ISSN 2224-2007

TECHNOLOGY FOR ADVANCEMENT
CENTER OF EXCELLENCE

MIST Journal of Science and Technology

Volume- 6
Issue- 1
December 2018

Military Institute of Science and Technology (MIST)
www.mist.ac.bd

MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY (MIST)

Mirpur Cantonment, Dhaka-1216, Bangladesh

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MIST JOURNAL OF SCIENCE AND TECHNOLOGY

THE ANNUAL TECHNICAL JOURNAL
OF
MILITARY INSTITUTE OF SCIENCE AND TECHNOLOGY

Volume-6	Issue-1	December 2018

MIST, Mirpur Cantonment, Dhaka-1216, Bangladesh

EDITORIAL BOARD

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ISSN: 2224-2007

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Subscription Rate (Single Copy)

Individuals	: BDT 300 / USD 05 (including postage)
Institutions	: BDT 375 / USD 08 (including postage)

Published by Military Institute of Science and Technology, Bangladesh

Designed and Published by:
Research and Development Wing, MIST

FOREWORD

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I congratulate all the authors who have contributed to this journal. My special thanks to the editorial board and associated personnel for their relentless efforts in publishing the current issue of the journal, 'MIST Journal of Science and Technology'. May Almighty Allah bless us all in the pursuit of the motto of the institute, 'Technology for Advancement' with His boundless blessings and adorn MIST as "Center of Excellence".

Major General Md Abul Khair, ndc, PEng
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EDITORIAL

Research activity engages and empowers students in hands on learning and also provides effective career preparation which promotes interest in graduate education as well. MIST being one of the leading engineering institutions, patronizes multifarious research activities at all engineering departments related to national and international issues.

The scope of the journal covers the full range of research, evaluation, design, operations and functioning of all engineering disciplines. Research activities provides platform and empowers faculty members and students for effective career preparation in engineering field.

MIST always promotes research works in applied science and Technology and this Journal publishes fundamental, objective and innovative research works from writers of different universities and institutions from home and abroad.

I express my deepest gratitude to Major General Md Abul Khair, ndc, PEng, the Chief Patron of MIST journal of Science and Technology for his invaluable and dynamic guidance during editorial period of volume-6, Number-1, December 2018 issue. I must mention the hard work and relentless support of members of the editorial board. I also express sincere thanks to the advisory board for their whole-hearted cooperation in publishing the journal. I believe this publication will raise the interest among the learned readers in relevant fields.

Brigadier General Md Abdul Wohab, ndc, PEng
Director
Research and Development Wing
Military Institute of Science and Technology
and
Editor in Chief, MIST Journal of Science and Technology

EVALUATION OF ENVIRONMENTAL POLLUTION IN BANGLADESH BY INLAND CARGO SHIP OPERATION

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ABSTRACT

Inland Water Transportation is still considered as the major transportation sector in Bangladesh. Over ten thousand of different types of registered vessels and thousands of unregistered vessels are plying in inland routes. This sector carries over 50% of cargo, 80% of fuel-oil and more than one quarter of all passenger traffic per year. River network has been regarded as safe and cost-effective route of the country, especially in the southern part. The fleet of cargo vessels has the static capacity of about 1,000,000 tons. The cargo fleet consists of 2,213 registered ships (2,043 cargo vessels and 170 bay crossing coasters) and make an average 3/4 trips per ship per month. This huge no of operations in inland route has made us vulnerable to significant marine pollution due to direct discharge of bilges, oily water mixture, solid waste and also the air pollution due to age old running engines/ machineries. In this paper, an approximate estimation of pollutants such as bilges, oily water and solid waste has been made followed by the air pollution. An environmental modelling has been done followed by the impacts of pollutants with the help of Eco Indicator 99 (I) of SimaPro. It has been revealed that there are considerable impacts of marine pollution for prolonged inland cargo vessel operation. The major consequences includes the climate change, destruction of fishing zone, respiratory problems of human being and the rise of sea level. At the end, few preventive measures have been suggested in light of design modification, regulatory enforcement to reduce the marine pollutions.

Key Words: Marine Pollution, Cargo Vessel, Bilge, Bilge Water, Solid Waste. Sewage etc

1.0 INTRODUCTION

Bangladesh is a riverine country with a network of huge no of rivers, canals, creeks and water bodies, which are occupying about 11 per cent of the total area of the country. Since long, the river network has been regarded as safe and cost-effective route in Bangladesh. The inland waterways comprise a total length of nearly 6000 km of navigable waterways. More than half of the country's total land area is within a distance of 10 km from navigable waterway. Due to cheapest, safest and reachable means, the Inland Water Transportation (IWT) sector has become one of the major means of transport of the country. For that a huge number of different types of vessels are plying in inland routes. The IWT sector carries over 50% of all arterial freight traffic and one quarter of all passenger traffic each year which clearly defines the dependency on this sector [1] & [2].

The dependency on IWT sector paves the way to increase the number of vessels each year. It is anticipated that this trend is likely to continue in the coming years too largely due to poor condition and huge traffic on road, the increase demand for freight transport and the expected increase in personal mobility. This significant number of vessels plying in inland routes has made us vulnerable to significant marine pollution. The inland water ways are getting polluted by discharging of bilges, solid waste, oily water, and ballast water into the water and also making air pollution through burning of fuel while running of engines or machineries [5].

On the other hand, nowadays climate change issues have become major concern throughout the world and Bangladesh is one of the most vulnerable countries which may experience worst impact of climate change. One of the major causes of climate change could be marine pollution and it can contribute global warming, acid rain, eutrophication, destruction of fishing zone and even degradation the quality of local air. Also, the possible source of environmental

impact is very important to understand the level of mitigation. But unfortunately no such level of study or data has been done so far for accounting the inland vessel source pollution, its impact and possible remedial measures etc.

This paper aims at estimating pollutants such as discharge of bilges, and solid waste as well as fuel consumption by inland cargo vessels operation. Then quantifications of these pollutants have been used for environmental modelling with the help of Eco Indicator 99 (I) of Sima Pro Software. Sima Pro is the most widely used Life Cycle Analysis software which offers standardization as well as the ultimate flexibility and it has also unique features such as parameterized modelling and interactive results analysis. The impacts of such pollutants from inland cargo vessel operation have been found by damage oriented method of Sima Pro through Exposure and effect analysis followed by Fate analysis [6 & 7]. The finding of study can be used to access the scenarios of pollution by inland cargo vessels and may be useful while making some policy to combat pollution.

2.0 RESEARCH METHODOLOGY

The present research is primarily based on collecting quantitative and qualitative primary data and information to address the pollution for different types of inland vessels of Bangladesh. This data has been collected and recorded systematically through field study, open ended questionnaires and interviews with technical personnel. The major information collected are as follows:

- Physical dimensions of different types of inland vessels have been collected from DOS, BIWTA, regional concerned offices and also from on ground survey. These vessels are then categorized for the convenience of estimating different types of pollutants like bilges, solid waste etc.
- Engine power for different types of vessels has been ascertained from approved drawings, interviews with ship designers and builders as well as field data.
- Capacity plan along with line plan have been used to verify quantity of bilges. Moreover the field study was carried out to find out the tank capacity of various vessels.
- Fuel tank has been calibrated to find out hourly consumption of fuel. Moreover the field study, interviews with engine drivers of different types of vessels and ship builders were consulted to find out hourly fuel consumption.

Secondary data source and information have been explored from related private & government organizations, books, journals, research publications, official record etc. that have been kept in the published or unpublished form. Environmental modelling has been done from calculated pollutants to quantify the emission of compounds which causes damage to human health and ecosystem quality.

3.0 BRIEF DESCRIPTION OF INLAND VESSELS OF BANGLADESH.

Different types of vessels like passenger vessels, cargo vessels, ferry, oil tankers, dumb barges, speed boats, sand carriers and dredgers are plying in the rivers of Bangladesh. Figure 1 shows the percentage of different type vessels in inland routes of Bangladesh:

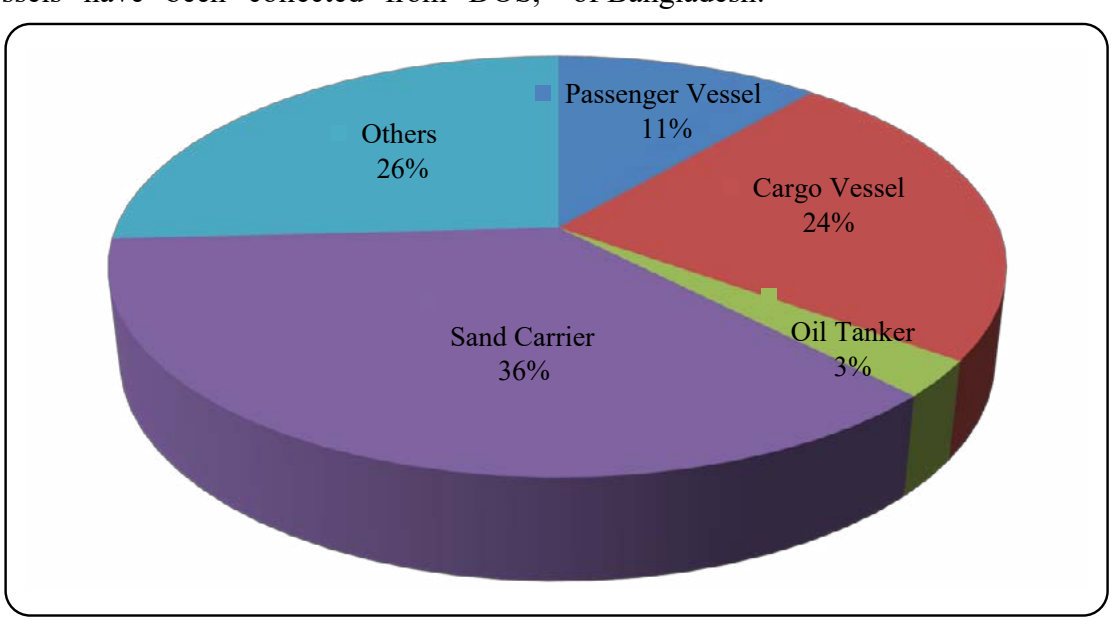

Fig 1: Percentage of Different Types of Inland Vessels

Inland ports and other facilities of Bangladesh include 11 major inland ports, 23 coastal island ports, 133 launch stations and more than 1,000 minor landing points located in rural areas. BIWTA and BIWTC regulate the movement of over 1000 passenger vessels and maintain 22 inland ports along with about 800 terminals. Location of inland ports and other installations are shown in Figure 2.

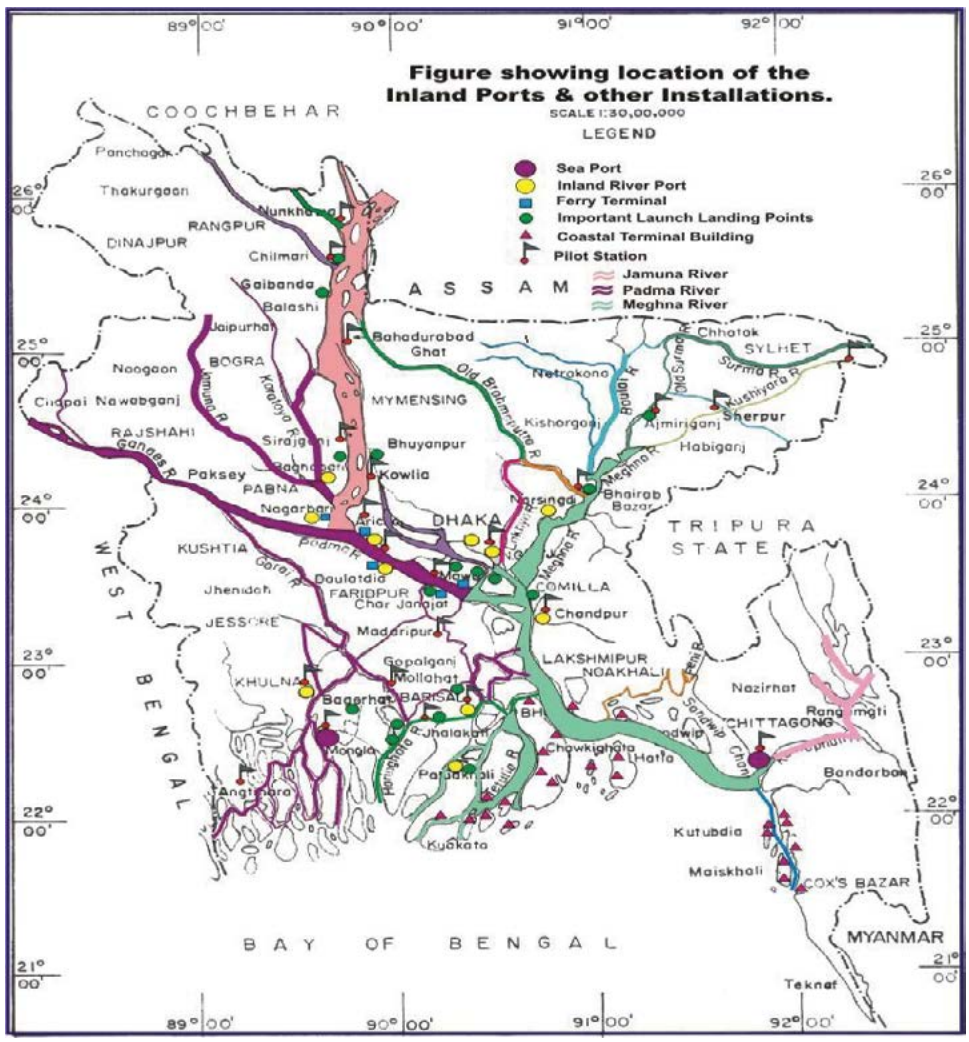

Fig 2: Location of the Inland Ports and Other Installations

Although cargo vessels constitutes around 24% of the total fleet size of inland shipping, but its economic impact is very important and significant. The majority of the cargo services are operated privately. Cargo ships are basically larger vehicles which are made of steel hull and often designed with sub-divisional bulkheads to provide water tightness to the cargo holds. In addition, cargo ships contain cargo hatch openings on the upper deck through which the commodities are being loaded and unloaded. Also some cargo ships contain self-sufficient pumping facilities to load or unload liquid cargoes on or off the cargo holds. Cargo Service Unit is mainly responsible for carrying of various kinds of commodities like food, food grains, Jute & jute goods, cement and clinker from Chittagong and Mongla Port to different inland river ports of the country. In addition, cargo vessels also send to Kolkata (India) port under the Inter country transit and trade protocol agreement between the two countries. The total capacity offered by the cargo fleet is estimated 35.2 million tons [5]

The fleet of cargo vessels has significantly changed since 1998-99. Dumb barges of 300 tons on average have been replaced by self-propelled vessels of higher capacity of 500 to 700 tons. The total static capacity has increased by about one third from about 750,000 tons to about 1,000,000 tons. The fleet consists of 2,200 units (2,030 cargo vessels and 170 bay crossing coasters).Cargo vessels make an average 3/4 trips per month. The breakdown of total cargo vessels is shown below in Table 1.

Table 1: Cargo Vessels of Bangladesh

Catagory	Type	Length Range	Total No
Cat - 1	Small	Upto 30 m	348
Cat - 2	Medium	30 to 50 m	1554
Cat - 3	Large	Above 60 m	311
Total			2213

4.0 ESTIMATION OF POLLUTANT

The cargo ships of inland routes are polluting the marine environment by discharging bilges, solid waste and emission of exhaust gases and pollutants by burning fuel. As the quantification of bilge, solid waste & fuel consumption is necessary to assess the impact of these pollutants, accurate approximation is very crucial. First hand data collected by the researchers had to be verified using various scientific means. For example, quantity of bilge collected from field data is further verified considering running hour of bilge pump from the operators of the ships. Using capacity plan drawing along with sectional shape of the aft portion of ship, quantity of bilge is further verified through measurement of height of bilge water for round trip operation by the ship. Fuel consumption of engine is verified by taking average running hour of the engine as well as log book of the engine where available. First hand data of fuel consumption is also verified using the fuel consumption of engine from manufacturer catalogue. The detail particulars of inland cargo vessels for the calculation are shown below in Table 2:

Table 2: Details of Inland Cargo Vessels of Bangladesh

Cat (Length)	Total No	Engine Power (HP)	No of Engine	Fuel Cons (Ltr/hr)	Avg Running hr/month	Bilge/month/Ship (Ltr)
Cat – 1 (Up to 30m)	348	300-350	01	60	150	375
Cat – 2 (30-50m)	1554	300-350	02	60	120	600
Cat – 3 (Above 50m)	311	450-720	02	75	120	675

In Table 3 the summary of calculation of running hour, fuel consumption and distance covered by cargo vessels Per Year is shown. Similarly, Figures 3 to 6 shows the approximate running hour, distance covered, fuel consumption and quantity of bilges thrown by cargo vessels of Bangladesh. While quantification of pollutants, it has been assumed that the cargo vessels are operating yearly eleven month and remain one month non-operational for maintenance.

Table 3: Summary of Running Hour, Fuel Consumption and Distance Covered by Cargo Vessels per Year

Type	Total No	Total Running Hour (Hr)	Total Fuel Consumption (Ton)	Total Distance Covered (Km)
Category -1 (Up to 30m)	348	574200	34452	6287490
Category – 2 (30m to 50m)	1554	2051280	246153.6	29948688
Category – 3 (Above 50 m)	311	410520	61578	7491990
Total	2213	3036000	342183.6	43728168

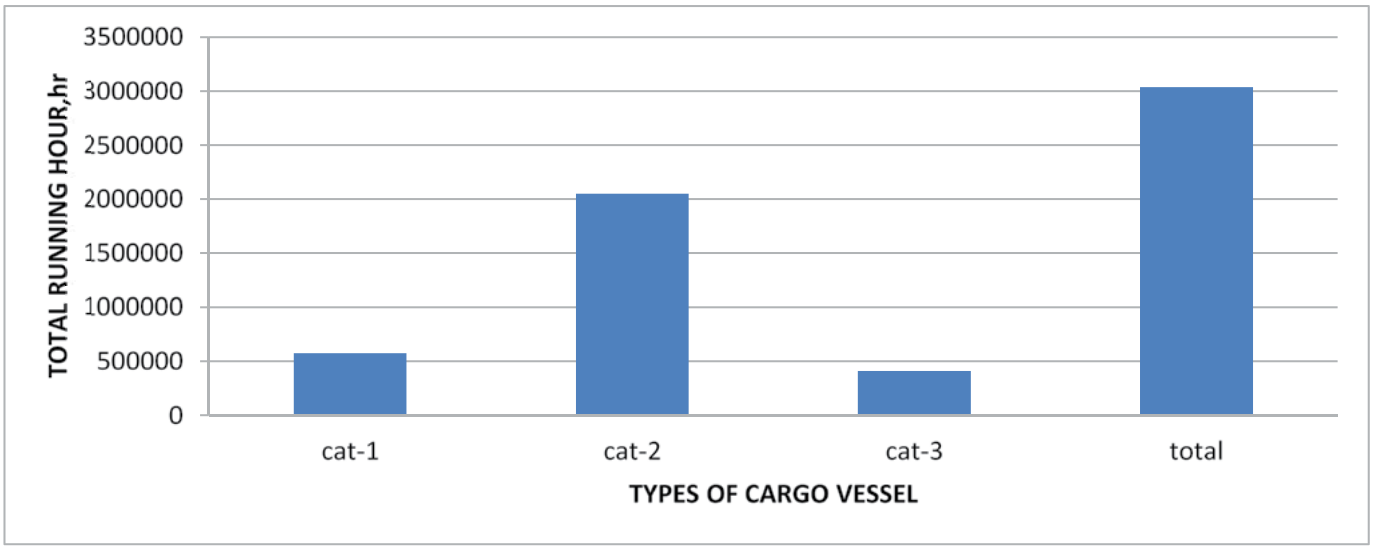

Fig 3: Summary of Calculation of Running Hour (Cargo Vessels)

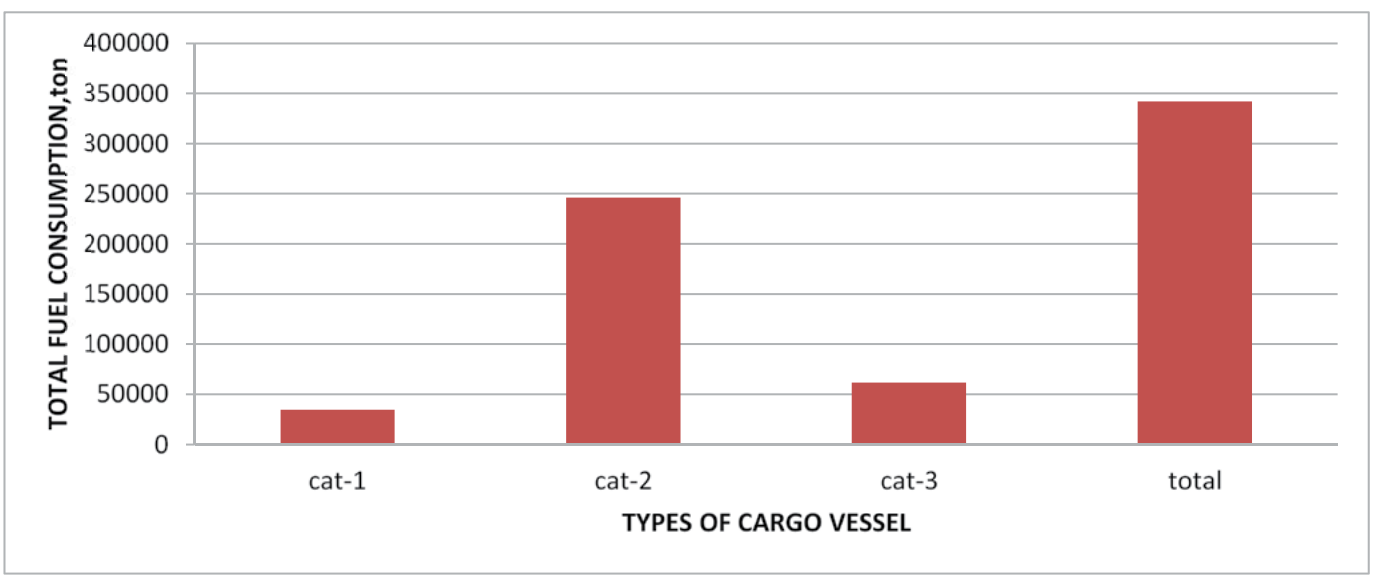

Fig 4: Summary of Total Fuel Consumption by Inland Cargo Vessels of Bangladesh

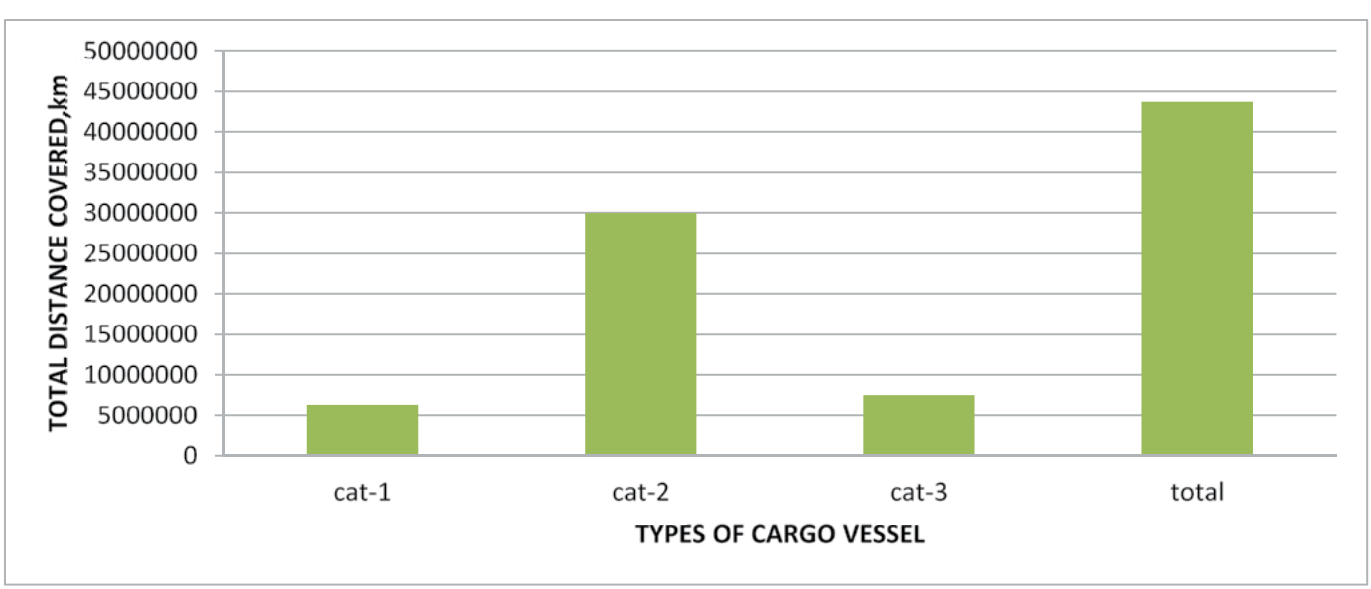

Fig 5: Summary of Calculation of Distance Covered (Cargo Vessels)

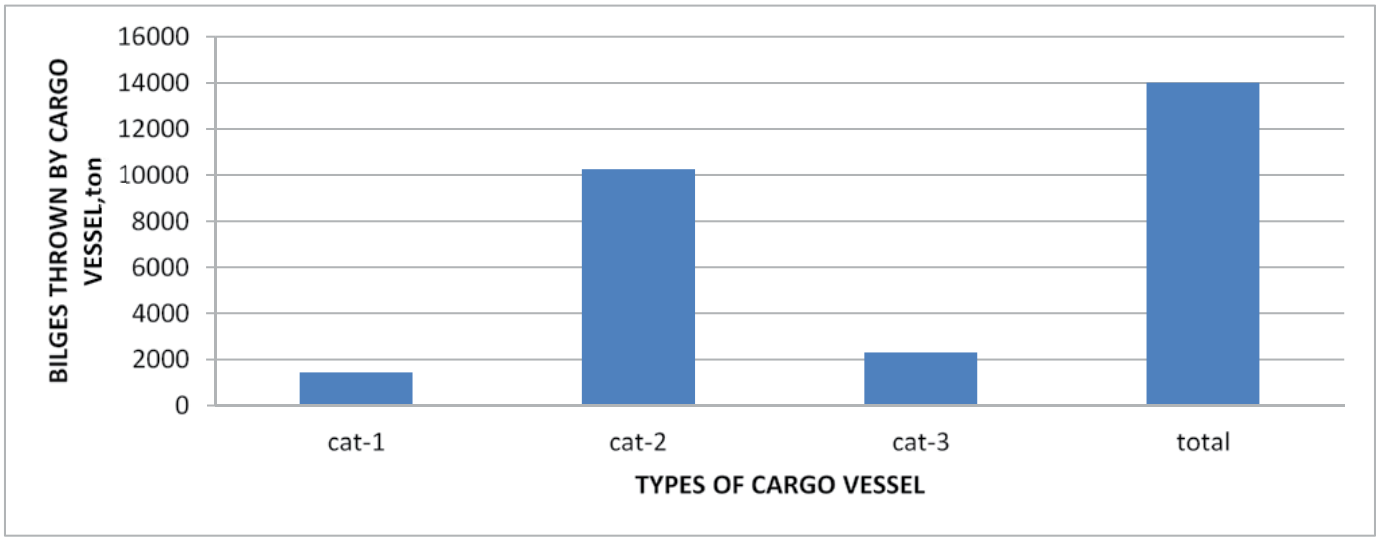

Fig 6: Summary of Total Bilges Thrown by Inland Cargo Vessels of Bangladesh

5.0 IMPACT ANALYSIS OF POLLUTANT

The estimated quantity of pollutants has been used as input to find out the impact on environment using Sima pro software, Eco indicator 99 (I) v2.04. Sima Pro is the most widely used Life Cycle Analysis software which offers standardization as well as the ultimate flexibility and it has also unique features such as parameterized modelling and interactive results analysis. Eco-indicator 99 uses the damage-oriented approach. The development of the Eco-indicator 99 methodology started with the design of the weighting procedure. However, the impacts of such pollutants from inland cargo vessels operation have been found by damage oriented method of Sima Pro through Exposure and effect analysis followed by Fate analysis [6 & 7].The environmental impact model of cargo vessel is shown Figure 7. The impacts of pollutants for different sizes of cargo vessels through characterization, weighting and single score were found using the above mentioned software and shown in Figures 8 to 11

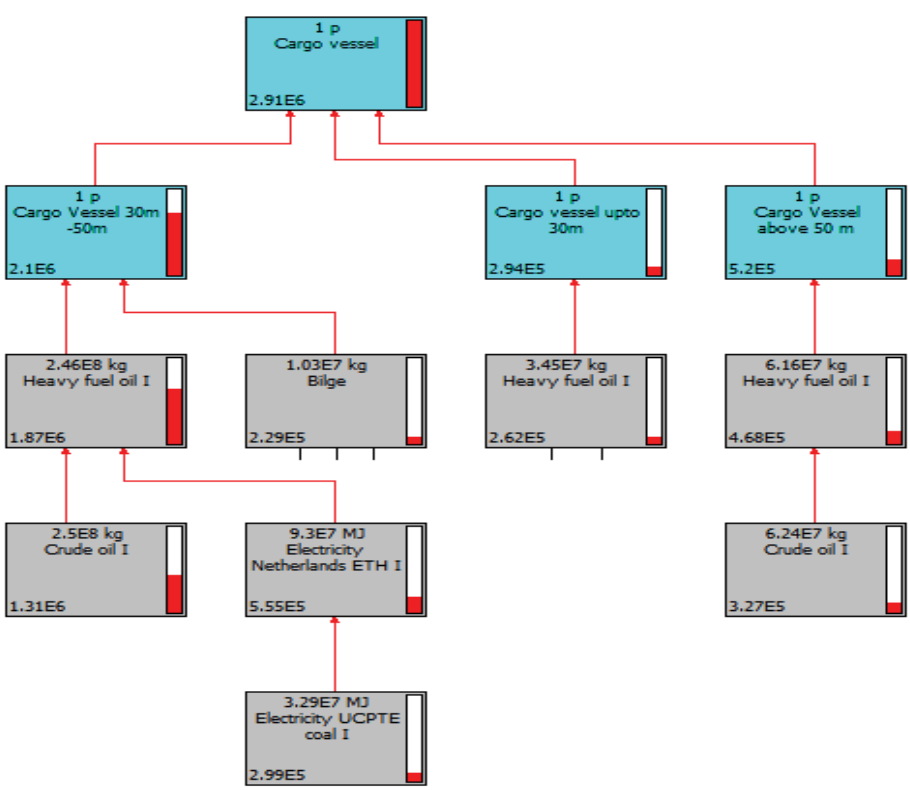

Figure 7: Impact Model of Inland Cargo Vessels

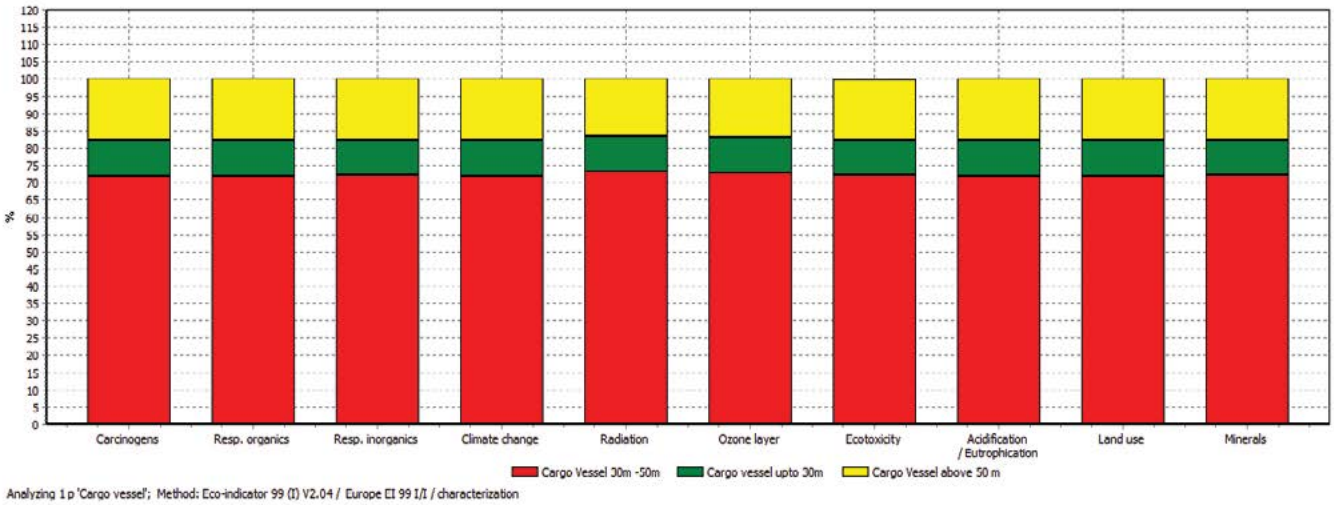

Fig 8: Impacts of Pollutants Discharged by Cargo Vessels/Yr 'Eco-Indicator 99 (I) (Characterization)

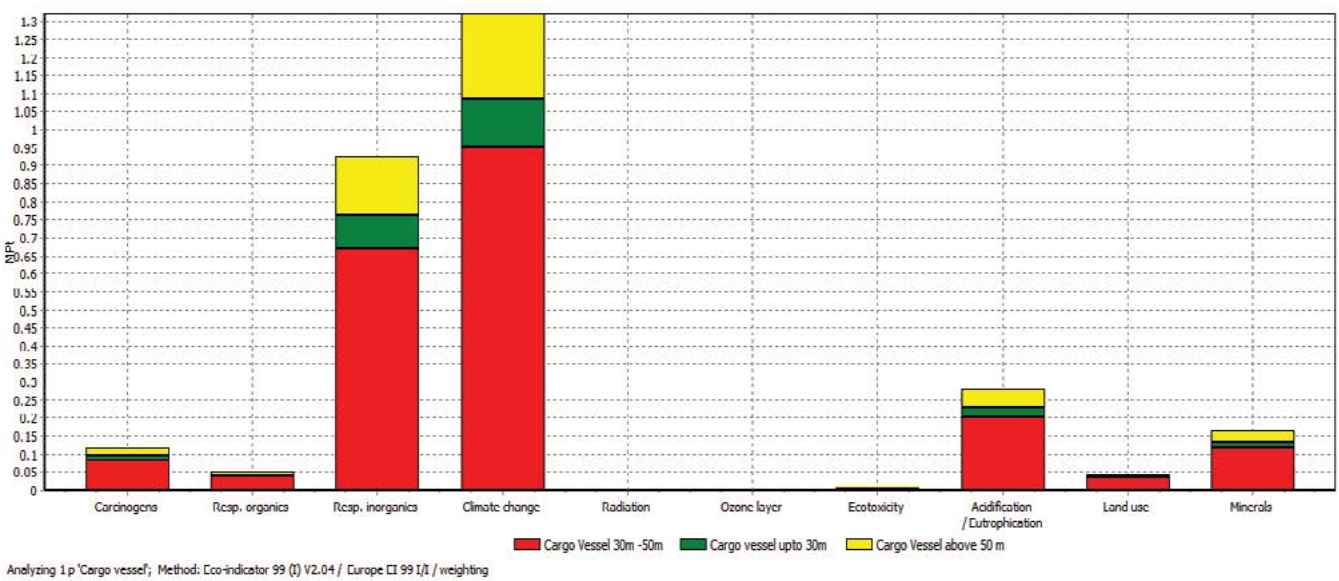

Fig 9: Impacts of Pollutants Discharged by Cargo Vessels/Yr 'Eco- Indicator 99 (I) (Weighting)

