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Journal of Surveying and Structural Engineering

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Structural Development of Skyscrapers

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A B S T R A C T

This paper presents a review on the evolution of the structural system of skyscrapers from earlier to the modern and the effects of this on the society and environment

Keywords- Skyscrapper/Tall Buildings, Height Premium, Internal, external and hybrid structural system, Building Loads, Shear Walls, lateral rigidity, Lateral Sway, Floor Vibration

I. INTRODUCTION

Tall buildings emerged in the late nineteenth century in the United States of America. They constituted a so-called "American Building Type," meaning that most important tall buildings were built in the U.S.A. Today, however, they are a worldwide architectural phenomenon. Many tall buildings are built worldwide, especially in Asian countries, such as China, Korea, Japan, and Malaysia.

The distribution of tall buildings has changed radically with Asia now having the largest share with 38%, and North America's at 22%(Fig. 1). This data demonstrates the rapid growth of tall building construction in Asian while North American construction has slowed.

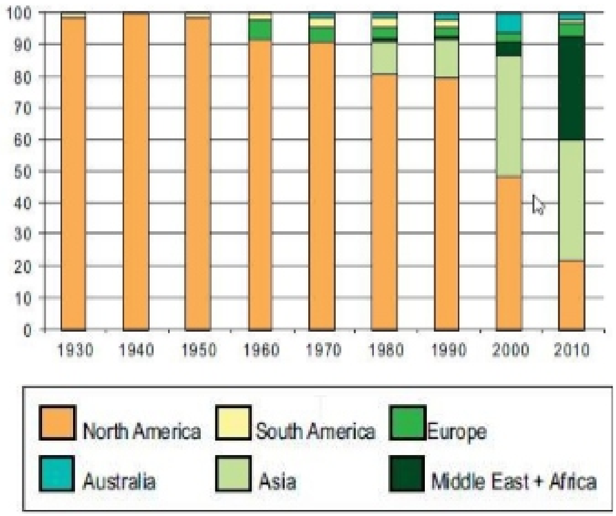


Figure 1: 100 Tallest buildings of the world by region

II. BRIEF HISTORY

Till mid 1800's the maximum height for the buildings was 4-6 stories due to several factors:

1. Too many steps to climb up & down daily
2. Masonry wall thickness is too high at base, eating up floor space

3.Framing could go up so high before become unstable in wind

The Bessemer Process was the first industrial process for the mass-production of Steel from molten pig iron. The inventor Henry Bessemer took out a patent on the process in 1855.

In 1857, Elisha Otis and the Otis Elevator Company began manufacturing passenger elevators. Invention of Elevator allowed vertical transportation of people and goods without stair Chicago is the birthplace of the skyscraper The Home Insurance building (1885) in Chicago, (ten storied with 42 meter in height) is generally referred as the first high rise building (Architect :William Jenney) The Home Insurance Building was built followed by the Great Chicago Fire, 1871

- The physical envelope of construction was traditional load-bearing system.
- Thick masonry external walls creates comfortable indoor thermal environment
- Large window and high ceiling was provided to allow the daylight to the interiors.
- Maximizing the financial return over a fixed plot size, initiates the development of modern high rise building in North America during mid-nineteenth century

III. PREMIUM FOR HEIGHT

The primary structural skeleton of a tall building can be visualized as a vertical cantilever beam with its base fixed in the ground. The structure has to carry the vertical gravity loads and the lateral wind and earthquake loads. Gravity loads are caused by dead and live loads. Lateral loads tend to snap the building or topple it. The building must therefore have adequate shear and bending resistance and must not lose its vertical load-carrying capability.

Fazlur Khan realized for the first time that as buildings became taller, there is a "premium for height" due to lateral loads and the demand on the structural system dramatically increased, and as a result, the total structural material consumption increases drastically (Ali, 2001).Further to this, the columns need to be even heavier towards the base to resist lateral loads. The net result is that as the building becomes taller and the building's sway due to lateral forces becomes critical, there is a greater demand on the girders and columns that make up the rigid-frame system to carry lateral forces. The concept of premium for height is illustrated in Figure 2.

If we assume the same bay sizes, the material quantities required for floor framing is almost the same regardless of the number of stories. The material needed for floor framing depends upon the span of the framing elements, that is, column-to- column distance and not on the building height. The quantity of materials required for resisting lateral loads, on the other hand, is even more increased and would begin to exceed other structural costs if a rigid- frame system is used for very tall structures. This calls for a structural system that goes well beyond the simple rigid frame concept. Based on his investigations Khan argued that as the height increases beyond 10 stories, the lateral drift starts controlling the design, the stiffness rather than strength becomes the dominant factor, and the premium for height increases rapidly with the number of stories. Following this line of reasoning, Khan recognized that a hierarchy of structural systems could be categorized with respect to relative effectiveness in resisting lateral loads for buildings beyond the 20- to 30-story range (Khan, 1969).

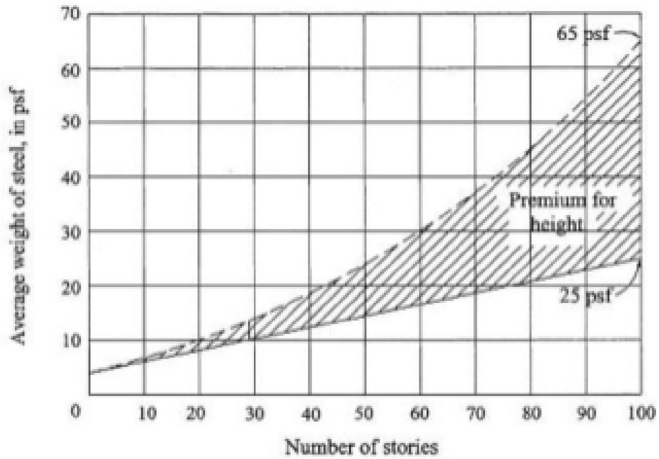


Figure 2: Premium for height.

IV. CLASSIFICATION OF SKYSCRAPERS STRUCTURAL SYSTEMS

The Structural system of the skyscrapers can be classified in three types:

1. Internal
2. External
3. Hybrid

1. Internal: A system is categorized as an interior structure when the major part of the lateral load resisting system is located within the interior of the building. It includes mainly Rigid Frame System, Vertical Shear Truss System, Frame - Shear Truss System.

Rigid Frame System:

Rigid Frame or moment-resisting frame (MRF) consists of Girder and Column rigidly connected together in a planar grid Such frames resist load primarily through the flexural stiffness of the members. The size of the columns is mainly controlled by the gravity loads, progressively larger column sizes towards the base The size of the girders, is controlled by stiffness of the frame to ensure acceptable lateral sway of the building.

Some of rigid frame tall buildings is - 860 & 880 Lake Shore Drive Apartments (1949) Chicago, 82 m, 26 stories.

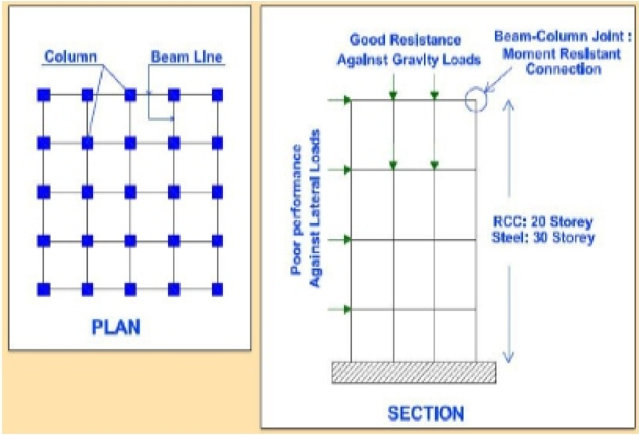


Figure 3: Rigid Frame Buidings

Vertical Shear Truss:

Vertical Shear Truss System (RC coupled shear wall) can effectively resist lateral forces caused by wind and earthquakes. They are treated as vertical cantilevers fixed at the base.

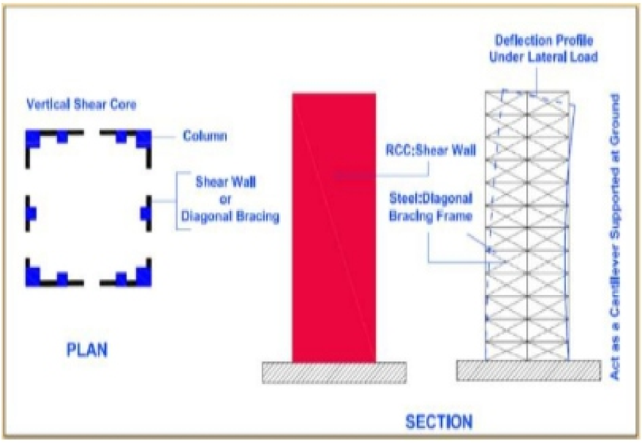


Figure 4: Vertical Shear Truss

Frame - Shear Truss System:

Rigid Frame is not efficient for buildings over 30 stories because the sway caused by the bending of columns is excessive. Vertical Shear Trusses alone provide resistance up to 35 stories.

When vertical Shear Trusses are combined with Rigid Frame , the interactive system, results in a common deflected shape of the structure.

