUATION IN DHAKA CITY

Investigators:
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H M Imran
Supervisor: Md. Hasanuzzaman

Based on secondary data collected from different sources, required dumping area for solid waste in Dhaka city was calculated for the next 10 years, which is 1109.5 acres. At the same time by using empirical formula, the quantity of rapidly decomposable gas was calculated to be 13.9 ft^3/lb, slowly decomposable gas 16.7 ft^3/lb and development of leachate was calculated as 1.70×10^6 gal per 10 years. It has been found that due lack of landfill regulation the solid wastes are indiscriminately disposed around the city. Due to this indiscriminate disposal of solid waste, the gas and leachate are emitted to the natural environment, which is creating potential environmental impacts. The potential impacts are ozone depletion, toxic VOCs in air, odor, noise, birds, rodents, insects etc., litter dust, explosion and fire hazards, vegetable damage, soil pollution, surface water pollution. A unique landfill regulation and solid waste management policy is required to control the emission from the solids. Otherwise it will create an environmental disaster in the future.