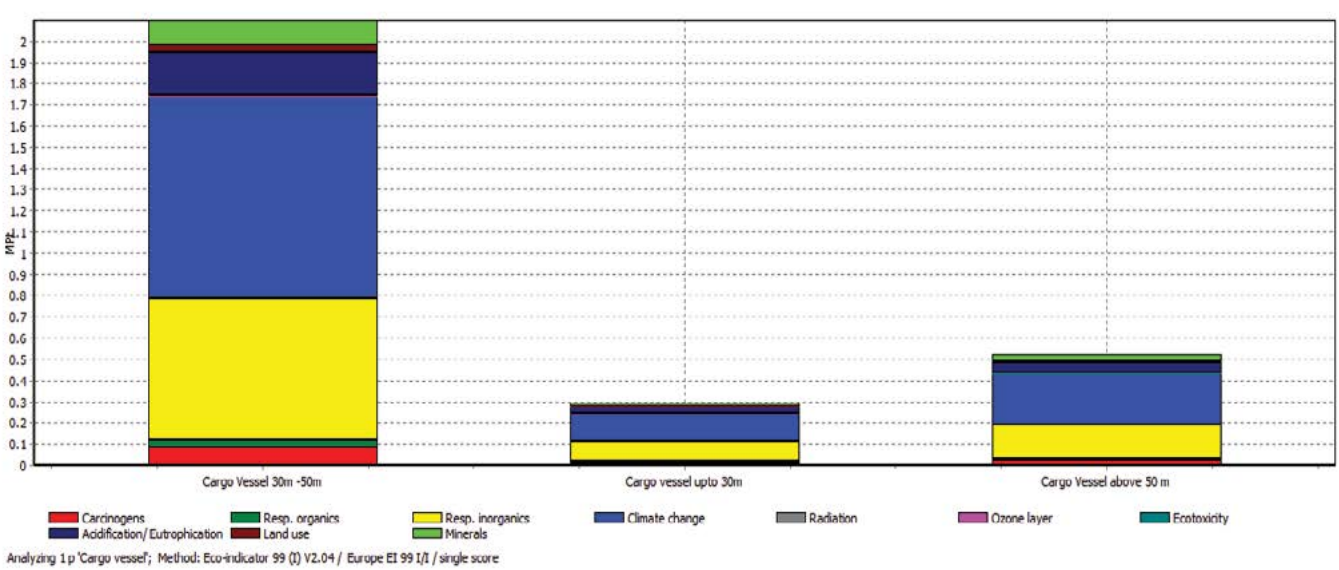

Fig 10: Impacts of Pollutants Discharged by Cargo Vessel 'Eco-Indicator 99 (I) (Single Score)

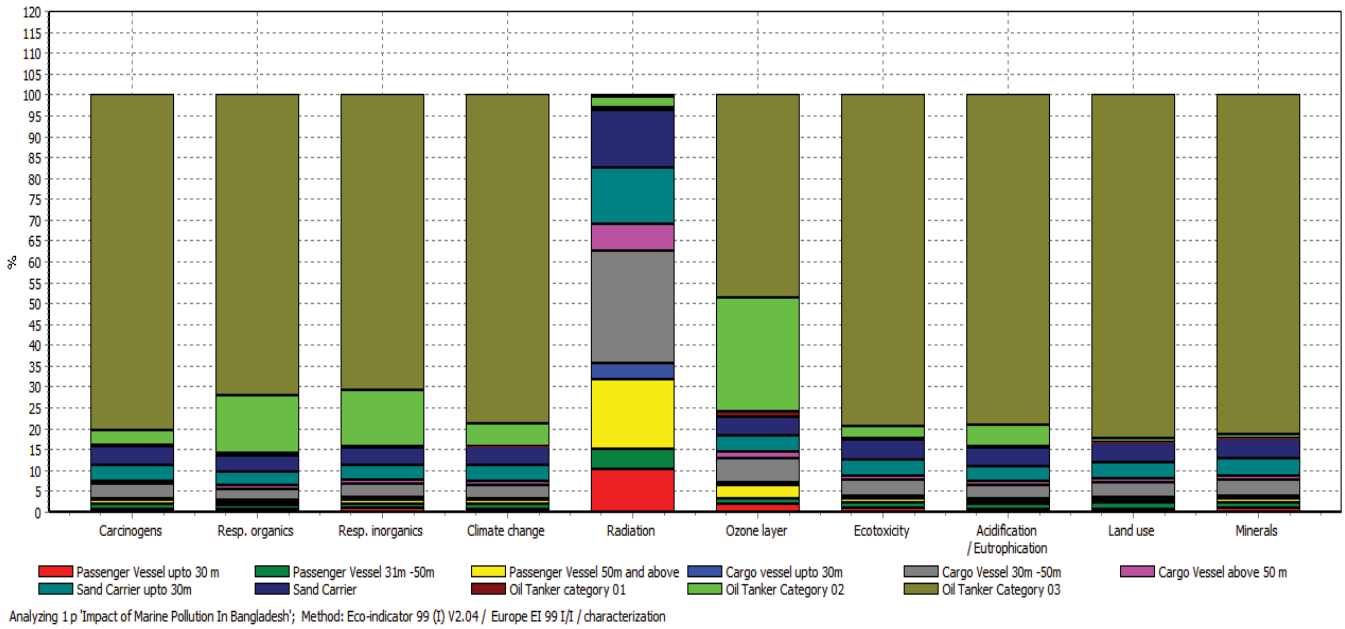

Fig 11: Overall Impacts of Pollutants 'Eco-Indicator 99 (I) (Characterization)

6.0 PREVENTIVE MEASURES

There are various methods of pollution prevention but relatively the best technique includes:

a. Technical Framework. The technical framework recommends the combination of two technical solutions for ship waste treatment; stationary waste reception facilities (such as green terminals in ports) and self-propelled waste collection vessels. As our concern is only the inland cargo vessel operation, the ships must have Sewage Treatment Plant and Bilge Water Separator on board to prevent the environmental pollution. Though the inclusion of these system may additional expenditure but will provide environmental friendly ships with negligible marine pollution. In this respect, the frameworks for our passenger vessel should be provided with following structures as shown in Table 4:

Table 4: Proposed Technical Framework for Pollution Prevention

Type	Category	Pollutants	Measures
Cargo Vessel	All categories E-mail address: kaosar518@gmail.com	a. Bilge b. Solid waste	a. Storage Tank b. Bilge –Water separator and c. STP on board
		a. Air Pollution	a. New ropulsion Engine and machinery instead of age old machinery

b. Legal Framework. Environmental laws can make it tougher for people to pollute the marine environment. In accordance with 1976 ordinance, the discharge of bilges, oily mixture and sewage into inland water is prohibited. The owners and the Ship builders should be respectful about the rules and provide the necessary facilities on board ship to prevent the marine pollution.

c. General Awareness, Coordination & Monitoring. Greater public awareness can make a positive impact to reduce the ship borne marine pollution. The coordination among the ship designer, builder, owner and the related government bodies can reduce the marine pollutions significantly. Government monitoring mechanism should ensure proper utilization of rules and regulations in case of ship building, survey and operation.

7.0 CONCLUSIONS

7.1 Bangladesh depends heavily on inland water transportation for transportation of goods, cargos, fuel-oil and passengers. Over ten thousands various types of vessels (like passenger ship, cargo ship, oil tanker and sand carrier) are plying in inland routes with a significant increasing rate in every year. However, the quantity of various pollutants like bilges, solid waste, sewage and harmful gases discharged by the inland cargo fleet (consists of 2213 registered ships of various sizes) were calculated for one year considering the vessels operational time as eleven month in this research work. The quantity

of pollutants discharged by Cargo vessels were also compared with other vessels (Sand carriers, Passenger vessels and Oil tankers) and found much higher followed by Sand carriers, Passenger vessels and Oil tankers. The accumulated quantities of pollutant by the inland vessels are shown below in Table 5.

Table 5: Discharged Quantity of pollutants/Year

Type	Cat	Bilges Discharged (Ton)	Sewage Discharged (MT)	Oily water (Ton)	Ballast water (Ton)	Fuel Burnt (Ton)
Cargo Vessel	Cat -1	1435.50	-	-	-	34452
	Cat -2	10256.40	-	-	-	246453.6
	Cat -3	2309.175	-	-	-	61578
	Total	**14001.075**	**-**	**-**	**-**	**3424836**
Passenger Vessel	Cat -1	3856.050	42.845	-	-	51414
	Cat -2	1815.00	229.9	-	-	101640
	Cat -3	647.90	111.98	-	-	49104
	Total	**6318.95**	**384.73**	**-**	**-**	**202158**
Oil Tanker	Cat -1	212.85	-	39150	-	5108.40
	Cat -2	935	-	1054680	-	25357.20
	Cat -3	255.75	-	-	306900	6138
	Total	**1403.60**	**-**	**1093830**	**306900**	**36603.60**
Sand Carrier	Cat -1	5179.02	-	-	-	286209
	Cat -2	5182.10	-	-	-	158794.35
	Total	**10361.12**	**-**	**-**	**-**	**632669**

Considering the calculated quantity of pollutants, the environmental impact models of cargo vessels have been made and the impacts of pollutants through characterization, weighting and single score were determined. It has been revealed that there are considerable impacts of marine pollution for prolonged inland cargo vessel operation. The major consequences includes the climate change, destruction of fishing zone, respiratory problems of human being and the rise of sea level.

7.2 Few Preventive measures to reduce the environmental pollution from the practical point of view are also suggested here which includes the technical frame works, legal frame works, general awareness, coordination & monitoring. Though it is quite difficult to nullify the marine pollution in our country but our efforts will obviously reduce the significant marine pollution in near future.

References

[1] Baten, A. S. M. A., "Internal water transportation system: safety of inland Passenger vessels", National Defence College Journal, (2005).
[2] Bangladesh: National Programme of Action for Protection of the Coastal and Marine Environment from Land-Based Activities. Government of Bangladesh, Ministry of Environment and Forests, (2005-2006).
[3] Hasan, K., "Pollution of marine environment in Bangladesh by shipping and the preventive methods, "Proc. of International Conference on Environmental Aspects of Bangladesh, Japan, Sept (2010).
[4] Iqbal, K.S. and Rahim, A., "Mechanized country boats of Bangladesh: Assessing environmental impacts of hull form modification" in International Shipbuilding Progress vol 53, (2006).
[5] Karim, I., Assessing the impacts of oil spillage from ships on coastal environment of Bangladesh: means for response and mitigation, Thesis, Masters in Disaster Management, BRAC University, 2009.
[6] "Eco-Indicator 99 manual for designers" A damage oriented method for life cycle assessment by Sima Pro.
[7] ISO (1997b). Environmental management-Life cycle assessment-LCA ISO/CD 14042.1. 997.01.15.
[8] Rashid, Kaosar, "Evaluation of environmental pollution in Bangladesh by inland shipping operation" A thesis paper submitted to NAME department, BUET in fulfilment of the curriculum of M Sc Engineering, 2015.
[9] "Turn down the heat; Confronting the new climate normal" Report no 3, November 2014 by World Bank.
[10] Singh, RIB, "Marine pollution, its Causes, Consequences and Cure" Thesis report, Masters, Panjab University.

SOCIAL INCLUSION THROUGH HOUSING: AN EXPERIMENTAL PROPOSITION FROM A THEORETICAL PERSPECTIVE

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ABSTRACT

It is widely asserted by the 20th century housing experts that 'housing is a process, not a product'. As a process, housing has a phenomenal strength to change the behavioral pattern of a community. Here in this paper Monihar Harijan Slum (Harijan: an ethnic group of 'Dalit' or outcastes) of Jessore, Bangladesh was taken as a case to draw an experimental housing proposition from the perspective of this widely acclaimed theoretical concept. In Bangladesh, although Islam does not support caste based social discrimination still Muslim dominated mainstream society of the country is negligence to the Harijans claiming their unholy occupation (street sweepers) and uncleanness, results in the exclusion of these people from the society. The Monihar Harijan community of Jessore municipality suffers from exclusion and low-income occupation hereditary since their expulsion from Allahabad City during the British colonial era and these realities compelled them to live in inhumane conditions inside their slum. With this background, this research aimed to identify the appropriate housing proposition that can change the behavioral pattern of the community to eliminate the public claim and thus it can include the Harijans into the mainstream society. Various types of survey methods and research methods were used to determine the issues and prospects. It was found that strategic changes in the built-form pattern, a low-cost vertical extension of the built-forms, affordable sanitation infrastructure development and provision of income generation are the suitable strategies to achieve the desired goal. Finally, a housing proposition has been simulated adopting those strategies. Here, in this simulated proposition housing is seen as a society reformation tool as well as a model for the communities who share the same vulnerabilities.

1.0 INTRODUCTION

During the British colonial era Harijans, who were street sweepers in occupation by ethnicity, were expelled by the British government from different areas of Indian sub-continent to East Bengal (now Bangladesh) to fill the paucity of cleaners of the new British towns. Hereditarily Harijans were the victim of Hindu caste-based social discrimination. Although, Muslim dominated society of East Bengal had no caste discrimination, the society never accepted the Harijans and treated them as 'untouchable' since their advent [1]. Independence of Bangladesh was established with the cognition of social equity, secularism, and economic development. However, till today people fosters negligence to the Harijans with the same manner as before.

Due to low-income occupation and social exclusion, every Harijan in the cities of Bangladesh lives in slum within his own community and belongs to a poor economic condition. Monihar Harijan slum is one of the three Harijan slums located in Jessore town. The Harijans of this slum were expelled from Allahabad city to Jessore in 1926. The municipal authority

provided the 0.5-acre land of the slum upon their advent. Over time, the population of the community tripled but the land remained the same. High population density and poor sanitation infrastructure made this slum congested and unhygienic, which resulted in inhumane living and frequent illness among the dwellers.

With this background, this research aimed to find out the appropriate housing for the Monihar Harijan community of Jessore municipality with a key target of eliminating social exclusion and poverty. There is, however, no current plan or policy on Harijan's housing neither by government bodies nor any private organization. Therefore, the implementation policies of the proposed design have been determined in a self-help approach. Moreover, no preceding research or implemented project into sustainable Harijan housing in Bangladesh has been found. As a first endeavor, this research aimed to produce a unique approach to self-help housing for Harijan communities, which is 're-incarnation with minimum demolition with phase-wise self-help implementation policy'. At site study, various types of survey methods such as non-participatory observation, unstructured interviews, and field surveys were used for collecting the primary data. Information from secondary sources was also used. Collected data was analyzed through SWOT matrix. Two major issues were found in the study- first, poverty and social exclusion due to society's negative outlook and second, the poor physical environment of the settlement. Both issues are interrelated. It was understood that a strategic improvement of the physical environment can turn the society's outlook from negative to positive as well as can contribute to alternative income generation to eliminate poverty. The whole paper describes the strategies for improvement of the existing housing so that it can contribute to eliminating poverty and social exclusion, which concludes with a self-funded implementation plan.

2.0 SITE STUDY

2.1 Socio-cultural realities:

Harijans are excluded from mainstream society; however, this social rejection strengthened their community bonding & belongingness. To the outsider, their settlement is just a warren but in reality, socially & culturally Harijans lead a very rich life of social compromise, mutual support, mutual dependence and resourcefulness within their own community. This rich social mannerism shaped their culture & lifestyle. These greatly affected their space use pattern. They never bother about privacy and never close their doors. They use their 'front of the house' as a social meeting & sharing space. The most important thing is that they made the settlement by themselves according to their known construction technique, affordability, lifestyle & cultural need, which created a strong sense of belongingness to their architecture & settlement.

2.2 Socio-economic condition:

Social realities compelled the Harijans to belong to a specific occupation. This limited work opportunity kept them poor for decades. All of them are cleaner in occupation; besides some of them do pig rearing around the homestead and weave Nakshi Katha (ornamented blanket) for alternative income generation. They are not allowed to work in hotels-restaurants or shops. No one hires them for homestead works except cleaning of septic tanks. However, both male & female members of a family try to contribute to the family income. Their average monthly family income (avg. family member: four nos) is 5000 BDT (65 USD). The following table (table 1) shows their income data:

Table 1. Income Data

Source of Income	Cleaning	Pig rearing	Others
Income/month	4500 BDT	3000 BDT	1000 BDT

2.3 Physical environment:

The settlement of the Harijan is located in the central business district of Jessore town, having all amenity services (e.g. hospital, markets, educational institutes, transportation stoppages) around. Along with congestion, the settlement suffers bad odour, mosquitoes & flies due to unmanaged pig rearing (i.e. uncovered wet food reservoir of the pigs inside the settlement) and unhygienic latrines. The housing units are arranged in a spontaneous & flexible pattern, which reflects their lifestyle & culture. The circulation cannot be defined as road rather it can be defined as space, which they also use for 'front of the house' activity (Figure 4). The settlement has a one-story brick building containing 15 dwelling units and 16 bamboo/CI sheet houses containing 32 dwelling units. At present 47 families with a number

of 160 people are living in this settlement. The brick building was built in 1974 with a financial support from the municipal authority. Other houses are self-built & suffer from inadequate natural lighting and ventilation. There are only one tube-well & three toilets for the whole community and two temples for the religious rituals.

Fig. 1: Existing condition

3.0 PROBLEM IDENTIFICATION AND SOLUTION

The major problem is found from the observation is the habit of unclean living of the Harijans. Although the socio-cultural-economic condition is a major catalyst behind the formation of a settlement, this Harijan slum suffers mostly by habitual problem as well as knowledge deficiencies of managing unhygienic contents. After rigorous investigation, the following solutions were determined.

3.1 Renovation of built form to tackle congestion and to provide quality built environment:

It was found that they use only one conventional wooden window in each room. In the local market, this type of windows is quite expensive. To make it affordable they reduced the size into 3ft×3ft, which is inadequate for proper natural lighting & ventilation inside the rooms. In the proposed design, the bamboo bat/CI sheet facade has been cut with a regular interval & it has been transformed into several top-hung windows. A rack has been added under the roof so that the goods can be kept and thus the usable space of the room has been increased. By considering every house as 'a money maker', several components have been added. The proposal suggested a conventional pigeon-cote in front of every housing unit, hanging beneath the front roof cornice; a pig house on the back of every housing unit; and an ash gourd platform in between the housing unit & the pig-house. This ash-gourd platform will make a semi-outdoor space, which will also serve as a buffer between the housing unit & the pig-house. The ash gourd will not only make money but also keep the roof cool in the hot season and provide oxygen to freshen the air. After some years, the Harijan may need an extension of housing units to meet up their housing need. In this case, the proposal suggested to extend the units vertically & showed an affordable way of vertical extension with the conventional low cost bamboo-wood structure. Figure 2 shows the details.

Fig. 2: Built-form Renovation

3.2 Rearrangement of the settlement to improve unhygienic environment:

As the settlement is a reflection of Harijan's unique culture and lifestyle, therefore, the proposed rearrangement neither demolished any built form nor broke the basic settlement pattern; it just suggested relocating the uncovered wet food reservoir from the front of the house to back of the house area & keep it covered. Therefore, the odor will not spread out and mosquitoes & flies will not grow. Three biogas plants have been also proposed at the peripheral area of the site, which can be operated easily with the solid waste of pig. Two zones of toilet & tube well consisting of low cost sanitary latrines have been proposed. A drainage network has been developed connecting all toilet zones. The proposal also suggested planting trees around the site area for providing fresh air. (Figure 3 & 5)

Fig 3: The proposition

3.3 Making catalyst to eliminate poverty & social exclusion:

It was found from the survey that the Harijan women often get work orders from boutique houses for weaving Nakshi Katha. There is a demand in the market for Nakshi Katha due to its ethnic artistic value. However, it is not available in local shops, as shopkeepers do not keep it in their shops prejudicing 'unclean'. Therefore, a community market has been provided in the proposed design where the Harijans will sell the Nakshi Katha and other handicraft products. The proposed community market is designed in such an architectural approach so that it can attract people to visit. While people will be ambling inside the market, they will be able to see the settlement too. It is expected that the neat and clean built-environment of the settlement may change the 'unclean' prejudice of the people and thus it may work as a catalyst to eliminate social negligence and exclusion. This concept is an 'inside-out' endeavor to eliminate society's negative outlook.

4.0 IMPLEMENTATION PLAN

Every design decision has been taken keeping in account the Harijan's known construction technique and affordability to assure the self-help capacity. There is flexibility to use materials whatever the Harijans can afford, because, with the economic improvement of the Harijans the choice of material may be changed.

4.1. Cost:

Table 2. Development Cost

	ExtensionR			enovation	
Option	Materials		Cost	Materials	Cost
	Wall	Floor			
01	Bamboo	Bamboo +Wood	11000 BDT (142 USD)	Bamboo	2000 BDT (26 USD)
02	CI Sheet	Bamboo +Wood	16000 BDT (207 USD)	CI Sheet	3000 BDT (39 USD)

4.2 Development phase:

The implementation has been planned with 5-phase development scheme requiring 15 months to be executed, which needs only an investment of 200 BDT initially!

Phase 1: First of all they will plant the seed of ash gourd on back of their house and will make a platform for that ash gourd so that the plant can climb the roof. It will cost 200 BDT. After three months this plant will give about 12-15 ash gourds, which's market price is about 1000 BDT.

Phase 2: With this 1000 BDT profit they will make a conventional wooden pigeon-cote which will cost 500 BDT. With the rest 500 BDT, they will buy 10 young pigeons. After two months they can make a profit of BDT 1500 by selling that pigeons. After more four months the profit will be 4500 BDT.

Phase 3: With this profit of 4500 BDT they will make the pig-house and buy two young pigs. After 6 months they can make a profit of 14000 BDT.

Phase 4: with this profit, they will reconstruct their housing unit, pig house & buy more young pigs for rearing.

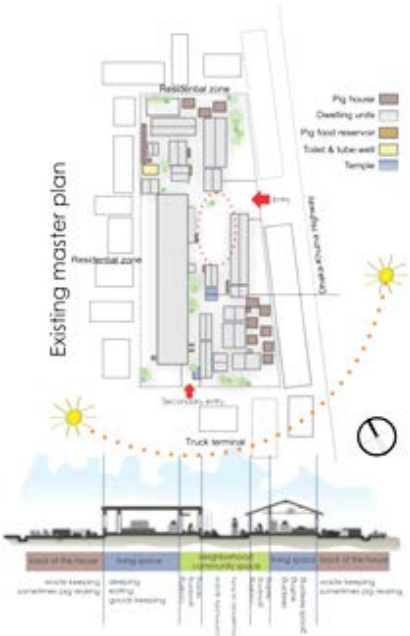

Fig 4: Existing Master Plan

5.0 CONCLUSION

Housing is a process, not a product. Housing needs to engage the multiple socio-cultural, economic, and political dynamics surrounding the livelihood of residents and the politics of place, addressing the diversity in realities and necessities of communities. Similarly, housing integrates people and makes a change in their livelihood, socio-cultural-economic state even behavioral pattern [2]. Therefore, a housing can be used as a tool to make positive changes to a community. Human makes space and objects of space which can be a dwelling, parks, roads, dustbin etc, according to their needs and demands. Through another lens, these needs and demands also can be created by existing elements. (i.e. if there is a road, the need of a car can be aroused). As an example, a newborn baby who discovers all of these elements just after his arrival on the earth, he just copes with those elements; his growth will be directed by the elements. Housing is an integration of livelihood and culture that produces its physical elements such as a house, roads, drains, public spaces as per culture and livelihood. Therefore, housing has the strength to impact on human psychology and thus it can change the livelihood, behaviors, and culture of the human.

It may be a matter of argument that- is it possible to eliminate social exclusion through 'housing'? The society of Bangladesh is liberal to respect all people despite their economic condition or occupation. Then why do the Harijan suffer from negligence? When a mainstream child goes to school, he/she is instructed by his/her parents not to touch his/her Harijan classmates. On a contrary, the parents never forbid their child to play with the child of a rickshaw puller/day laborer. Then why do they reject Harijans? Field survey and observation revealed Harijans suffer from this negligence and exclusion due to their visible unclean lifestyle, which proves the 'unclean' accusatory of the mainstream people.

Fig 4: Proposed Master Plan

As discussed, 'Housing' as a process can reshape a community's lifestyle. From first to last this research focused on the redesign of the settlement of Harijans, which will contribute to eliminating 'unclean' accusatory from the mind of mainstream people and thus gradually social exclusion and poverty will be eliminated.

References

[1] Chowdhury, I. U. (2009). *Caste-based Discrimination in South Asia:* A Study of Bangladesh. New Delhi, India: Indian Institute of Dalit Studies.

[2] Turner F.C. (1972). 'Housing as a verb', Retrieved from www.communityplanning.net/JohnTurnerArchive on 12/04/17.

EFFECTIVENESS OF DAMPERS IN ENHANCING THE LATERAL LOAD BEARING CAPACITY OF HIGH-RISE STEEL BUILDING

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ABSTRACT

This research paper describes the results of analysis of the seismic behavior of a thirty story steel building with and without damper under different earthquake acceleration signals. The proposed procedure placed the various types of damper like friction damper, bilinear damper and exponential damper on the top three floors of the building. The study compares the different performances such as the joint displacement, joint acceleration, the base force of structure with and without damper for a thirty-story steel building using ETABS 2015. The study further performs time history analysis for different seismic accelerograms to observe the actual time domain responses of the structure. Finally, static pushover analysis in both X and Y direction studies the demand and capacity spectrum. Linear time-history analysis on this steel building structure indicates that maximum joint displacement increases for S-Monica2 seismic accelerogram and decreases for Altadena and Corralit accelerograms; whereas, maximum base force and maximum joint acceleration are effectively reduced for all the seismic accelerograms in the presence of damper at top three floors of the building.

Key Words: — earthquake, damper, static pushover analysis, linear time history, demand and capacity spectrum

1.0 INTRODUCTION

Over the last few decades, the world has experienced numerous devastating earthquakes. As a result, due to the collapse of buildings and severe structural damages in densely populated areas, an increased loss of human life occurred. In developed societies with modern infrastructure, major earthquakes claim significantly fewer lives when compared to prior generations. Our understanding of earthquake mechanisms and seismic ground motions is continually advancing. Furthermore, the understanding of how buildings respond to earthquakes continues to enhance. Recent studies give more importance to the research and development of structural control techniques such as passive control system, active control system, and semi-active control system giving particular importance to the improvement of seismic responses of buildings. Passive control systems do not require any power supply. For the typical design of building against earthquake, resistant of the building stems from the stiffness, ductility, and structural damping, thus, large amounts of energy dissipate through localized damage or plastic hinges formed in the lateral resistant system. Energy dissipation action in a frame system, such as beam and column in a moment-resisting frame produces damage in those components. Repair of such damage after an earthquake is very expensive and often requires evacuation of the building. By locating energy dissipation device to new and existing structures earthquake-induced energy can dissipate efficiently. This enhanced structural system can reduce damage to the structures. Energy-induced by the earthquake can disperse by adding additional equipment called damper. Damper, a device useful as a seismic retrofit or strengthening in new construction, dissipates a significant portion of the induced energy in the most critical parts, so damage to the structure minimizes.

Among the three structural control systems referred in the preceding section, damper system belongs to the passive control group. There are various types of dampers such as a viscous damper, tuned mass damper, friction, bilinear and exponential damper. Among this dampers, exponential, bilinear, friction dampers act as a function of displacement. In Bangladesh, the practice of application of energy dissipation device in existing or new buildings is still at an early stage. This paper intends to focus on the advantages of nonlinear mass damping devices. Nonlinear time history analysis is of paramount importance for seismic analysis and performance study. This research paper presents the nonlinear time history analysis of thirty story steel building frame with and without damper considering S-Monica2, Altadena, Corralit earthquake acceleration signals. The damper proves to be a significant device in enhancing the seismic performance of a building. Current investigation supports the conclusion by proving the contribution of the damper in the reduction of the story displacement, base shear, and joint acceleration while increasing the natural period of the structure.

2.0 METHODOLOGY

The study focuses on the seismic behavior of a 30-story 3D steel frame. Several researchers reported various aspects of damper enhanced structures including linear and nonlinear Static and linear and nonlinear dynamic analysis of buildings frames fitted with dampers. This study locates the damper in top three floors for to enhance its seismic behavior. A comparison of time history analysis with and without damper compares the significant parameters such as story displacements, joint acceleration, and base shear.

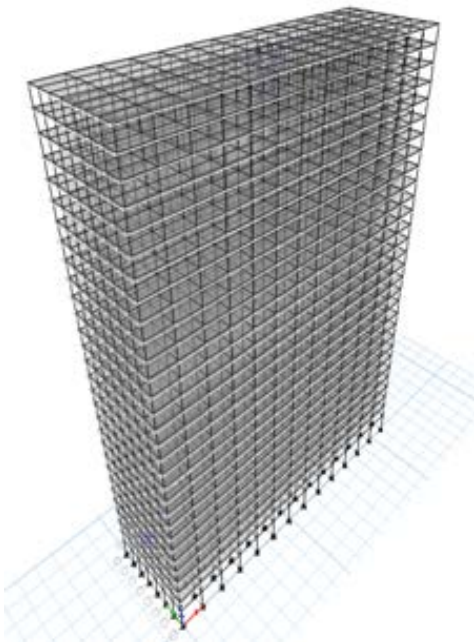

Fig 1: 3d view of model

2.1 Modeling and Assumptions

Structural system analyzed in this paper is a steel frame structure.The building has 13 bay in the X direction and eight bay in Y direction [Figs. 1, 2 and 3], and the height of the building is 305 ft. The damper locates in 30th, 29th, and 28th storey. The current study employs the seismic behavior of the structure assuming that the seismic response is in two perpendicular directions and independent of each other.

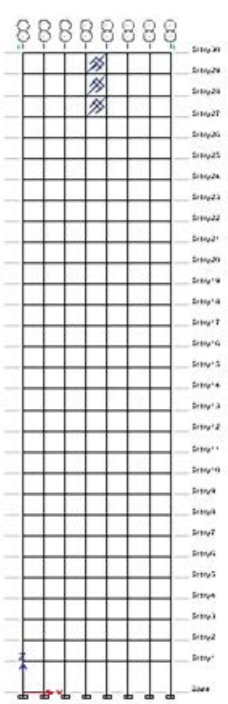

Fig 2: Elevation of model

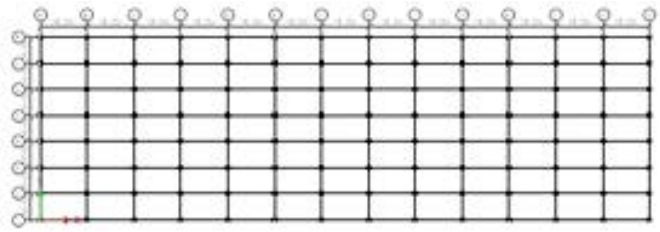

Fig 3: Plan view of model

2.2 Damper Modeling

This study simulates and compares the effect of exponential, bilinear, and friction dampers on the seismic performance of the structure. This paper presents nonlinear time history analysis of the structure using ETABS 2015, a nonlinear FE based structural analysis software.

2.3 Modeling and Specification

Figure 1, 2 and 3 illustrate the 3D, elevation and plan view of 30 story steel frame structure respectively.

Table 1: Damper properties

Properties	Exponential	Bilinear	Friction Spring
Mass (lb-s^2/ft)	73454.1	73454.1	73454.1
Weight (kip)	1301.70	1301.70	1301.70
Effective stiffness (kip/in)	666.5	666.5	666.5
Effective Damping (kip-s/in)	216.82	216.82	216.82
Stiffness (kip/in)	1000	1000	1000
Damping coefficient (kip-s/in)	271.02	-	-
Damping Exponent	1	-	-
Initial Damping coefficient (kip-s/in)	-	1212.056	-
Yielded Damping coefficient (kip-s/in)	-	0	-
Linear Force Limit (kip)	-	0.001	-
Slipping Stiffness(loading) (kip/in)	-	-	1200
Slipping stiffness (unloading) (kip/in)	-	-	1000
Stop displacement (in)	-	-	0

3.0 RESULT AND DISCUSSION

Figures 4 to 7 illustrate the findings from the time history analysis of the 30 story building steel frame structure with mass damper. Table 3 lists the values in the form of the period, moment, and shear value for EQY and WINDY of building frames, base shear or force and base acceleration; story displacement. The investigation observed that there is significant variation in results due to the different earthquake motions.

3.1 Mode Numbers with Period

For modal analysis, the natural period of the building increase with the installation of dampers in the structure. In this regard, exponential dampers work more efficiently, and bilinear damper along with friction spring damper display more or less the same natural period of the building. The reasoning is that as the mass of the building increases, the period also increased according to the following equation

$$T=(2\times\pi\times\sqrt{m})\div(\sqrt{k}) \qquad (1)$$

Here, m= mass of damper
k= stiffness of damper
Table 2 represents the increment of the period for different mode shapes. The increase of building period varies from four to ten percentages.

Table 2: Increment of building period

Modal number	Time period (sec) Without damper	Time period(sec) Exponential damper	Time period (sec) Bilinear damper	Period (sec) Friction damper
1	4.321	4.949	4.949	4.947
2	3.784	3.806	3.806	3.806
3	3.126	3.525	3.525	3.523
4	1.394	1.526	1.526	1.523
5	1.234	1.239	1.239	1.239
6	1.029	1.126	1.126	1.124
7	0.754	0.805	0.805	0.805
8	0.694	0.696	0.696	0.696
9	0.597	0.636	0.636	0.634
10	0.523	0.549	0.549	0.547
11	0.421	0.521	0.521	0.521
12	0.415	0.486	0.486	0.486
13	0.324	0.44	0.44	0.439
14	0.309	0.409	0.409	0.413
15	0.261	0.36	0.36	0.37
16	0.238	0.336	0.336	0.337
17	0.218	0.309	0.309	0.311
18	0.187	0.276	0.276	0.28
19	0.164	0.27	0.27	0.26
20	0.146	0.229	0.229	0.224
21	0.129	0.194	0.194	0.191
22	0.109	0.16	0.16	0.158
23	0.087	0.124	0.124	0.123
24	0.066	0.087	0.087	0.086
25	0.034	0.038	0.038	0.037

3.2 Moment and Shear Value

Moment and base shear value of analyzed building frames increase if dampers locate on the involved frames. Thus, this study only investigates elevation 45GH frames and load cases EQY and WINDY and are shown in figure 4 to 7. Table 3 illuminates the percentages of the maximum increase in shear and moment values of the beams for the 45GH frame performing linear dynamic analysis.