The upper part of the truss is restrained by the frame, The lower part, frame is restrained by the truss. This effect produces increased lateral rigidity of the building. Some of the frame truss buildings are The

Empire State Building (1931) New York, 381m, 102 Storied, 311 South Wacker Drive (1949) Chicago, 293 m, 65 stories

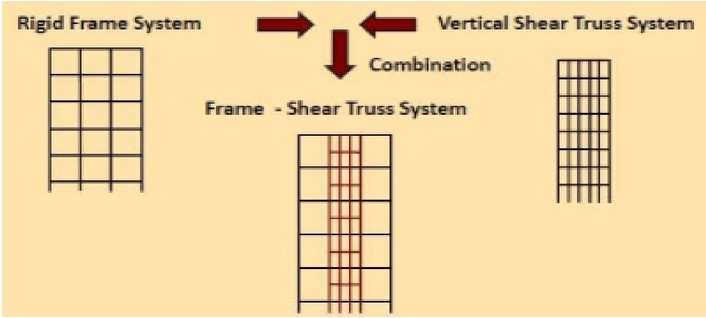


Figure 5: Frame - Shear Truss System

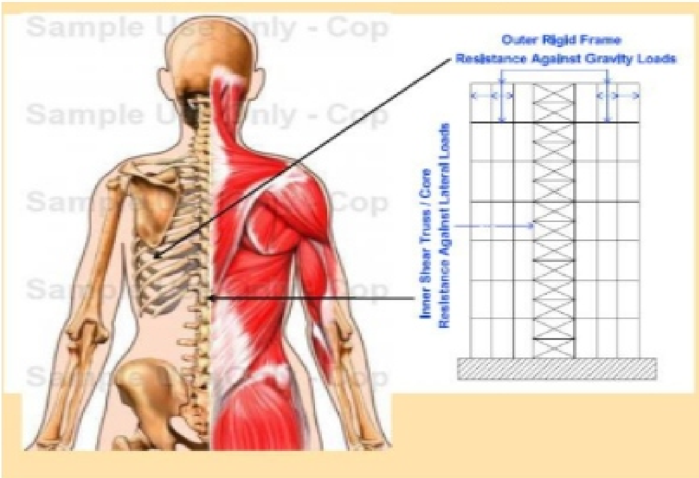


Figure 6: Frame - Shear Truss System nature example

2. External: If the major part of the lateral load- resisting system is located at the building perimeter, a system is categorized as an exterior structure.

It is desirable to provide lateral load-resisting system components as far as possible on the perimeter of tall buildings to increase their structural depth. Tubes are known as basic exterior structures. It can be defined as a three-dimensional structural system utilizing the entire building perimeter to resist lateral loads. It includes mainly Frame Tube System, Braced Tube System, Tube in Tube System, Bundled Tube System

Frame Tube System:

It has closely spaced columns and deep spandrel beams rigidly connected together throughout the exterior frames. Depending upon the structural geometry and proportions, exterior column spacing should be from 5 to 15ft (1.5 to 4.5m) Practical spandrel beam depths should vary from 24 to 48in (600 to 1200mm). Resulting structural organization the lateral load resisted by the whole tube. Some of the frame tube buildings are Water Tower Place (1975) Chicago, 262 m, 74 stories; Aon Center (1973) Chicago, 346 m, 83 stories; WTC(1971) New York, 417m, 110 storied.

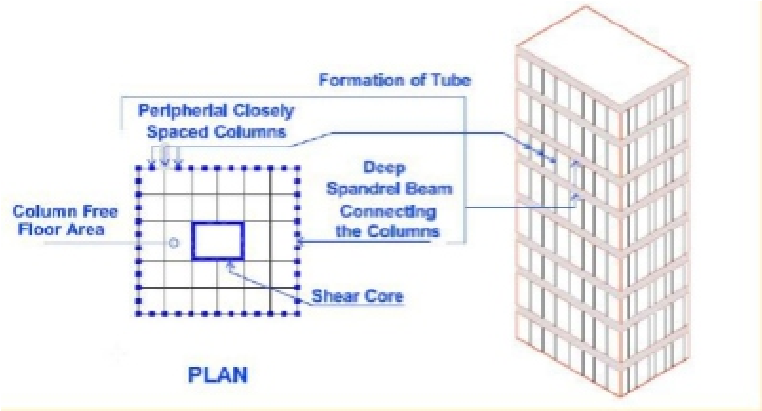


Figure 7: Frame Tube System

Braced Tube System:

It is possible to stiffen the building Structure by introducing diagonal braces. Introduction of Diagonals also increase the spacing of columns in frame tube.

The diagonals participate in dual role action as it collect gravity loads from floors as inclined columns also act as a stiffener in case of lateral loads. Some of Braced tube structures are John Hancock Center (1970) Chicago, 344 m ,100 stories; Onterie Center(1986) Chicago, 174 m ,58 stories.

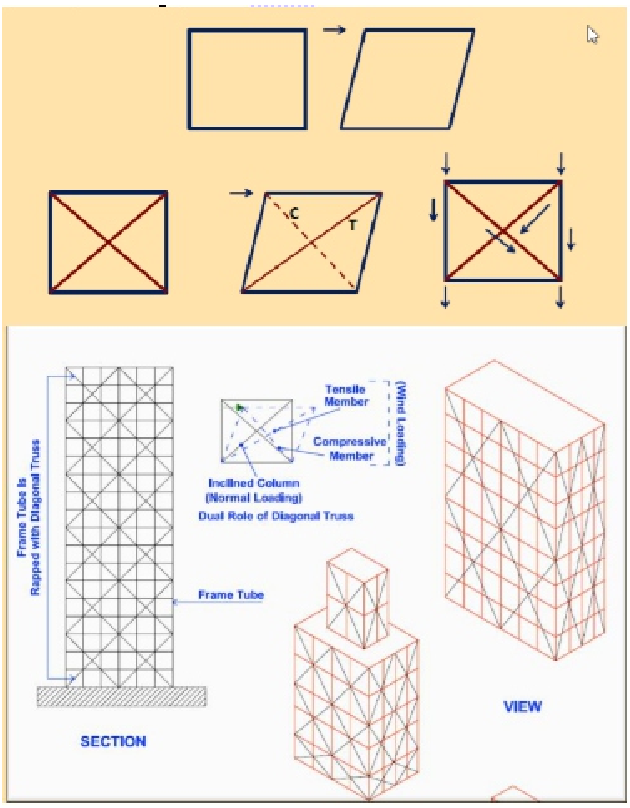


Figure 8: Braced Tube System

Tube in Tube System:

The stiffness of a Framed Tube can be further enhanced by using a core tube to resist part of the lateral load resulting in a tube-in-tube system. The floor diaphragm connecting the core and the outer tube transfer the lateral loads to both systems. It is also possible to introduce more than one tube inside the perimeter tube.

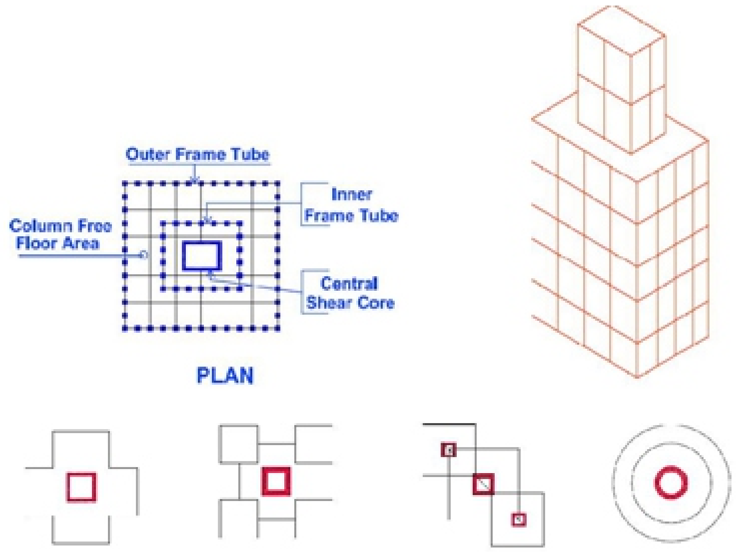


Figure 9: Tube in Tube SystemBundled Tube System:

In tall buildings with larger floor areas, simple frame tube system become very uneconomical structural solution. To overcome this, many frame tubes are symmetrically grouped together to create larger floor space. Further these grouping of frame tubes (called bundled tubes) are actively participate to transmit the super-structure load to the ground as well as provide the lateral stability against the transverse loading.

Some of the Bundled tube structure are Sears Tower (1973) Chicago, 442 m,108 Stories; Burj Khalifa (2010) Dubai, 828m, 163 habitable floors plus 46 maintenance levels.

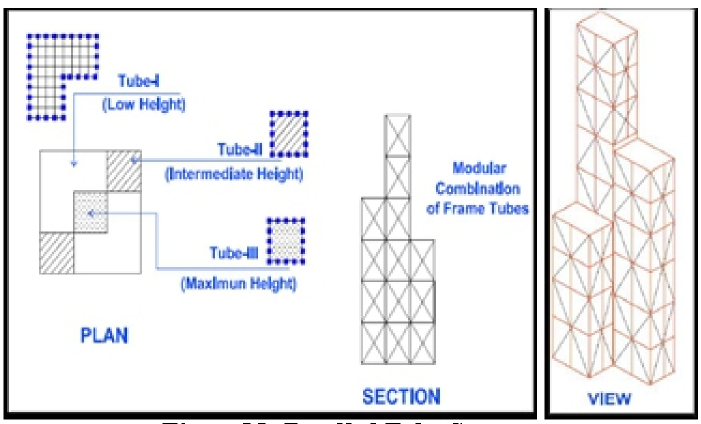


Figure 10: Bundled Tube System

3. Hybrid: These are the advance structural systems.It includes Diagrid, Exoskelton, Super frames, Outrigger

Diagrid:

Almost all the conventional vertical columns are eliminated. This is possible because the diagonal members in diagrid can carry gravity loads as well as lateral forces due to their triangulated configuration in a distributive and uniform manner.