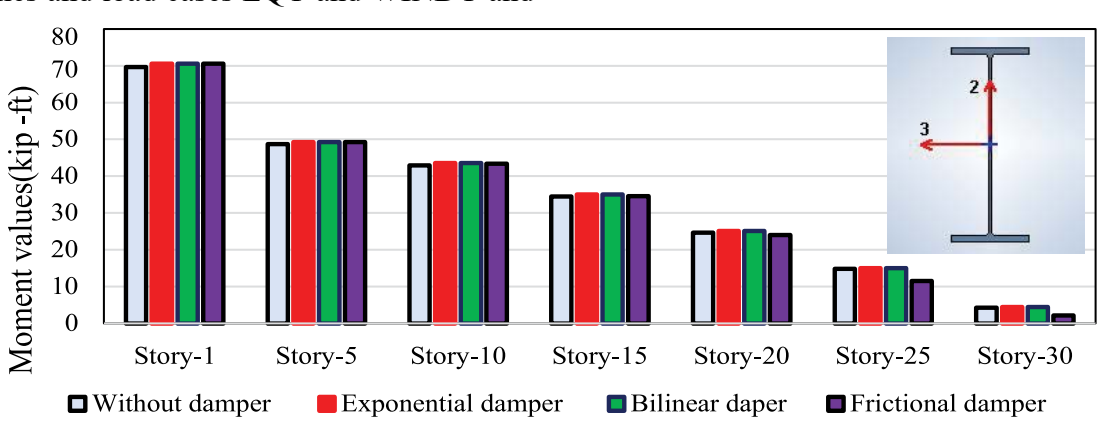

Fig 4: Moment values for WINDY

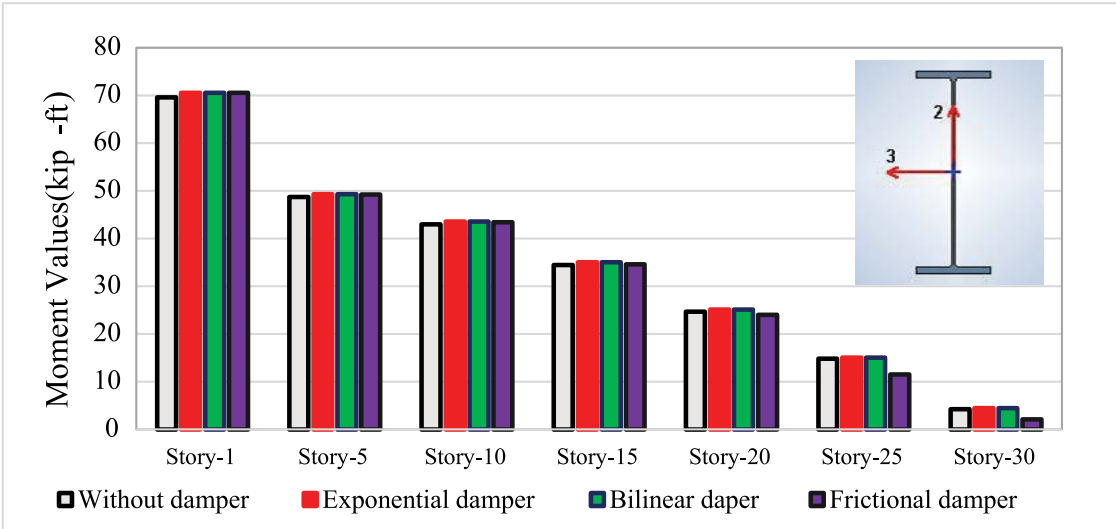

Fig 5: Moment values for EQY

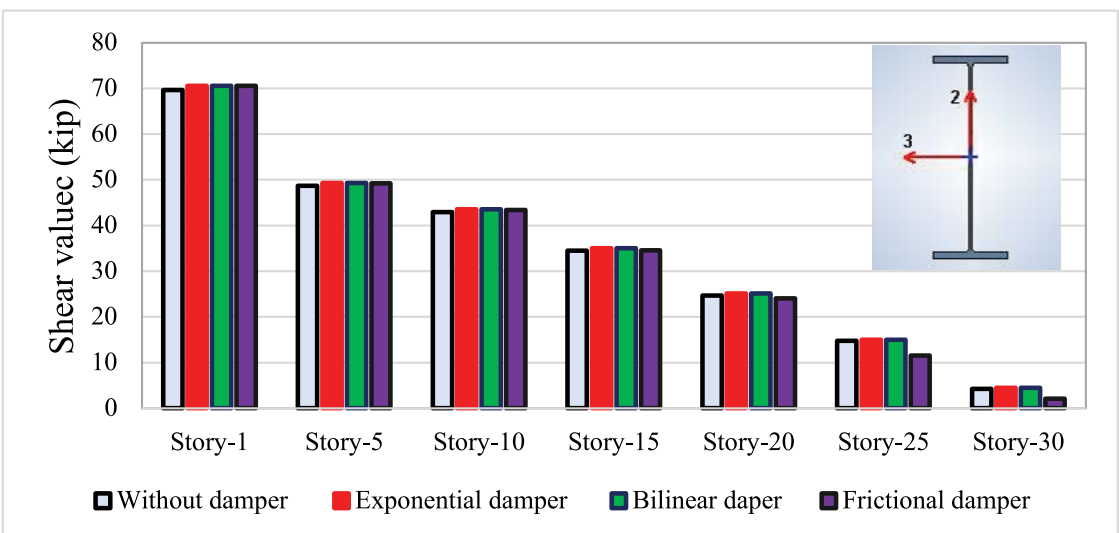

Fig 6: Shear values for EQY

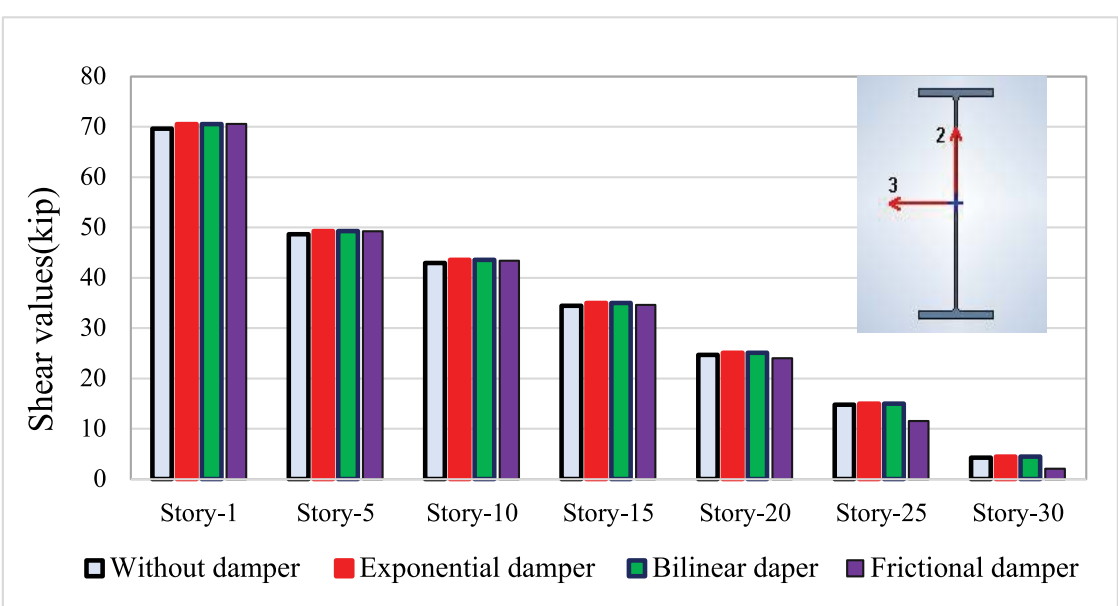

Fig 7: Shear values for WINDY

Table 3: Moment and shear value

Kind of Response	Without Damper	Bilinear Damper	Percent Reduction %	Friction Dampers	Percent Reduction %
Moment (kip-ft) EQY	121.855	140.07	14.95	139.955	14.85
Moment (kip-ft) WINDY	302.531	306.61	1.34	306.513	1.32
Shear (kip) EQY	28.04	32.232	14.95	32.205	14.85
Shear (kip) WINDY	69.61	70.549	1.34	70.568	1.32

3.3 Time History Analysis of Building Frame

ETABS is an FE-based structural design and analysis software. The current research utilizes ETABS 2015 to analyze a thirty-story building frame to study its seismic performance with and without a damper under both linear and nonlinear time history analysis.

3.4 Residual Drift

Residual drift is very threatening for a building as it is the permanent deformations that remain after the earthquake. Installation of dampers at the top portion of the building can successfully reduce the residual drift. Table 4 and figure 8 demonstrate that the residual drift decreases after the installation of the damper, and it becomes almost zero for the exponential damper. Residual drifts of lower levels as well as interstory drift can also be compared if the dampers are installed in the building for different time history analysis like Corralit and Altadena along with S-Monica2. But here only S-Monica2 is shown as drift is maximum at top story of a building for lateral loads and drift reduces for different time history analysis by installing dampers.

Table 4: Residual drift for S_Monica2 at top story

Dampers	Residual Drift*100	Percent Reduction (%)
Without Damper	0.023556	-
Exponential Damper	0.0000856	99.63
Bilinear Damper	0.0002076	99.12
Friction Spring Damper	0.0004079	98.268

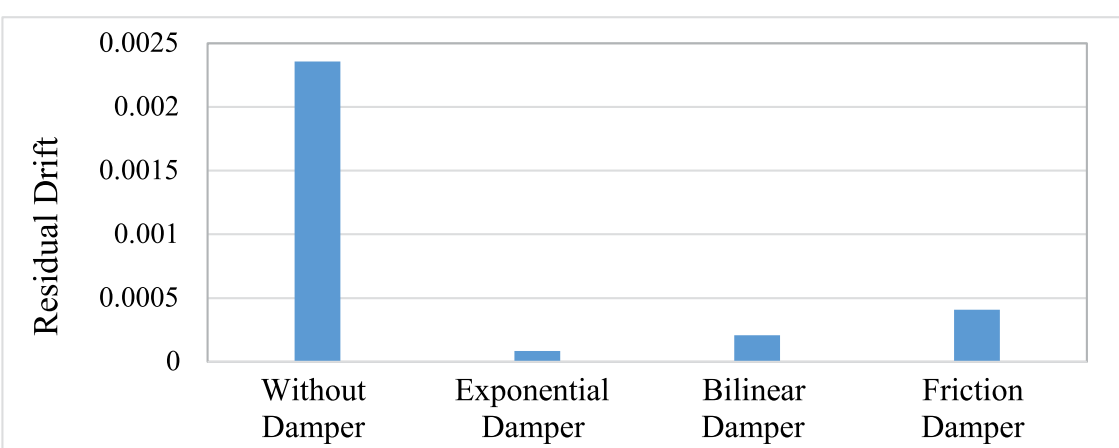

Fig 8: Residual Drift for S_Monica2 at top story

3.5 Maximum Base Shear or Force

Base shear is another important parameter in deriving the response of the frame against earthquake. Base shear decreases with the installation of dampers. Figure 9 and table 5 illustrate that the base shear forces decrease for all three time history analysis by installing exponential, bilinear and friction spring dampers from the frame having no damper.

Table 5: Base shear for different EQ loads

EQ	WO Damper(kip)	Base Reaction With Damper (Kip)		
		Exponential Damper	Bilinear Damper	Friction Spring Damper
S_Monica2	1565.612	1377.396	1315.1	1376.8
Altadena	3199.046	3063.848	3016.7	3087.70
Corralit	1951.22	1950.22	1897.0	1951.01

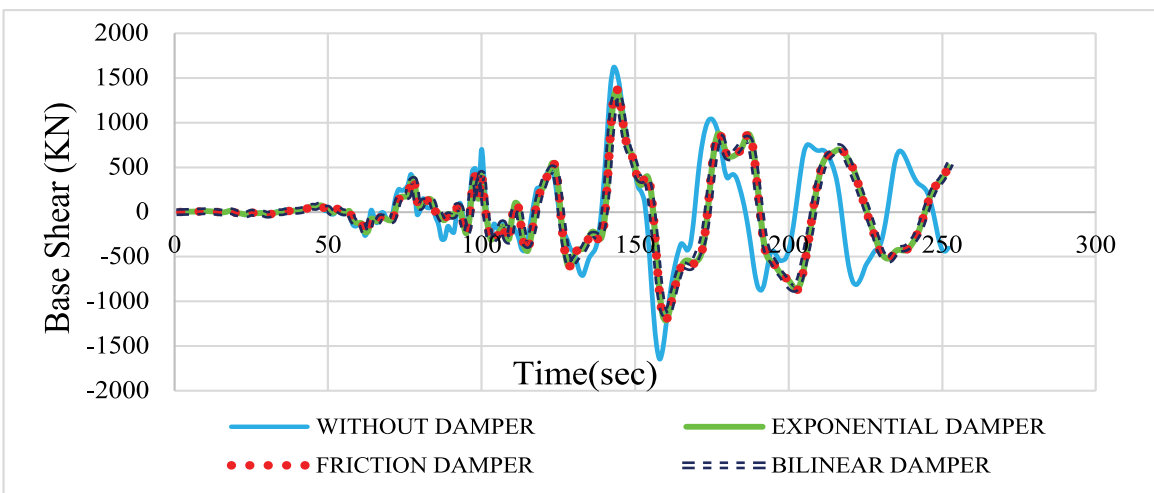

Fig 9: Differences in base shear for S-Monica2 applying different dampers

3.6 Maximum Joint Acceleration

Joint acceleration of 30 story steel frame structure decreases when the damper locates on top three floors for all three-earthquake accelerograms namely, EQ S_Monica2, EQ Altadena, and EQ Corralit load. Table 6 represents the reduction of top floor joint (number 60) acceleration for different earthquake load case when dampers locate in the building compared to the frames without a damper. Joint acceleration reduces more significantly for EQ Altadena. This study extracts from figure 10 table 6 that the installation of mass dampers decreases the joint acceleration for EQ S_Monica2, Altadena and Corralit.

Table 6: Joint acceleration for different EQ loads

EQ	WO Damper (in/sec^2)	Joint Acceleration With Damper (in/sec^2)		
		Exponential Damper	Bilinear Damper	Friction Spring Damper
S_Monica2	164.536	164.235	164.21	164.235
Altadena	502.4486	501.387	501.36	501.981
Corralit	198.267	188.193	177.9	188.034

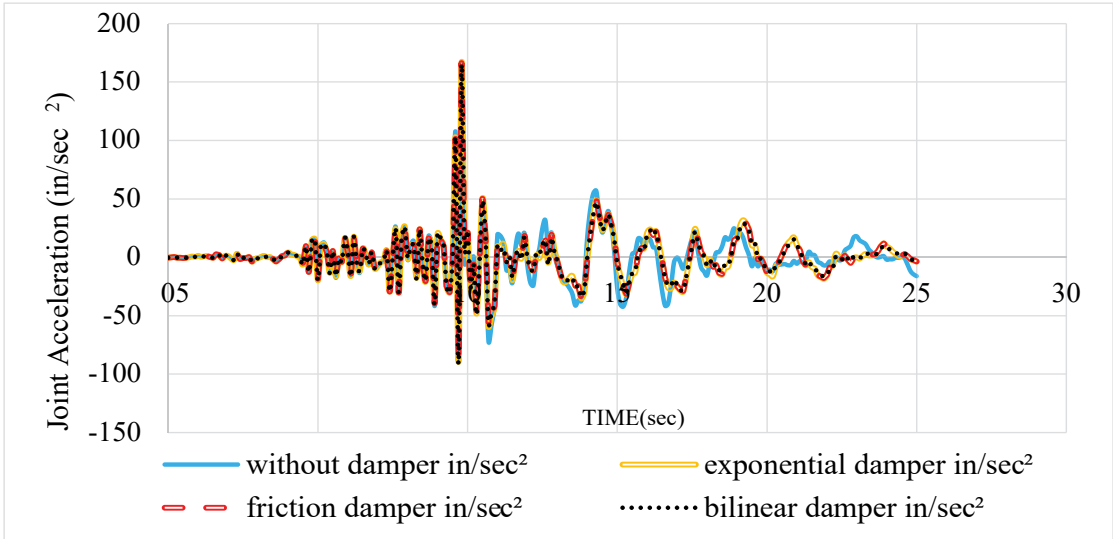

Fig 10: Difference in joint acceleration for S-monica2 applying different dampers

3.7 Maximum Joint Displacement

Table 7 represents that the reduction of top floor joint (number 60) displacement for various earthquake load case when dampers provided in the building compares to the frame without a damper. However, here an interesting result is observed. For EQ S_Monica2, joint displacement is increased but for Altadena and Corralit EQ, joint displacement is decreased. This is because; EQ S_Monica2 has larger amplitude and intensity than the other two earthquakes. Here, figure 11 represents joint displacement only for Corralit EQ. Other time history analysis can also be compared.

3.8 Hysteresis Loop

Energy dissipated by three types of dampers highlights in the graphs provided on the structure. Figure 12 to 14 shows that energy dissipation for bilinear damper is more for steel building than the exponential and friction spring dampers and the displacement indicate the displacement of damper or hysteresis of damper. From figure 14 it is observed that, friction spring dampers are well within the elastic limit showing its linear behavior as its linear diagram shows. Here, only S_Monica2 is analyzed. Other time history analysis for different dampers can also be perceived.

Table 7: Joint displacement for different EQ loads

EQ	WO Damper (in)	Joint Displacement With Damper (in)		
		Exponential Damper	Bilinear Damper	Friction Spring Damper
S_Monica2	5.717643	6.541009	6.4486	6.49356
Altadena	6.468611	5.143085	4.97329	5.10152
Corralit	8.487805	4.699361	4.74011	4.93359

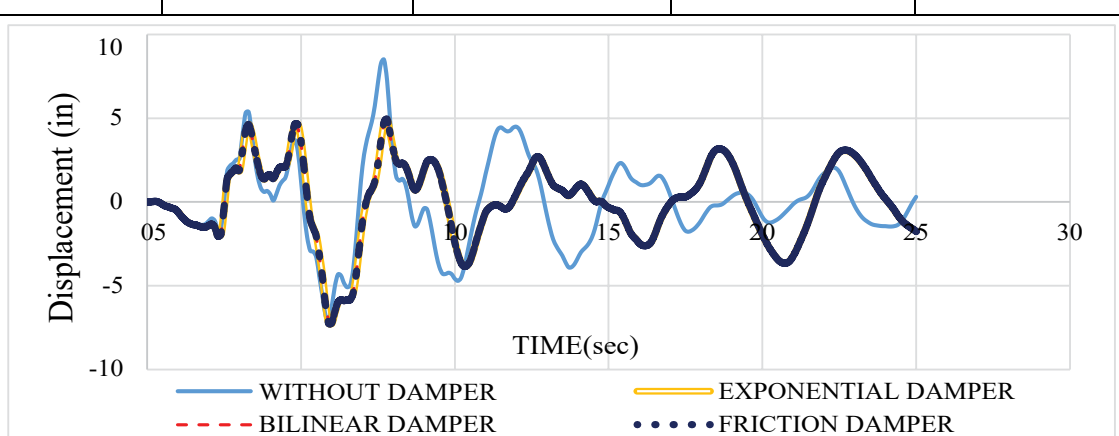

Fig 11: Difference in joint displacement for Corralit applying different dampers

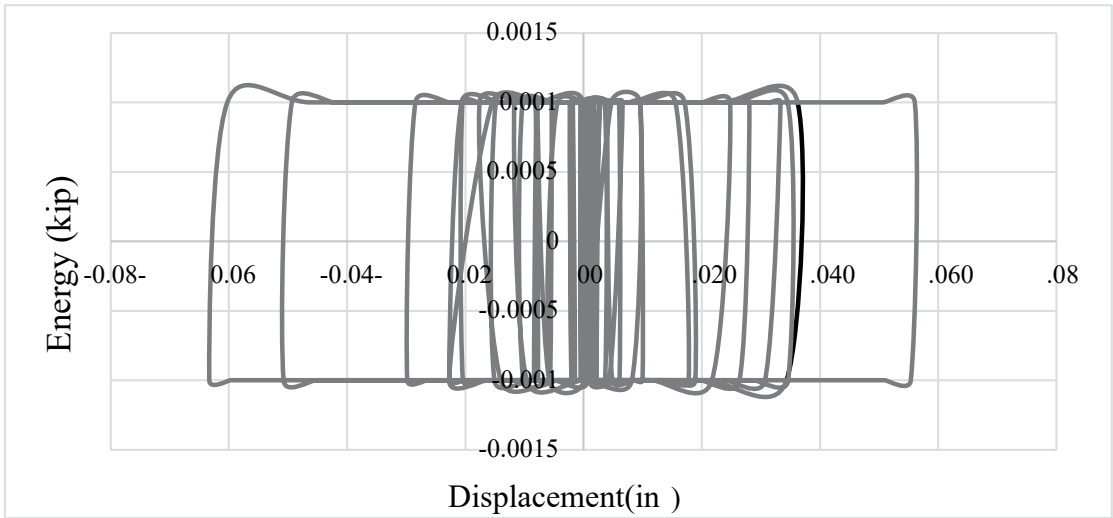

Fig 12: Hysteresis loop for S-Monica2 applying bilinear damper

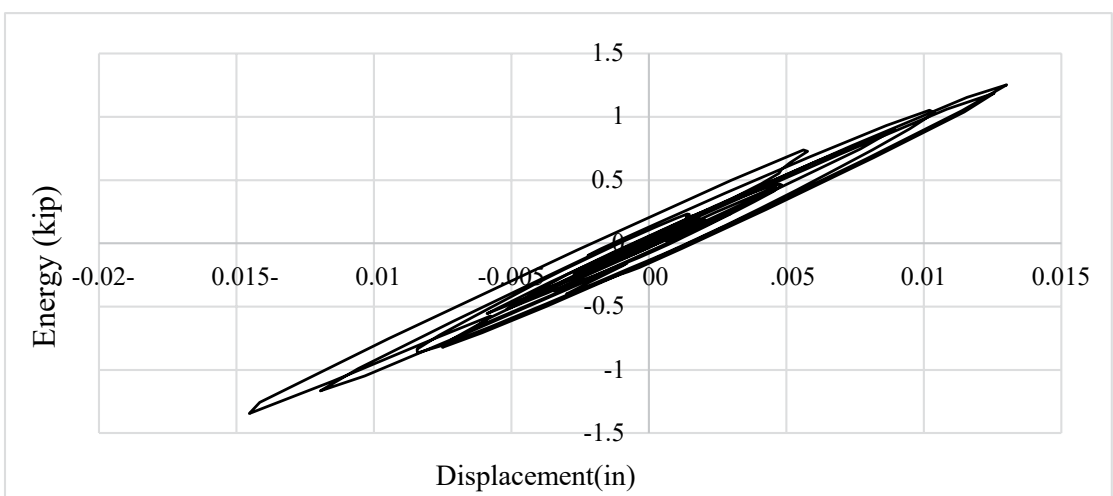

Fig 13: Hysteresis loop for S-Monica2 applying exponential damper

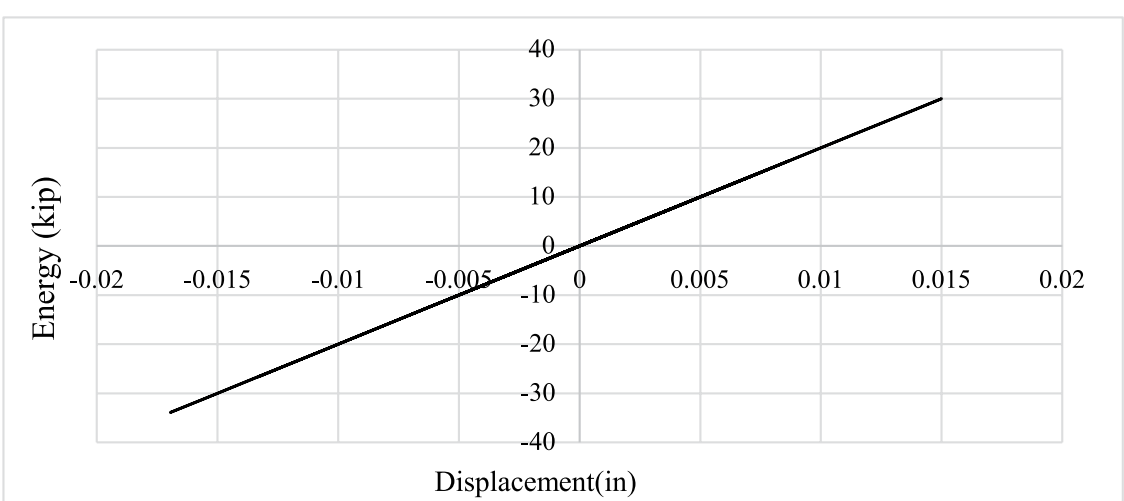

Fig 14: Hysteresis loop for S-Monica2 applying friction spring damper

4.0 CONCLUSION

From the overall discussion and analyses of the study, it can be concluded that:

1. Seismic performance of a building can be improved by installing energy dissipating device (damper) as it absorbs and dissipate energy during an earthquake.
2. Reduction of base shear has been achieved with the deployment of the damper.
3. Reduction of joint acceleration has been achieved with presence of damper, so the inertia forces also reduces.
4. As the story displacement reduces, the structure requires less ductility to resist same earthquake forces. On the other hand, a typical building with limited ductility can withstand larger earthquake loads.
5. Seismic performance can be improved as the modal period increases beyond the typical site period of the structure by installing dampers.

References

[1] Balakrishna G.S, J. Jacob, "Seismic Analysis of Building Using Two Types of Passive Energy Dissipation Devices," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684, p-ISSN: 2320-334X, PP 13-19

[2] Khan W., Dr. S. Akhtar, A. Hussain (2014), "Non- linear time history analysis of tall structure for a seismic load using a damper," International Journal of Scientific and Research Publications, Volume 4, Issue 4, ISSN 2250-3153, April 2014.

[3] Lopez I., J.M. Busturia, H. Nijmeijer (2003), "Energy dissipation of a friction damper," Journal of Sound and Vibration, 278 (2004) 539–561, October 2003.

[4] Purasinghe R, Seismic Evaluation and Retrofit Of A Moment Frame Building With Viscous Dampers, Professor of Civil Engineering, California State University at Los Angeles, California

[5] Rao S-S (2011), "Mechanical Vibrations", 5th-edition, ISBN 978-0-13-21281-9-3, Lake Street, Upper Saddle River, Prentice Hall.

[6] Shaukat Khan Q, A. Ullah Case and M. Ilyas (2013), Improved Seismic Response of RC Frame Structures by Using Fluid Viscous Dampers, Pak. J. Engg. & Appl. Sci., July 2013, Vol. 13, (p. 8-18),

[7] Saiful Islam A.B.M., M. Jameel, Md. A. Uddin, M. Zamin Jumaat (2012), "Competent Building Elevation for Incorporating Base Isolation in Aseismic Structure," presented at International Conference on Advances Science and Contemporary Engineering, ICASCE 2012.

[8] Thakur V.M and P.D. Pachpor (2012), "Seismic Analysis of Multistoried Building with TMD (Tuned Mass Damper)," International Journal of Engineering Research and Applications (IJERA), Vol. 2, ISSN: 2248-9622, Issue 1, pp. 319-326,

[9] Wolff E. D., E C. Ipek, M. C. Constantinou and M. Tapan (2014), "Effect of Viscous Damping Devices on the Response of Seismically Isolated Structures," Published online in Wiley Online Library, DOI:10.1002/eqe.24643, 2014.

[10] Wong, K. F., and Johnson, J. G. (2009). Seismic Energy Dissipation of Inelastic Structures with Multiple Tuned Mass Dampers. Journal of Engineering Mechanics. 135(4), 265-275.

TRAFFIC IMPACT ASSESSMENT OF KHILGAON FLYOVER

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ABSTRACT

This paper aims to delve into the inquisitive understanding regarding the impact of Khilgaon Flyover on roadway segments along the corridor and also adjacent to the flyover. Traffic flow and congestion degree have been estimated to justify evaluation of performance of the flyover. Level of Service (LOS) of individual segments as well as that of the overall facility have been evaluated according to the Highway Capacity Manual by Transport Research Board. To the best of authors' knowledge, no study has been previously done at home to evaluate level of service of links in the influence area of flyovers. This paper has evaluated the performance of segments during weekday day, which represents the worst traffic conditions. LOS F was found at each segment and also at the total facility, suggesting very poor traffic conditions. Such findings have the potential to provide proper guidelines to adopt any policy to tackle with the problem of prodigious traffic growth in Dhaka city.

Key Words: Traffic Impact Assessment, Level of Service, Performance of Flyovers. Congestion Level.

1.0 INTRODUCTION

In line with Strategic Transport Plan, flyovers have been constructed around Dhaka city with aim of improving traffic conditions [1], [2]. However, despite construction of eight flyovers, congestion degree increased while the mobility decreased [1]–[6]. Existing flyovers were constructed in Dhaka considering only the localized impact of flyovers on its aligned roads, rather than conducting additional impact studies on adjacent areas to assess overall impact. As a result, overall traffic scenario in Dhaka city has not improved. To the best of authors' knowledge, negligible study has been done in Bangladesh, to assess mobility and congestion degree of flyovers in their adjacent areas, even though numerous studies abroad emphasize its importance [7]–[13]. It is of paramount importance that future flyovers be built considering a holistic Traffic Impact Analysis (TIA) of both the flyover corridor and adjacent areas, which is the key focus of this paper.

This paper addresses the impact of Khilgaon Flyover on adjacent areas. The government undertook a number of remedial measures to address the public sufferings caused by intolerable traffic congestions in Dhaka city. As a part of the total initiatives to improve the traffic situation in Dhaka, the then government approved the Khilgaon Flyover project in the ECNEC meeting in 2000. Accordingly Local Government Engineering Division (LGED) constructed the flyover, which was opened for traffic from March 2005. However, the implementation was not done as per original plan or design because the subsequent government (2001-2006) dropped one of the important loops (Saidabad side) from the project. This has seriously constrained the objectives and expected benefits of the flyover as originally planned. This is illustrated in Figure 1. It is clearly evident that hazard in the form of conflict between pedestrian, vehicular and rail movement has not decreased, which essentially shows that neither rail nor road has benefited from construction of Khilgaon Flyover.

(a) 2003 (b) 2017

Fig 1: Comparison of Traffic Flow at Khilgaon Level Crossing Before and After Construction of Khilgaon Flyover.

Till now the large volume of traffic coming from Progoti Sarani and eastern part of the city (Mothertek, Kadamtali, Basabo, Shepaibag, Meradia, Goran) cannot use the existing flyover and they do not have any other uninterrupted access toward Motijheel commercial area and Rajarbag [14].

2.0 LITERATURE REVIEW

Given the prevalence of flyovers in Dhaka city, surprisingly few studies have approached this subject methodically. Anwari et al. (2016) assessed conditions of partially grade separated flyovers in Dhaka city without considering the variation during different times of the day [5]. Again, Anwari et al. (2016) explored the reasons for poor traffic operation and rail-road conflict at Shaheed Ahsanullah Master Flyover [6]. Later, Islam et al. (2018) evaluated the performance of Jatrabari-Gulistan Flyover incorporating temporal variation [3], [4]. But these studies did not incorporate traffic impact assessment of the studied flyover. Additionally, these studies lack evaluating the level of service of the studied flyovers. Anwari et al. assessed the impacts of Mohakhali Flyover on the adjacent roads along with the flyover corridor incorporating temporal variation [1], [2]. However, the aforementioned literatures neither dealt comprehensively with traffic impact assessment of Khilgaon flyover nor did they quantify the identified problems. This paper addresses the impact of Khilgaon flyover both along corridor and in the adjacent area.

3.0 METHODOLOGY AND STUDY AREA

Reconnaissance survey along the flyover alignment identified and quantified existing roadway conditions as well as intersections under influence area of each flyover approach ramp. The flyover and its influence area is shown in Google map based Figure 2. Video based 15 minute classified traffic counts conducted by cordon count method at each flyover approach ramp during peak hours, identified from hourly flow fluctuation over a period of 24 hours, was used to determine traffic flow. Queue length was measured using video based image processing technique. Travel time measured using intra-frame scene capture based on superimposed image at free-flow conditions was used to determine space mean free flow speeds validated by radar gun spot-speed studies [15]. Operational speeds at each segment was measured using floating car method [16], [17].The period of measurement when data were collected was weekday day, because that period was observed to have the worst traffic conditions. Collected data were analyzed to identify level of service (LOS) and flow-capacity ratio, and compared spatio-temporally and with previous studies. LOS was calculated as per guidelines of Highway Capacity Manual [18].

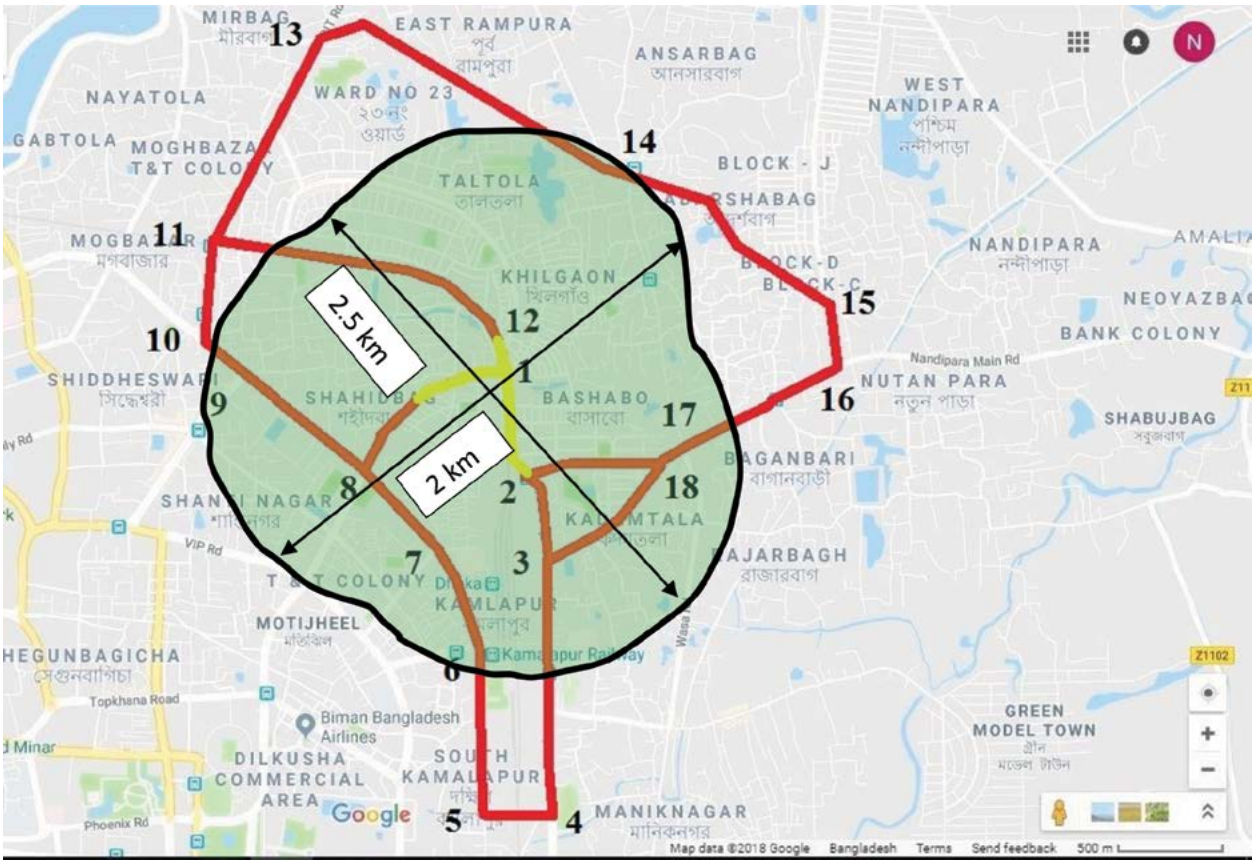

Fig 2: Google Map Image of Study Area

A total of 18 intersections and 21 road segments were identified adjacent to Khilgaon flyover i.e. within the project influence area. Due to limitations of the study, only the primary roads were considered. Secondary and lower-tier roads were ignored, because empirical observations revealed only low impact on these roads. The impact of the flyover on the identified primary links have been studied. Primary data collected in order to determine the level of service include roadway geometry, parking maneuver rate, bus stopping rate and intersection phase times. The intersections are labelled as per Figure 2.The yellow lines in Figure 2 indicate the route along the flyover corridor while the red lines indicate the route adjacent to the flyover. The intersections are marked from 1 to 18 along the selected study route. The numbered segments represent the travel time segment, namely, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 1-8, 8-9, 9-10, 10-11, 11-12, 11-13, 13-14, 14-15, 15-16, 16-17, 16-18, 17-2, 17-3 and 12-1. To measure travel time, floating car method was used where an observer inside the car noted down the travel time at predefined checkpoints along the road. The distance between checkpoints defining a particular road was found from Google Map and validated using GPS receiver on field. Cordon line used for traffic volume count is shown in Figure 3.

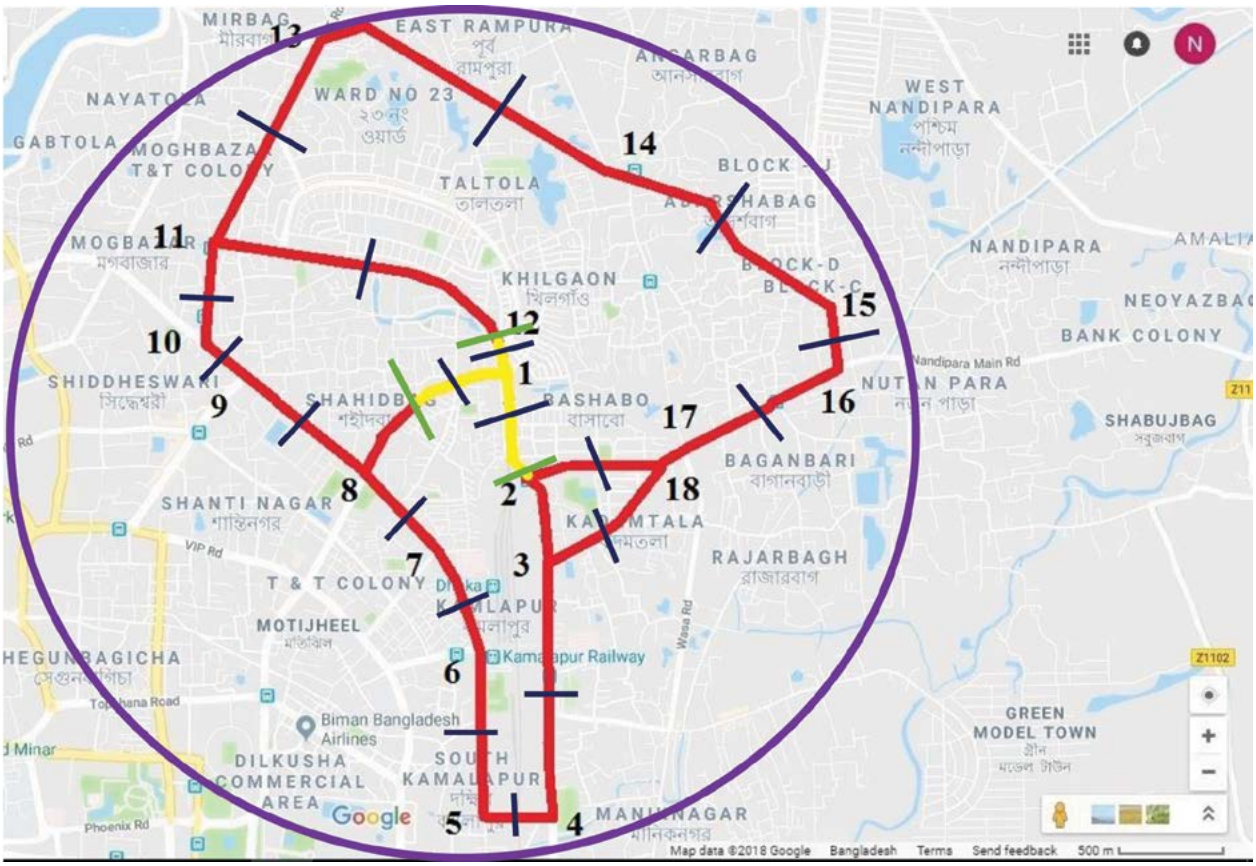

Fig 3: Google Map Image of Study Area along with Cordon Line

The purple circle in Figure 3 represents the cordon line. Cordon screens were used for traffic volume observation of individual road segments. Counts were taken where the cordon screens intersect the roads. Blue screen lines were used to count at-grade traffic vehicles, while green screen lines were used to count above-grade traffic vehicles.

An example of the traffic count is shown in Figure 4.

Fig 4: Satellite View of Segment 4-5/5-4 Showing Location of Cordon Screen

In Figure 4 the blue line represents the location of cordon screen for segment 4-5/5-4. Traffic volume was measured separately for the opposing directions. The flow coming from intersection 4 and going to intersection 5 was designated as traffic flow for segment direction 4-5, while the reverse flow was designated as traffic flow for segment direction 5-4. Traffic stream flow from access roads were observed to be negligible compared to the flow along the studied routes, therefore access roads were not considered separately. Video camera was set up at mid-block to observe at-grade flow while at the 3 down ramps to observe above-grade flow. Referring back to Figure 3, the traffic flow at only the up ramps of green screen lines were measured and aggregated to get above grade traffic flow.

As per HCM (2010) [18], the considered roadways were identified as urban street segments. An urban street segment is defined as length of urban street from one boundary intersection to the next, including the upstream boundary intersection but not the downstream boundary intersection. From Figure 1, the segments along the flyover corridor are: 1-2, 1-8, 1-12 and 12-11. The remaining segments are considered as segments adjacent to the flyover. All primary data were collected in 2017. In addition, traffic parameters are compared with a similar study performed by Anwari et al. [5] to assess temporal trends.

4.0 DATA COLLECTION AND ANALYSIS

4.1 Traffic Flow Assessment

15 minute classified traffic count was performed to assess the relative level of usage of road space under and over the flyover. Since vehicles of various sizes and weights pass through the study area, it was indispensable to expedient their impact using a common measuring unit. Hence, the vehicle counts were converted to passenger car units, as depicted in Table 1, using the following passenger car equivalent (PCE) factors prescribed by the Geometric Design Standards for Roads & Highways Department, Bangladesh: Rickshaw/Van: 2.00, Motorcycle: 0.75: Bicycle: 0.50, Car: 1.00, CNG: 0.75,Tempo: 0.75, Bus: 3.00, Utility: 1.00, Truck: 3.00, Bullock Carts: 4.00 [19]. Accordingly, traffic flow in terms of PCUs were obtained multiplying vehicle count data by their corresponding PCE factors.

Table 1:15-Minute Classified Traffic Count at Khilgaon Flyover (PCUs)

Survey Time	Over/ Under	Rickshaw/ Van	Motorcycle	Bicycle	Car/ Jeep/ Microbus	CNG	Human Haulers	Bus	Utility	Truck	Total equivalent hourly flow (PCU)	Percentage of Total (%)	Ratio of Vehicles Passing over to those Under
Weekend, Day	Over	0	424	1	589	366	1	196	23	3	6634	43.69	0.78:1
	Under	1091	27	51	51	14	18	4	6	1	8551	56.31	
Weekend, Night	Over	0	289	0	857	438	0	190	35	0	7387	59.61	1.48:1
	Under	622	31	18	26	40	36	0	1	0	5006	40.39	
Weekday, Day	Over	0	329	0	1719	254	0	358	69	2	12163	53.24	1.14:1
	Under	1376	37	33	42	33	32	2	4	2	10683	46.76	
Weekday, Night	Over	0	215	0	2253	238	0	353	58	5	13707	63.08	1.71:1
	Under	1015	46	54	23	37	40	0	8	0	8023	36.92	

Table 1 and Figure 5 reveal that a larger proportion of vehicles travelled through at grade level as compared to above grade in weekend night, weekday day and weekday night, indicating that the flyover was evidently unsuccessful in mitigating congestion at at- grade level. It is also evident that traffic flow was greatest during weekday day and least during weekend night. Data are also compared with 2015 data taken by Anwari et al. [5]. Compared to 2015 weekday day period, flow has increased 1106% at above-grade and 58.14% at at-grade respectively, which essentially suggests that the flyover has been successful in diverting greater portion of traffic at above-grade level.

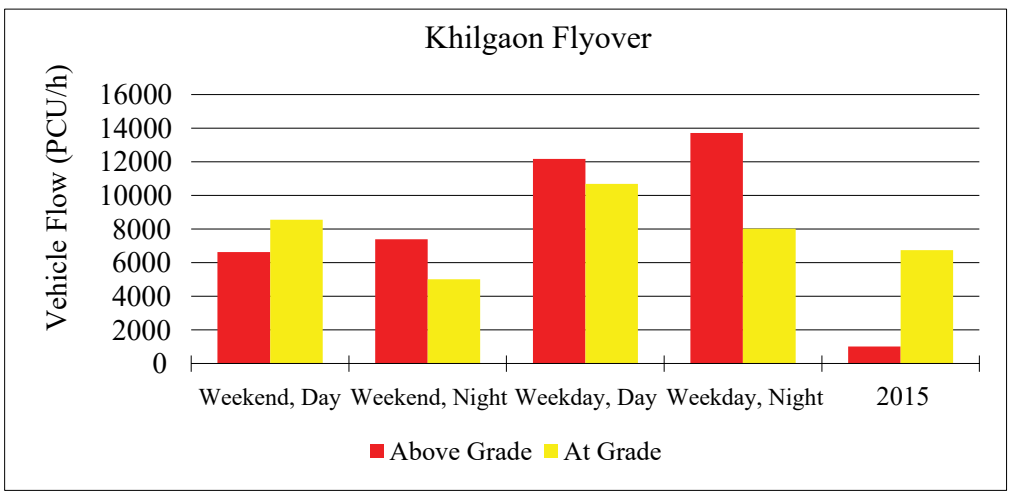

Fig 5: Traffic Flow along Khilgaon Flyover Alignment

4.2 Assessment of Congestion Degree

Queue length was taken at the most critical intersection (intersection 1) near the level crossing as shown in Figure 1.This refers to a high degree of congestion, as delineated in Figure 6. The longest queue length was recorded at weekday night (866.1 m) while the shortest was recorded at weekend day (202.1 m). Weekday day had experienced the second highest queue length (368 m). Data is also compared with queue length data taken by Anwari et al. [5] in 2015. Compared to 2015, queue length in weekday, day had nearly been doubled in 2017.

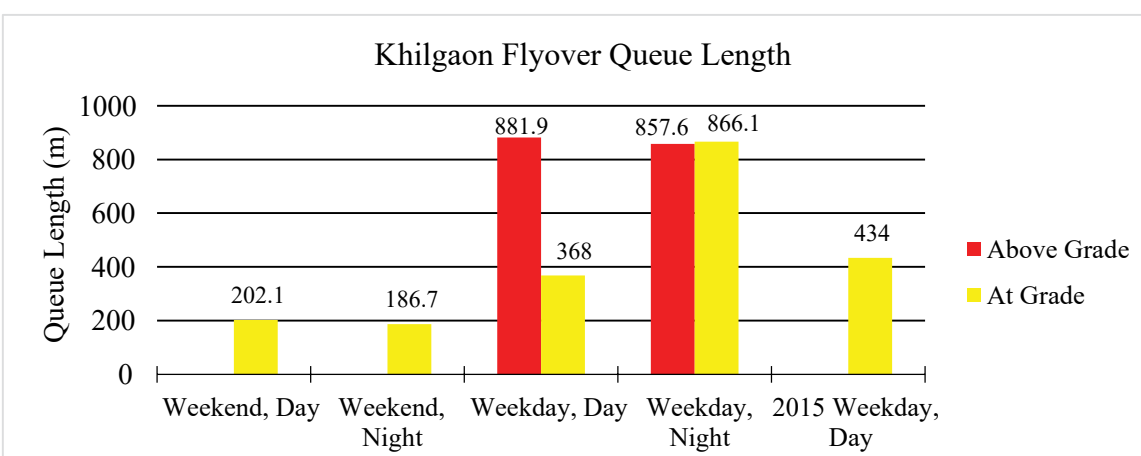

Fig 6: Queue Length Measured at Khilgaon Flyover

The fact that queue length has developed at grade along the corridor of Khilgaon Flyover means that the flyover has failed to reduce congestion, even after having facilities to divert through traffic above grade. This comes despite the fact that a larger portion of traffic travelled above grade in 2017 compared to at-grade. In addition, measurement of above grade queue length shows that queues have developed at weekday, whereas there was no queue length in 2015. Since Khilgaon flyover has failed to

reduce congestion in its target area, this warrants a thorough assessment of the impact of flyover along its corridor and in the adjacent area. As most of the previous studies identified weekday day traffic period as the most critical to analyzed, the following part of this study will consider analysis pertaining to weekday day period.

4.3 Assessment of Travel Speed

Floating car method was used to assess travel speed at each direction of each segment by recording the travel time (including motion time, segment delay and through vehicle delay) and dividing the segment length by the travel time. So this speed considers any stop-time delay. A permitted error of ± 1.0 miles/hour and 95% confidence interval was chosen to get speed difference (R) of 4 miles/hour between maximum and minimum value of travel times. As a result, a minimum of 10 test runs were required as per Manual of Transportation Engineering Studies [20]. Hence, 10 test runs over each segment was done during peak hour to determine the operational speed. Analysis of 15-minute traffic volume counts for a period of 24 hours on a weekday revealed that the highest traffic flow occurred in 5:15-5:30 pm slot. Hence, all subsequent data except free flow speed data were collected during this time period. The summary of the speed results is provided in Table 2. For example, the average speed in direction 1-2 was observed to be 7.08 km/h, while that in direction was observed to be 7.29 km/h, giving an overall speed of 7.17 km/h. Overall speed ranged from 3.76 km/h to 13.18 km/h, while total facility speed was found to be 8.77 km/h.

Table 2: Travel Speed at Weekday Day along different segments adjacent to Khilgaon Flyover

Segment Label	Segment Length (km)	Average Speed		
		Overall (km/h)	First Direction (km/h)	Opposite Direction (km/h)
1-2	0.52	7.17	7.06	7.29
2-3	0.41	6.46	6.53	6.39
3-4	1.25	13.18	13.11	13.26
4-5	0.32	7.52	7.65	7.39
5-6	0.81	12.52	12.36	12.69
6-7	0.49	6.63	6.64	6.61
7-8	0.52	6.56	6.55	6.57
8-9	0.74	7.12	6.99	7.26
9-10	0.28	4.03	3.94	4.11
10-11	0.47	6.60	6.54	6.65
11-12	1.52	13.18	13.20	13.16
12-1	0.14	7.95	7.61	8.32
1-8	0.89	7.74	7.61	7.88
11-13	1.09	11.98	12.14	11.83
13-14	1.69	10.41	10.25	10.57
14-15	1.17	8.74	8.57	8.91
15-16	0.30	4.98	4.93	5.03
16-17	0.84	10.18	10.07	10.29
17-18	0.13	3.76	3.89	3.64
18-2	0.64	8.45	8.35	8.55
18-3	0.74	9.09	9.19	8.99
Total Facility	14.97	8.77	8.71	8.83

4.4 Determination of Free Flow Speed

HCM (2010) defines Free Flow Speed (FFS) as the average speed of the traffic stream when traffic volumes are sufficiently low that drivers are not influenced by the presence of other vehicles and when intersection traffic control is not present or is sufficiently distant as to have no effect on speed choice. The FFS was determined by measuring the distance travelled by a vehicle over a 90-100 ft length of segment in the mid-block part of segment and then dividing the distance travelled by time taken. The average classified FFS at weekday, day is shown in Figure 7.

The classified FFS presented includes non-motorized vehicles (NMVs) such as rickshaws and bicycles. Rickshaw is a para-transit vehicle, the determination of whose LOS has not been fully covered in HCM (2010) [18]. In addition, bicycle only makes up a negligible portion of total traffic. Hence these two modes of traffic have been omitted during LOS evaluation. From Figure 7, the highest above-grade FFS occurred at weekend day (46.90 km/h) while lowest above-grade FFS occurred at weekday day (26.80 km/h). The highest at-grade FFS occurred at weekday day (16.07 km/h) while lowest at-grade FFS occurred at weekend day (12.24 km/h). It is seen that at-grade FFS is lower than above grade FFS by 60% on average.

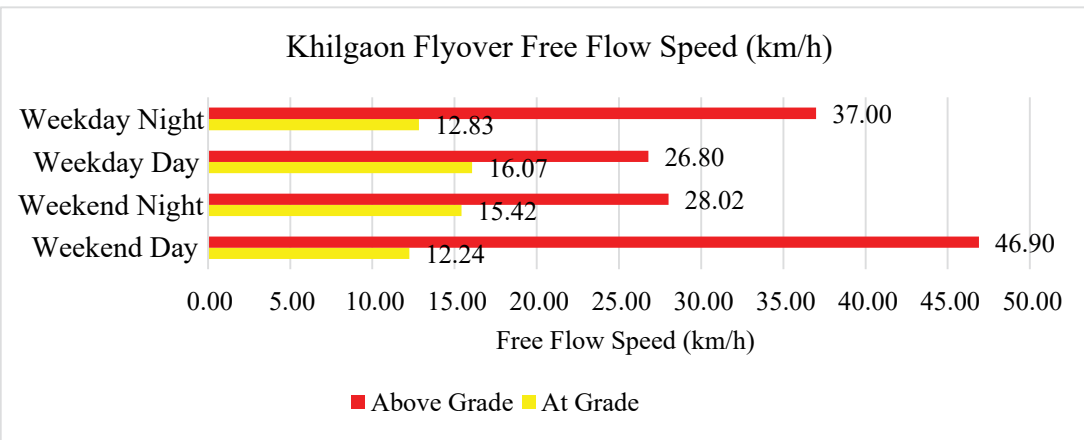

Fig 7: Free Flow Speed at Khilgaon Flyover in Various periods of Measurement

4.5 Determination of Saturation Flow Rate

A vital parameter to determine the LOS is the saturation flow rate, calculated using the following equation:

$s = s_o f_w f_{HV} f_g f_p f_{bb} f_a f_{LU} f_{LT} f_{RT} f_{Lpb} f_{Rpb}$

Where, the parameters are listed as follows along with the values used in common for all analysed segments:

s = adjusted saturation flow rate (veh/h/ln),
s_o = base saturation flow rate (pc/h/ln) = 1900 pc/h/ln
f_w = adjustment factor for lane width
f_{HV} = adjustment factor for heavy vehicles in traffic stream
f_g = adjustment factor for approach grade = 1 (because of zero grade)
f_p = adjustment factor for existence of a parking lane and parking activity adjacent to lane group
f_{bb} = adjustment factor for blocking effect of local buses that stop within intersection area
f_a = adjustment factor for area type = 0.9
f_{LU} = adjustment factor for lane utilization = 1,
f_{LT} = adjustment factor for left-turn vehicle presence in a lane group = 1/1.18
f_{RT} = adjustment factor for right-turn vehicle presence in a lane group = 1/1.05
f_{Lpb} = pedestrian adjustment factor for left-turn groups = 1
f_{Rpb} = pedestrian-bicycle adjustment factor for right-turn groups = 1

Base saturation flow rate was taken as 1900 pc/h/ln as per HCM (2010) [18]. Adjustment factor for lane width was taken as 1.0 since all lanes had width in the range of 10 ft to 12.9 ft. All approach grades were assumed to be zero. Hence adjustment factor for approach grade was taken as 1.0. All lane group had shared lanes, hence adjustment factor for lane utilization was taken as 1.0. All turning movements were observed to be generally protected, hence pedestrian adjustment factors were taken as 1.0. The observed parking maneuver rates and bus stoppage rate for each directional segment is provided in Table 3.

Table 3: Observed Parking Maneuver Rate and Bus Stopping Rate at Each Segment

Segment	Direction	Parking Maneuver Rate, N_m (maneuvers/h)	Bus Stopping Rate, N_b (buses/h)	Segment	Direction	Parking Maneuver Rate, N_m (maneuvers/h)	Bus Stopping Rate, N_b (buses/h)
1-2	1-2	12	15	12-1	12-1	5	6
	2-1	12	15		1-12	5	6
2-3	2-3	15	15	1-8	1-8	15	20
	3-2	15	15		8-1	15	20
3-4	3-4	13	18	11-13	11-13	12	21
	4-3	13	18		13-11	12	21
4-5	4-5	14	15	13-14	13-14	4	0
	5-4	14	15		14-13	4	0
5-6	5-6	12	11	14-15	14-15	8	0
	6-5	12	11		15-14	8	0
6-7	6-7	17	15	15-16	15-16	5	0
	7-6	17	15		16-15	5	0
7-8	7-8	18	11	16-17	16-17	6	0
	8-7	18	11		17-16	6	0
8-9	8-9	20	7	17-18	17-18	6	0
	9-8	20	7		18-17	6	0
9-10	9-10	10	15	18-2	18-2	5	0
	10-9	10	15		2-18	5	0
10-11	10-11	12	15	18-3	18-3	8	0
	11-10	12	15		3-18	8	0
11-12	11-12	25	15				
	12-11	25	15				

The segment capacity was then calculated using

$$c = Nsg/C$$

where, c = capacity (veh/h)
N = number of lanes (ln)
s = saturation flow rate
g = effective green time (s)
C = cycle time. (s)
The Level of Service was calculated using the criteria provided in Table 4:

Table 4: Determination of Level of Service

Travel Speed as a Percentage of Base Free - Flow Speed (%)	LOS by Volume-to-Capacity Ratio	
	≤ 1	≥ 1
>85	A	F
>67-85	B	F
>50-67	C	F
>40-50	D	F
>30-40	E	F
≤ 30	F	F

Collected data were analyzed in Table 5 to determine Directional Segment Capacity:

Table 5: Determination of Directional Segment Capacity

Segment	Direction	s_o (veh/h/ln)	fW	fHV	fg	fp	fbb	fA	fLU	fLT	fRT	fLph	fRph	s (veh/h/ln)	C	g	N	c
															(s)	(s)	(ln)	(pcu/h)
1-2	1-2	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1229.10	236	75	3	1171.81
	2-1	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1229.10	200	35	3	645.28
2-3	2-3	1900	1	0.998	1	0.91	0.97	0.9	1	0.847	0.952	1	1	1219.08	211	78	3	1351.97
	3-2	1900	1	0.998	1	0.91	0.97	0.9	1	0.847	0.952	1	1	1219.08	236	75	3	1162.26
3-4	3-4	1900	1	0.998	1	0.92	0.98	0.9	1	0.847	0.952	1	1	1233.34	280	85	3	1123.22
	4-3	1900	1	0.998	1	0.92	0.98	0.9	1	0.847	0.952	1	1	1233.34	211	55	3	964.46
4-5	4-5	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1222.42	183	83	2	1108.86
	5-4	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1222.42	280	70	2	611.21
5-6	5-6	1900	1	0.998	1	0.92	0.98	0.9	1	0.847	0.952	1	1	1239.24	170	55	2	801.86
	6-5	1900	1	0.998	1	0.92	0.98	0.9	1	0.847	0.952	1	1	1239.24	183	35	2	474.03
6-7	6-7	1900	1	0.998	1	0.91	0.97	0.9	1	0.847	0.952	1	1	1212.40	255	75	2	713.18
	7-6	1900	1	0.998	1	0.91	0.97	0.9	1	0.847	0.952	1	1	1212.40	170	65	2	927.13
7-8	7-8	1900	1	0.998	1	0.91	0.98	0.9	1	0.847	0.952	1	1	1219.03	286	80	2	681.98
	8-7	1900	1	0.998	1	0.91	0.98	0.9	1	0.847	0.952	1	1	1219.03	255	65	2	621.47
8-9	8-9	1900	1	0.998	1	0.90	0.99	0.9	1	0.847	0.952	1	1	1222.21	283	80	2	691.00
	9-8	1900	1	0.998	1	0.90	0.99	0.9	1	0.847	0.952	1	1	1222.21	286	55	2	470.08
9-10	9-10	1900	1	0.998	1	0.93	0.97	0.9	1	0.847	0.952	1	1	1235.78	207	45	2	537.30
	10-9	1900	1	0.998	1	0.93	0.97	0.9	1	0.847	0.952	1	1	1235.78	283	73	2	637.54
10-11	10-11	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1229.10	184	46	3	921.83
	11-10	1900	1	0.998	1	0.92	0.97	0.9	1	0.847	0.952	1	1	1229.10	207	45	3	801.59
11-12	11-12	1900	1	0.998	1	0.89	0.97	0.9	1	0.847	0.952	1	1	1185.68	222	69	3	1105.57
	12-11	1900	1	0.998	1	0.89	0.97	0.9	1	0.847	0.952	1	1	1185.68	184	55	3	1063.25
12-1	12-1	1900	1	0.998	1	0.94	0.99	0.9	1	0.847	0.952	1	1	1275.72	200	55	3	1052.47
	1-12	1900	1	0.998	1	0.94	0.99	0.9	1	0.847	0.952	1	1	1275.72	222	77	3	1327.44
1-8	1-8	1900	1	0.998	1	0.91	0.96	0.9	1	0.847	0.952	1	1	1206.51	286	71	2	599.04
	8-1	1900	1	0.998	1	0.91	0.96	0.9	1	0.847	0.952	1	1	1206.51	200	55	2	663.58
11-13	11-13	1900	1	0.998	1	0.92	0.96	0.9	1	0.847	0.952	1	1	1213.90	150	45	3	1092.51
	13-11	1900	1	0.998	1	0.92	0.96	0.9	1	0.847	0.952	1	1	1213.90	184	68	3	1345.84
13-14	13-14	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1294.66	180	55	1	395.59
	14-13	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1294.66	150	25	1	215.78
14-15	14-15	1900	1	0.998	1	0.93	1.00	0.9	1	0.847	0.952	1	1	1280.89	160	45	1	360.25
	15-14	1900	1	0.998	1	0.93	1.00	0.9	1	0.847	0.952	1	1	1280.89	180	55	1	391.38
15-16	15-16	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1291.22	203	65	1	413.44
	16-15	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1291.22	160	45	1	363.15

16-17	16-17	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1287.77	229	55	1	309.29
	17-16	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1287.77	203	55	1	348.90
17-18	17-18	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1287.77	173	53	1	394.52
	18-17	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1287.77	229	60	1	337.41
18-2	18-2	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1291.22	236	71	1	388.46
	2-18	1900	1	0.998	1	0.94	1.00	0.9	1	0.847	0.952	1	1	1291.22	173	48	1	358.26
18-3	18-3	1900	1	0.998	1	0.93	1.00	0.9	1	0.847	0.952	1	1	1280.89	211	63	1	382.45
	3-18	1900	1	0.998	1	0.93	1.00	0.9	1	0.847	0.952	1	1	1280.89	173	57	1	422.03

Table 5 shows that the directional capacity of segment direction 2-3 was highest (1351.97 pcu/h) while that of segment 14-13 was lowest (215.78 pcu/h). The average directional capacity of each segment was 708.30 pcu/h, which is significantly lower than the base capacity.

LOS calculation is shown in Table 6. FFS used in calculation of LOS as presented in Table 6 only considers motorized vehicles.

Table 6: LOS Calculation

Segment	Direction	Travel Speed	Free Flow Speed	TS/FFS	Flow	Capacity	v/c	LOS
		(km/h)	(km/h)		(pcu/h)	(pcu/h)		
1-2	1-2	9.65	69.78	0.138	4887.04	1171.81	4.17	F
	2-1	10.30	69.78	0.148	4784.00	645.28	7.41	F
2-3	2-3	8.37	69.78	0.12	4231.08	1351.97	3.13	F
	3-2	7.93	69.78	0.114	4962.48	1162.26	4.27	F
3-4	3-4	17.06	69.78	0.244	4263.28	1123.22	3.8	F
	4-3	17.44	69.78	0.25	3790.40	964.46	3.93	F
4-5	4-5	9.50	69.78	0.136	3455.52	1108.86	3.12	F
	5-4	9.50	69.78	0.136	3595.36	611.21	5.88	F
5-6	5-6	15.49	69.78	0.222	2944.92	801.86	3.67	F
	6-5	15.69	69.78	0.225	3680.92	474.03	7.77	F
6-7	6-7	8.46	69.78	0.121	4496.96	713.18	6.31	F
	7-6	8.32	69.78	0.119	4253.16	927.13	4.59	F
7-8	7-8	8.41	69.78	0.12	4497.88	681.98	6.6	F
	8-7	8.20	69.78	0.118	3681.84	621.47	5.92	F
8-9	8-9	8.79	69.78	0.126	3725.08	691.00	5.39	F
	9-8	9.14	69.78	0.131	4686.48	470.08	9.97	F
9-10	9-10	4.78	69.78	0.068	4164.84	537.30	7.75	F
	10-9	5.21	69.78	0.075	3121.56	637.54	4.9	F
10-11	10-11	8.29	69.78	0.119	3166.64	921.83	3.44	F
	11-10	7.97	69.78	0.114	2496.88	801.59	3.11	F
11-12	11-12	16.09	69.78	0.231	3200.68	1105.57	2.9	F
	12-11	15.35	69.78	0.22	3139.96	1063.25	2.95	F

12-1	12-1	9.55	69.78	0.137	3595.36	1052.47	3.42	F
	1-12	9.30	69.78	0.133	3865.84	1327.44	2.91	F
1-8	1-8	10.11	69.78	0.145	5380.16	599.04	8.98	F
	8-1	10.04	69.78	0.144	5324.96	663.58	8.02	F
11-13	11-13	15.45	69.78	0.221	2806.00	1092.51	2.57	F
	13-11	15.27	69.78	0.219	3357.08	1345.84	2.49	F
13-14	13-14	11.50	69.78	0.165	1753.52	395.59	4.43	F
	14-13	11.05	69.78	0.158	1985.36	215.78	9.2	F
14-15	14-15	9.83	69.78	0.141	1870.36	360.25	5.19	F
	15-14	9.58	69.78	0.137	2171.20	391.38	5.55	F
15-16	15-16	6.13	69.78	0.088	2057.12	413.44	4.98	F
	16-15	6.19	69.78	0.089	1656.00	363.15	4.56	F
16-17	16-17	12.64	69.78	0.181	1659.68	309.29	5.37	F
	17-16	12.53	69.78	0.18	1710.28	348.90	4.9	F
17-18	17-18	4.03	69.78	0.058	978.88	394.52	2.48	F
	18-17	4.72	69.78	0.068	1062.60	337.41	3.15	F
18-2	18-2	11.16	69.78	0.16	1176.68	388.46	3.03	F
	2-18	10.54	69.78	0.151	1459.12	358.26	4.07	F
18-3	18-3	11.46	69.78	0.164	1527.20	382.45	3.99	F
	3-18	11.68	69.78	0.167	1100.32	422.03	2.61	F
Total Facility		**10.78**	**69.78**	**0.154**	**3136.30**	**708.30**	**4.43**	**F**

Table 6 shows that irrespective of capacity, the LOS at all segments adjacent to Khilgaon Flyover is F during peak hour at weekday day, indicating the lowest level of service and that drivers are dissatisfied with the existing roadway conditions. It means that the flyover has not been effective in mitigating traffic crisis in Khilgaon. The flyover has failed to improve traffic conditions both along the flyover corridor and in the adjacent areas.

5.0 CONCLUSION

Analysis of LOS revealed that LOS is found to be F at all segments and also in the overall facility during peak hour of weekday day. It reveals that all segments have poor driving conditions. Based on this investigation and the analysis in previous studies it can be concluded that neither through traffic nor local traffic has benefited much from Khilgaon flyover. Through traffic has suffered because the entry and exit ramps of the flyover have been directly constructed over primary roads. Such ramps should have been connected to local roads so that through traffic enjoys uninterrupted flow. Right now what is happening is that congestion has been shifted from Khilgaon level crossing into another intersection, namely the Malibagh Rail Gate Intersection (Intersection #11 in Figure 2). As a result, the performance of surrounding roadway segments continue to suffer. The study has also revealed the short-sightedness of transport authorities. The flyover was built because of a political commitment to improve the safety situation around Khilgaon level crossing with aims to increase mobility, reduce congestion and improve safety for all road users. However, the flyover was constructed without proper feasibility study. That is why no engineering data such as traffic volume and delay were considered. The dearth of traffic data before construction of this flyover is a limitation of this study. So, the impact on surrounding roads before construction of this flyover could not be evaluated. Even though the principle objective was to improve safety situation, conflicting situations still remain. The degree of exposure has not been reduced rather it has increased because of rising volume of vehicular traffic, rail traffic and pedestrian movements. It is envisaged that the conflicting situation will be deteriorated further by the construction of on-going 3rd and 4th dual gauge rail tracks in Kamalapur-Tongi section [21]. Besides, temporal analysis has disclosed that overall mobility along the flyover intervention area has decreased due to high degree of congestion particularly at at-grade

level. It essentially suggests that this partially grade separated flyover could not provide sustainable solution at the level crossing in terms of minimizing conflicting situation among vehicular, pedestrian and rail traffic. At the level crossing, full grade separation would be the better option to provide conflict free safer movements for both roadway and railways operation. It is also recommended that to tackle prevailing chronic congestion problem of urban built up area, instead of constructing flyovers which merely shift traffic bottlenecks from one place to another, the rapid mass transit oriented measure should be undertaken, since it has the demand responsive sustainability potential.

References

[1] N. Anwari, M. R. Islam, and M. S. Hoque, "Traffic Impact Assessment of Mohakhali Flyover," Can. J. Basic Appl. Sci., vol. 6, no. 1, pp. 15–25, 2018.

[2] N. Anwari, M. R. Islam, and M. S. Hoque, "Traffic Impact Assessment of Mohakhali Flyover," in 6th International Congress on Technology - Engineering & Science (International Conference on Advances in Civil, Architecture and Environmental Engineering), 2018, p. 55.

[3] M. R. Islam, N. Anwari, and M. S. Hoque, "Performance evaluation of Jatrabari-Gulistan Flyover (Mayor Mohammad Hanif Flyover) constructed over rail-road level crossing in Dhaka," Can. J. Basic Appl. Sci., vol. 6, no. 1, pp. 1–14, 2018.

[4] M. R. Islam, N. Anwari, and M. S. Hoque, "Performance Evaluation of Jatrabari-Gulistan Flyover (Mayor Mohammad Hanif Flyover)," in 6th International Congress on Technology - Engineering & Science (International Conference on Advances in Civil, Architecture and Environmental Engineering), 2018, pp. 53–54.

[5] N. Anwari, M. S. Hoque, and M. R. Islam, "Effectiveness of Flyovers Constructed Over Railway Line," in BUET-ANWAR ISPAT 1st Bangladesh Civil Engineering SUMMIT 2016, 2016, p. TE3.

[6] N. Anwari, M. S. Hoque, and M. R. Islam, "Investigating Conflicts between Rail-Road Traffic at Shaheed Ahsanullah Master Flyover," in BUET-ANWAR ISPAT 1st Bangladesh Civil Engineering SUMMIT 2016, 2016, p. TE27.

[7] B. Maitra, M. Azmi, N. Kumar, and J. R. Sarkar, "Modeling Traffic Impact of Flyover at an Urban Intersection Under Mixed Traffic Environment," Eur. Transp., vol. 27, no. 2004, pp. 57–68, 2004.

[8] A. Sala, "Assessment of Traffic Flow Benefits of Flyovers : A Case Study," J. Soc. Transp. Traffic Stud., vol. 4, no. 3, pp. 1–9, 2013.

[9] N. Salatoom and P. Taneerananon, "An Evaluation of Flyover-Improved Intersections: A Case Study of Airport Intersection," J. East. Asia Soc. Transp. Stud., vol. 11, pp. 2028–2040, 2015.

[10] M. L. Rahman, "Modelling Flyover Induced Travel Demand in Dhaka, Bangladesh," Queensland University of Technology, 2017.

[11] P. Luophongsok, N. Cathrynchu, and N. Dithwirulh, "Cost-Benefit Analysis of Sanpatong-. Hangdong (Phase 1) Bypass Project, Chiangmai," J. Manag. Sci. Inf. Sci., vol. 6, no. 2, 2011.

[12] R. B. Machemehl, C. E. Lee, R. Durrenberger, M. Hunter, and A. Naqvi, "Montana A Venue Feasibility Study," 1994.

[13] N. Salatoom and P. Taneerananon, "A study of a flyover-bridge - improved intersection," Eng. J., vol. 19, no. 1, pp. 1–12, 2015.

[14] M. R. Islam, "Performance Evaluation of Flyovers Constructed over Level Crossings in Dhaka City," M.Sc. Thesis, Department of Civil Engineering, Bangladesh University of Engineering and Technology (BUET), 2018.

[15] M. R. Islam and N. Haque, "Non-lane Based Heterogeneous Traffic State Measurement using Robust Vision System," Undergraduate Thesis, Department of Civil Engineering, Bangladesh University of Engineering and Technology (BUET), 2016.

[16] Transportation Research Board, "Highway Capacity Manual," Washington, DC United States, 2016.

[17] S. M. Turner, W. L. Eisele, R. J. Benz, and J. Douglas, "Travel time data collection handbook," Washington, DC United States, 1998.

[18] Transportation Research Board, Highway capacity manual. 2000.

[19] Ministry of Communication, Geometric Design Standards for Roads & Highways Department, no. October. 2000.

[20] Institute of Transportation Engineers (ITE), Manual of Transportation Engineering Studies, Washington, DC United States, 1994.

[21] Ministry of Railways, "Five Years of Development (2009-2013)," pp. 73-88, 2014.

COMPARATIVE ANALYSIS OF DIABETIC NEPHROPATHY PATIENTS AMONG DIFFERENT ECONOMIC LEVEL (UPPER, MIDDLE AND LOWER CLASS) BASED ON THEIR SOCIOECONOMIC, NUTRITIONAL AND HEALTH CONDITION IN KHULNA CITY, BANGLADESH.

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ABSTRACT

The main purpose of the study was to compare the occurrence of diabetic nephropathy disease among the upper, middle and lower class family at Khulna city in Bangladesh. Data were collected from randomly selected 120 diabetic nephropathy patients in Khulna city through personal interview during August to November, 2014. Mainly socioeconomic condition, nutritional knowledge, anthropometric and dietary pattern were compared among them. In Bangladesh, people belonging to these three classes are suffering from this disease but those from upper class are more affected (near 51.7%). The prevalence of this diseases is higher in male (63%) than female. Amount of drinking water is restricted (Less than 1 liter per day while a health person can drink 4-5-liter water) for Diabetic nephropathy patient, in this survey it has been found that about 52.5% patients drink water by following prescription. Hypertension, constipation and dyspepsia are very common complication associated with diabetic nephropathy and about 73.3%, 55% and 54.2% patients are suffering from hypertension, dyspepsia and constipation respectively. Most of the people were unconscious about their health and they don't have enough knowledge about the disease and nutrition. In this study, it has been shown that 64.2% patients have no previous knowledge about this disease. At the initial stage of the disease, they could not even realize that they are suffering from this disease. At the severe stage, they understand that they have this problem. The survey found that 40.0% patients were in stage 5 (kidney failure) of diabetic nephropathy where 35% and 25% patients are in stage 3 and stage 4 of diabetic nephropathy respectively. Therefore, it can be said that by growing the awareness among people about the health, disease and nutrition we can reduce the risk of diabetic nephropathy. Drugs, discipline and dietary guide lines help to control the prevalence of diabetic nephropathy.