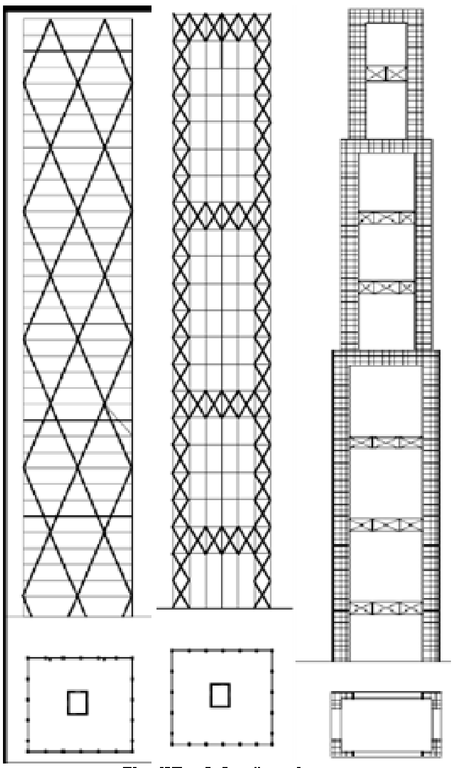
Some of diagrid buildings are Hearst Building (2006) New York, 182m, 46 Stories, Swiss Re Building (2004) London, 181m, 41 Stories.

Exoskelton:

In exoskeleton structures, lateral load-resisting systems are placed outside the building lines away from their facades. The system is associated with other conventional types Due to the system's compositional characteristics, it acts as a primary building identifier. Some of Exoskelton buildings are Burj Al Arab, Dubai.

Superframe:

A super-frame is composed of mega columns comprising braced frames of large dimensions at building corners Like Exo-skeleton, the system is also associated with other conventional types The mega columns usually linked by multistory trusses at about every 15 to 20 stories. Some of Superframe buildings areParque Central Tower (1979) Caracas, Venezuela, 221 m ,56 stories.



Diagrid Exoskelton Superframe Figure 11

Outrigger:

The Frame-Shear Truss system is further modified with introduction of outriggers band in differential vertical levels The outriggers are generally in the form of trusses in steel structures, or walls in concrete structures.

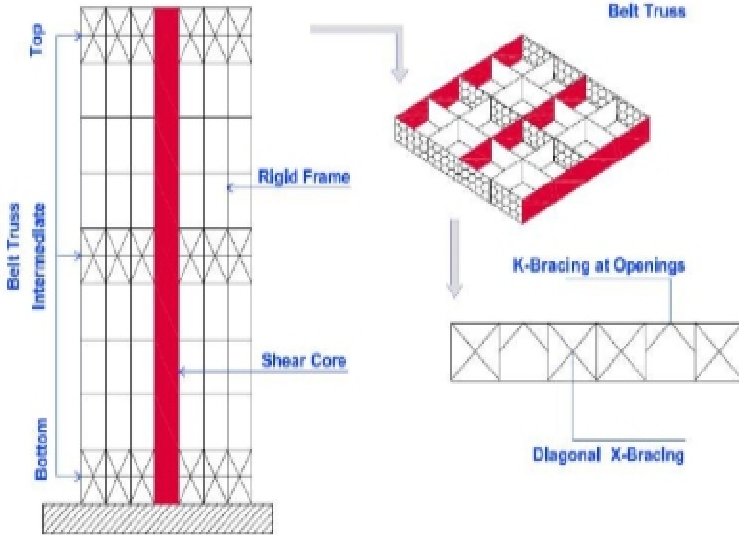


Figure 12. Outrigger Truss System

Outriggers reduce the overturning moment in the core Outriggers can also be supported on mega-columns in the perimeter of the building. thus resisting the lateral push on the building by 'feet – spread' technique as shown in figure 13.

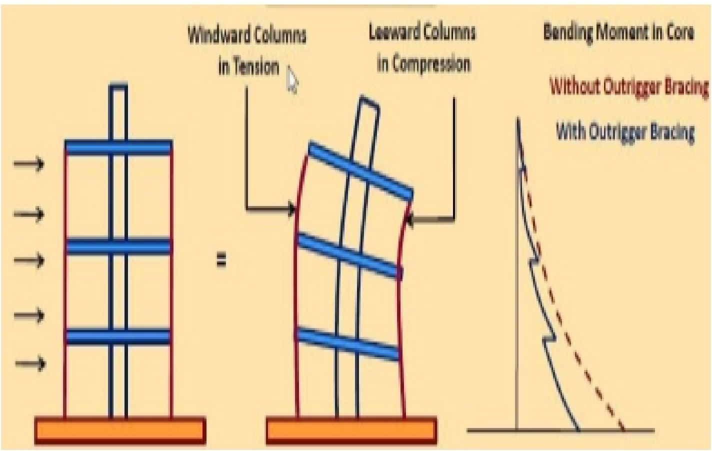


Figure 13.

Outrigger systems have been historically used by sailing ships to help resist the wind forces in their sails as shown in figure 14.

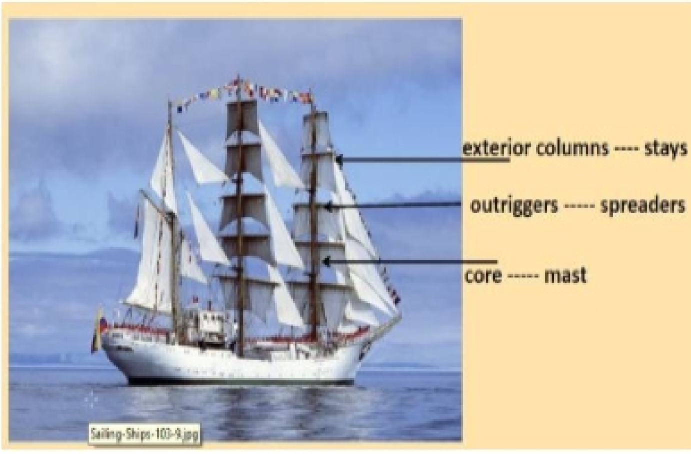


Figure 14.

Some of the outrigger buildings are Taipei 101(2004) Taiwan, 509 m, 101 Storied, Jin Mao Building (1999) Shanghai, China, 421 m ,88 Stories.

CONCLUSION

This paper has presented a general review of structural systems for tall buildings. Various structural systems within each category of the new classification have been described with emphasis on innovations.

This paper demonstrates that structural systems have come a long way since the late nineteenth century when they were conceived as framed systems. With the development of increasingly taller buildings using lighter members, serviceability issues like lateral sway, floor vibration, and occupant comfort need to be given more attention by researchers. More research is needed for exterior structural systems which are technically more efficient.

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Determining Hydrological Characteristics of A Stream by Using Gis Methods

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ABSTRACT

To protect river basins, it is necessary to know about the river and the basin. Geographical Information System (GIS) software are used to determine river basin parameters. In the study; hydrological properties of Malatya-Derme sub- basin were investigated. Derme sub-basin has contains drinking water for Malatya province, irrigation projects and hydroelectric power plants. ArcGIS software was used in the study. Hydrological properties of Derme sub-basin were determined and commented.

Keywords- Derme sub-basin, ArcGIS, Hydrological characteristics, Basin shape.

I. INTRODUCTION

Freshwater resources consist 2.7% of global water resources. Only 1% of the freshwater is in streams and lakes. Freshwater are one of the vital resources that sustain all organisms, primarily the human life. Thus, it is of utmost importance not to pollute and waste freshwater resources (Ermis 2014).

Provision of quality water is indispensable in increasing the quality of life and prevention of diseases (Oluduro and Adewoye 2007). Natural waters could contain different pollutions of different quality and quality based on the source (Drever 1988). Prevention of streams and their basins and leaving a clean and habitable environment for future generations is a social responsibility. To protect river basins, it is necessary to know about the river and the basin. Thus, meteorological, hydrological, geological and environmental characteristics of the basin should be determined and possible pollutants should be established.

Prevention of flood damage is also important up to protect streams. To determine the overflow potential of streams, initially the hydrological characteristics of the basin should be identified. Today, Geographical Information System (GIS) software are used to determine river basin parameters. Bağdatlı and Öztürk (2014) determined basin characteristics of Çorlu stream basin using GIS software and constructed the digital elevation model for that basin. Rahmati et al. (2016) compared the analytical hierarchical calculations for Iran-Yasooj river region and the results of the hydraulic model they developed with the help of GIS software. Seenath et al. (2016) compared the hydrodynamic model and GIS software to determine the increases in sea level due to the effects of climate change. Youssef et al.

(2016) researched the reasons of the floods that occurred in Jeddah, Saudi Arabia in 2009 and 2011 using a GIS model. Vizireanu et al. (2016) determined that the infrastructure was damaged and epidemics were observed due to the Danube floods. They have designed flood risk plans with the help of a GIS model.