Key Words: Diabetic Nephropathy, Economic Level, Nutritional status.

1.0 INTRODUCTION

At present diabetes is a very common disease all over the world and the rate of diabetes patients is increasing day by day due to changing of life style and food intake patter. Now a days diabetes becomes a burden issues for all the developing countries and Bangladesh is not out of them. According to International Bangladesh (HKIB) "There are currently more than 3.2 million people with diabetes in Bangladesh. This number is expected to rise by more than 11 million by 2030. This would make the country the seventh largest diabetes population in the world." [Khan A.R., 2013].

Diabetic nephropathy is damage to our kidneys caused by diabetes. In severe cases it can lead to kidney failure. Diabetic nephropathy (nephropatia diabetica), also known as Kimmelstiel–Wilson syndrome or nodular diabetic glomerulosclerosis and intercapillary glomerulonephritis, is a progressive kidney disease caused by angiopathy of capillaries

in the kidney glomeruli. [American Diabetes Association, 2004].

Diabetic nephropathy is the leading cause of kidney disease that affects ~40% of type 1 and type 2 diabetic patients [Gross J. L. et al., 2005]. Nephropathy remains a significant cause of morbidity and mortality in the diabetic population and is the leading cause of end-stage renal failure (ESRD) in the Western World. The abnormal levels of albumin (≥30 mg/day or ≥20μg/min) in the urine is the earliest clinical evidence of nephropathy and this stage is referred to as microalbuminuria. ESRD develops in 50% of type 1 diabetic patients with macroalbuminuria or overt nephropathy (≥300 mg/day or ≥200μg/min) within 10 years and in >75% by 20 years. With type 2 diabetes high proportions of patients are found to have macroalbuminuria or microalbuminuria. Around 20-40% of type 2 diabetes patients with microalbuminuria are gradually proceeds to macroalbuminuria in them only around 20% patients will have progressed to ESRD [American Diabetes Association, 2004].

There are mainly five stages of development of diabetes nephropathy. The rate of kidney filtration is increased during stage 1. The urine albumin levels and blood pressure may be mildly raised or normal with no pathological damage. On the second or hypertrophic hyper filtrationstage,there is structural damage of the glomeruli and microalbuminuria starts. The GFR is higher than normal. This stage starts approximately two years after the onset of the disease and is characterized by kidney damage with basement membrane thickening and mesangial proliferation. microalbuminuria stage or initial nephropathy is on the third stage which is also termed as early stage renal disease. The albumin excretion rate is continuously raised around 30-300 mg/d. Blood levels of creatinine are raised and blood pressure may be increased or normal. Stage four is termed as clinical diabetic nephropathy, an irreversible stage of disease. Large amounts of protein pass into the urine (albumin > 300 mg/dU) and blood pressure is almost raised. This stage is also known as chronic kidney failure stage. Last stage is kidney failure or end stage renal disease. This stage requires kidney replacement therapy (peritoneal dialysis, hemodialysis, kidney transplantation) [Vujičić B. et al, 2012].

Edema or swelling of the ankles, feet, lower legs or hands due to water retention, as well as loss of appetite and weight gain due to fluid retention and edema, headaches, difficulty sleeping, confusion and trouble concentrating, feeling unwell and tired, high blood pressure etc are the symptoms of diabetic kidney diseases [Kerr S.J., 2012]. The risk factors for the development of DN include race, genetic susceptibility, hypertension, increased blood sugar, hyper filtration, smoking, male gender, dyslipidemia, length of time to have diabetes and age. DN has been found to be increased in black skin people [Rohilla A. et al, 2011]. The prevention and the treatment of diabetes nephropathy are depending on the stage and severity of the disease [Kerr S.J., 2012].A major aspect of initial treatment should consist of lifestyle modifications, such as weight loss, reduction of salt and alcohol intake, and exercise [American Diabetes Association, 2004].

According to the National Kidney Disease Education Program (NKDEP) diet therapy are prescribed to maintain good nutritional status, slow progression of kidney disease, and treat complications such as high blood potassium or phosphorus. Key components of the diet include managing blood sugar through carbohydrate control, managing blood pressure by decreasing sodium intake and reducing protein intake. High-fiber and slow-release carbohydrates are digested more slowly, thus preventing our body from producing too much insulin. So DN patients should choose high fiber carbohydrate. Protein is a very essential nutrient for growth but in DN patient, it was recommended that keeping daily protein intake to 0.8 to 1 grams of protein per Kg of body weight [Otoda T. et al, 2014]. In patients with overt nephropathy and/or renal impairment moderate protein restriction of 0.6–0.8 g/kg/day may be considered. With hypertension and/or proteinuria patient, sodium intake should be restricted to <80 mmol/day or 5g sodium chloride [Clinical Practice Guidelines, 2004]. Phosphorus level in blood should not get to exceed 4.6 milliequivalents per liter because in DN patients it can making bones more brittle and causing itchy skin and bone and joint pain. Excess potassium may build up in the blood in DN patients. If blood level exceeds 5 milliequivalents per liter, will need to limit intake of high potassium foods because high potassium can affect heart rhythm [Otoda T. et al, 2014].

DN is an important public and medical health problem not only in Bangladesh but also in the world and one the major causes of mortality. The genetic cause, food intake pattern, life style, diseases history are linked to the progression of this diseases. In this

study, we try to find out the ration of DN patient among upper, middle and lower family class and to correlate their life style, nutritional pattern related to the development of DN. Large scale epidemiological, genetic and clinical research are needed to explore the different aspect of DN in Bangladesh.

2.0 MATERIAL AND METHOD

2.1 Area selection:

Study area is selected according to the objectives of the study. It is remarkable that the ultimate success of any research work fully depends on the selection of the study area. The study area is Khulna city, is an industrial and developing city. By considering the entire objective, Khulna Diabetic Association and Sheikh Abu Naser Specialized Hospital has been selected for survey. The diabetic association is situated in word number 23 of Khulna City Corporation (KCC) area. All people suffering from diabetes come here for their pathological test, for treatment and as well as for their routine checkup. The Sheikh Abu Naser Specialized Hospital is situated in word number 9 of KCC area. Most of the people who are suffering from Kidney and Heart disease comes here for their pathological test, for treatment and as well as for their routine checkup. The map of the study area is shown in below-

Fig 1: Map of survey area in Khulna city

2.2 Surveillance assay

Once the research area has been selected, a reconnaissance visit was conducted for sample units, working schedule and enlisting data sources. This survey has helped us to get a perfect idea about the study area and effective questioner preparation. In this survey attention was given on the pattern of different types and ages of diabetic nephropathy patients among different classes.

2.3 Study period:

This study was conducted in between the time frame of May 2014 to December, 2014. The survey work was done from August, 2014 to November 2014 in the selected study area.

2.4 Study Population

The adult male and female diabetic nephropathy patients who live in different areas of Khulna city of Bangladesh selected for the study population.

2.5 Sample Size Determination

In this study, Purposive sampling method has been used. Total number of selected sample is 120. These were selected purposively and principle of proportionality

2.6 Sources of Data

The data were collected from the following sources:
a. Primary sources are respondents belonging to the field where the incidence occurs. Data were collected through face-to-face interaction.
b. Secondary source is such a data, which is supplied by some institution. For conducting the study, secondary data were collected from different sources as relevant books and journal, relevant thesis and relevant articles from website.

2.7 Data Collection Methods

The study is mainly based on primary data. Secondary data is also collected to supplement primary data. To fulfill the objective some data is collected from reference materials, official records and other secondary sources.
Interview and examination: The patient interviews were conducted by using well organized questionnaires including the information on demographics, including food intake pattern, nutritional status, physical activity and life style (smoking habits; and use of drugs etc).
Measurements taken included height, weight and blood pressure (BP). Weight was measured while the subjects were light clothing with no shoes. Body mass index (BMI) was calculated as weight (kg)/height (m2). A sphygmomanometer was used to measure BP while the subjects were in a sitting

position and after they had rested for 5 min. The diagnosis of diabetes was based on previous diagnosis by a physician or if their fasting plasma glucose concentration was ≥ 7 mmol/l. The anthropometric data is collected by calculated BMI which helps to measures the nutritional status. The Following cut-off points of BMI are used to categorizes the nutritional status: Severe malnutrition (BMI<16), Moderate malnutrition (BMI 16-16.99), Mild malnutrition (BMI 17-18.49), Normal (BMI 18.5-24.99), Overweight (BMI 25-29.99), Obese (BMI >30).

Food records: 24 hours (1 day) food record was completed at hospital by the patients and they estimated the amounts of food consumed using portion sizes listed in a booklet. The food records were returned during the interview and all records were checked by a clinical or hospital nutritionist and missing information was completed if necessary.

Laboratory measurements: Blood samples were collected and then serum albumin, serum creatinine, serum electrolyte, serum sugar was analyzed.

2.8 Data Processing, Analysis and Presentation

The required data after collection have been processed and analyzed to extract the findings of the study. Collected data were compiled, code, tabulated for processing and analysis in accordance with the objectives of the study to reach the meaningful conclusion. For processing and analysis purpose, Statistical Package for Social Scientist (SPSS 20).

3.0 RESULTS AND DISCUSSION

Bangladesh is one of the most densely populated country in the world with 1015 persons per sq. km.As Khulna is the third largest city of Bangladesh with population about 17,84,623 as of 2010. [Banglapedia, 2012], Khulna is not so much costly city like the capital Dhaka city. Considering the monthly earning we classified three different economic level of respondent. We selected the upper class with monthly earning more than 25000 BDT, middle class with 11000 to 25000 BDT per month and monthly earning less than 11000 BDT belongs to lower class.

3.1 Socioeconomic Condition of DN patients:

Among 120 DN patients, maximum number respondent are from upper class family (51.7%), 28.3% patients from lower class and only 20% respondents comes from middle class (Table I).

Table I: Distribution of respondents according to economic level

Economic Level	Frequency (=n)	Percentage (%)
Upper(>25,000 tk)	62	51.7
Middle(11,000-25,000 tk)	24	20.0
Lower(<11,000 tk)	34	28.3
Total	120	100

DN diseases is more common in male in both upper and middle class family as 35% and 10.8% respectively. But in lower class the opposite scenario was observed, male (6.7%) and female (21.7%). 31 year to 60 year age group are at risk for DN diseases than less than 31 years and more than 60 years. (Table II).

Table II: Distribution of respondents according to their gender and age in different classes

Economic level	Gender		Age		
	Male n (%)	Female n (%)	18-30 years n (%)	31-60 years n (%)	> 60 years n (%)
Upper Class	42 (35)	20 (16.7)	12 (10)	28 (23.4)	22 (18.3)
Middle Class	13 (10.8)	11 (9.2)	12 (10)	7 (5.8)	5 (4.2)
Lower Class	8 (6.7)	26 (21.7)	8 (6.7)	13 (10.8)	13 (10.8)
Total	63 (52.5)	57 (47.5)	32 (26.7)	48 (40)	40 (33.3)

The data from table II reveal that about 40% patients are 31-60 years old among them about 23.4% patients come from upper class families where only 10.8% and 5.8% patients come from lower and middle class families respectively. This table shows that total 26.7% patients are less than 31 years old and 33.3% patients are above 60 years old.

Table III: Distribution of respondents according to their educational qualificationin different classes

Economic level	Education Level							
	Illiterate (%)	Signature (%)	Primary (%)	Secondary (%)	S.S.C (%)	H.S.C (%)	Graduate (%)	Post graduate (%)
Upper	0	0.8	6.7	10	5.8	11.7	11.7	5
Middle	0	0	0.8	4.2	3.4	4.2	6.7	0.8
Lower	2.5	4.2	7.5	5	5.8	1.6	1.6	0
Total	2.5	5	15	19.2	15	17.5	20	5.8

A minor portion (only 2.5%) of patients is illiterate and only present in lower class. In middle and upper class families, there were no illiterate patients. The education level (secondary, S.S.C, H.S.C, graduate and postgraduate level is high in upper class. Most of the lower class patient can only give signature (4.2%) successfully passed the primary level (7.5%). Around 20% patients were graduate, in them 11.7% patients belong to upper class families and only 1.6% patients belong to lower. Post graduate patients belong mainly in upper class (5%) and very few in middle class (0.8%) (Table III).

Table IV: Distribution of respondents according to their occupation and working hour per day in different classes

	Occupation							Working hour per day			
	Unemployed n (%)	Business n (%)	Service n (%)	Day labor n (%)	Housewife n (%)	Student n (%)	Retired n (%)	>8 hours n (%)	7-8 hours n (%)	4-6 hours n (%)	>4 hours n (%)
Upper	13 (10.8)	7(5.8)	12(10)	0(0)	20(16.7)	4 (3.3)	6 (5)	12 (10)	10 (8.3)	14 (11.7)	26 (21.7)
Middle	0 (0)	2(1.7)	9(7.5)	0(0)	11(9.2)	0 (0)	2 (1.7)	11 (9.2)	2 (1.7)	9 (7.5)	2 (1.7)
Lower	2 (1.7)	7(5.8)	2(1.7)	10(8.3)	7(5.8)	2 (1.7)	4 (3.3)	19 (15.8)	2 (1.7)	7 (5.8)	6 (5)
Total	15(12.5)	16(13.3)	23(19.2)	10(8.3)	38(31.7)	6 (5)	12 (10)	42 (35)	14 (11.7)	30 (25)	34 (28.3)

in lower class most of the patients are day labor around 8.3%. As diabetic nephropathy is most common in female, the percentage of housewife (31.7%) is slightly high. The second highest percentage is service person. Around 18.3% patients are service person. Students and retired person from different classes are comparatively safe from DN. The above data also shows how long a respondent works in a day. We know that if a person works above 8 hours per day for a long duration, become more vulnerable for kidney disease where as well as it is also vulnerable to lead a sedentary life. The present survey shows that about 42% respondents work over 8 hours per day and 34% respondents work below 4 hours. In 34% respondents about 21.7% respondents belong to upper class (Table IV).

3.2 Nutritional status and Health condition of DN patients:

Nearby 57.5% patients have normal nutritional status among them 30% patients come from upper class where 11.7% and 15.8% patients belong to middle and lower class families respectively. Obesity is not common in middle and lower class families. Malnourished is more common in lower class families approximately 12.5% as they are not aware about the nutrition and low income Table-V).

Table V: Distribution of respondents according to their nutritional status in different classes

Economic level	Malnourished (BMI: <16-18.49) n (%)	Normal (BMI: 18.5-24.99) n (%)	Overweight (BMI: 25-29.99) n (%)	Obese (BMI: >30) n (%)
Upper Class	12 (10)	36 (30)	9 (7.5)	5 (4.2)
Middle Class	8 (6.7)	14 (11.7)	2 (1.7)	0 (0)
Lower Class	15 (12.5)	19 (15.8)	0 (0)	0 (0)
Total	35 (29.2)	69 (57.5)	11 (9.2)	120 (100)

Table VI: Distribution of respondents according to the presence of hypertension, Asthma, Constipation and Polydipsia in different classes

	Hypertension n (%)		Asthma n (%)		Constipation n (%)		Polydipsia n (%)	
	Present	Absent	Present	Absent	Present	Absent	Present	Absent
Upper Class	47 (39.2)	15 (12.5)	34 (28.3)	28 (23.3)	36 (30)	26 (21.7)	62 (51.7)	0 (0)
Middle Class	17 (14.2)	7 (5.8)	15 (12.5)	9 (7.5)	9 (7.5)	15 (12.5)	24 (20)	0 (0)
Lower Class	24 (20)	10 (8.3)	17 (14.2)	17 (14.2)	20 (16.7)	14 (11.6)	34 (28.3)	0 (0)
Total	88 (73.3)	32 (26.7)	66 (55)	54 (14.2)	65 (54.2)	55 (45.8)	120 (100)	0 (0)

hypertension and asthma is a very common symptom in DN patients. Around 73.3% patients have hypertension where only 26.7% patients have not hypertension. Around 55% patients have asthma where only 45% patients have not asthma. Among 55% patients, 28.3% patients belong to upper class families where 12.5% and 14.2% patients come from middle and lower class families respectively. Constipation is not so much related to DN, it is mainly related to food habit and life style. Around 54.2% patients have constipation where only 45.8% patients do not have constipation. Among 54.2% patients, 30% patients belong to upper class families where 7.5% and 16.7% patients come from middle and lower class families respectively. As thirsty feeling (Polydipsia) is most visible symptom in diabetic nephropathy patients so here among 120 respondents 100% respondents have thirstiness. Although all the diabetic nephropathy patients have thirsty feeling, they all have limitation of drinking water consumption. They can drink nearby 1-1.5 liters of water per day (Table VI).

Table VII: Distribution of respondents by their family history and presence of pre knowledge in different classes

Economic level	Family History n (%)		Previous knowledge n (%)	
	Present	Absent	Has	Has not
Upper	27 (22.5)	35 (29.2)	28 (23.4)	34 (28.3)
Middle	6 (5)	18 (15)	7 (5.8)	17 (14.2)
Lower	12 (10)	22 (18.3)	8 (6.6)	26 (21.7)
Total	45 (37.5)	75 (62.5)	43 (35.8)	77 (64.2)

The data from table VII relevant that among 120 respondents 37.5% has hereditary diabetic nephropathy, among them 22.5% patients belong to upper class and 62.5 % did not gain diabetic nephropathy from their family. Among all the DN patients, about 64.2% respondents had no pre knowledge about this disease and only 35.8% respondents had this knowledge.

In this study, most of the respondents (58.3%) suffer this disease for less than 1 year where only 0.8% respondents suffer this disease for more than 15 years who comes from middle class.

At initial stage, diabetes nephropathy is an asymptotic characterized disease which means that most individuals who develop it are unaware of the condition until it has already caused considerable damage. Kidney damage can begin 5 to 10 years before symptoms start [Kerr S.J., 2012]. Stage 1 and stage 2 were not found as these stages, patients do not feel any problem. When patients feel abnormalities at that time they found themselves at stage 3 and 35% patients were found on stage 3. Around 40% (the maximum value) respondents are in stage 5 diabetic nephropathy. Stage 5 is the final stage of DN and the patients need proper dialysis for their survival (Table VIII).

Table VIII: Distribution of respondents according to the suffering time and stage of diseases in different classes

Economic level	Duration of Suffering				Stage of Diseases				
	< 1 year n (%)	1-5 years n (%)	5-10 years n (%)	> 15 years n (%)	Stage 1 n (%)	Stage 2 n (%)	Stage 3 n (%)	Stage 4 n (%)	Stage 5 n (%)
Upper Class	35(29.2)	19 (15.8)	8(6.7)	0 (0)	0 (0)	0 (0)	21 (17.5)	17 (14.2)	24 (20)
Middle Class	13(10.8)	9 (7.5)	1 (0.8)	1 (0.8)	0 (0)	0 (0)	10 (8.3)	7 (5.8)	7 (5.8)
Lower Class	22(18.3)	10 (8.3)	2 (1.7)	0 (0)	0 (0)	0 (0)	11 (9.2)	6 (5)	17 (14.2)
Total	70 (58.3)	38 (31.7)	11 (9.2)	1 (0.8)	0 (0)	0 (0)	42 (35)	30 (25)	48 (40)

Table IX: Distribution of respondents according to prescribed food intake, Calorie intake, water intake and the other type drinks intake pattern in different classes

Economic level	Prescribed food intake pattern n (%)		Calorie intake pattern n (%)		Water intake pattern n (%)			Other type drink intake n (%)			
	Follow	Don't follow	Adequate	Inadequate	< 1 liter	1-2 liters	2-3 liters	No drink	Milk	Alcohol	tea/coffee/ soft drinks
Upper Class	56 (46.7)	6 (5)	45 (37.5)	17 (14.2)	32 (26.7)	29 (24.2)	1 (0.8)	40 (33.3)	8 (6.7)	0 (0)	14 (11.6)
Middle Class	21 (17.5)	3 (2.5)	19 (15.8)	5 (4.2)	13 (10.8)	10 (8.3)	1 (0.8)	15 (12.5)	0 (0)	1 (0.8)	8 (6.7)
Lower Class	29 (24.1)	5 (4.2)	21 (17.5)	13 (10.8)	18 (15)	16 (13.3)	0 (0)	23 (19.2)	3 (2.5)	0 (0)	8 (6.7)
Total	106 (88.3)	14 (11.7)	85 (70.8)	35 (29.2)	63 (52.5)	55 (45.8)	2 (1.7)	78 (65)	11 (9.2)	1 (0.8)	30 (25)

Table IX illustrates that most of the patients (88.3%) respondents follow the prescribe food chart and patients from upper class are more aware about the food chat.70.8% respondents adequately intake calorie where 29.2% respondents do not intake calorie adequately. Among 70.8% respondents, 37.5% respondents belong to upper class family where 15.8% and 17.5% respondents belong to middle and lower class families respectively. More water intake is restricted for DN patients, so 52.5% patient intake water less than 1 liter where 45.8% and 1.7 % patients drink 1-2 liters and 2-3 liters water per day respectively. Patients not being dialyzed can take < 1 liter to 1.5 liters water according to the health condition of patient. While some time doctor prescribe 1-2 liters water for patient according to

their health condition. The above table indicates that about 65% patients don't drink other type of drinks like milk, alcohol, tea, coffee etc.9.2 % patients drink milk where 0.8% patient drinks alcohol. Among 120 patients, 25% patients' intake other drinks (tea/ coffee/ soft drinks).

Table X: Distribution of respondents according to the Serum albumin level

Serum albumin level	Frequency (n)	Percentage (%)
< 4.65 g/dl	13	10.8
>4.65g/dl	90	75.0
Don't Know	17	14.2
Total	**120**	**100**

Table XI: Distribution of respondents according to the Serum creatinine level

Serum creatinine level	Frequency (n)	Percentage (%)
0.8-1.2 mg/dl	14	11.7
>1.2mg/dl	100	83.3
Don't Know	6	5.0
Total	**120**	**100**

Table X and XI show 10.8% respondents have below 4.65g/dl serum albumin level where 75% respondents have above 4.65 g/dl serum albumin level. 11.7% respondents have below 0.8-1.2 mg/dl serum creatinine level where 83.3% respondents have above 1.2 mg/dl serum creatinine level. 14.2% respondents don't know their serum albumin level because some of them belong to lower class family so they have not sufficient money to do the test. 5.0% respondents don't know their serum creatinine level because some of them take dialysis regularly so they do not check this test after dialysis.

4.0 CONCLUSION

Through this research, it has been found that the incident rate of diabetic nephropathy is slightly higher in upper (51.7%) and lower (28.3%) class families. In this research work it has been shown that males are most vulnerable group for diabetic nephropathy. About 88% patients have hypertension and it is influencing their kidney problem. Hypertension is a major risk factor for both macrovascular and microvascular complications including diabetes nephropathy. Diabetic patients with a blood pressure between 130/80 and 140/90 mm Hg have a greater decline in GFR, with 30% of patients developing associated microalbuminuria or proteinuria. Hyperglycemia is another factor which contributes to the progression of renal damage in diabetic nephropathy. It induces an abnormal activation of protein kinase C (PKC), which is involved in the development of diabetic nephropathy. In this study, it has been shown that most of the people have no pre-knowledge about this disease. In Bangladesh people from each economic society are at risk of diabetic nephropathy because of uncontrolled food habit and life style. The incidence rate of diabetic nephropathy can be minimized by changing life style, food habit and physical activity. Avoid sedentary life style, heavy working, alcohol; smoking may reduce the risk of diabetic nephropathy. It is agreed that diet governs many situations favoring the onset of diabetic nephropathy disease. By changing food habit like minimum amount intake of protein, sodium, phosphorus, potassium may also help to reduce the risk of diabetic nephropathy. Proper knowledge, consciousness, available medical facilities, propagation of information, well-regulated life style, etc may help to reduce the risk of diabetic nephropathy. More study and research may perform on diabetic nephropathy to get more information and knowledge.

5.0 ACKNOWLEDGEMENT

We would like to show our gratitude to the Dr. Chitto Ranjon Bachar, Senior Medical Officer, Diabetic Association, Khulna for his active cooperation and scholarly advice, precious suggestion and instruction which made us possible to complete this study. We are also immensely grateful to Shahnaz Shamsi, Assistant Professor of Food and Nutrition

Department, Khulna City Corporation Women's College for her valuable comments during survey and also during data analysis.

Reference:

1. American diabetes Association (2004) Nephropathy in Diabetes; Diabetes Care, 27(1): 579-583.
2. Clinical Practice Guidelines of Diabetic Nephropathy (2004) Malaysian Society of Nephrology, Ministry of Health, Malaysia, 30-45.
3. Gross J.L., deAzevedo M.M.J., Silveiro M.S.P., Canani M. L.H.,Caramori M.M.L. and Zelmanovitz M.T., (2005) Diabetic Nephropathy: Diagnosis, Prevention and Treatment; Diabetes Care, 28(1):176-188.
4. Kerr S.J.,(2012) Diabetic Nephropathy (Nephropathy, Diabetic; Diabetic Glomerulosclerosis), NYU Langone Medical Center, 1-4.
5. Khan A.R. (2013), 3.2 million people in Bangladesh suffer from diabetes; News and views on environment and climate change, energy, water, public health and agriculture.
6. Otoda T., Kanasaki K. and Koya D. (2014) Low protein diet for Diabetic Nephropathy; Current Diabetes Reports, 14(9): 523.
7. Rohilla A., Tiwari S. K., Rohilla S. and Kushnoor A., (2011) Diabetic Nephropathy: Pathogenesis, Prevention and Treatment, Pelagia Research Library, European Journal of Experimental Biology, 1 (4): 72-80.
8. Vujičić B, Turk T, Crnčević-Orlić Z, Đorđević G and Rački S., (2012) Diabetic Nephropathy, INTECH, 4:71-96

SINGLE ELECTRON TRANSISTOR (SET): OPERATION AND APPLICATION PERSPECTIVES

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ABSTRACT

The concept of miniaturization originated after the deliberation of a talk given by physicist Richard Feynman on 29th December 1959, led to the development of quantum dot (QD), which is the basic building block of single electron transistor (SET). SET is a new type of switching device used controlled tunneling of electron to amplify current. According to Moor's law, SET may be alternative of complemented metal oxide semiconductor (CMOS) device for the next generation electronic devices and sensors. This is a review article intended to consolidate the knowledge on the working principle of SET along with relevant other aspects and also highlighting the promising applications with limitation of implementations in the 21st century in order to reduce power dissipation.

Key Words: SET, QD, FET, CMOS

1.0 INTRODUCTION

The concept of miniaturization of devices is date back, which originated from the classic talk entitled "There's Plenty of Room at the Bottom" given by physicist Richard Feynman in an annual meeting of American Physical Society on 29th December 1959[1]. In his talk, he challenges the miniaturization and focuses idea on how to manipulate and control the matter in atomic and molecular levels. Finally his dream came into reality with the discovery of carbon nanotube by Sumio Ijima in 1991 at the NEC laboratory, Tsukuba, Japan. This discovery became the launching pad of Today's nanoscience and nanotechnology [2]. Since then worldwide, scientists, researchers, engineers and technologists have started to investigate a variety of ways to synthesize materials in the size of nanometer and finally led to the development of quantum dots (QD). This QD is a nanoparticle having all the dimensions reduced to below 100 nm, which is the main building block of Single Electron Transistor (SET). This SET is actually a new type of switching device that uses controlled electron tunneling to amplify current [3].

According to Moor's law every after 18 months the density of transistor in integrated circuit is becoming almost double [4-7]. The resulting fact of size reduction and power dissipation may limit the scope of further miniaturization of integrated circuit using the existing semiconductor technology (silicon based) and leads to evolve alternatives using nanoscience and technology [8]. As such, SET is expected to be an option to replace normal transistor either bipolar transistor (BJT) or field effect transistor (FET), the building block of computers, for the next generation of electronic devices like optical computers etc. However, the SET is yet in its infancy because of complexity in cost effective fabrications but still having promising applications in the next generation electronic devices and sensors. The objective of this paper is to review the fundamental understanding on operation of SET and its promising applications in the alternative devices to meet the upcoming challenges for further miniaturization and reducing the power dissipation.

2.0 TRANSISTOR

Transistor was first invented by Shockley, Brattain and Barden in 1948 [9]. Then it was integrated in a chip as integrated circuit in 1961. In 2003, it was reduced to processor consisting of millions of transistors in a chip to be used in the computer. Finally, the processor size became 22 nm by the year of 2013. As such, miniaturization of transistor has made the complemented metal oxide semiconductor (CMOS) as the workhorse of modern electronics. By the forecast of Moor's law as shown in figure-1, CMOS has attained its least most possible size and likely ending the regime of semiconductor technology.

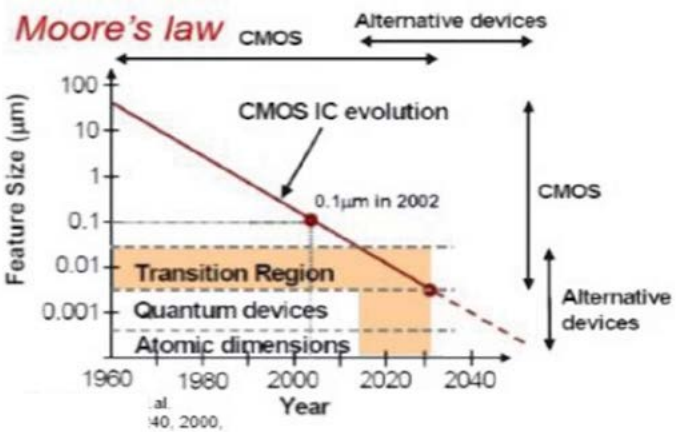

Fig-1: Graphical presentation of Moor's forecast [10]

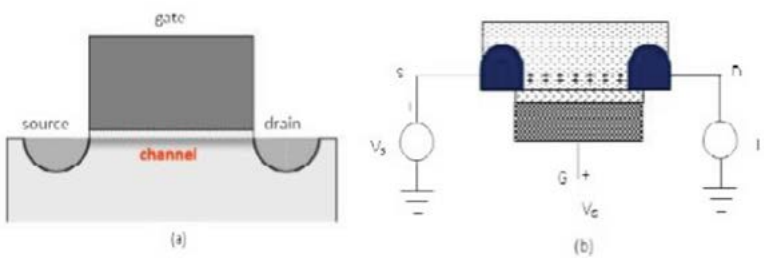

Fig-2: (a) Schematic view of Construction of FET (b) schematic view of operation of FET

Field Effect Transistor (FET) is a three terminal switching device used in computers as well as electronic devices. The three terminals are source (S), drain (D) and gate (G) [11]. It is of two kinds such as n-channel and p-channel depending on the type of material of channel. They are broadly classified as bipolar transistor (BJT) and field effect transistor (FET). Complementary metal–oxide–semiconductor (CMOS) is the latest version of FET [12]. The FET is constructed with n-type (n-channel) or p-type (p-channel) semiconductor as channel and one or two gate consisting of p-type (for n-channel) or n-type (p-channel) semiconductor separated from the channel by insulating layer as shown in figure-2(a).

Principle of Operation

In its operation, the drain-to-source voltage (VDS) provides current through the channel. The gate voltage (VGS) controls the current (electrons) flow through the channel by depleting immobile opposite charge layers as shown in figure-2(b). Notable here, millions of electrons flows through the channel in its operation and maximum of them dissipated as heat, which ultimately heats up the device and radiates out. The resulting effect is therefore power loss. Further miniaturization and power dissipation are the challenges, which may be meeting by the use of SET in the next generation technology. By the time, the fabrication of SET has been possible in the laboratory, wherein QD is the main part, but yet to be publicly available in the market with any devices.

3.0 QUANTUM DOT (QD)

When all the three dimensions of a material reduced to the nanometer range, then this material is called quantum dot (QD). It may have cubical or spherical shape. When the material dimensions reduce then the delocalized electrons become localized and confined with discrete energy levels, which can be called quantized. As such, they behave like an atom and therefore sometimes referred to as artificial atom [13]. Accordingly, its electrical and optical properties depend mostly on its size and geometrical structure of the quantum dot (QD).There is metallic and semiconductor QDs. The metallic QD used in the construction of SET. The density of quantum energy states of localized electrons depend on the size of QD. The smallest QDs have the compressed quantum energy states whereas the biggest QDs have spaced quantum energy states of localized electrons as shown in figure-3.

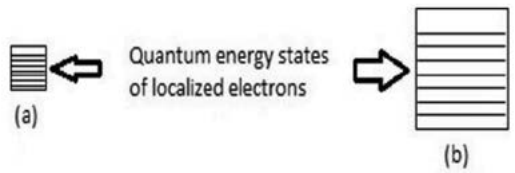

Fig-3: (a) Smallest QD and (b) biggest QD

4.0 SINGLE ELECTRON TRANSISTOR (SET)

A single electron transistor (SET) is a new type of switching device that uses controlled electron tunneling to amplify current. This transistor is constructed based on quantum mechanical principle. The single electron transistor is similar to the normal transistor (FET) except the channel is replaced by QD. The QD is separated by thin insulators from both the source and drain. The thin insulators act as tunnel barrier between source to QD and QD to drain. The gate is connected to the QD by a capacitor, Cg. as shown in figure-4. In SET, electron tunnels in two steps such as source to dot and dot to drain. The gate voltage Vg controls the charge on this capacitor Cg.

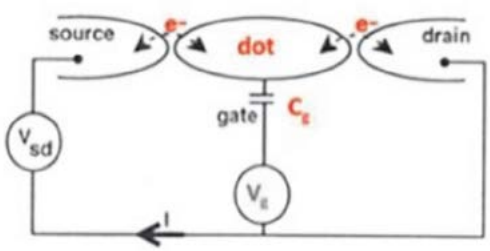

Fig-4: Construction of SET

Working Principle

The metallic QD, which is separated from the source and drain by the thin insulators, is capacitively coupled to the gate as shown in figure-5(a). This gate controls the tunneling current across the tunnel barrier and operates on the principle of coulomb blockade.

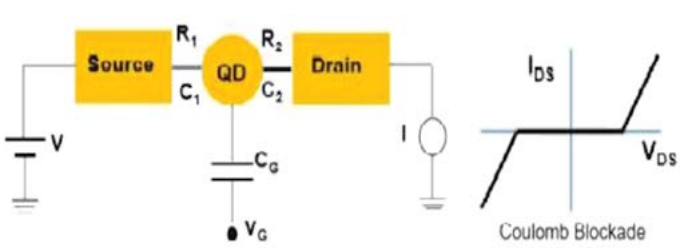

Fig-5: (a) Circuit of SET (b) Coulomb Blockade

The energy needed to charge the capacitor is $e^2/2$. It is typically 80 meV [1]. If this energy is not supplied to the system electron transport will be blocked at sufficiently lower temperature, this is known as coulomb blockade (CB) as shown in figure-5(b). The working principle with the help of biasing is discussed below:

Under no bias condition, the transportation of electron from source to drain will not take place because the Fermi levels of both the source and drain will be in the same level and the localized as well as quantized electrons are in quantum mechanically confinement as discrete energy levels and provides coulomb blockade in QD. This situation is shown in figure-6(a).

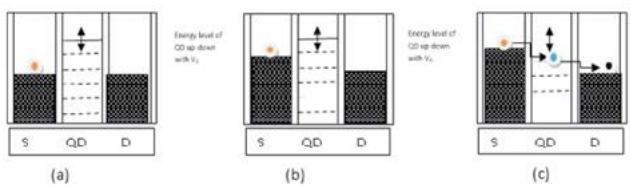

Fig-6: (a) No bias (b) with bias, VDS (c) with gate voltage, VG

Now if a bias voltage applied between drain to source (V_{DS}), then the Fermi level of sources, S will go up and of drain, D go down by the amount of energy /2, which cause off Fermi levels between source and drain. This situation is shown in figure-6(b). In this case, electron may transfer from source to QD but without gate voltage (V_G) it will not happened because for an extra electron, the energy of QD will be increased by the same amount, which is contrary to the principle of conservation of energy of the system. As such, by sweeping the gate voltage for a fixed drain to source voltage, V_{DS}, the tunneling of one electron through the QD in a fashion source to QD and QD to drain is possible to make. In that, when a gate voltage, VG is changed by $\Delta V_g = e/C_g$, then for a certain situation, the whole energy levels of QD go down below the Fermi level of source region but remain above the Fermi level in the drain region as shown in figure-6(c). Under this condition, electron from source will hope to the QD and from QD to drain. Accordingly, the laws of conservation of energy will be maintained inside the QD. By thus gate controls tunneling of one electron from source to drain. This is the working principle of SET.

Now if a curve for drain current, I as a function of gate voltage, V_G is plotted then the current spike will be obtained every after e/C_g volt as shown in figure-

6(a). For different gate voltage, V_G by changing the bias, V_{DS} the current, I will increase, which is shown in figure-6(b). If both the bias is simultaneously changed and plot the data as V_{DS} vs. V_g, then the coulomb diamond will be obtained as shown in figure-6(c).

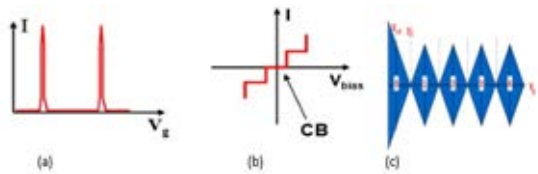

Fig-6: (a) I vs. Vg (b) I vs. VDS (c) VDS vs.Vg

5.0 DISTINCTIONS BETWEEN FET AND SET

Although SET is similar to normal transistor (FET), but there are differences between them in same aspects as given in tabular form:

Table-1: Differences between FET and SET

Aspect	FET	SET
Mode of operation	All electrons move through the channel from source to drain directly, where gate voltage controls the number of electron.	Only one electrons hopes the tunnel barrier and passed through the source to QD and QD to drain
Mode of switching	When electrons ar e added to the semiconductor then switch on which represents logic 1 and when remove them the switch off which represent logic 0 in the computers.	Switch on or off is controlled only by one electron. As such it is faster than FET in its switching operation
Power dissipation	While moving electrons through the channel causes heat to the system or device due to their collisions and the generated heat is dissipated by radiation from the device.	Single electron hopes from the source to QD and QD to drain in its operation, it does not heat up the system or device. So almost no power dissipated by radiation from the device.
Tunnel barrier	It does not have tunnel barrier rather there is depletion region of positive charge inside the channel to control the flow of electrons	It has tunnel barrier which is developed between source and QD, and QD and drain because QD is separated from both the source and drain by a thin insulating materials.
Coulomb blockade	It does not have coulomb blockade (CB)	It has Coulomb blocked, which equals to e^2/C_g
Linking	Normal conductor wire is sufficient enough to outside environment linking.	A quantum cellular automation (GCA)[1] the best option to form a circuit link with the outside environment.
Current Carriers	Millions of electrons are the current carriers in conduction bands in the semiconductor used as channel.	Electrons are densly packed in QD and also localized by quantum mechanical confinement.

[1]The static electronic force is to link up between the basic clusters and QD to form a circuit linked by cluster, which is called quantum cellular automata (QCA).

6.0 PROMISING APPLICATIONS OF SET

The SET used in a variety of applications as describe below:

a. The SET are efficient charge sensors for reading out the spin or charge qbits confined in QD. The SET can be used as an efficient probe of signal-to-noise ratio both for dc and radio frequency single shot measurement [3].

b. The SET can effectively detect infrared signal at the room temperature and therefore can serve as IR sensor in sophisticated device like IR camera.

c. The SET can be used as extremely sensitive and potentially useful detector of microwave wave radiation.

d. The high sensitivity of SETs has enabled them to be used as supersensitive electrometers in unique physical measurements.
e. Another application of single-electron electrometry is the possibility of measuring the electron addition energies (and hence the energy level distribution) in quantum dots and other nanoscale objects [3].
f. The problem of leakage current is solved by the use of another logic device name charge state logic in which single bits of information are presented by the presence/absence of single electrons at certain conducting islands throughout the whole circuit [13]. In these circuits the static currents and power vanish, since there is no dc current in any static state.
g. An SET having nonvolatile memory function is a key for the programmable SET logic.
h. One new avenue toward a new standard of absolute temperature can be developed by the use of 1D single-electron arrays [3].
k. The single-electron transistors can be used in the "voltage state" mode.

7.0 LIMITATIONS OF SET IMPLEMENTATIONS

Despite variety of applications, SET implementation in the device has some limitations as discussed below:

a. The first major limitation with the single electron logic circuits is the randomness of the background charge [13].
b. The another big limitation with all the known types of single electron logic devices is the requirement Ec~100kB T, which in practice means sub-nanometer island size for room temperature operation[14].
c. Outside environment linking with SETs by normal wire connection is another limitation considering the size of SET [3, 14].
d. Lithography technique is another major limitation with single electron devices because of difficulty in fabrication at room temperature [3, 14].
e. The rate of coherent quantum mechanical process is crudely less than that for the single-electron-tunneling.

8.0 CONCLUSION

SET is similar to the normal transistor (FET) only the exception is that QD replaces the channel of FET. QD is separated from both the source and drain by thin insulating material. The insulating layers act tunneling barriers. The tunneling barriers need to overcome to hop electron from source to QD and QD to drain. In SET, QD is capacitively connected with the gate. This gate controls the electron to hop by changing the quantum energy states of electrons those are quantum mechanically confined in the QD. In FET, millions of electrons flow through the channel dissipated as heat due to collision of electrons. But in SET one electron passes the through QD, so no heat generates and does not dissipated as heat radiation.

In QD the delocalized electrons become localized and confined with discrete energy levels, which can be called quantized. This quantized energy states in the QD can move up and down (i.e. varies) according to the voltage applied to it. This variation of quantized electrons gives rise to unique electrical and optical property. SET has numerous promising applications such as, charge sensors, microwave detector, infrared detector, supersensitive electrometer etc. Despite these promising applications, SET has some limitation of its implementations, such as lithography, background charge etc.

ACKNOWLEDGEMENT

This work was supported by Military Institute of Science & Technology (MIST).

References

[1] February1960 issue of Caltech's Engineering and Science

[2] K. Eric Drexler, Nano systems: molecular machinery, manufacturing, and computation by, Wiley 1992

[3] Anil Kumar and Dharmender Dubey, "Single Electron Transistor: Applications and Limitations", Advance in Electronic and Electric Engineering Volume 3, Number 1 (2013), pp. 57-62

[4] G. E. Moore, "Cramming more components onto integrated circuits", *Electronics*, vol. 38, no. 8, pp. 114-117, Apr. 1965.

[5] G. E. Moore, "Progress in digital integrated electronics", *Proc. IEDM Tech. Dig.*, pp. 11-13, 1975.

[6] G. E. Moore, "VLSI: Some fundamental challenges", *IEEE Spectrum*, vol. 16, no. 4, pp. 30-37, Apr. 1979.

[7] K. Eric Drexler, Bulletin of Science, Technology & Society, Vol. 24, No. 1, February 2004, 21-27

[8] W. F. Brinkman et al., *IEEE Journal of Solid-State Circuits*, vol. 32, 1997.

[9] Jacob Millman (1985), *Electronic devices and circuits. Singapore:* McGraw-Hill International. p. 397

[10] D. J. Plummer et al, *IEEE Proceedings*, 89, 240 (2000).

[11] Junction Field-Effect Devices, *Semiconductor Devices for Power Conditioning,* 1982

12] Baker, R. Jacob (2010). CMOS: *Circuit Design, Layout, and Simulation, Third Edition*. Wiley-IEEE

[13] Kouwenhoven et al., Few Electron Quantum Dots, Rep. Prog. Phys, 64 701 (2001)

[14] Om Kumar and Manjit Kaur, Single Electron Transistor: Applications & Problems, *International journal of VLSI design & Communication Systems (VLSICS),* Vol.1, No.4, December 2010.

REGULATORY COMPLIANCE OF IFRS # 7: A STUDY ON THE FOREIGN COMMERCIAL BANKS OF BANGLADESH

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ABSTRACT

This paper is aimed to scrutinize the existing reporting standard for the Foreign Commercial Banks in Bangladesh and find out the extent of compliance by them. Banking industry's nature of operation is totally different from others. Recognizing this aspect some specific IFRSs (International Financial Reporting Standards) have been prescribed for them. One of which is IFRS # 7 (Financial Instruments: Disclosures) which was formulated by IASB in 2004 and obliged to comply from on after 1st January, 2007 n the Annual Reporting. Institute of Chartered Accountants of Bangladesh (ICAB) prescribed to comply with IFRS # 7 from on or after 1st January, 2010 in Bangladesh. Hence compliance of IFRS 7 is of immense importance here. Scrutinization has been operated on 9 Foreign Commercial Banks. As per requirement, all the Foreign Commercial Banks are required to comply with the standard to uphold the stakeholders' interest inspite of possessing the large portion ownership by the Foreigners. And the result of the study shows that all of the Foreign Commercial Banks compliance almost 68.18% of the IFRS # 7 requirements. Finally this study recommend on the degree of compliance for the Foreign Commercial Banks financial reporting.

Key Words: Compliance, IFRS, Bank, Foreign Commercial Banks,

1.0 INTRODUCTION

At present, banking industry is the most flourishing and the most contributing sector in any country. Bank is the nerve center of money market and capital market in any economy. Commercial Banks conquer the lion part of banking sector and foreign commercial bank is also important here. It is more than truth for a developing country like Bangladesh. At present Bangladesh have 57 scheduled banks and 6 non- scheduled banks. Among the schedule bank, commercial banks are of 46 in number classifying nationalized as well as private. Foreign Commercial and native is also classes here. Foreign Commercial Banks are 9 in number and obviously others are of 37 (Bangladesh Bank website, 2017). The foreign commercial banks play a pioneer role in economic activities of our country. Hence their beneficiaries are many. Above all they are business entities. Therefore compliance of required laws and regulations are compulsory for them. Here lie the major clues for the compliance of accounting standard. To disclose the financial performance and financial position of this type of financial institutions, regulatory watchdogs like International Accounting Standard Board (Henceforth IASB), prescribed different techniques. One of such techniques is to comply with the applicable accounting standard such as International Financial Reporting Standard (IFRS) - 7 which aims at faithful representation of financial performance and financial position of an entity.

2.0 THEORETICAL BACKGROUND

2.1. Foreign Commercial Banking

Foreign Commercial Banking is a type of foreign bank that is obligated to follow the regulations of both the home and host countries. Because the foreign branch banks' loan limits are based on the parent bank's capital, foreign banks can provide more loans than subsidiary banks. Banks often open a foreign branch; provide more services to their

multinational corporation customers. However, operating a foreign branch bank may be considerably complicated because of the dual banking regulations that the foreign branch needs to follow. For example, suppose the Bank of America opens a foreign branch bank in Canada. The branch would be legally obligated to follow both Canadian and American banking regulations.

2.2. Foreign Commercial Banks in Bangladesh:

In Bangladesh there are 9 foreign commercial Banks which are trying to provide all modern facilities to their customers. They are proving Internet banking, credit card, debit card, ATM booth. Here is the list of foreign Commercial Bank of Bangladesh

S.N	Name of the Foreign Commercial Bank
1	Commercial Bank of Cylon
2	Citi Bank N/A
3	Habib Bank Limited
4	HSBC Bank Limited
5	National Bank of Pakistan
6	Bank Al Falah
7	Standard Chartered Bank
8	State Bank of India
9	Woori Bank Limited

[Source: Bangladesh Bank online]

IFRS # 7: FINANCIAL INSTRUMENTS AND DISCLOSURES

The objective of this IFRS is to require entities to provide disclosures in their financial statements that enable users to evaluate the significance of financial instruments for the entity's financial position and performance; and the nature and extent of risks arising from financial instruments to which the entity is exposed during the period and at the reporting date, and how the entity manages those risks. The IFRS-7 is admixture of two IASs named IAS 32: Financial Instruments: Presentation and IAS 39 Financial Instruments: Recognition and Measurement.

The two main categories of disclosures required by IFRS 7 are: (a). Information about the significance of financial instruments and (b) information about the nature and extent of risks arising from financial instruments. Under first category, the disclosures will be about

1. Balance sheet items like financial assets measured at fair value through profit and loss, held-to-maturity investments, loans and receivables, available-for-sale assets, financial liabilities at fair value through profit and loss, showing separately those held for trading and those designated at initial recognition and financial liabilities measured at amortized cost
2. Income Statement and Equity Items like income, expense, gains, and losses.
3. Other disclosures like accounting policies for financial instruments [IFRS 7.21], and information about hedge accounting,

Under second category, the disclosures will be about

1. Qualitative disclosures [IFRS 7.33] describing risk exposures for each type of financial instrument and management's objectives, policies, and processes for managing those risks and changes from the prior period
2. Quantitative disclosures providing information about the extent to which the entity is exposed to risk, based on information provided internally to the entity's key management personnel. These disclosures include: [IFRS 7.34] Credit Risk, Liquidity Risk and Market Risk [IFRS 7.40-42]
3. Transfers of financial assets [IFRS 7.42A-H] disclosing information that enables users to understand the relationship between transferred financial assets that are not derecognized in their entirety and the associated liabilities; and to evaluate the nature of, and risks associated with, the entity's continuing involvement in derecognized financial assets. [IFRS 7 42B]

4.0 RESEARCH QUESTIONS

As per formulation of instructions by the IASB (International Accounting Standard Board), Bank Company will disclose the financial instruments for stakeholders' complying IFRS-7. ICAB (Institute of Charted Accountant Bangladesh) instructed also for the Bangladeshi Bank Companies from 2010. Now several enquiries are the followings:

1. What is the degree of compliance of IFRS 7 in the Annual Reports of the foreign Commercial Banks of Bangladesh?
2. What is the deviation from the IFRS-7 in the Annual Reports of the foreign Commercial Banks of Bangladesh?

5.0 OBJECTIVES OF THE STUDY

The objectives of the study are the followings:

1. To find out the degree of compliance of IFRS 7 in the Annual Report of the foreign Commercial Banks of Bangladesh.

2. To identify the deviation from the IFRS-7 in the Annual Report of the foreign Commercial Banks of Bangladesh.

6.0 METHODOLOGY OF THE STUDY

To draw the conclusion on the topic only the secondary source of information has been analyzed. This includes annual reports, articles on this issue, different relevant acts etc. The analysis is done by content analysis which is widely being used in a social science research which involves reading the annual report and pocking up both qualitative and quantitative information. So this technique has been used for this empirical study. Next to find out the average percentage of compliance weight was given as, for compliance of each requirement 1, for partial compliance 0.5 and for noncompliance 0.

7.0 SCOPE OF THE STUDY

7.1. Limitation

1. The analysis of the topic has been done on the annual reports of the nine Foreign Commercial Banks.
2. The analysis is limited to whether the financial reports have been prepared according to the IFRS # 7. Any other standard has not been scrutinized here.
3. The entities whose financial statements have been analyzed are basically guided by separate guideline than that of other Bank like specialized Banks, or other Islamic Banks state owned banks. These Banks are merely conventional, non-Islamic Foreign Commercial Bank. So there is a risk of matching disclosure of certain important items regarding IFRS # 7.

7.2. Future area of study:

As this study is gone through the only IFRS # 7 compliance, which is not sufficient to measure the overall financial reporting disclosures by the Foreign Commercial Banks, so further study is mostly needed to meet up the whole thing together. As Commercial Banks are operated on the different sector, and give short term loan to customer, so to meet up the interest of the users of financial report, special study should gone through to find out what standards are needed to serve this purpose.

8.0 LITERATURE REVIEW

Foreign Commercial Banking is the update area in the banking world and it's an integral part of current and future financial market. Almost every country in the world, multinational corporate formed Banks are operated. As the history of foreign commercial banking in the legal format is not so long, research study on the financial reporting disclosures by the Conventional Commercial Banking is not so rich. Hossain Sh, Hossain I and Azad M. H (Feb 2013) stated the compliance of IAS 30 of the Islamic banks disclosure. They have shown that the Islamic Banks practiced IAS 30, 87.5%. In their article it is seen that about trust activities disclosures, no banks state any word and about Assets Pledges and Securities only one bank, EXIM Bank states. Another two authors, Hossain Sh, and Baser M.A, described the compliance of IAS 30 (supersede by IFRS 7) of the specialized banks disclosure. They showed specialized banks disclose no word about General Banking Risk (para. 50-52), Assets Pledged as Securities (para. 53-54), Trust Activities (para. 55) and about Related Party Transaction (para. 56-58). Hossain M. I. and Sultana N (2014) stated the compliance of IFRS 7 of the Private Commercial Banks disclosure. The study was based on 10 selected Banks, and result 61.52% compliance. Here it is marked that financial liabilities at fair value through profit or Loss (IFRS 7 para 10 and 11) is ignored to disclose by all Banks. In addition nature of transferred asset is also ignored to disclose, Collateral is disclosed by some banks, and some are not. Then it is needed to identify whether the foreign banks comely the IFRS 7 fully or not. There is no study in Bangladesh as well as in the world about the current topic what is the degree of compliance of IFRS-7 of the Annual report of the Foreign Commercial Banks of Bangladesh. This study will fill up the research gap. It will scrutinize the 09 Foreign Commercial Banks Annual reports disclosures and conclude about the IFRS 7 compliance as well as identify the degree of noncompliance.

9.0 ANALYSIS & FINDINGS

9.1. Compliance of IFRSs by the Foreign Commercial Banks

The business entities design their accounting system as per the requirements of the Income Tax Law. And above all in order to provide a standardized report all types of banks try to follow the IFRS 7 (BFRS 7) which is the demand of the modern competitive business world. Here is the investigation whether the foreign Commercial banks of Bangladesh follows this underlying standard regarding the preparation of their financial statements. The result can be derived as follows:

Table-2: Schedule of compliance status:

Requirement/ Disclosures	**Commercial Bank of Cylon**	**Citi Bank N/A**	**Habib Bank**	**HSBC**	**NBP**	**Bank Al Falah**	**Standard Charted**	**State Bank of India**	**Woori Bank**
Classes of Financial Instrument [Para 6]	√	√	√	√	√	√	√	√	√
Balance Sheet [Para 7]	√	√	√	√	√	√	√	√	√
Categories of Financial Assets and Liabilities [Para 8]	√	√	√	√	√	√	√	√	√
Financial Liabilities at fair value through Profit or Loss [Para 10 and 11]	×	×	×	×	×	×	×	×	×
Collateral [Para 14 and 15]	√	√	√	√	×	×	√	√	√
Income Statement & Equity (Income, Expense Gains Losses) [Para 20]	√	√	√	√	√	√	√	√	√
Other Disclosure: Accounting Policies [Para 21]	√	√	√	√	√	√	√	√	√
Qualitative Disclosure Risk exposures for each type of financial instrument Management's objectives, policies, and processes for managing those risks Changes from the prior period	√	√	√	Partial √	Partial √	Partial √	√	√	√
Quantitative Disclosure Credit Risk Liquidity Risk Market Risk[Para 34-42]	√	√	√	√	√	√	√	√	√
The nature of the transferred assets [Para 42 D]	×	×	×	×	×	×	×	×	×
Transferred financial assets that are derecognized in their entirety [Para 42 E]	×	×	×	×	×	×	×	×	×

The empirical findings of the study from table1are shown below—

No. of companies	9
No. of requirements as per IFRS-7	11
Maximum number of requirement complied by the company	8
Minimum number of requirement complied by the company	6
Average number of compliance by the companies	7

Table-3: Summary of compliance by Individual Commercial bank:

Complying banks	Total compliance requirement	No. of requirement fulfilled	(%) compliances fulfilled	Deviation from the industry average (%)
Commercial Bank of Cylon PLC	11	8	72.72%	(4.54%)
Citi Bank N/A	11	8	72.72%	(4.54%)
Habib Bank Limited	11	8	72.72%	(4.54%)
HSBC Bank Limited	11	7.5	68.18%	0
National Bank of Pakistan	11	6.5	59.09%	9.09
Bank Al Falah	11	6.5	59.09%	9.09
Standard Chartered Bank	11	7.5	68.18%	0
State Bank of India	11	8	72.72%	(4.54%)
Woori Bank Limited	11	7.5	68.18%	0

(%) of compliance = Requirement complied/ Total requirement.

The analysis shows that of the nine banks and of the total 11 requirements, four Banks, Commercial bank of Cyclon Citi Bank N/A, Habib Bank, State Bank of India complied with 8 requirements (72.72%), and, HSBC, Woori Bank and Standard Chartered Banks complied 7.5 (68.18%) and other two Banks like National Bank of Pakistan, Bank Al Falah, complied 6.5 (59.09%) requirements. Another important finding is that some requirements were completely ignored where some were partially followed and others were fully complied. Besides, 6 requirements were fully complied with by all the nine companies, 3 requirement is totally not complied by any of them and two are partially complied.

Table-4: Average no. of compliance:

Status of compliance	No. of requirement	Weight	Weighted score
Fully complied	6	1	6
Partially complied	2	0.5	1
Not complied	2	0	0
Total			7

For full compliance weight = 1
For non-compliance weight = 0
For partially complied weight = 0.5
Weighted score= 7/11 = 63.63%

It is also worth mentioning that the average compliance of the standard by the companies is 68.18%. Of the nine banks the deviation from the industry is almost same for all the banks (4.54%).

Table-5: (%) compliance of the individual requirement:

Requirement	No. of complied companies	(%) of compliance
Classes of Financial Instrument [Para 6]	9	100%
Balance Sheet [Para 7]	9	100%
Categories of Financial Assets and Liabilities [Para 8]	9	100%
Financial Liabilities at fair value through Profit or Loss [Para 10 and 11]	0	.....

Collateral [Para 14 and 15]	7	77.77%
Income Statement & Equity (Income, Expense Gains Losses) [Para 20]	9	100%
Other Disclosure: Accounting Policies [Para 21]	9	100%
Qualitative Disclosure [Risk exposures for each type of financial instrument Management's objectives, policies, and processes for managing those risks Changes from the prior period]	7.5 Full 6 partially 3	67.5%
Quantitative Disclosure [Credit Risk Liquidity Risk Market Risk] [Para 34-42]	9	100%
The nature of the transferred assets [Para 42 D]	0	.....
Transferred financial assets that are derecognized in their entirety [Para 42 E]	0	...
Total =		745.27
Average = 866.66/11=		68.18%

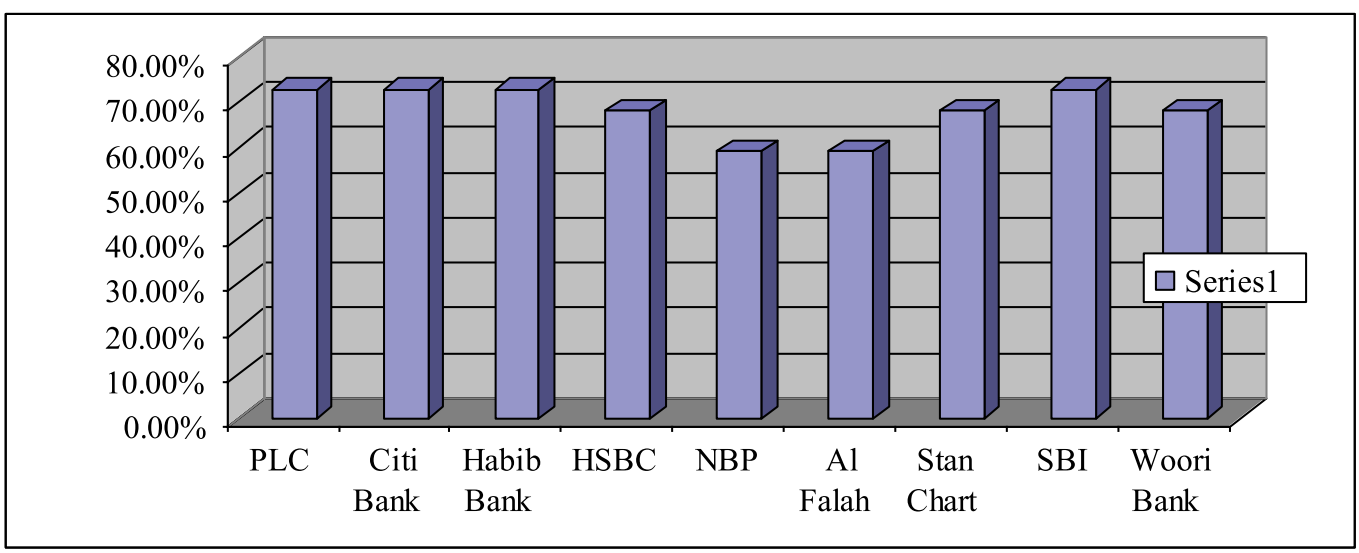

Fig: Compliance of IFRS 7 requirements by Foreign Commercial Banks in Bangladesh

Apart from above numerical analysis the detailed version of compliance findings are described as follows:

1. Classes of Financial Instrument

All the nine banks fully comply with this requirement by showing classes of financial instrument. So compliance status for this requirement is 100%

2. Balance sheet

All the nine banks fully comply with this requirement by showing classes of Assets, Liabilities and Equity in Balance sheet. The compliance status for this requirement is 100%

3. Categories of Financial Assets and Liabilities

Disclosures are presented by all nine Banks showing separate assets Liabilities and their maturities. This is also 100% complied requirement.

4. Financial Liabilities at fair value through Profit or Loss

All the banks can not comply with the requirement as required by the IFRS 7 stating the fair value of Liabilities as there is bindings of Bangladesh bank rules and orders. Therefore the compliance status is 0 this requirement.

5. Collateral

Only seven banks complied with the requirement

as required by the IFRS 7 stating the collateral .All banks except Al Falah and NBP followed this the compliance status is 77.77% for this requirement.

6. Income Statement & Equity (Income, Expense Gains Losses)

All the banks show this just after the balance sheet. It has been presented classifying Income expenses Gains and Losses. This requirement is compiled by 100%.

7. Other Disclosure: Accounting Policies [Para 21]

All the banks show Accounting policies such as valuation of Assets and their own depreciation policy. Apart from this the impairment of Assets has been also shown in the Reports. It is compiled by 100%.

8. Qualitative Disclosure [Para 33]

All the banks show Accounting policies such as valuation of Assets and their own depreciation policy. But three banks presented partially. It is compiled by 67.5%.

9. Quantitative Disclosure [Para 34-42] [Credit Risk, Liquidity Risk, Market Risk]

All the banks show Accounting policies such as valuation of Assets and their own depreciation policy. Apart from this the impairment of Assets has been also shown in the Reports. It is compiled by 100%.

10. The nature of the transferred assets [Para 42 D]

Nothing is mentioned in the long annual reports of nine banks except Citi Bank N/A as to the nature of the transferred assets. So the compliance is only 11.11%.

11. Transferred financial assets that are derecognized in their entirety [Para 42 E]

Nothing is mentioned about the transferred financial assets that are derecognized in their entirety by any bank.

In a nut shell, it is stated that the compliance of IFRS-7 in the annual reports of foreign commercial Banks is not full, rather it is partial. The compliance rate is on average 68.18%. And therefore, deviation from compliance of IFRS-7 is 30.82% by the foreign commercial banks of Bangladesh.

9.2. Effect of Compliance:

The objective of IFRS 7 is to prescribe appropriate presentation and disclosure standards for disclosures of financial Instrument of an entity especially for banks which supplement the requirement of other standards. The intention is to provide users with appropriate information to assist them in evaluating the financial position and performance of banks and to enable them to obtain a better understanding of the special characteristics of the operations of banks. The compliance with the standard will face the following scenario:

- ❖ Obviously the major objective of any IFRS is to provide true and fair view of the entity to the stakeholders. Consequently the compliance of IFRS will enhance the credibility of the information provided.
- ❖ The compliance will also important for the compliance of requirements by the regulatory watchdogs
- ❖ The legal framework of the state also requires the full compliance of IFRS.
- ❖ The third pillar of BASEL-2 deals with market discipline through effective disclosure to encourage safe and sound banking practices. This disclosure pillar is closely related to what the International Financial Reporting Standard (IFRS)
- ❖ This compliance will be helpful for credit rating purpose and can collect investment from outsider also.
- ❖ The compliance will make the management more accountable and thus go a long a way to fulfill the intended objectives of specialization.
- ❖ These banks can meet up their fund problem by issuing shares in the capital market, but before that compliance with required standard is must.
- ❖ These compliances will convince the public about the transparency of foreign bank.

9.3. Effect of Non-compliance:

IFRSs are the guidelines to present a true and fair view of the financial performance and financial position of an entity to its users. Obviously if not complied with the standards it poses to some negative results. So it is very clear that the noncompliance will act as a hindrance in fulfilling the core objective of financial reporting. The non-compliance will fetch the following problem.

- ❖ Noncompliance will enhance the scope of corruption by the management.

- ❖ It will not be justifiable to be list in the capital market without perfectly complying the accounting standard.
- ❖ Simply speaking noncompliance of IFRS is the violation of laws as according to the Companies Act 1994 and is subject to punishment according to section# 211-218 of the said act.
- ❖ Principally it reduces the degree and scope of usefulness of financial information.
- ❖ Consolidation with other entity becomes difficult due to improper valuation.
- ❖ Earnings management happens continuously and it has severe impact on our resource mobilization.
- ❖ Corporate governance requires compliance with all rules and regulation to uphold the interest of the stakeholders. This is also a part of the corporate social responsibility. So this can't be maintained without full compliance of the required standard.

10.0 RECOMMENDATIONS

After a careful scrutiny of the annual reports of four foreign commercial banks it has been found that the companies are presenting their information on the financial statements in line with the IFRS-7 partially. Their compliance rate is 68.18% and non-compliance rate is 30.82%. Although the degree of compliance of the banks is very high, following recommendation should considered by all the parties concerned

- ✓ To have a fair picture of the organization, as the banks play a significant role in the development of our country, they should report Financial Liabilities at fair value through Profit or Loss.
- ✓ Every Bank should report about Collateral.
- ✓ Every Bank should report carefully accounting policies regarding valuation of Assets and their own depreciation policy.
- ✓ The entity should also mention separately about the nature of the transferred assets
- ✓ The accounting personnel of the concerned entities should be trained as to the update of the new accounting pronouncement identifying the non-compliances
- ✓ As these foreign banks are the large part of banking in the country and large contributory, the special supervising and incentives under Bank division of Finance ministry should be set up for flourishing foreign aid and banks in our country

11.0 CONCLUSION

Presentation of financial reporting complying IFRS is of immense importance to the users of those because it enhances the degree and scope of usefulness of accounting information. It is now becoming increasingly evident that existence of properly functioning banking system facilitates the development process in many important ways. Proper accounting and reporting contribute positively on proper functioning of banks. That's why the International Financial Reporting Standards 7 (IFRS 7) is developed to give standardized reporting aspects for banking sector. It is evident from the above analysis that foreign banks are good at complying with the required compliance by the standard prescribed for them. It is hoped that due to the globalization, Multinational commercial banking can easily capture the essence of the international requirements, which make them competitive in providing the services. Based on the analysis, it has been found that there is no significant difference in terms of compliance of IFRS 7, among the nine foreign commercial banks in Bangladesh. That means all of the banks try to follow similar items needed to comply with the international standard in order to provide accountability and transparency in financial reporting, which ensure maximum disclosure of the relevant, reliable and useful information to the interested user groups. In fine it can be culminated that preparation of financial reports of the companies in line with the IFRS-7. So to eliminate the deviation due to different ownership of banking it is demanding that all the relevant bodies should work together to develop a unique standards for the financial reporting standard of Commercial banking for native users and foreign users .

References

[1] Jucca, Lisa; Emilio Parodi; Gavin Jones; Sophie Sassard (March 9, 2013). *"Special Report: Downfall of the world's oldest bank"*.

[2] Ahmed M. uddin, S.K. Bala and A. Chowdhury (2004) *"Financial reporting in compliance with IAS: A study in Bangladesh"* The journal of Business studies,Vol. XXV, No.2.

[3] Hossain. M. Mohabbat (2011) *"Disclosure Requirements in Annual Reports by the Listed Banking Companies: Cases from Bangladesh",* the Bangladesh Accountant, July – September, pp. 22-43.

[4] Hossain. M. Mohabbat (2010) *"A Review of Corporate Financial Reporting Regulations in Bangladesh"*, BUBT Journal, Vol. 3, pp. 175-187.

[5] Hossain. M. Mohabbat (2012) *"Impact of BFRS 7 in the Financial Statements of Banks: A Case from Bangladesh"*, the Cost and Management, Vol. XL, No. 2, pp. 13-17.

[6] Hossain. M. Mohabbat (2012) *"International Financial Reporting Standard (IFRS) 7: Issues and Challenges for Banks"*, Paper Presented in Research Workshop, November 11, BIBM, Dhaka.

[7] Hossain. M. Mohabbat. (2009) *"Accounting Standards for*

Bangladesh", BIBM Bulletin, A Quarterly Publication of BIBM, Vol. 12, No. 2, pp. 2.

[8] Hossain. M. Mohabbat (2012) *"International Financial Reporting Standard 7 and Financial Statements of Banks"*, BIBM Bulletin, A Quarterly Publication of BIBM, Vol. 15, No. 1 & 2, pp 3-10.

[9] Hossain M. I and Sultana N (2014) Regularory *Compliance of IFRS 7 of the Private Commercial Banks Disclosures of bangladesh: An Empirical Study on the ten Selected banks World Vision Jpurnal, ISSN: 2078-8460*, Vol.8, No.1, 2014,

[10] Annual report from 2009 to 2011 of Commercial Bank of Cylon. [Online] available: https://www.combankbd.com

[11] Annual report from 2009 to 2011 of Habib Bank Limited, [online] available: www.hbl.com/bd

[12] Annual report from 2009 to 2011 of HSBC Bank Limited, [online] available: www. hsbc. Com. bd

[13] Annual report from 2009 to 2011 of National Bank of Pakistan, [online] available: www.nbp-bd.com

[14] Annual report from 2009 to 2011 of Bank Al Falah, [online] available: www.bankalfalah.com/bd

[15] Annual report from 2009 to 2011 of Standard Chartered Bank, [online] available: www.standardchartered.com.bd

[16] Annual report from 2009 to 2011 of State Bank of India, [online] available: www.sbibd.com

[17] Annual report from 2009 to 2011 of Woori Bank Limited, [online] available: bd.wooribank.com

[18] Annual report from 2009 to 2011 of Citi Bank N/A, [online] available: *https://www.citibank.com/bangladesh*

[19] Epstein, Mirza (2005) IFRS-Interpretation and Application, John Wiley & Sons Inc.

[20] GOB (Government of Bangladesh), The Bank companies Act 1991.

[21] GOB, The companies Act 1994.

[22] Haque T. and M.A.Islam (2005) *"Compliance of IAS 30 by bank companies of Bangladesh"* The cost and Management.

[23] Institute of Chartered Accountant of Bangladesh (ICAB) Journals, Bangladesh Accounting Standard (2005)

[24] List of banks in Bangladesh [online] available: www. bangladeshtrades.com/banks-in-bangladesh/bangladesh-banks-list.

CFD SIMULATION OF FLOW AROUND 3D SUBMARINE SHAPED BODY

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ABSTRACT

Drag estimation and shape optimization of submarine shaped hulls are important for energy efficiency and hull form improvement. In this study, fluid flow around the 3D DREA bare submarine hull is simulated with the help of finite volume method. Widely implemented Reynolds-averaged Navier-Stokes (RANS) approach and SST k-ω turbulence model with low-Re version are used to represent turbulent transport equations. Computed results are compared with experimental results as well as simulated results of other researchers and found satisfactory. The velocity distribution (vectors, contours and streamlines), pressure distribution and drag coefficient are also analyzed. The result of this study illustrated the flow physics around 3D submarine shaped hull which might be helpful for improvement of design of such underwater bodies.

Key Words: Computational Fluid Dynamics (CFD), Hull Form Optimization, Numerical Simulation, Underwater Vehicle, Turbulence Model, 3D Submarine Shape.

1.0 INTRODUCTION

Computational fluid dynamics constitutes a new approach in the theoretical study and development of the whole discipline of fluid dynamics. Throughout most of the twentieth century the study and practice of the fluid dynamics involved use of the pure theory on one hand and pure experiment on the other hand. The advent of the high-speed digital computers combined with the development of accurate numerical algorithms for solving physical problems on these computers has revolutionized the way we study and practice fluid dynamics today. CFD is a major tool in solving hydrodynamic problems associated with ships, submarines, torpedoes, etc. It can offer cost-effective solution to many problems including underwater vehicle hull forms. The modeling and simulation of an underwater vehicle and calculation of the relevant hydrodynamic coefficients have been performed by many researchers. However, effective utilization of CFD for marine hydrodynamics depends on proper selection of turbulence model, grid generation and boundary conditions. Finite volume method for computation of hydrodynamic forces is based on Reynolds-averaged Navier-Stokes (RANS) equations. Various researchers used turbulence modeling to simulate flow around axisymmetric bodies since late seventies. Patel and Chen [1] made an extensive review of the simulation of flow past axisymmetric bodies. Choi and Chen [2] gave calculation method for the solution of RANS equation, together with k-εturbulence model. *Sarkar et al*. [3] used a low-Re *k-ε* model of Lam and Bremhorst [4] for simulation of turbulent flow past underwater axisymmetric bodies. Karim *et al*. [5-8] showed that SST *k-ω* model is more effective to calculate drag force and unstructured grid gives more accurate results than structured grid for the underwater slender bodies. However, these studies were limited to 2D axisymmetric underwater bodies. In this study, SST *k-ω* (with low-Re version) model is used to simulate fluid flow past 3D DREA bare hull with the help of ANSYS Fluent 16.2 CFD software.