Drinking and utility water needs for Malatya province in Turkey is brought from Pınarbaşı karst source located on the left cost of Derme stream 20 km south of the urban center. Derme stream is utilized for drinking and in energy projects at the source and for irrigation at the downstream. During irrigations season, Derme stream is fed by Çat reservoir located at the neighboring basin and the stream passes through settled areas to reach irrigation land at the downstream. Protection of Derme stream and basin which are vital for Malatya province and identification of flood risks are significant for the province. Thus, it is necessary to determine hydrological characteristics of the basin. The objective of the present study is to determine certain hydrological parameters for Derme stream, located within the Malatya province drinking water resource, using GIS software.

II.MATERIAL AND METHOD

2.1 Field of Study

Derme stream is located 12 km south of Malatya, at a 2 km distance from Yeşilyurt township center and on the map sheets L40 a3 and L40 b4 of 1/25000 scale national maps. Derme stream is located in the river basin no: 21.

Derme source is the most important karst source in Malatya province with a mean flow rate of 2.6 m3/s. It is discharged from the faulted contact of permocarboniferous aged articulate limestone with plenty of faults (Pmkl) and impermeable schists (Pms) of the same age located below the former at 1205 m altitude. It is in the form of a group of springs. The source was collected by General Directorate of Provincial Bank and supplies drinking- utility water demand of Malatya center, Battalgaziand Yeşilyurt counties. The source is operated by Malatya municipality (Önal,1993).

People living in the area of research lives on orchard agriculture, primarily apricots and cherries. Yeşilyurt township and Gündüzbey town are main recreational spots of Malatya province with several recreational facilities.

2.2. Hydrological Characteristics

Certain hydrological characteristics of the area of study were determined using Geographical Information System (GIS) software and digital maps. Calculated parameters for Derme stream basin were basin and surrounding area, maximum, minimum and average elevation in the basin, basin vector, average slope, Main canal slope and length, distance between basin center of gravity and project cross-section, with and the length of the basin, maximum basin diameter, basin shape indices, exposure map, drainage frequency and drainage density.

III. METHOD

3.1. Geographical Information System (GIS)

GIS has several definitions, but in short, it could be described as a systems network that includes computer hardware, software and users and used to collect, store, control, processing, analysis and display of certain spatial information about the earth (Aronoff, 1991). GIS data have two characteristics: geographical (spatial, graphical) feature and attribute (non-geographical, non-graphical). GIS technologies are utilized in almost all disciplines today. Furthermore, earth science branches that utilize almost exclusively spatial data are the most important application fields of GIS. One of these leading branches is hydrology where research is a little more difficult compared to other fields. Because variables change not only spatially in hydrology, but also with time. Therefore, integration of GIS techniques with other mathematical models is necessary in hydrological GIS applications in addition to direct operations. The following are among the areas of use for GIS in the fields of water resources engineering and hydrology (Anonymous, 2013):

- River basin management,
- Erosion – sedimentation prediction, control and protection operations,
- Design and management of drinking water, wastewater and urban rainwater networks,
- Selection of dam location, plotting altitude-area- volume curves, calculation of the reservoir volume, reservoir operations,
- Water quality modeling, monitoring and management,
- Underground water monitoring and modeling,
- Flood control and prediction, constructing flood maps,
- Water resource planning and management,
- Determination of irrigable land, yield prediction, finding the channel route,
- Soil classification
- Constructing the digital altitude model for the basin,
- Determination of basin boundaries and characteristics,
- Running different hydrological models in connection with GIS software.

3.1.1. ArcGIS Software

In the study, ArcGIS 10.1 GIS software copy licensed to Inonu University Civil Engineering Department and produced by ESRI corporation was used.

ESRI ArcGIS is an integrated software product collection that could build a complete geographical information system (GIS) specific to an organization. ArcGIS technology enables the user to integrate GIS functionality and business logic in desktops, servers or mobile devices, or in special applications or web services based on a particular need.

These features of geographical information systems are significant with respect to the geographical data that is used or will be used in geographical information systems. Because, these are among the important features for studies that are conducted to relate geographical data to a particular location and create different products from the details of this geographical data (Anonymous, 2013).

IV. RESULTS

Digital Elevation Model (DEM) was constructed using digital contour lines in GIS environment. Study field basin and drainage system was determined using the ArcHYDRO tool in ArcGIS 10.1 software (Figure 1). Data obtained for the study field were transformed into usable form and transferred into the system. basin area for the study field was found as 94.69 km2 and circumference was found as 80.1 km.

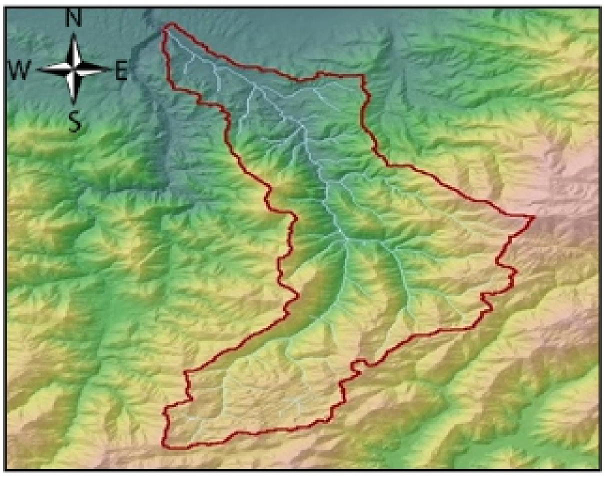

Figure 1. Basin of Derme Stream (Ermis 2014)

Drainage density is defined as the river length per unit area (Bayazıt, 1999; 2001) and calculated with Equation (1):

$$D_d = \sum L_u / A \quad (1)$$

Drainage frequency is defined as number of tributaries per unit area:

$$D_f = \sum N_u / A \qquad (2)$$

where Dd is drainage density, Lu is total river network length, A is basin area, Df is drainage frequency and Nu is the number of tributaries.

Drainage network and drainage length of the Derme drainage system were determined as 101,898 km and this figure was divided by the basin area that was 94.69 km2 gave the drainage density, which was found as 1.08.

Minimum basin altitude was 900 m and maximum basin altitude was 2493 m. Altitude map was generated using the software (Figure 2).

As could be observed on the constructed slope map, the slope varied most frequently between 20 and 45, and towards the downstream basin slope varied especially between 6-15 and 0-6 (Figure 2)

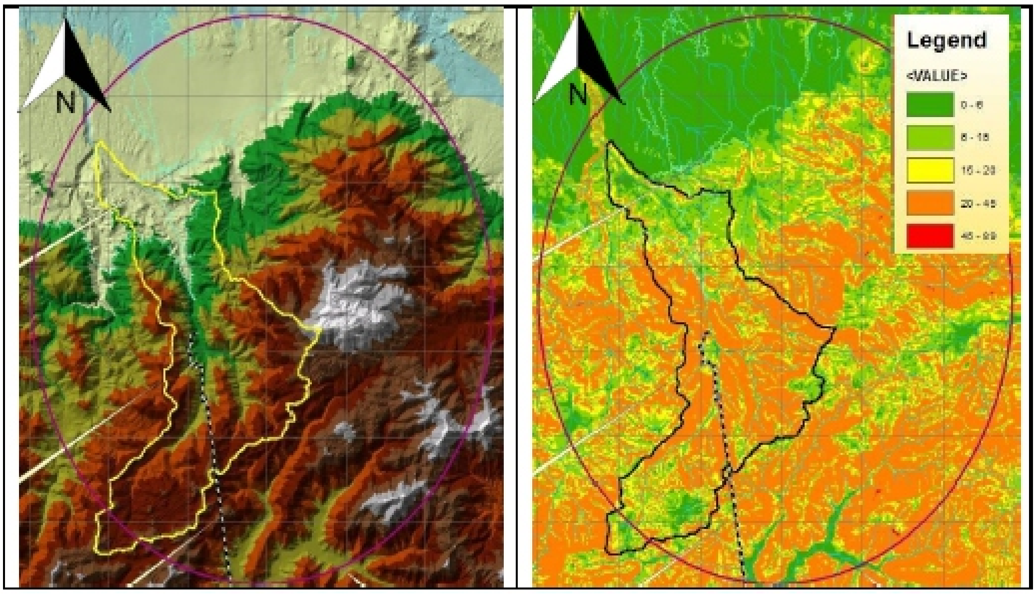

Figure 2. Elevation Map and Slope Map of Derme Stream (Ermis 2014)

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The main slope that is considered in flood calculations is the basin main waterway slope (Türkyılmaz, 1996). It is obtained by the division of the difference in altitude between the point where the main waterway commences and the basin exit point by the length of the main waterway.

Main waterway length was determined as 18,396 km. The channel main waterway between the altitudes of 1510 m and 900 m was calculated as 0.03 with the division of the altitude difference by the main waterway length.

Derme stream was divided 10 equal parts in length and slopes of each division were identified Table 1). Using the data provided in this table and Equation (3), Derme stream harmonic slope was calculated.

$$S = \left(\frac{10}{\sum \frac{1}{\sqrt{S_i}}}\right)^2 = (10/60.2124)^2 = 0.0276 \qquad (3)$$

The distance between the intersection point of the vertical line drawn from the basin center of gravity to the main waterway and basin exit point was calculated as 13.85 km (Lc).

Basin length is the air line between the point found by extending the main waterway line until the basin boundary and the basin exit. Basin width (WH) is calculated by dividing basin area by the basin length (LH).

$$W_H = {}^{A}/_{L_H} \qquad (4)$$

The length of the straight line drawn between the basin exit point and the most distant basin boundary gives the maximum diameter of the basin. Basin shape indices are calculations that demonstrate whether the basin resembles a circle or a square. These are:

$$SI_1 = {}^{L_H}/_{W_H} \qquad (5)$$

$$SI_2 = {}^{A}/_{A_d} = 4\pi \frac{A}{P^2} \qquad (6)$$

$$K_c = 0,28 \frac{P}{\sqrt{A}} \qquad (7)$$

where SI^1, SI^2 are shape indices, Kc is the Gravelius index, A is the basin area, Ad is the area of the circle with an identical circumference with the basin, and P is the circumference of the basin.