2.1 Mass Conservation Equation

The equation of conservation of mass or continuity equation can be expressed as:

$$\frac{\partial \rho}{\partial t} + \nabla.(\rho \vec{v}) = S_m \quad (1)$$

Equation (1) is the general form of the mass conservation equation and is valid for incompressible as well as compressible flows [9]. The source S_m is the mass added to the continuous phase from the dispersed second phase (for example, due to vaporization of liquid droplets) and any user-defined sources.

2.2 Momentum Conservation Equations

Conservation of momentum in an inertial (non-accelerating) reference frame is described by -

$$\frac{\partial}{\partial t}(\rho \vec{v}) + \nabla.(\rho \vec{v}\vec{v}) = -\nabla \mathrm{p} + \nabla.(\bar{\bar{\tau}}) + \rho \vec{g} + \vec{F} \quad (2)$$

where p is the static pressure, $\bar{\bar{\tau}}$ is the stress tensor and $\rho \vec{g}$ and $\vec{F}$ are the gravitational body force and external body forces respectively. $\vec{F}$ is also contains other model-dependent source terms such as porous-media and user-defined sources.

2.3 Shear-Stress Transport (SST) k-ω Model

The SST *k-ω* turbulence model, developed by Menter in 1993, is a two-equation eddy-viscosity model which has become very popular. The use of a *k-ω* formulation in the inner parts of the boundary layer makes the model directly usable all the way down to the wall through the viscous sub-layer; hence the SST *k-ω* model can be used as a low-*Re* turbulence model without any extra damping functions. The SST formulation also switches to *k-ε* behavior in the free-stream and thereby avoids the common *k-ω* problem that the model is too sensitive to the inlet free-stream turbulence properties. The SST *k-ω* model is similar to the standard *k-ω* model, but includes the following refinements:

- The standard *k-ω* model and the transformed *k-ε* model are both multiplied by a blending function and both models are added together.
- The blending function is designed to be one in the near-wall region, which activates the standard *k-ω* model and zero away from the surface, which activates the transformed *k-ε* model.
- The SST model incorporates a damped cross-diffusion derivative term in the *ω*-equation.
- The definition of the turbulent viscosity is modified to account for the transport of the turbulent shear stress.
- The modeling constants are different.

These features make the SST *k-ω* model more accurate and reliable for a wider class of flows than the standard *k-ω* model [8].

Transport equations for the SST *k-ω* Model are:

$$\frac{\partial}{\partial t}(\rho k) + \frac{\partial}{\partial x_i}(\rho k u_i) = \frac{\partial}{\partial x_i}\left(\Gamma_k \frac{\partial k}{\partial x_i}\right) + G_k - Y_k + S_k \quad (3)$$

and

$$\frac{\partial}{\partial t}(\rho \omega) + \frac{\partial}{\partial x_j}(\rho \omega u_j) = \frac{\partial}{\partial x_j}\left(\Gamma_\omega \frac{\partial k}{\partial x_j}\right) + G_\omega - Y_\omega + D_\omega + S_\omega \quad (4)$$

In these equations, the term G_k represents the production of turbulence kinetic energy and is defined in the same manner as in the standard *k-ω* model. G_ω represents the generation of ω, calculated as described for the standard *k-ω* model in Modeling the Turbulence Production. Γ_k and Γ_ω represent the effective diffusivity of k and ω respectively. Y_k and Y_ω represent the dissipation of k and ω due to turbulence. D_ω represents the cross-diffusion term. S_k and S_ω are user-defined source terms.

3.0 METHODOLOGY

A finite volume based CFD package ANSYS Fluent 16.2 is employed to obtain the solution of the Reynolds-averaged Navier-Stokes equations. The pressure based segregated solver was selected, which solves the pressure and momentum sequentially. Semi-Implicit Method for Pressure-Linked Equations (SIMPLE) algorithm is used for coupling between the pressure and velocity fields. Second order upwind interpolation scheme for the convection term was selected for 2nd order

accuracy. Least squares cell based approach is used to determine the gradients of solution variables at cell centers. Second order interpolation scheme is selected for calculating cell-face pressure. An absolute convergence criterion of 10^{-3} is set for all the discretized equations.

3.1 Hull Geometry

In this study, the computational domains are created around the DREA (Defence Research Establishment Atlantic) standard bare submarine hull as used by Department of Research and Development Canada, 1988. The geometry of the hull is considered to stay consistent with the experimental result. The vertices of 2D axisymmetric geometry are created using following formulas:

For nose section,

$$\frac{r_1(x)}{l} = \frac{d}{l}\left[2.56905\sqrt{\frac{x}{l}} - 3.48055\frac{x}{l} + 0.49848\left(\frac{x}{l}\right)^2 + 3.40732\left(\frac{x}{l}\right)^3\right] where, 0 \le \frac{x}{l} \le 0.2 \quad (5)$$

For mid body,

$$\frac{r_2(x)}{l} = \frac{d}{l} \quad where, \ 0.2 \le \frac{x}{l} \le 1 - \frac{3d}{l} \quad (6)$$

For tail section,

$$\frac{r_3(x)}{l} = \frac{d}{2l} - \frac{l}{18d}\left[\frac{x}{l} - \left(1 - \frac{3d}{l}\right)\right]^2 \quad (7)$$

$$where, \quad 1 - \frac{3d}{l} \le \frac{x}{l} \le 1$$

where, l is the length of the hull, d is the maximum diameter and $l/d = 8.75$. By revolving 2D axisymmetric sketch 360^0 around x-axis 3D DREA bare hull has been created and shown in Fig 1.

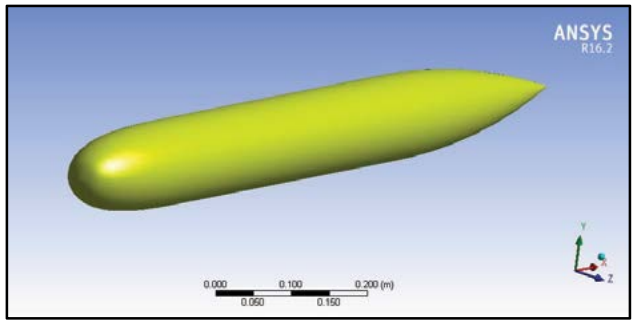

Fig 1: DREA bare submarine hull

3.2 Flow Domain

Fig 2 shows computational domain for this present study. Distances of the inlet and outlet boundary from leading edge of the DREA body are considered $0.25l$ and $2l$ respectively. The sides, top and bottom boundary is located at $0.25l$ from DREA centerline. Since the flow is incompressible, the considered downstream solution domain is ensured large enough to capture the entire viscous-inviscid interaction and wake development.

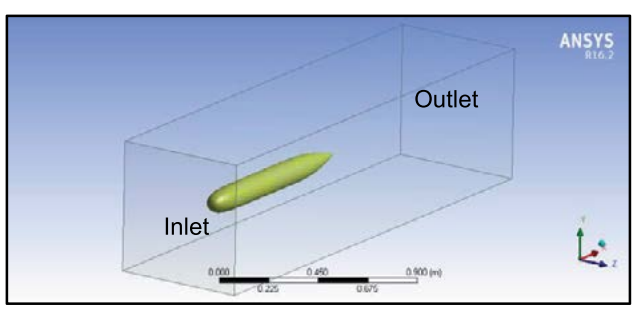

Fig 2: Computational domain

3.3 Mesh Generation

Finite volume method is the common approach to solve RANS equations in the computational domain. Computational domain needs to be discretized to solve discretized RANS equations within them. In this study, unstructured grid is generated by using ANSYS Fluent Meshing software. The mesh was then exported to Fluent Solver for numerical study. Tetrahedral method with patch conforming algorithms used to generate mesh of the flow domain and 3D inflation is also created. Total 1012048 regular elements were built with 272602 nodes in the solution domain. Minimum orthogonal quality is found 4.20×10^{-1}, maximum ortho skew is found 5.42×10^{-1} and maximum aspect ratio is found 9.89, which are in acceptable range.

In order to ensure that sufficient numbers of grid points are used to resolve the boundary layer, the turbulence closure model requires that the wall $y^+ = \frac{yu_r}{\nu}$ (where, $u_r = \sqrt{\frac{\tau}{\rho}}$ is the friction velocity) parameters must satisfy a certain criterion. Grid points supposed to keep close enough near DREA body in such way that wall $y^+ < 40$ to obtain accurate results using SST k-ω turbulence method [10], which is maintained for the present study.
Fig 3 shows y^+ distribution around the body and Fig 4 shows details of generated unstructured mesh of the domain.

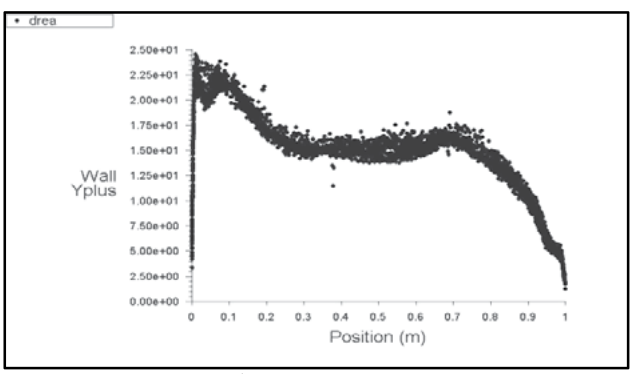

Fig 3: Wall Y^+ distribution around the 3D submarine body

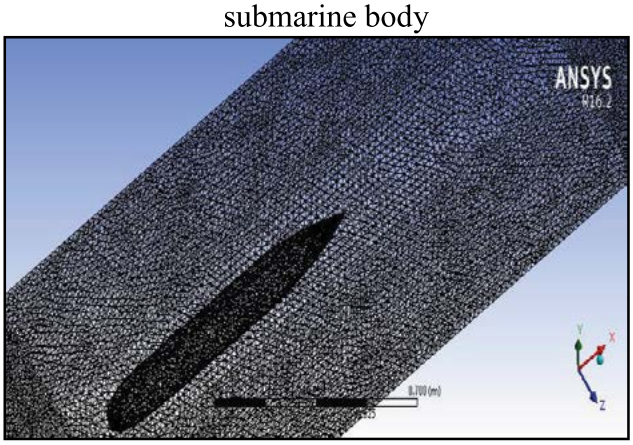

Fig 4(a): Unstructured mesh of the flow domain

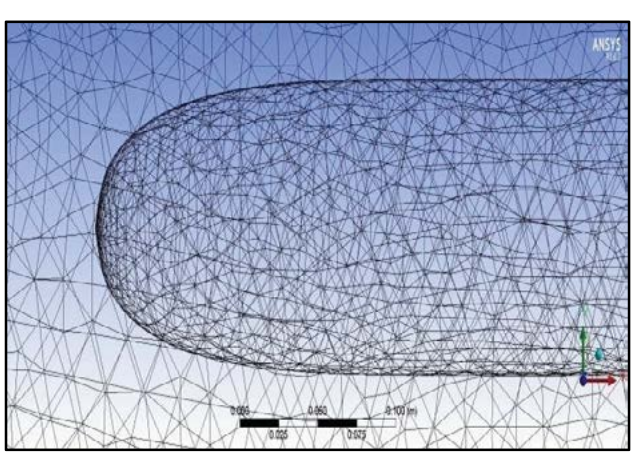

Fig 4(b): Enlarged view of mesh near bow

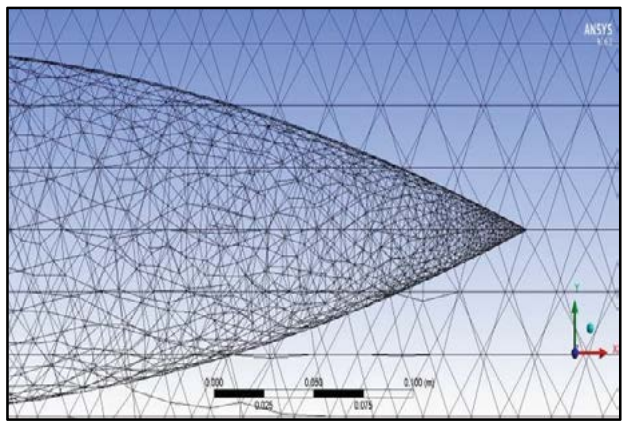

Fig 4(c): Enlarged view of mesh near stern

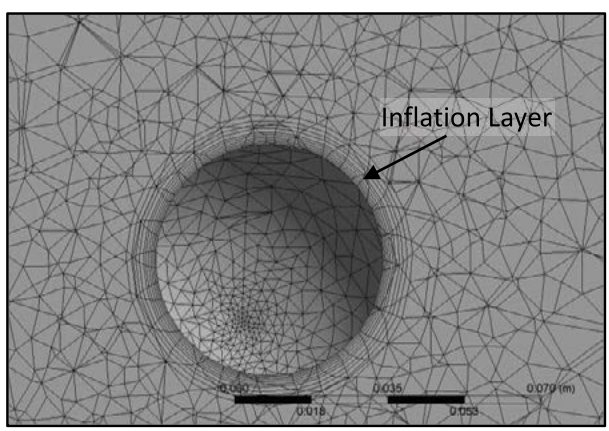

Fig 4(d): Cross sectional view of inflation layer

3.4 Model Selection and Boundary Conditions

Shear Stress Transport (SST) *k-ω* turbulence model is used for capturing turbulent flow. This model combines the accurate near-wall treatment of the *k-ω* method with the free-stream independence of the *k-ε* method by using a blending function; thus it enables the model to switch between the standard *k-ω* model near the wall and standard *k-ε* model in the far-field. Reynolds number (*Re*) value is kept to 23003039 to keep consistency with the experiment. At the upper boundary, free-slip boundary condition is specified $\left(\frac{\partial u}{\partial y} = v = 0\right)$. At the outlet, the outflow boundary condition, given by $\frac{\partial u}{\partial x} = \frac{\partial v}{\partial x} = 0$ with zero turbulence $(k = \omega = 0)$, is imposed. At the solid wall of the hull, the widely used wall boundary conditions $(u = v = 0)$ are used. All other parameters are kept in model default value.

4.0 MODEL VALIDATION

The 2D axisymmetric geometry of the DREA bare hull is selected for the purpose of validating the numerical model. Obtained results are found

satisfactory, as shown in Table 1, compared to the CFD results of Baker [11], Karim *et al.* [5], Ray *et al.* [10] and the original experimental results of Mackay [12].

Table 1: Results Comparison

Results Comparison	Drag Coefficient (C_D)
Experimental [12]	0.00123 ±0.000314
Baker [11]	0.00167
Karim *et al.* [5]	0.00104
Ray *et al.*[10]	0.00153
Present Study	0.00119

For 3D model grid-independent solution test is carried out for the unstructured mesh of the solution domain. Table 2 shows variation of grid numbers do not affect results significantly. In general higher grid numbers give accurate resolution. But mesh size should be kept at minimum but sufficient value to reduce computational time. It is mentionable that, the computer having Processor- Intel(R) core(TM)2 Duo CPU E750@ 2.93GHz 2.94 GHz RAM- 2GB took around 25 hours to give optimum results of the model with ANSYS Fluent software version 16.2.

Table-2: Comparison of drag coefficient with experimental result for different number of unstructured grids

No. of Cells	No. of Nodes	Computed Drag Coefficient (C_D)	Experimental [12]
595385	123418	0.0011737878	0.00123 ±0.000314
714963	207031	0.001182085	
1012048	272602	0.0011985613	

5.0 RESULT AND DISCUSSION

Problem setup has been done on completion of grid generation. Flow is solved using the ANSYS Fluent software. Fig 5 shows residuals plot, where the solution is found convergent after completing 275 iterations. Fig 6 and Fig 7 show convergence history of drag and lift coefficients respectively.

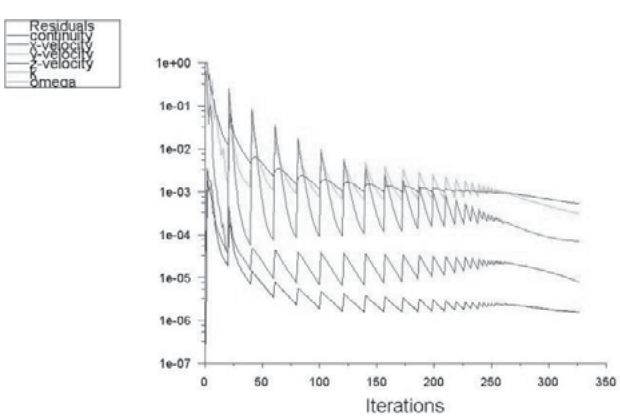

Fig 5: Residuals plot

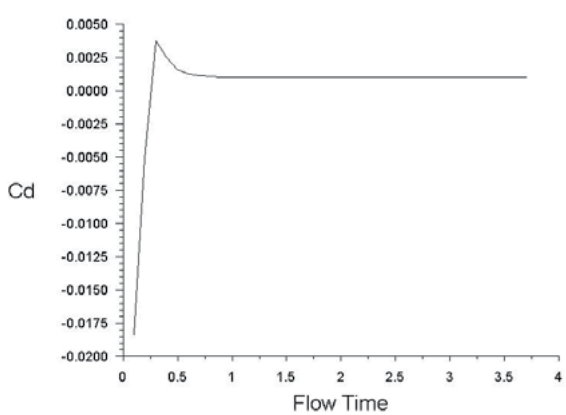

Fig 6: Drag coefficient (C_d) convergence history

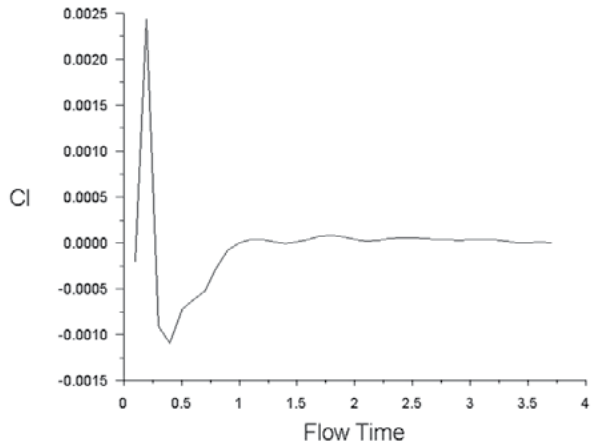

Fig 7: Lift coefficient (C_l) convergence history

Table 3 shows computed value of drag coefficient (C_d) around the body is 0.00119 for *Re* value 23003039 (velocity of 3.422 m/s). Viscous coefficient dominates pressure coefficients because of large body. Flux imbalance between inlet and outlet is found less than 1%.

Table 3: Numerical Results

Reynolds Number (*Re*)	23003039
Pressure Coefficient (C_p)	0.00046685576
Viscous Coefficient (C_v)	0.00073170558
Drag Coefficient ($C_d=C_p+C_v$)	0.0011985613
Flux Imbalance (kg/sec)	5.2970085e-07

Fig 8 shows the contours of static pressure around the body using unstructured grid. Fig 8(a) shows that total pressure field located in the longitudinal plane. The stagnation point of high pressure at the front tip, the favorable pressure gradient at the bow section and the adverse pressure gradient at the stern section of the DREA body are clearly shown. Fig 8(b) shows close-up view of the bow section. Stagnation point and the favorable pressure gradient are even more visible with red color.
Fig 8(c) shows close-up view of the stern section.

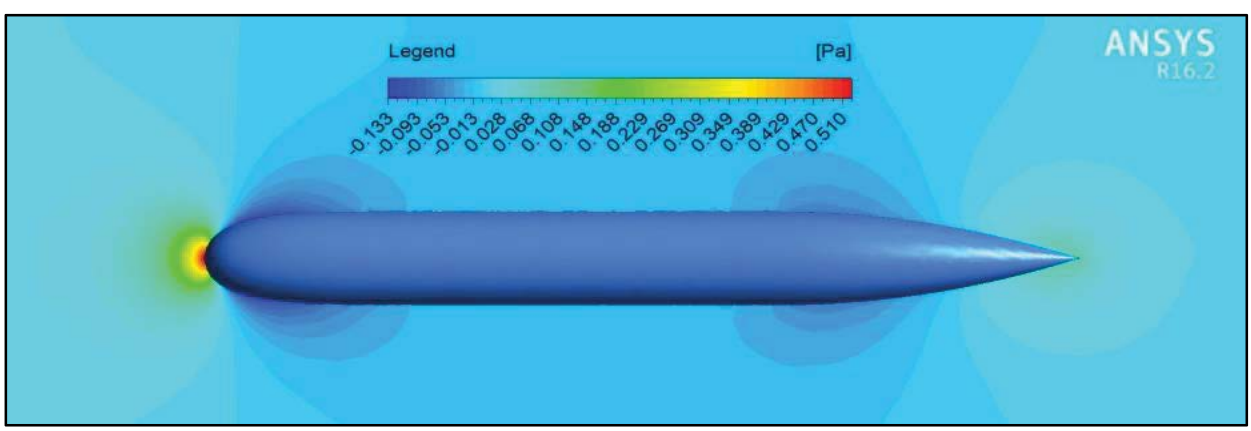

Fig 8(a): Pressure contours on xy plane of the domain

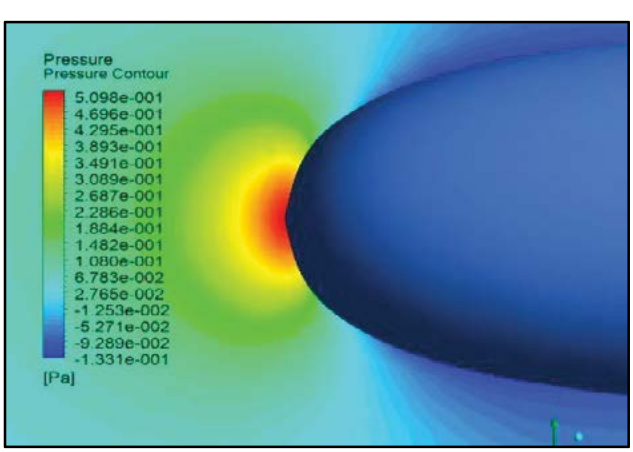

Fig 8(b): Enlarged view of pressure contours near at the bow

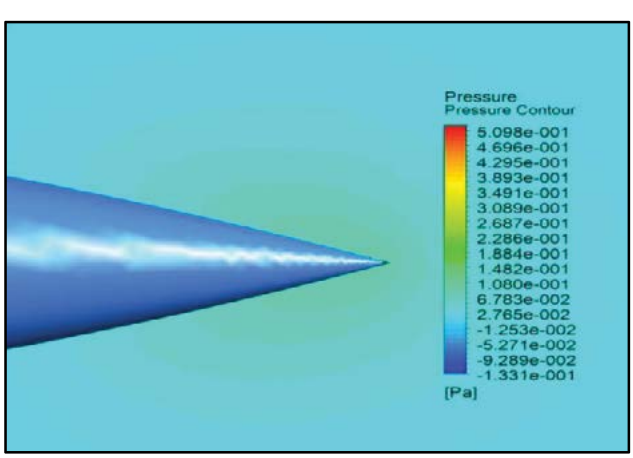

Fig 8(c): Enlarged view of pressure contours near at the stern

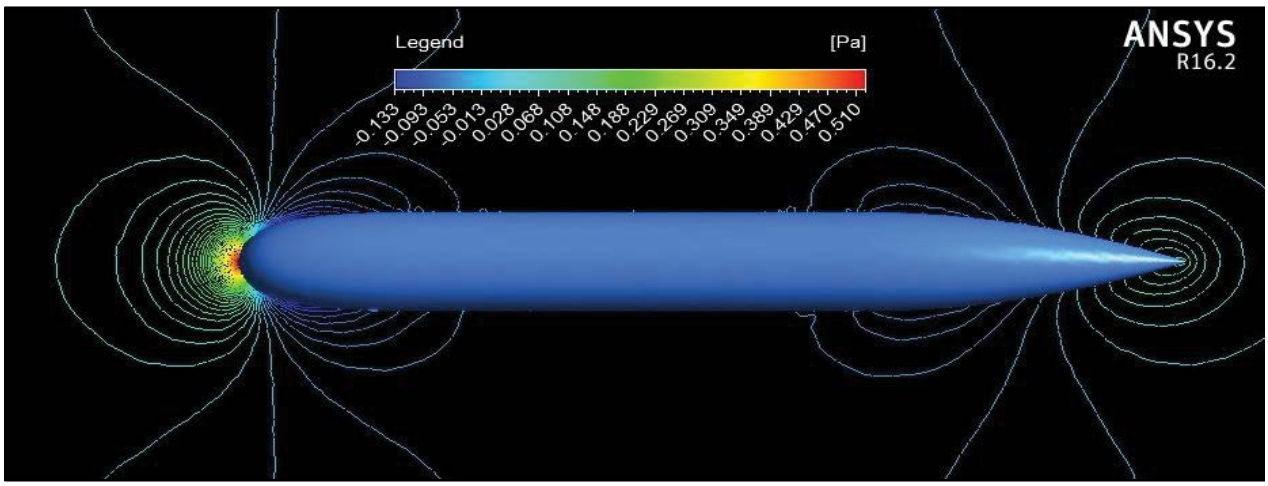

Fig 8(d): Pressure contours lines on xy plane of the domain

Overall the pressures at the bow and stern sections are higher compared to the pressure along the main DREA body.

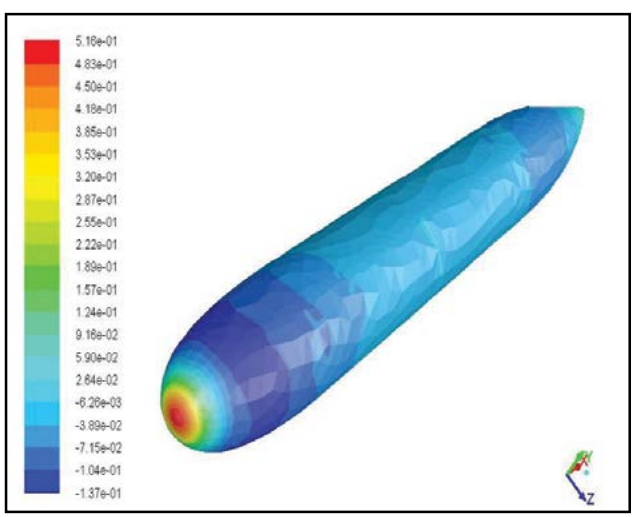

Fig8(e): Contours of static pressure around the body

Fig 9 shows the velocity distribution around the submarine body. It can be seen that the velocity near the nose is lower and the flow is accelerated as it reaches to the stern. This can be explained from the conservation of energy, an increase in the pressure of the fluid occurs simultaneously with a decrease in the velocity. As the pressure at the nose of the DREA is higher, therefore the velocity is lower (at stagnation point is actually a point with zero velocity) at this region. As the outlet gauge pressure is set to zero, and also due to the shape of tail, the flow-stream converges when it reaches to the stern and velocity increases.

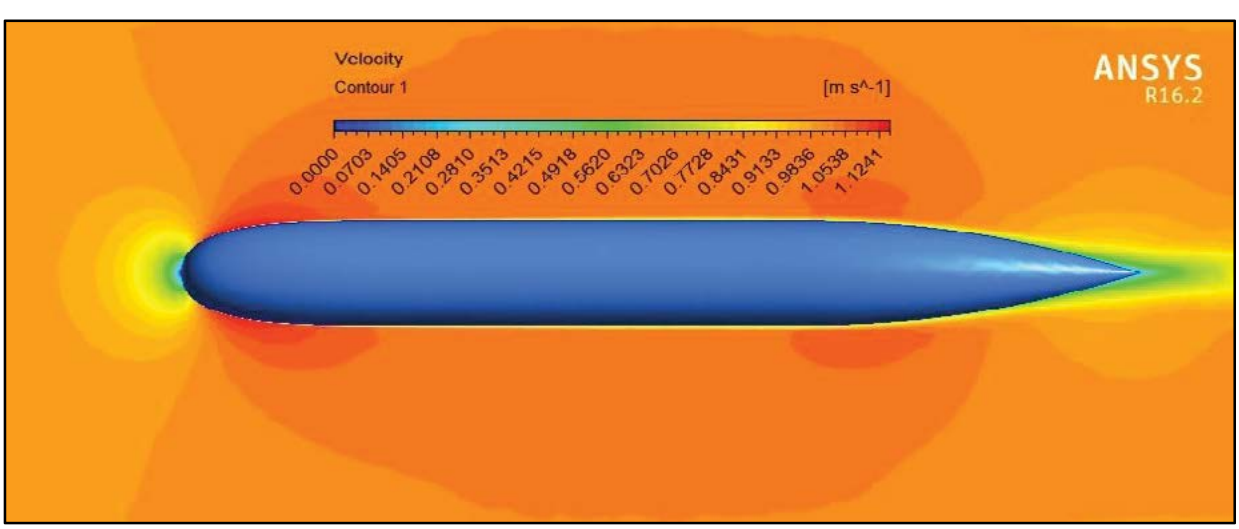

Fig 9(a): Velocity contours on xy plane of the domain

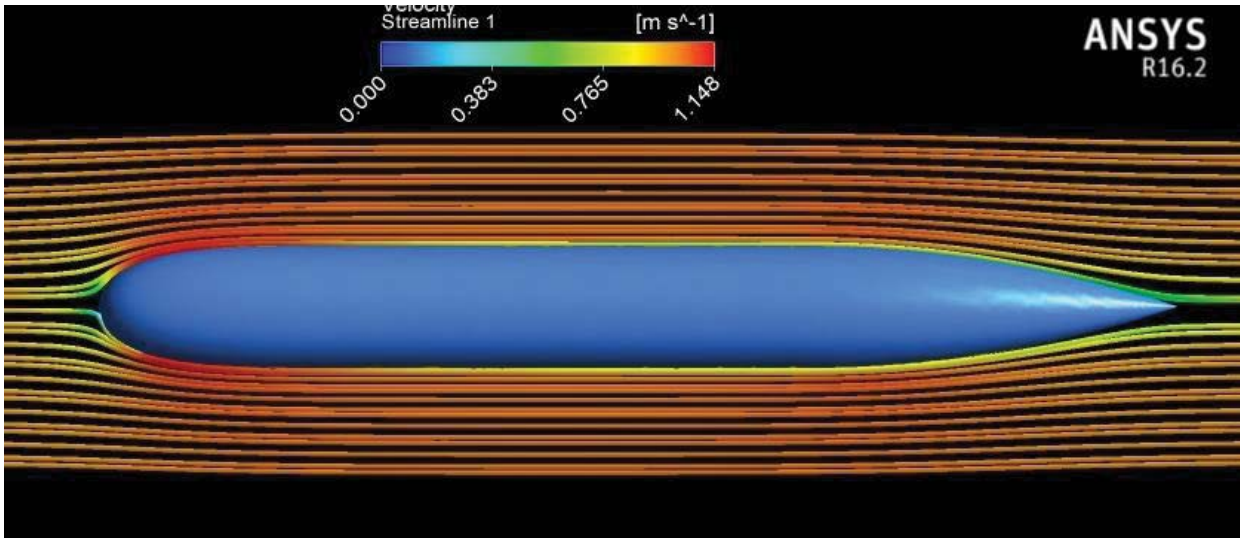

Fig 9(b): Velocity streamlines on xy plane of the domain

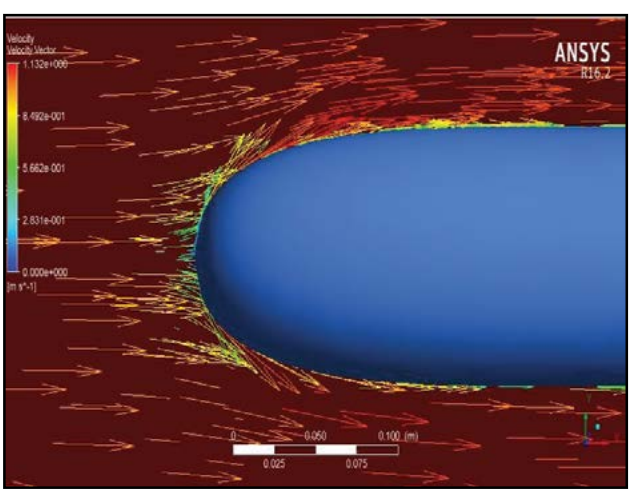

Fig 9(c): Velocity vectors near at the bow

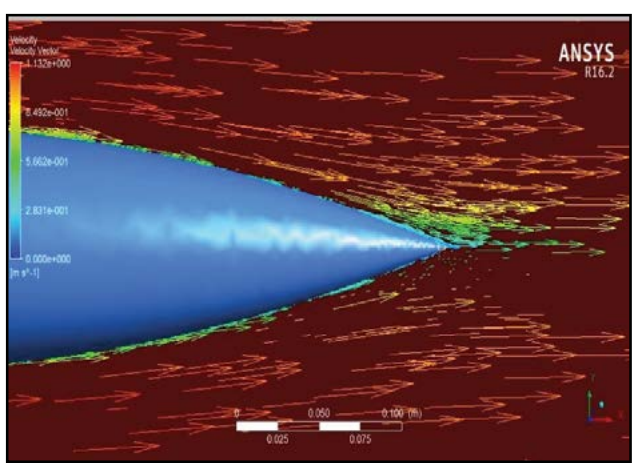

Fig 9(e): Velocity vectors near at the stern

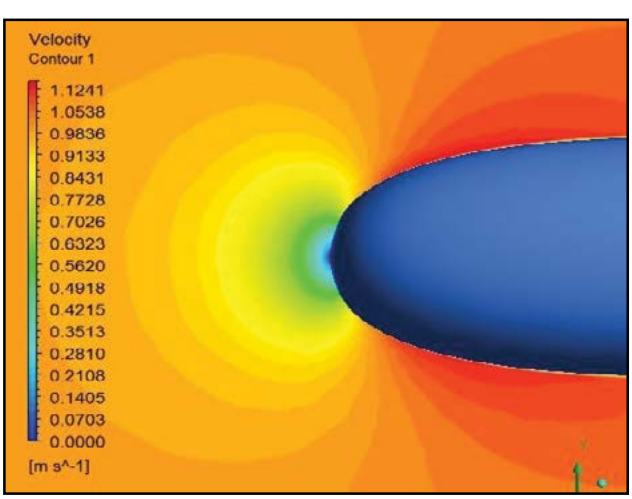

Fig 9(d): Enlarged view of velocity contour near at the bow

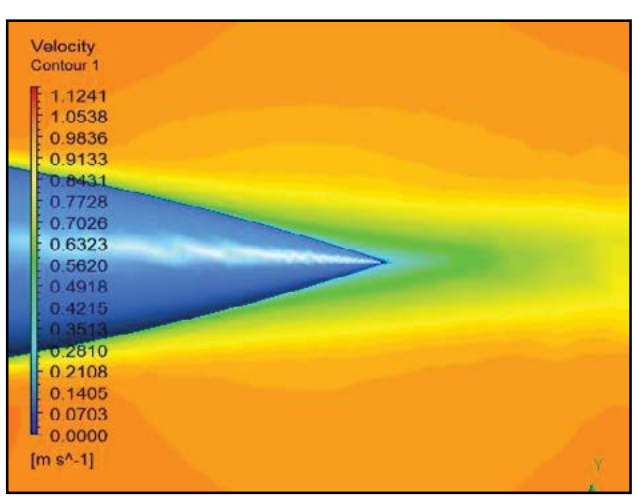

Fig 9(f): Enlarged view of velocity contour near at the stern

Fig 10(a) shows pressure coefficient (C_p) around the body. Due to the blunt edge, the highest pressure is found at bow area as expected. After that pressure decreases and becomes constant near the mid body. Near the aft body, the pressure decreases for a while and then moves up. Fig 10(b) shows variation of skin friction coefficient (C_f) around the body having opposite tendency compared to C_p which is usual. Fig 10(c) shows wall shear stress having similar trend of the curve of skin friction coefficient. Fig 10(d) shows variation of specific dissipation rate (ω) around DREA body. Turbulence increases both at leading and tailing edge and remain constant around mid body.