Basin length was measured as 18.98 km and maximum diameter was measured as 18.99 using the basin map. Basin width and drainage frequency were calculated as 4.99 km and 0.877, respectively. Basin shape indices were calculated as $SI^1 = 3.8$, $SI^2 = 0.185$, $Kc = 2.31$. These index values showed that the basin was not circular or square, but more like a rectangle.

Basin Shape Coefficient (Bk) is expressed as the ratio of main waterway length squared to the drainage

$$B_k = U_{em}^2 / A \qquad (8)$$

For the field of study, Bk value was calculated as 3.58.

It could be deducted from the exposure map that the orientation of the basin was mostly towards south and east (Figure 3).

Table 1. Derme stream harmonic slope calculation (Ermis 2014)

H_1	H_2	ΔH	l=L/10	S_i=h/L	$\sqrt{S_i}$	$1/\sqrt{S_i}$
1510	1415	95	1840	0.05	0.22	4.40
1415	1340	75	1840	0.04	0.20	4.95
1340	1280	60	1840	0.03	0.18	5.53
1280	1170	110	1840	0.05	0.24	4.08
1170	1140	30	1840	0.01	0.12	7.83
1140	1045	95	1840	0.05	0.22	4.40
1045	997	48	1840	0.02	0.16	6.19
997	958	39	1840	0.02	0.14	6.86
958	928	30	1840	0.01	0.12	7.83
928	900	28	1840	0.01	0.12	8.10
					Toplam	60.21

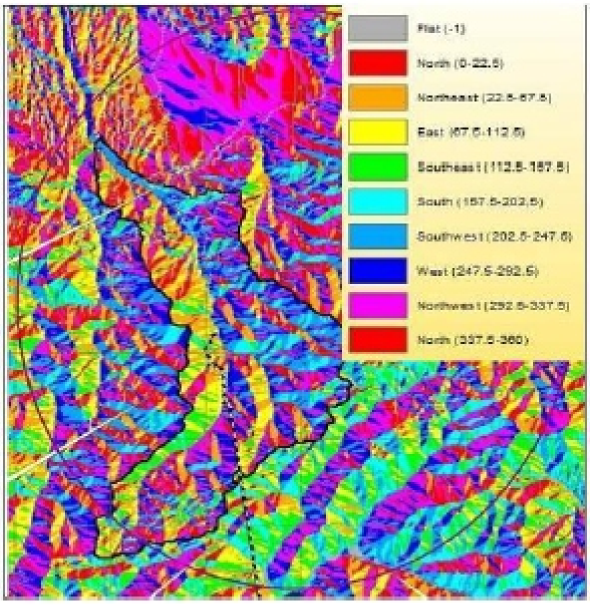

Figure 3. Exposure map of Derme Basin (Ermis 2014

CONCLUSION

- Derme stream basin area was 94.69 km2 and circumference was 80.10 km. Total drainage length was 101.89 km and drainage density was 1.08.
- Minimum basin altitude was 900 m, maximum altitude was 2493 m. Based on the constructed slope map, the slope varied most frequently between 20 and 45, and towards the downstream basin slope varied especially between 6- 15 and 0-6. Harmonic slope was 0.0276.
- Main waterway length was determined as 18.39 km. The slope of the main waterway between the altitudes of 1510 m and 900 m was 0.03. Straight distance between the basin center of gravity and

the main waterway was 284 m. It could be said that the orientation of the basin is mostly southern and eastern.

- The basin is similar to a rectangle and basin shape coefficient was calculated as 3.58.
- Malatya province annual mean precipitation is 380 mm and higher altitudes of the study field receive snow during winter months. Southern and eastern orientation of the basin indicates high snowmelt during mid-spring months. Since there is low water demand for irrigation during these months, there is a high flood risk.

ACKNOWLEDGMENT

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A Case Study of the Contention Between Government and Community in "Mahakarn Fort" Conservation Project for Tourism

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ABSTRACT

This study aim to work out on the best solution of "Mahakarn Fort" Conservation and Public park project to provide green area and historical attraction for sustainable tourism in Ratanakosin Island. Bangkok's oldest fortress may soon be confined to the history books. Remaining residents of Mahakan Fort, whose community dates back to the 1800s, have been told by the city to move out for the public park project.

The 6,400 sqm.of this area will be turned into a public park intended to be a tourist attraction. The whitewashed Mahakan Fort is one of two from 14 Forts surviving citadels that defended the old walled city. The octagonal fort is a picturesque, but the neighbor in village is more interesting. This small community of wooden houses has been here for more than 100 years, but since the mid-1990s it has fought the Bangkok municipal government's plan to demolish it and create a 'tourist' park.

The community blocked progress and even proposed the development of another tourist attraction: a lígair (bawdy dance- drama) museum honouring the dance tradition that traces its creation to a school located here in 1897. Some of the homes were eventually demolished, resulting in the park you see today. But behind the fort many others remain.

For 24 years, residents in Mahakan Fort have been living with an uncertain future as governor after governor tried to proceed with the park project. Last month, however, an eviction notice was put up a final call for the remaining 57 families living here.

Keywords: Mahakarn Fort, Public Park, Mahakarn Community, Living Museum, conservation, Sustainable tourism.

INTRODUCTION

Today only two forts remain out of 14 (Fig.1)that were built more than two centuries ago. PhraSumen Fort is one of the remaining forts that was built during the end of the 18th century to protect Bangkok from possible invasions.

When King Buddha YodfaChulaloke (Rama I) ascended the throne as the first ruler of the Chakri dynasty in 1782, he decided to establish Bangkok as the new capital of the Kingdom. The capital was founded on the Eastern side of the Chao Phraya river in the Rattanakosin area. Because only a few years before that, in 1767, the Burmese had completely destroyed the old capital of Ayutthaya, the King had a number of fortifications built and canals dug out to protect Bangkok. PhraSumen Fort was built in 1782 as one of 14 forts (fig.1) of which only two remain today, the other one being Mahakanfort.

The King also had city walls built and a number of canals dug out that acted as a moat surrounding the city. With the Chao Phraya river protecting Rattanakosin in the West, Brief Statement of the threat and conflict. Ratanakosin Island Project is conceptual framework start on B.E.2478 focus on Ratanakosin Island conservation specify called " Rattanakosin Area" with the tourism promotion. According to Ratanakosin Area consist of the important historical places including the national culture. The concept of the conservation emphasize on the conservation and rehabitation in King Rama V.

moreover, The government office, community, andorther building will be rebuild for the development serve the conservation committee targets. Conservation and improvement of Mahakarn Fort is one part of this project as the master plan (Fig.2) have to remove the community out of this area and turn on the entire area into public park. Bangkok Metropolitan Administration has return back this land in B.E.2536 from the private sector and the royal property. Next, the community will be planed the transmigrant at Chalong Krung Sub-District, Minburi District under National Housing Authority. (Ratanakosin Project, 1996)

In fact, the people was assisted only the land, the people must find the fund for their new house. The new place have no facilities such as schools, hospital, lack of transportation and far away from their working area.so the return back to Mahakarn Fort Community again.

The Community start a new negotiation with Bangkok Metropolitan Administration by requesting 1 rai of the land to build the regulated housing and volunteer of security guard by themselves, moreover, the people provide security guard 24 hours at the public park. The will return 75% of prepaid money back to BMA.

BMA. Confirmed the previous conception as in Rattanakosin master. The reason was the government official must work by the function and the law. Therefore, Mahakarn Fort Community submitted the request to the Administrative Court.

Fig1: The map show 14 forts location.

Fig2: Master plan of Mahakarn Fort conservation

BMA needs to follow 1992's royal decree but it's not true that we can't change the situation. In fact, if we look at history, there are many cases in which royal decrees were changed. I also see a degree of inequality in law enforcement.

Government-backed projects often receive special legal treatment, like the new Supreme Court building—Rattanakosin construction regulations limit buildings to 16 meters tall, yet the government allowed itself to build a 32-meter-tall building. Recently, the Marine Department has also been eyeing changes to regulations governing rivers as the government promotes its River Promenade project. For Mahakan Fort, it has been 24 years since the decree came out, and there are many studies—not just mine—pointing out how the original park project does not fit with modern needs.

The plot is dead space surrounded by a wall and the river, which does not make it a suitable or safe space for a park. There are two crucial groups that can change the situation now: the government's Rattanakosin preservation committee and the cabinet. The committee is actually overlooking Rattanakosin policy. They can reconsider the plan and propose a new scheme to the cabinet, who can then state a new royal decree to help save the Mahakan community. (ChatriPrakitnonthakan Associate Professor of Silpakorn University's Faculty of Architecture)

Fig.3:Mahakarn Forts and community are located at the center of the important historical place including with the national culture.

Origin of conflict. The government provide Mahakarn Fort improvement project and combined area for public park as one of " Ratanakosin Area " . The project determine to move all of Mahakarn community. The mentioned community was interested as the historical initiated community, way of life, and ancient profession. The conflict between government and the people concerning the development strategic, historical value of the place(Fig.3) which the people has to reside in this area. The summary of the differ conceptual framework as follow

The government concept: The government want to remove the old house of the communityto fulfill the concept for the conservation "Mahakarn Fort " (Fig.4-Fig.5) and provide viewing around the public park for the people and tourist The Community concept: The people in the community don't want to move from this area they want to stay to conserve the cultural way of life as a living museum. From the reason mentioned above show the difference in conservation conceptual framework this was an original of conflict.

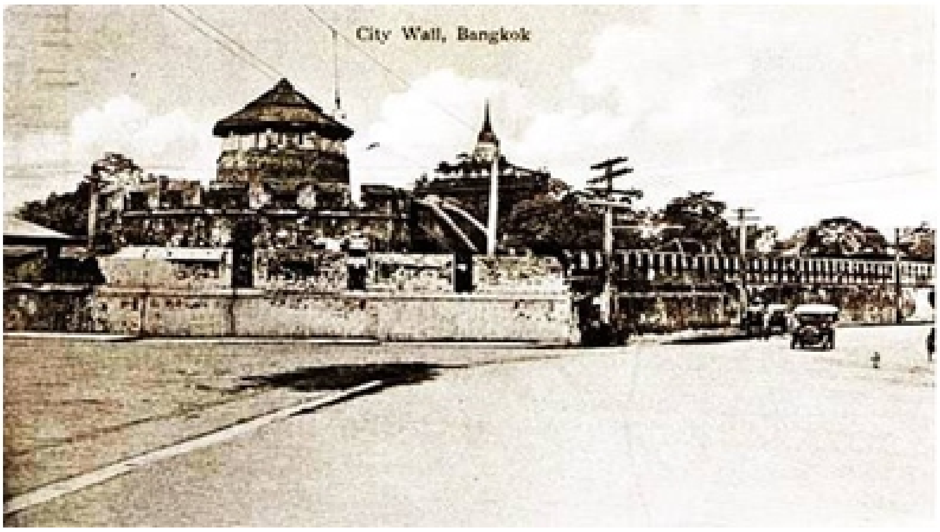

Fig.4:Mahakarn Fort in the past.

Fig.5: Mahakarn Fort at present.

Today, the BMA claims present community members have no original historical link to the area, since the original owners moved out when the BMA expropriated the land in 1992. The community, however, insist they are the descendants of families who lived in the area centuries ago, and who gave birth to a rich part of Thailand's arts and crafts heritage that includes Phraya Petchpanilikay, Thailand's first musical folk drama performance. (This is actually where the area's original name, Trok Phraya Petch, comes from.) Craftsmanship still exists in the area today, with locals making traditional-style birdcages and carving Rue Si Dud Ton (miniature statues of hermits).

Fig.6:Households originally located in the Mahakan Fort community

Living museum. A living museum, also known as a living history museum, is a type of museum which recreates historical settings to simulate past time periods, providing visitors with an experiential interpretation of history. It is a type of museum that recreates to the fullest extent

Fig.7: Members of the Pom Mahakan community and their supporters lock arms together in asymbolic show of opposition to eviction by the city. Photo: Matichon

Is the living museum concept a good solution? We all agree that Bangkok has a really sparse amount of public space compared to other cities. But Bangkok is also not like other cities. It has a dense concentration of old communities(fig.6), so whenever you decide you want a new public space that means it will affect one of these communities. The BMA just thinks about getting rid of people in order to create their vision of a beautiful city. But look at SaphanLek market. Getting rid of that market has resulted in a deserted space next to the canal which has been of no help to the city whatsoever. If the Mahakan model proposed in 2009 were to be attempted, it could change Bangkok's vision for public space development. The BMA should follow a development model which puts people first. Given this area's long history, it truly is a living museum."

The Government final call. On Mar 28, the BMA's Public Works Department set a notice sign in front of the fort wall telling residents that they must relocate from the area by Apr 30. Now, conservationists, environmentalists, academics and other communities have come together to help save the area from transformation into a park and remove all the community out of the historical site. Having fought eviction for more than 24 years, community representatives insisted they will not leave.

Summary.The movement of Mahakarn Fort Community (Fig.7) is one of the various examples encounter the conflict concerning land use for public park between people and the government. This is the only one option for government treats to the community serve the public area as the green space of the city. (Nardsupa,1997)Bangkokian want to conserve the local historical area, did not like to destroy the ancient historical evidence of Ratanakosin and could not continue the community along with the green area and the conservation of historical architectural heritage. It has importance both physical and cultural dimension. On the other hand, people of the community suggest the improvement of both physical and cultural dimension .This is an alternative concept for the best solution of the conflict.So, the government should improve and decide for the implementation as follows;

1. Receiving the community suggestion on the development community residence as living museum
2. People participation in the final decision making will be conducted.
3. Compromise the concept of architectural heritage conservation and culture as harmony condition.
4. Provision public opinion for the appropriated conservation model for both side.
5. Suggestion the final conservation concept to the authority for the consideration.

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Application of Frequency Response Function Method for Detection of Damage in A Cantilever Beam Structure

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A B S T R A C T

Damage detection in structures is a major concern for scholars all around the world nowadays. It provides a quantitative and qualitative data of any structure which can be used to predict the condition of a structure. Many numerical and experimental approaches have already been established by various authors, which have their respective advantages and disadvantages. Howsoever the experimental studies have been proved more efficient than numerical models. In this study the concept frequency response function and change in natural frequency has been used. The experiment is carried out on a cantilever mild steel beam and different damage scenarios are being induced and studied and the data is recorded, analyzed and finally compared to obtain the results. Data is recorded with the help of an accelerometer and the excitation force is given by a hammer. The data is analyzed in a FFT analyzer and responses are shown in the BRUEL & KJAER PULSE LABSHOP software. Lastly the obtained FRF curves are compared and results show that the damage is effectively detected in the steel structures. This method is more efficient in higher modes rather than lower frequencies.

Keywords - Modal parameters, Natural Frequency, Frequency Response Function (FRF), Damage Detection, Accelerometer, Hammer and FFT Analyzer

I. INTRODUCTION

As we live in a country which is developing in a very fast rate and growth of urbanization is very rapid. New structures are taking place of old structures. So it is very necessary for us to have such methods with the help of which we can successfully and effectively assess the condition of a structure. So that we can get to know that which structure is still useful and can be used, which one can be used with some remedial measures and the extent of the remedial measures and which structures should be completely demolished.

Detection of damage in structures can be classified in two methods; destructive methods and non-destructive methods. And due to its non-destructive nature and easiness of application it is preferred over destructive methods. In destructive methods both static and dynamic methods have been extensively studied and used for damage analysis. As we already know changes in geometric and material parameters which are associated with the health reduction of structures is known as damage and these geometric and material parameters are associated the modal parameters of a structure. As the damage increases more and more modification of these modal parameters take place. These modal parameters are stiffness, natural frequency and mode shapes. Most of the damage detection methods have been based on these parameters in most of the studies. But dynamic method of damage detection is becoming popular these days, as it is more effective and direct approach than the other older methods.

Dynamic response of a structure can be defined as response of the system to an impulse loading or forced vibration. In the dynamic method of damage detection these responses of the structures are measured in the form of displacement, velocity or acceleration. And these responses are being plotted with respect to frequency and time. Instead of using a traditional response parameter of a structure the damage detection with help of frequency response function is used nowadays. Here in this study a direct experimental approach of damage detection is being carried out and the response of the structure in the form of frequency response function versus frequency is obtained. A frequency response function is nothing but a ratio of response of a structure to applied force. The experiment which is being carried out on a mild steel cantilever beam clearly shows that apart from some difficulties associated with the experiments, it is completely able to detect the damage in the structure. The results are obtained by comparing different health scenarios of the beam structure and this approach proved quite satisfactory in comparison to numerical model approaches. This experimental approach is unaffected by the data pollution due to noise. Coherence is also checked during the experiment to check the quality of the measurements. Change in modal parameters of the structures is noticed with increasing damage, as we know change in stiffness of a structure leads to change in the modal parameters. And this change of modal parameters signifies the damage present in the structure. This approach proved less efficient in lower modes of structure but quite significant in higher modes.

As this study is successfully carried out on a local damage case for a steel structure, it can be efficiently used for damage detection in steel structures. And further investigations are required for localization ofdamage and detection of damage globally in a structure.

II.DETAILS EXPERIMENTAL

2.1. Specimen Description

For the experimental study a mild steel beam specimen is taken. The specification of the specimen and the support condition is given in the Table 1.

Table 1: Beam specimen description

S.NO.	DISCRIPTION	BEAM 1
1	Material	Mild Steel
2	Support condition	Cantilever
3	Mass (gm)	205.7
4	Length (mm)	300
5	Width (mm)	17.8
6	Depth (mm)	5
7	Section Modulus (cc)	74.2
8	Modulus Of Elasticity (GPa)	192.8

2.2. Experimental Setup

Apart from the beam the experimental procedure requires particular accessories along with the software. Experimental setup consists of following parts:

1. Front end module (Type- 3560 C)
2. Hammer (Type- 8206 003)
3. Accelerometer (Type- 4507 01)
4. Pulse Labshop analysis software
5. Laptop
6. Dongle
7. Others

In above setup the hammer (Type- 8206 003) is an exciting force agent and is used to apply the force in specimen. The response of a structure is measured by the accelerometer (Type- 4507 01), which is a unidirectional response measurement transducer.