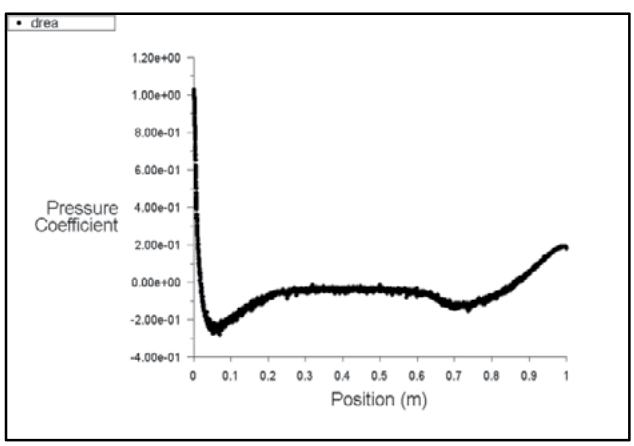

Fig 10(a): Variation of pressure coefficient (C_p) around DREA hull

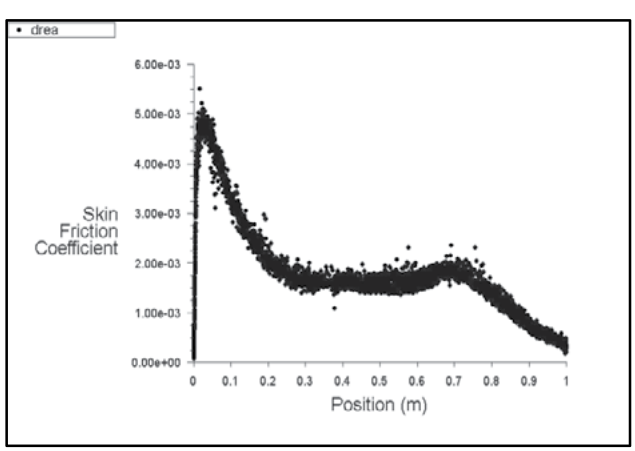

Fig 10(b): Variation of skin friction coefficient (C_f) around DREA hull

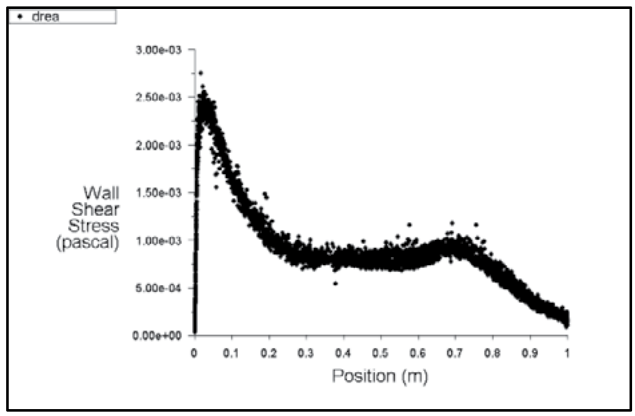

Fig 10(c): Variation of wall shear stress (τ_w) around DREA hull

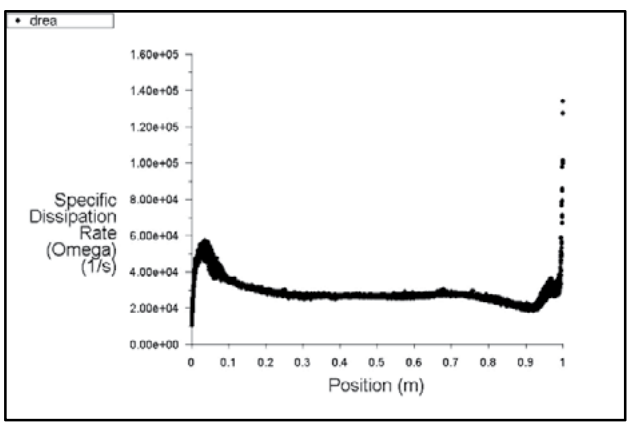

Fig 10(d): Variation of specific dissipation rate (ω) around DREA hull

6.0 CONCLUSION

In this study, flow around DREA bare submarine hull has been analyzed. Unstructured grid for the box type domain around 3D hull at zero angle of attack and SST k-ω turbulent model is used. Obtained results show good agreement with experimental and other researchers' results. The result of this study is important for understanding the flow visualization around the submarine shaped bodies that can be useful for improving design of autonomous underwater vehicles. Also the results show that numerical methods can be employed for estimation of the drag forces acting on 3D submarine shaped underwater bodies within reasonable accuracy. This estimation on drag force is useful for the calculation of power requirements at the early stage of design. In future, the simulation on similar types of body may be carried out with structured mesh and at various angles of attacks.

References

[1] V. C. Patel and H. C. Chen, Flow over tail and in wake of axisymmetric bodies: review of the state of the art, Journal of Ship Research, Vol. 30, No. 3, pp. 202-314 (1986).

[2] S. K. Choi and C. J. Chen, Laminar and turbulent flows past two dimensional and axisymmetric bodies, Iowa Institute of Hydraulic Research, IIHR Report 334-II (1990).

[3] T. Sarkar, P. G. Sayer, S. M. Fraser, A study of autonomous underwater vehicle hull forms using computational fluid dynamics, International Journal for Numerical Methods in Fluids, Vol. 25, pp. 1301-1313 (1997).

[4] C. K. G. Lam and K. Bremhorst, A modified form of the k-ε model for predicting all turbulence, ASME Journal Fluid Engineering, Vo.103, pp. 456 (1981).

[5] M. M. Karim, M. M. Rahman and M. A. Alim, Numerical computation of viscous drag for axisymmetric underwater vehicles, JurnalMekanikal, 26, 9-21 (2008).

[6] M. M. Karim, M. M. Rahman and M. A. Alim, Effectiveness of two-equation Eddy-Viscosity turbulence models for calculation of flow over underwater bodies of revolution, Southeast University Journal of Science and Engineering, Vol. 2, No.2 (2008).

[7] M. M. Karim, M. M. Rahman and M. A. Alim, Computation of turbulent viscous flow around submarine hull using unstructured grid, Journal of Ship Technology, ISSN: 0973-1423, Vol. 5, No. 1, pp. 38-52 (2009).

[8] M. M. Karim, M. M. Rahman and M. A. Alim, Performance of SST k-ω turbulence model for computation of viscous drag of axisymmetric underwater bodies, IJE Transactions B: application, Vol. 24, No. 2, 139-146 (2011).

[9] H. K. Versteeg and W. Malalasekara, An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical, England (1995).

[10] J. Anderson, Computational Fluid Dynamics, McGraw-Hill, Inc., New York, 1995.

[11] C. Baker, Estimating Drag Force on Submarine Hulls, Contract Report, DRDC Atlantic CR 2004-125, Canada, (2004).

[12] M. Mackay, Flow visualization experiments with submarine models in a wind tunnel, Defence Research Establishment Atlantic, Canada (1988).

[13] ANSYS Fluent Theory Guide, Release 15.0, ANSYS, Inc., Canonsburg (2013).

A STUDY ON JUSTIFICATION OF SRAC 2006 CODE SYSTEM BY BENCHMARKING INTEGRAL PARAMETERS OF TRX AND BAPL CRITICAL LATTICES OF THERMAL REACTORS FOR TRIGA NEUTRONICS CALCULATION

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ABSTRACT

The aim of this study is to justify Standard Reactor Analysis Code System (SRAC2006) based on the evaluated nuclear data libraries such as Evaluated Nuclear Data File (ENDF/B-VI.8) and Joint European Fission-Fusion (JEFF-3.1) for core calculations of 3 MW TRIGA Mark-II Research Reactor at Atomic Energy Research Establishment (AERE), Bangladesh. The study was performed through the analysis of integral parameters of Thermal Reactor Cross section (TRX) and Bettis Atomic Power Laboratory (BAPL) benchmark lattices of thermal reactors. In integral measurements, the thermal reactor lattices TRX-1, TRX-2, BAPL-UO2-1, BAPL-UO2-2 and BAPL-UO2-3 were treated as experimental benchmarks for justifying the SRAC2006 code system. The integral parameters of the said lattices are calculated using the collision probability transport code SRAC-PIJ of the SRAC2006 code system at room temperature 20 0C based on the above libraries. The calculated integral parameters are compared to the measured values as well as the Monte Carlo Nuclear Particle (MCNP) values based on the Chinese Evaluated Nuclear Data Library (CENDL-3.0). It was found that the calculated results show a good agreement among the said data files as well as the experimental and the MCNP results. To enrich this justification study the group constants (in SRAC format) such as activation cross-section, fission cross-section, nu-fission cross-section, total cross-section, diffusion coefficients, absorption cross-section and scattering cross-section in fast and thermal energy range between the above data files for TRX and BAPL lattices were calculated using the SRAC-PIJ code in fixed source mode. By comparing the group constants it was found that the group constants were well consistent with each other. Therefore, this paper reflects the justification study of the SRAC2006 code system and it will be useful to meet up nuclear data for further core safety calculations of 3 MW TRIGA Mark-II research reactors at AERE, Savar, Dhaka, Bangladesh.

Key Words: SRAC2006, ENDF/B-VI.8, JEFF-3.1, TRX-1, TRX-2, BAPL-UO2-1, BAPL-UO2-2, BAPL-UO2-3, MCNP, SRAC-PIJ, Benchmark and validation.

1.0 INTRODUCTION

The 3 MW TRIGA Mark-II research reactor is most widely used for generation of neutrons due to its safety features, operational flexibility, wide capabilities and ability to utilize Low Enriched Uranium (LEU) fuels efficiently. This research reactor plays an important role in the development of nuclear science and technology. They are used to produce medical and industrial isotopes, for research in physics, biology and materials science, and for scientific education and training. They also occupy an indispensible place in nuclear power program.

For nuclear research and technology development to continue to prosper, research reactors must be safely and reliably operated, efficiently utilized, refurbished when necessary, and provided with adequate non-proliferating fuel cycle services. Number of endeavor had been taken in the past to the development and to the validation of adequate spectrum codes for safety and design calculation of light water reactors. Various accurate neutronics calculations have been performed using specific methods and nuclear data libraries. However, the repeated utilization of the existing code systems for calculations of Light Water Reactor (LWR) configurations require a continuous and careful verification and legalization of the quality of the results, especially when new evaluated nuclear data files are used.

This study deals with the validation study of the SRAC2006 code system based on evaluated nuclear data libraries ENDF/B-VI.8 and JEFF-3.1 for core safety analysis of 3 MW TRIGA Mark-II Research Reactor at AERE, Saver, Bangladesh. The study was performed through the analysis of integral parameters of TRX and BAPL benchmark lattices of thermal reactors. In integral measurements [1], the thermal reactor lattices TRX-1, TRX-2, BAPL-UO2-1, BAPL-UO2-2 and BAPL-UO2-3 were treated as experimental benchmarks for validating the SRAC2006 code system as well as evaluated nuclear data libraries ENDF/B-VI.8 and JEFF-3.1.Validation is an essential part of developing for accurate nuclear reactor physics calculations. The validation will be achieved through the analysis of the integral parameters of TRX and BAPL Benchmark Critical Experiment Lattices [1] of Thermal Reactors. The SRAC-PIJ [2] is a lattice transport code of the SRAC2006 code system [3] based on collision probability method and it is applicable to 16 different lattice modules. The integral parameters of TRX and BAPL Benchmark Lattices were calculated using the elementary code PIJ systematically based on evaluated nuclear data libraries JEFF-3.1 [4] and ENDF/B-VI.8 [5]. The calculated integral parameters were compared with the experimental values [1] and also MCNP results [6] based on CENDL-3.0 library respectively. It was found that in most cases, the calculated results show a good agreement among the said data files as well as the experimental [1] and the MCNP results [6]. To enrich this validation study the group constants (in SRAC format) such as activation cross-section, fission cross-section, nu-fission cross-section, total cross-section, diffusion coefficients, absorption cross-section and scattering cross-section in fast and thermal energy range between the above data files for TRX and BAPL lattices were calculated using the SRAC-PIJ code in fixed source mode.

2.0 THE PIJ CODE OF THE SRAC2006 CODE SYSTEM

The SRAC system [3] is designed and developed at Japan Atomic Energy Research Institute (JAERI) to permit overall neutronics calculations for various types of thermal reactors. The system covers production of effective microscopic and macroscopic group cross-sections, cell and core calculations including burn-up analyses. The collision probability method lattice transport code PIJ [2] is used to analyze this validation study. This code is applicable to 16 different lattice geometries and it does cell homogenization to obtain group constants needed for diffusion calculation of the whole TRIGA core in next. The input files of TRX and BAPL benchmark lattices of thermal reactors are modeled with SRAC-PIJ code, which support the optimized inputs suggested in the final report of the Library Update Project Stage-1 (WIMS). The integral parameters of TRX and BAPL benchmark lattices were calculated using the PIJ code based on 107 energy group (71 fast and 36 thermal) for both nuclear data files JEFF-3.1 and ENDF/B-VI.8 at room temperature 20 0C. The fast 71 group was divided into 4 energy groups and the thermal 36 group was also divided into three energy groups. The total 107 energy group was condensed into 7 energy groups. All calculations were performed in seven energy groups as shown in Table 1. Special consideration was made in development of energy group structure. In this case, the thermal cut-off energy was 0.60236 eV.

Table 1: Seven Energy Group Structure for Generation of Cross-sections Data Sets in SRAC-PIJ Code

Group No.	Energy (eV)		Flux Type
	Upper	Lower	
1	10.000E+06	8.2085E+05	Fast
2	8.2085E+05	5.5310E+03	
3	5.5310E+03	3.9279E+00	Epithermal
4	3.9279E+00	6.0236E-01	
5	6.0236E-01	2.5683E-01	Thermal
6	2.5683E-01	5.4520E-02	
7	5.4520E-02	1.0000E-05	

In addition, the group constants in fast and thermal energy range for TRX and BAPL lattices between ENDF/B-VI.8 and JEFF-3.1 libraries were calculated using the SRAC-PIJ code in fixed source mode where a flux calculation was carried out by separating fast groups 71 and thermal groups (36) in both cases. A fixed source problem by one-point fine-group equations with P_1 or B_1 approximation selected was solved for an imaginary media made by the homogenized cross-sections averaged in the whole system where a flat flux approximation and the fission spectrum of U-235 are assumed. The few-group diffusion coefficients were made from the inverse of the fine group transport cross-sections. After obtaining the few-group total cross-sections, the self-scattering cross-sections were adjusted to keep the neutron balance. The group constants as shown in Tables 5-8 and they were obtained individually in fast and thermal energy range for TRX and BAPL lattices of Thermal Reactors from cell homogenization in fixed source mode. The calculation scheme of SRAC2006 code system for this paper is shown in Figure 1.

3.0 EXPERIMENTAL FACILITY FOR TRX AND BAPL BENCHMARK LATTICES OF THERMAL REACTORS

For this analysis, two types of benchmark lattices were used: (i) H_2O-moderated uranium metal lattices TRX-1 and TRX-2 [7, 8] and (ii) H_2O moderated uranium oxide critical lattices BAPL-UO_2-1, BAPL-UO_2-2 and BAPL-UO_2-3 [9]. There are two types of systems such as TRX and BAPL systems.

4.0 SYSTEM DESCRIPTION OF TRX

These Cross Section Evaluation Working Group (CSEWG) experiments are moderated lattices of slightly enriched (1.3 wt. %) uranium rods with diameters of 0.98297 cm in a triangular pattern. Measured lattice parameters include ρ^{28}, δ^{25}, δ^{28} and C*. These lattices directly test the U-235 resonance fission integral and thermal fission cross section. They also test U-238 shielded resonance capture and the thermal capture cross section. They are sensitive to the U-238 fast fission cross-section, U-238 inelastic scattering and the U-235 fission spectrum. The scattering and thermal absorption cross sections of H_2O are also very important.

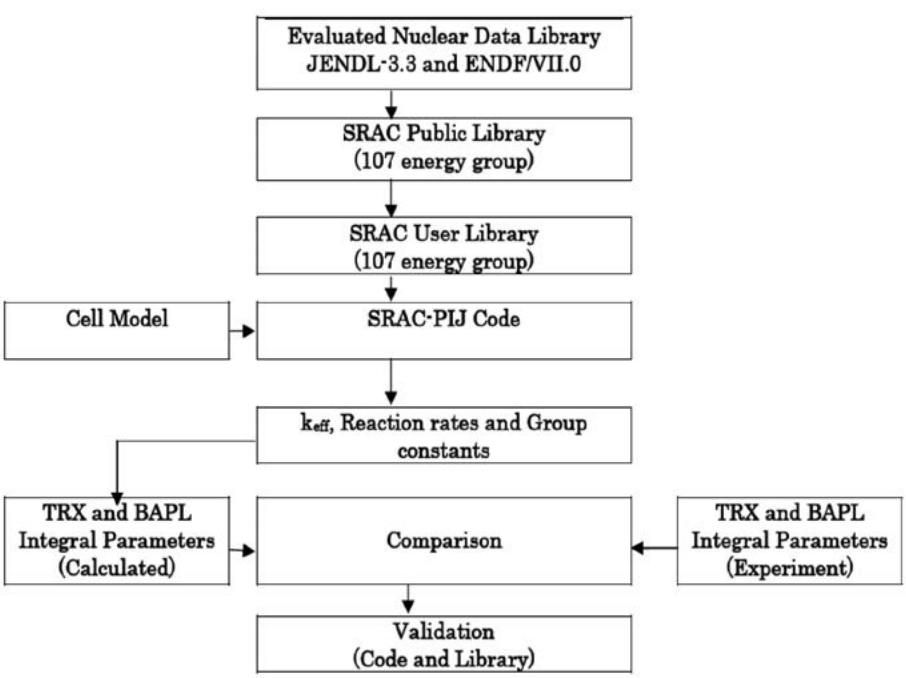

Fig. 1: The Calculation Scheme of the SRAC2006 Code System

4.1 System Description of BAPL

These CSEWG experiments consist of H_2O moderated critical lattices of 1.311 wt. % enriched uranium oxide rods with diameters of 0.9728 cm in a triangular pattern. The measured parameters include ρ^{28}, δ^{25}, δ^{28} and B2. Three lattices with moderator to fuel volume ratios of 1.43, 1.78, and 2.40 are specified.

4.2 Material and Dimensional Properties of TRX and BAPL

The material and dimensional properties of TRX [10] and BAPL [9] are given in the Table 2 and 3.

Table 2: Physical Properties of TRX [10]

Region	Outer Radius (in cm)	*Isotope*	Concentration (E+24 atoms/cm^3)
Fuel	0.4915	^{235}U	6.2530E-04
		^{238}U	4.7205E-02
Void	0.5042		
Clad	0.5753	Al	6.0250E-02
Moderator	*	^{1}H	6.6760E-02
		^{16}O	3.3380E-02

***Lattices spacing of 1.8060, and 2.1740 cm in triangular arrays.**

Table 3: Physical Properties of BAPL [9]

Region	Outer Radius (in cm)	Isotope	Concentration (E+24 atoms/cm^3)
Fuel	0.4864	^{235}U	3.1120E-04
		^{238}U	2.3127E-02
		^{16}O	4.6946E-02
Void	0.5042		
Clad	0.5753	Al	6.0250E-02
Moderator	*	^{1}H	6.6760E-02
		^{16}O	3.3380E-02

***Lattices spacing of 1.5578, 1.6523 and 1.8057 cm in triangular arrays.**

1.0 BENCHMARK CALCULATIONS

The integral parameters of TRX and BAPL benchmark lattices of Thermal reactors were calculated using the lattice transport code SRAC-PIJ of the SRAC2006 code system based on JEFF-3.1 and ENDF/B-VI.8 evaluated data files. TRX-1 and TRX-2 used uranium metal fuel in ^{235}U enriched to 1.305 wt. % and BAPL-1, BAPL-2, and BAPL-3 used uranium oxide fuel enriched 1.311 wt. %. TRX and BAPL were water (H_2O) moderated. In integral measurements [46], the thermal reactor lattices TRX and BAPL were treated as experimental/standard benchmarks to validate the physics models used in computer codes (like the SRAC2006 code system) in conjunction with the associated nuclear data libraries JEFF-3.1 and ENDF/B-VI.8 used to describe the microscopic phenomena underlying the macroscopic behavior. The integral parameters analyzed based on reaction rate ratios were defined as below [11] and the measured thermal cut-off energy in this definition was 0.6250 eV:

k_{eff} = Effective neutron multiplication factor (finite medium).

ρ^{28} = Ratio of epithermal to thermal ^{238}U captures.
$= (\Sigma_c)^{38}_{epth} / (\Sigma_c)^{38}_{th}$

δ^{25} = Ratio of epithermal to thermal ^{235}U fission.
$= (\Sigma_f)^{35}_{epth} / (\Sigma_f)^{35}_{th}$

δ^{28} = Ratio of ^{238}U fission to ^{235}U fission.
$= (\Sigma_f^t)^{38} / (\Sigma_f^t)^{35}$

C* = Ratio of ^{238}U captures to ^{235}U fissions.
$= (\Sigma_c^t)^{38} / (\Sigma_f^t)^{35}$

To enrich this validation study the group constants or cross-sections data sets such as activation cross-section, fission cross-section, nu-fission cross-section, total cross-section, diffusion coefficients, absorption cross-section and scattering cross-section in SRAC format for TRX and BAPL Benchmark lattices of thermal reactors were calculated using the SRAC-PIJ code in fixed source mode in fast and thermal energy range based on the evaluated nuclear data libraries JEFF-3.1 and ENDF/B-VI.8.

2.0 RESULTS AND DISCUSSION

The calculated results of integral parameters for TRX and BAPL benchmark lattices of thermal reactors with experiment and MCNP results were summarized in Tables 3 and 4 respectively. For each of the benchmark lattices the measured as well as the calculated values of integral parameters and the associated % uncertainty were given. The effective multiplication factor k_{eff} is the most important benchmark integral parameter. It comprises all reactor physics parameters of the problem: geometry, isotopic composition, cross sections of all isotopes, spectrum etc. For this reason it is very sensitive to the SRAC-PIJ input modeling. In comparison to the experimental results it was found

that the calculated values of k_{eff} for TRX and BAPL lattices using the said data libraries were generally well agreed with each other. But the maximum uncertainty in k_{eff} was 0.393 % for TRX-2 lattice for JEFF 3-1 library. In most TRX cases, the calculated values of other integral parameters were fewer errors than the measured values.

In case of BAPL-2 and BAPL-3 the values of δ^{25} and δ^{28} were somewhat slightly over predicted in comparison to the experiment but show a similar trend with the MCNP results. Since the measurements of parameter C* were not available for BAPL lattices, the comparison was limited to TRX lattices. The differences in the results based on JEFF-3.1 and ENDF/B-VI.8 evaluated data libraries were relatively small. Most of the calculated parameters lie within the % uncertainty interval of the MCNP results as well as experimental values, which indicates that the calculation technique the SRAC-PIJ code of SRAC2006 code system based on the said data files is reliable for the neutronics calculation of Thermal reactors. In addition, the results of the cross section data sets (group constants in SRAC format) in fast and thermal energy range between the said data files were summarized in Tables 5– 8, respectively. From the analysis of the cross section data sets or group constants it was found that the group constants show a good agreement with each other.

Table 3: Comparison of calculated integral parameters for TRX lattices with the values of experiment and reference MCNP.

Lattices	Integral Parameters	Experiment (CSEWG,1986)	Reference MCNP	JEFF-3.1 SRAC-PIJ	ENDF/B-VI.8 SRAC-PIJ
TRX-1	k_{eff}	1.0000(0.30)	0.9975(-0.25)[a]	1.00237(0.237)[a]	0.99536(-0.464)[a]
	ρ^{28}	1.3200(1.60)	1.3608(3.09)	1.3426 (1.71)	1.3404 (1.547)
	δ^{25}	0.0987(1.00)	0.0980(-0.71)	0.0951 (-3.78)	0.0956 (-3.140)
	δ^{28}	0.0946(4.30)	0.0962(1.69)	0.0944 (-0.150)	0.0991 (4.756)
	C^*	0.7970(1.00)	0.7922(-0.60)	0.787 (-1.254)	0.797 (0.114)
TRX-2	k_{eff}	1.0000(0.10)	0.9982(-0.18)	1.00393 (0.393)	0.99828 (-0.172)
	ρ^{28}	0.8370(1.90)	0.8530(1.91)	0.833 (-0.405)	0.831 (-0.705)
	δ^{25}	0.0614(1.30)	0.0620(0.98)	0.0582 (-5.211)	0.0584 (-4.78)
	δ^{28}	0.0693(5.10)	0.0681(-1.73)	0.0697 (-1.87)	0.0763 (1.443)
	C^*	0.6470(0.93)	0.6387(-1.28)	0.633 (-2.163)	0.641 (-0.898)

[a](Error in %)=[(Calculated value- experimental value)/experimental value]x100

Table 4: Comparison of calculated integral parameters for BAPL lattices with the values of experiment and reference MCNP.

Lattices	Integral Parameters	Experiment (CSEWG, 1986)	CENDL-3.0 MCNP	JEFF-3.1 SRAC-PIJ	ENDF/B-VI.8 SRAC-PIJ
BAPL-1	k_{eff}	1.0000(0.10)	1.0023(0.23)[a]	1.00184(0.184)[a]	0.99558(-0.442)[a]
	ρ^{28}	1.3900(0.72)	1.3923(0.16)	1.417 (1.942)	1.414 (1.43)
	δ^{25}	0.0840(2.40)	0.0820(-2.39)	0.080 (-4.76)	0.0812 (-3.33)
	δ^{28}	0.0780(5.10)	0.0736(-5.61)	0.073 (-6.41)	0.0765(-1.923)
	C^*	…..	0.7972	0.8061	0.816
BAPL-2	k_{eff}	1.0000(0.10)	1.0021(0.21)	1.00255(0.255)[a]	0.99055(-0.145)[a]
	ρ^{28}	1.1200(0.89)	1.1602(3.59)	1.17 (4.46)	1.171 (4.55)
	δ^{25}	0.0680(1.50)	0.0669(-1.61)	0.0658 (-4.41)	0.066 (-2.94)
	δ^{28}	0.0700(5.70)	0.0633(-9.57)	0.0679 (-3.00)	0.0658 (-6.0)
	C^*	….	0.7274	0.732	0.741

BAPL-3	k_{eff}	1.0000(0.10)	1.0021(0.21)	1.00329(0.329)[a]	0.99810(-.192)[a]
	ρ^{28}	0.9060(1.10)	0.9130(0.77)	0.917 (1.21)	0.9144(1.38)
	δ^{25}	0.0520(1.90)	0.0515(-0.96)	0.050 (-3.846)	0.050 (-3.84)
	δ^{28}	0.0570(5.30)	0.0518(-9.12)	0.0526 (-7.71)	0.0539 (3.65)
	C^*	….	0.6511	0.653	0.661

[a](Error in %)=[(Calculated value- experimental value)/experimental value]x100

Table 5: Comparison of calculated group constants for TRX lattices in Fast energy range between evaluated data files using SRAC-PIJ code

Lattices	Group Constants in Fast Energy Range	JEFF-3.1	ENDF/B-VI.8
TRX-1	Activation cross-section	0.80390E-01	0.79012E-01
	Fission cross-section	0.29434E-02	0.29654E-02
	Nu-fission cross-section	0.77659E-02	0.77945E-02
	Total cross-section	0.29850E+00	0.29284E+0
	Diffusion coefficient 1	0.11167E+01	0.11383E+01
	Diffusion coefficient 2	0.11167E+01	0.11383E+01
	Absorption cross-section	0.11344E-01	0.11293E-01
	Scattering out cross-section	0.26920E-01	0.26451E-01
TRX-2	Activation cross-section	0.84166E-01	0.83084E-01
	Fission cross-section	0.22259E-02	0.22375E-02
	Nu-fission cross-section	0.59060E-02	0.59109E-02
	Total cross-section	0.28814E+00	0.28397E+00
	Diffusion coefficient 1	0.11569E+01	0.11738E+01
	Diffusion coefficient 2	0.11569E+01	0.11738E+01
	Absorption cross-section	0.83161E-02	0.82969E-02
	Scattering out cross-section	0.33572E-01	0.33135E-01

Table 6: Comparison of calculated group constants for TRX lattices in Thermal energy range between evaluated data files

Lattices	Group Constants in Thermal energy range	JEFF-3.1	ENDF/B-VI.8
TRX-1	Activation cross-section	0.44883E+01	0.44646E+01
	Fission cross-section	0.55460E-01	0.55198E-01
	Nu-fission cross-section	0.13511E+00	0.13450E+00
	Total cross-section	0.14370E+01	0.14534E+01
	Diffusion coefficient 1	0.23196E+00	0.22935E+00
	Diffusion coefficient 2	0.23196E+00	0.22935E+00
	Absorption cross-section	0.97147E-01	0.96962E-01
	Scattering out cross-section	0.42900E-03	0.45613E-03
TRX-2	Activation cross-section	0.48082E+01	0.47755E+01
	Fission cross-section	0.39048E-01	0.38835E-01
	Nu-fission cross-section	0.95128E-01	0.94630E-01
	Total cross-section	0.16902E+01	0.17069E+01
	Diffusion coefficient 1	0.19721E+00	0.19528E+00
	Diffusion coefficient 2	0.19721E+00	0.19528E+00
	Absorption cross-section	0.74099E-01	0.73871E-01
	Scattering out cross-section	0.29990E-03	0.32111E-03

Table 7: Comparison of calculated group constants for BAPL lattices in Fast energy range between evaluated data files

Lattices	Group Constants in Fast Energy range	JEFF-3.1	ENDF/B-VI.8
BAPL-1	Activation cross-section	0.81024E-01	0.79858E-01
	Fission cross-section	0.19270E-02	0.19343E-02
	Nu-fission cross-section	0.50605E-02	0.50603E-02
	Total cross-section	0.27940E+00	0.27481E+00
	Diffusion coefficient 1	0.11930E+01	0.12130E+01
	Diffusion coefficient 2	0.11930E+01	0.12130E+01
	Absorption cross-section	0.88987E-02	0.88613E-02
	Scattering out cross-section	0.21837E-01	0.21515E-01
BAPL-2	Activation cross-section	0.82534E-01	0.81482E-01
	Fission cross-section	0.17652E-02	0.17707E-02
	Nu-fission cross-section	0.46455E-02	0.46411E-02
	Total cross-section	0.27713E+00	0.27302E+00
	Diffusion coefficient 1	0.12028E+01	0.12209E+01
	Diffusion coefficient 2	0.12028E+01	0.12209E+01
	Absorption cross-section	0.81400E-02	0.81135E-02
	Scattering out cross-section	0 .24655E-01	0.24409E-01
BAPL-3	Activation cross-section	0.84132E-01	0.83233E-01
	Fission cross-section	0.15369E-02	0.15402E-02
	Nu-fission cross-section	0.40560E-02	0.40476E-02
	Total cross-section	0.27423E+00	0.27074E+00
	Diffusion coefficient 1	0.12155E+01	0.12312E+01
	Diffusion coefficient 2	0.12155E+01	0.12312E+01
	Absorption cross-section	0.70622E-02	0.70477E-02
	Scattering out cross-section	0.28506E-01	0.28195E-01

Table 8: Comparison of calculated group constants for BAPL lattices in Thermal energy range between evaluated data files

Lattices	Group Constants in Thermal energy range	JEFF-3.1	ENDF/B-VI.8
BAPL-1	Activation cross-section	0.45288E+01	0.45069E+01
	Fission cross-section	0.41025E-01	0.40811E-01
	Nu-fission cross-section	0.99946E-01	0.99444E-01
	Total cross-section	0.11978E+01	0.12100E+01
	Diffusion coefficient 1	0.27828E+00	0.27548E+00
	Diffusion coefficient 2	0.27828E+00	0.27548E+00
	Absorption cross-section	0.72782E-01	0.72605E-01
	Scattering out cross-section	0.36159E-03	0.38141E-03
BAPL-2	Activation cross-section	0.46594E+01	0.46339E+01
	Fission cross-section	0.37280E-01	0.37064E-01
	Nu-fission cross-section	0.90820E-01	0.90315E-01
	Total cross-section	0.13110E+01	0.13240E+01
	Diffusion coefficient 1	0.25425E+00	0.25177E+00
	Diffusion coefficient 2	0.25425E+00	0.25177E+00
	Absorption cross-section	0.68018E-01	0.67809E-01
	Scattering out cross-section	0.31879E-03	0.33755E-03

BAPL-3	Activation cross-section	0.48131E+01	0.47829E+01
	Fission cross-section	0.31870E-01	0.31668E-01
	Nu-fission cross-section	0.77642E-01	0.77165E-01
	Total cross-section	0.14636E+01	0.14772E+01
	Diffusion coefficient 1	0.22775E+00	0.22565E+00
	Diffusion coefficient 2	0.22775E+00	0.22565E+00
	Absorption cross-section	0.61042E-01	0.60808E-01
	Scattering out cross-section	0.26799E-03	0.28505E-03

3.0 CONCLUSIONS

The present study deals with not only the integral parameters but also the group constants of TRX and BAPL benchmark lattices. By comparing the calculated results with experiment as well as earlier published MCNP values (numerical benchmarks) and it was found that the calculated results of integral parameters show no significant differences among JEFF-3.1 and ENDF/B-VI.8 libraries as well as experiment and also earlier published MCNP results (numerically benchmarked) based on CENDL-3.0, which reflect that the numerical benchmark model developed by the lattice transport code SRAC-PIJ was a good confidence level in forecasting integral parameters of TRX and BAPL benchmark lattices of thermal reactors. But it was obvious that different evaluated nuclear data library was the cause of the slight difference between the calculated results.

In addition, the analysis of the group constants or cross-sections data sets in SRAC format for TRX and BAPL benchmark lattices of thermal reactors in fast and thermal energy range based on the said data files show identical with very insignificant differences with each other and this analysis was used to enrich this justification study. Therefore, this study reflects the justification study of the SRAC2006 code system and it will meet up nuclear data for further calculations of TRIGA Mark –II research reactor.

References

[1] "Cross Section Evaluation Working Group (CSEWG): Benchmark Specifications with Supplements", Brookhaven National Laboratory, National Nuclear Data Center, Upton, New York 11973, BNL-19302, Vol. II, ENDF-202, Nov.1, USA, 1986.

[2] Beardwood, J. E., "PIJ: A Computer Programe for the Calculation of collision Probabilities", AEEW-R440, 1966.

[3] Okumura, K., Kugo, T., Kaneko, K., and Tsuchihashi, K., "SRAC2006: A Comprehensive Neutronics Calculation Code System", JAEA-Data/Code, 2007-004, February 2007.

[4] JEFF-3.1: OECD/NEA Data Bank, "The JEFF-3.1 Nuclear Data Library", JEFF Report 21, OECD/NEA Data Bank (2006).

[5] ENDF/B-VI.8 .F. Rose and C.L. Dunford, "ENDF-102, Data Formats and Procedures for the Evaluated Nuclear Data File, ENDF-6", BNL-NCS-44945, Brookhaven National Laboratory, revised by V. McLane (April 2001).

[6] Hongwei, Y. U., "Present Status of CENDL Project", China Nuclear Data Center, China Institute of Atomic Energy, April 2007.

[7] Hardy, J., Klein, Jr. D., Volpe, J. J., "A Study of Physics Parameters in Several Water-Moderated Lattices of Slightly Enriched and Natural Uranium", WAPD-TM-931, March 1970.

[8] Hardy, J., Klein, Jr. D., Volpe, J. J., Nuclear Science and Eng., Vol. 40, P 101, 1970.

[9] Hellens, R. L., Price, G. A., "Reactor Physics Data for Water-Moderated Lattices of Slightly Enriched Uranium", Reactor Technology Selected Reviews, 529, 1964.

[10] Brown, J. R., Harris, D.R., Frantz, F.S., Volpe, J.J., Andrews, J.C., Noordhoff, B.H., "Kinetics and Buckling Measurements in Lattices of Slightly Enriched U or UO2 Rods in H2O", WAPD-176, January 1958.

[11] Sher, R., Fiarman, S., 1976. "Studies of Thermal Reactor Benchmark Data Interpretation: Experimental Corrections", EPRI NP-209, October.

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