Both of the hammer and the accelerometer1. is connected to the front end setup. This front end module is the heart of the system. It measures the data, analyze it and represent the output in desired and orderly manner with the help of Labshop software. Accelerometer is connected on different points of a structure on which the response is to be measured and excitation force is applied on the respective points with hammer.

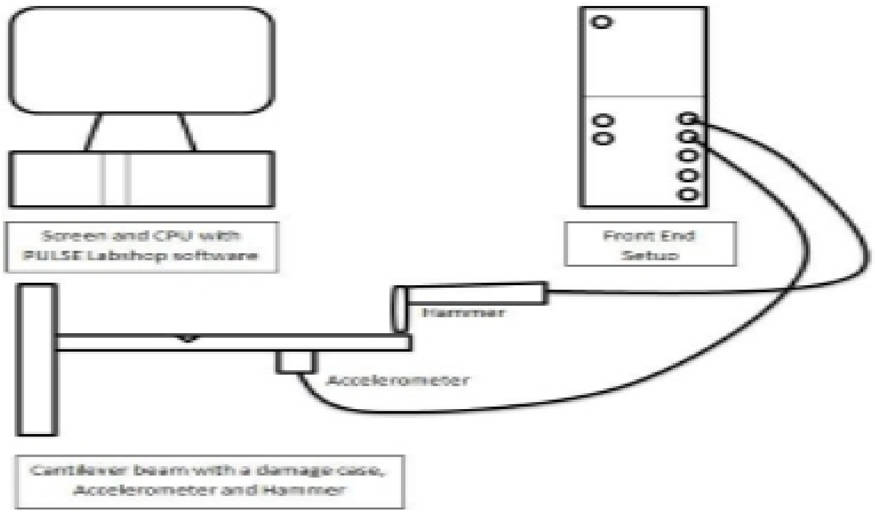

Fig.1. Complete experimental setup with all major parts

2.3. Experimental procedure

First the support condition of the structure is checked and desired degree of freedoms is defined. This study is done by defining three degree of freedoms in beam specimen. The points are defined equidistant. On all these points both the force is applied with hammer and response of structure is measured. We can do this in two ways; either fix the position of accelerometer and move the hammer or fix the point of application of load and move the position of accelerometer. Data is collected on a healthy beam (0% Damage case) at first. After taking these measurements the damage is induced in the beam specimen in a direction perpendicular to longitudinal direction of beam in the form of a vertical groove. The damage is induced in progressive manner in three stages (20%, 40% and 60% Damage case) and the response is measured and saved. While measuring the response of the specimen we have to take care of the coherence value of the structure and it is also measured simultaneously with other readings and is nothing but a qualitative parameter, which shows the quality of the reading taken during the experiment. The cantilever beam setup is shown in the figure 2.

Fig.2. Cantilever beam setup (With an accelerometer and a damage level)

RESULTS AND DISCUSSION

After the measuring response data of the tested beam specimen the data is analyzed. Primarily the data is collected for healthy beam, in other words for 0% damage case. This acts as the reference data for the further analysis of the beam for different damage levels. After this the 1 mm groove is cut which shows the 20% damage case followed by 2 mm groove showing 40% damage case and subsequently 3 mm groove showing 60% damage case is recorded. This data is arranged in a matrix format, known as receptance matrix or frequency response function matrix. Here the data is presented in tabulated manner. The data presented here belongs to first two modes of the beam specimen. Data shows the different elements of a matrix and also shows the modal frequencies of the different damage scenarios, as well as the response are also presented along with it.

As we can clearly see from the table 2 which is the response at mode 1 with different damage cases that there is very little change in the frequency of the structure as the damage is increasing the beam and the data is not reliable for detecting damage in a structure. But in the case of higher mode as the damage is increasing from 0% to 20% there is a significant change in the modal frequency of the specimen. This behavior in the beam of change in modal frequency is also present with the 40% damage case and 60% damage case as well. And these changes in the frequencies are considerable and easily detectable. There is a definite pattern in the results that the change in the modal frequency is increasing with the increasing damage. The change in not so significant in small damage cases and is very less but as the damage is very high this change in the modal frequency is notable.

Finally the data for the higher mode is presented in graph to compare the different damage scenario; here the graph for P22 and P32 is presented. We can compare the data at any given point, like here graph for 2 points are shown. In graph blue line is showing 0% damage, red line is showing 20% damage, green line is showing 40% damage and the purple line is showing 60% damage in the beam. We can clearly see in both the figure 3 and figure 4 that as the damage is increasing in the beam specimen the graph is shifting to the left, it means that there is a change in the modal frequency of the beam with the increasing damage.

Table 2: Response data of beam with different damage scenarios (Mode 1)

S. NO.		MODE 1							
		FREQUENCY(Hz)				FREQUENCYRESPONSE FUNCTION (m/N)			
	POINTNAME	BEAM2	BEAM2 D(1mm)	BEAM2 D(2mm)	BEAM2 D(3mm)	BEAM2	BEAM2D(1 mm)	BEAM2D(2mm)	BEAM2D(3mm)
1	P11	41	41	40	40	4.90m	5.43m	4.59m	5.71m
2	P12	41	41	40	40	3.21m	3.61m	2.39m	3.52m
3	P13	41	41	41	40	1.02m	995u	797u	1.02m
4	P21	42	41	42	42	3.16m	4.18m	2.59m	3.68m
5	P22	42	42	42	42	1.68m	1.62m	1.48m	1.85m
6	P23	42	42	42	42	558u	660u	435u	614u
7	P31	43	42	43	42	832u	996u	971u	1.02m
8	P32	43	43	43	42	659u	831u	480u	415u
9	P33	42	42	43	42	141u	182u	155u	191u

Table 3: Response data of beam with different damage scenarios (Mode 2)

S. NO.		MODE 2							
		FREQUENCY(Hz)				FREQUENCYRESPONSE FUNCTION (m/N)			
	POINTNAME	BEAM2	BEAM2 D(1mm)	BEAM2 D(2mm)	BEAM2D(3mm)	BEAM2	BEAM2D(1mm)	BEAM2D (2mm)	BEAM2D (3mm)
1	P11	269	265	259	252	414u	301u	170u	207u
2	P12	270	265	260	252	305u	370u	232u	126u
3	P13	269	265	259	252	401u	347u	313u	150u
4	P21	276	272	265	256	465u	202u	424u	313u
5	P22	276	272	265	255	286u	256u	244u	148u
6	P23	276	272	265	256	245 u	283 u	263 u	211 u
7	P3 1	276	271	265	253	277u	230u	462u	106u
8	P3 2	275	271	264	255	296u	265	240u	280u
9	P3 3	275	271	264	255	305 u	292 u	267 u	233

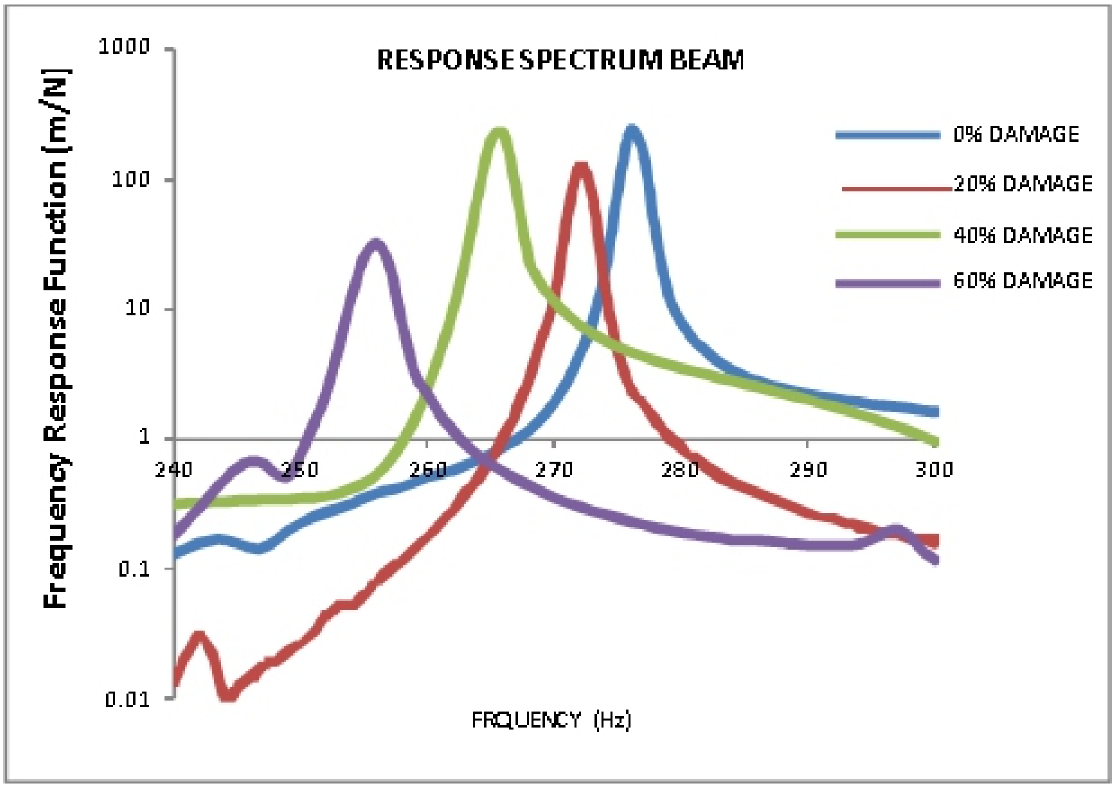

Fig.3. Frequency response function curve (P22) and different damage scenarios

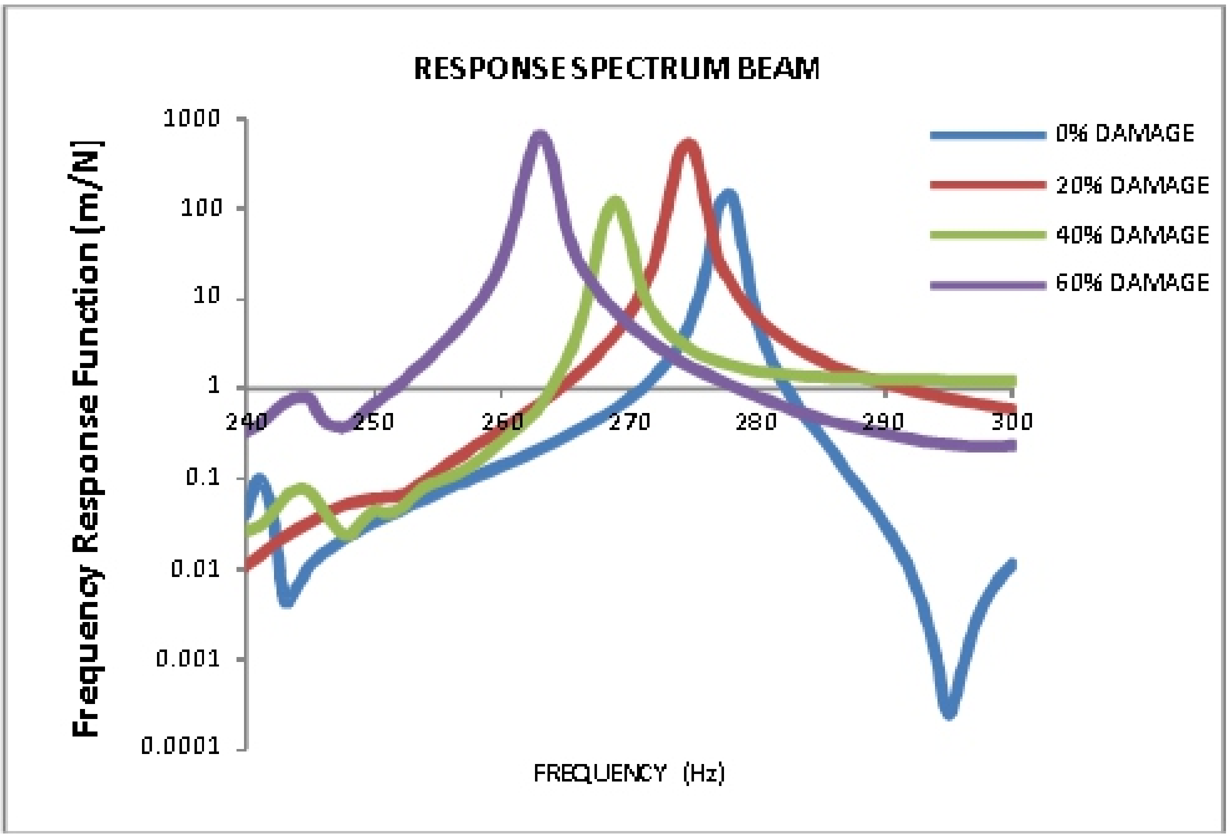

Fig.4. Frequency response function curve (P32) and different damage scenarios

2. As the damage increases in the beam there is an increase in the change in the modal frequencies of frequency response function the cantilever beam specimen, thus we can say that it implies that the increase in the change in frequency shows the increase in the deterioration of the structure.

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Frequency Response Function (m/N)Firstly and most importantly, I would like to thank my parents for their blessing, love and support. I am deeply indebted to my thesis guide Dr. R.P. Sharma, Professor, Department of Civil Engineering, National Institute Of Technology, Agartala for his sincere guidance, valuable suggestion and much appreciated correction at every step of this project work. Finally, I would like to thank the almighty god who helped me to overcome all the problems which came across me during this work.

CONCLUSIONS

From this study of damage detection in cantilever beam specimen we can bring out following conclusions:

1. The method is completely successful and reliable in detecting damage in a steel structure as the experiment is being done on a mild steel beam.

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Comparative Study of Responses of Symmetric Composite Plates under Different Loading Conditions

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ABSTRACT

The increasingly high demand placed upon the performance of laminated structures means that the design envelops for composite structures should be carefully developed. The unavailability of a robust failure criterion for composites makes it difficult to summarize the analysis procedure and their estimated life. In the view of significant increase in application of FRP composites this paper is an attempt to study the responses of symmetric composite for different loading conditions. In this paper the composite laminated plate is modeled in ABAQUS software with hinged end support all along the edges under varying load. Comparison of the induced bending stress and resulted maximum deformation is done in different fiber reinforced composites and then an attempt is made to find out the most effective symmetric laminate and after the analysis some fibers are found to be more efficient in load carrying capacity than the others for a certain loading condition.

Keywords - FRP Composite, ABAQUS, Laminate, Robust.

I. INTRODUCTION

Widespread engineering and high performance structural applications have made fibre reinforced composite materials ubiquitous in the present century [1]. These materials possess attractive mechanical properties for designers and manufacturers. Especially thanks to its light weight, high specific strength and specific modulus, corrosion resistant, good fatigue properties and the ability to tailor the properties in required direction as per the application[2].In civil engineering, structural application composites are generally used in the form of plate either with hinged support or fixed end connection. These plates can be subjected to any type of loading be it uniform bending or a complex set of loading condition. Since structures constructed of composite laminates may accumulate impact damage, such as delamination and transverse cracks, knowing their full potential becomes an essentiality in every single design case before using them that is their maximum load carrying capacity[3,4].The properties of a composite material depend on the properties of the constituents which are essentially the fibers and matrix, their geometry, and the distribution of the phase. The constituent parts of the structural components manufactured from these composite material systems are usually subjected to complex loading that leads to multi-axial stress and strain fields at critical surface locations [5].In order to ensure satisfactory performance over the predefined service period and to avoid the use of high safety factors to cover the high level of uncertainty these stresses and corresponding strain has to be analyzed carefully and also the failure criteria has to be understood for each composite plate that are exposed in different boundary condition. The response characteristics depend on the fibre and matrix material, the curing process, ply orientation, stacking sequence, inherent lamina and laminate level flaws introduced during the manufacturing process [6]. Hence, the analysis of these structures becomes very challenging. Linearized elastic model is employed throughout this study. It is shown that with proper model selection and mesh design, accurate computation of the desired response quantities is possible [7, 8]. Dispersion in the data can severely alter the critical response characteristics of a structure. Therefore, main purpose of this paperlies in comparing the bending stress induced and resulted maximum deformation in different fiber reinforced composite plate.

II.NUMERICAL INVESTIGATION

2.1. Material Properties and Loading

Laminated structures commonly have geometries with thicknesses small relative to their lateral dimensions. A symmetric composite thin plate consisting 3 layers [002 /900] is taken. The inter laminar boundaries that are the surface of abrupt discontinuity in material property are usually the sites of failure initiation [9]. So in this study interface is considered to be a rough interface (no slip) and the end support is hinged. A plate of 5 m in length, 2.5 m in breadth and of 1 cm thick is taken.

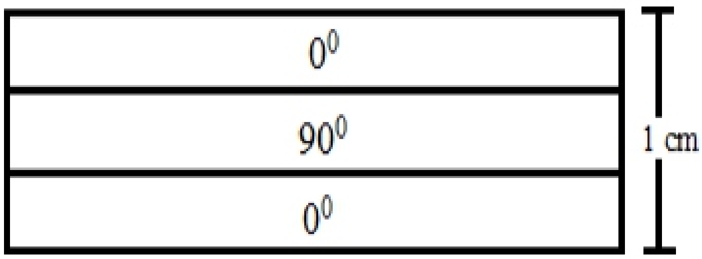

Fig.1. Composite plate layered up

This composite plate is assigned with following fiber given in Table 1[10]. One by one these composite materials are assigned and was analyzed.

Table1: Material Property of Composites taken

Properties	Glass- epoxy	Carbon- epoxy	Aramid- epoxy	Boron- epoxy
E1 (Gpa)	60	140	95	210
E2 (Gpa)	13	11	5.1	19
G12(Gpa)	3.4	5.5	1.8	4.8
μ12	0.3	0.27	0.34	0.21
σ1+ (Mpa)	1800	2000	2500	1300
σ1– (Mpa)	650	1200	300	2000
σ2+ (Mpa)	40	50	30	70
σ2– (Mpa)	90	170	130	300
τ12 (Mpa)	50	70	30	80

Total analysis was carried out in ABAQUS software [11]. The plate is modeled taking one composite at a time and was analyzed under different loading stated in the table below.

Table2: Types of Loads Used in Analyzing the Composite Plate

Types	Uniform moment	Concentrated Force	Uniformly distributed force
Load	1 KN-m	10 KN	1 KN/m^2

Uniform moment is applied along the edges, concentrated force is applied at midpoint of the plate and an uniformly distributed loadon top surface of the plateconsidering 8 nodded element[12]. Loads were so applied keeping the fiber strength and failures of fibersin mind [13,14].

III. RESULTS AND DISCUSSION

3.1. Bending Stress Distribution

In case of a plate element bending stress induced in it gives a good indication of its load carrying capacity, so much of the importance is given towards the bending stress of the plate[15]. Distribution of the bending stress over the plate remains same for all the composite for particular loading [17].

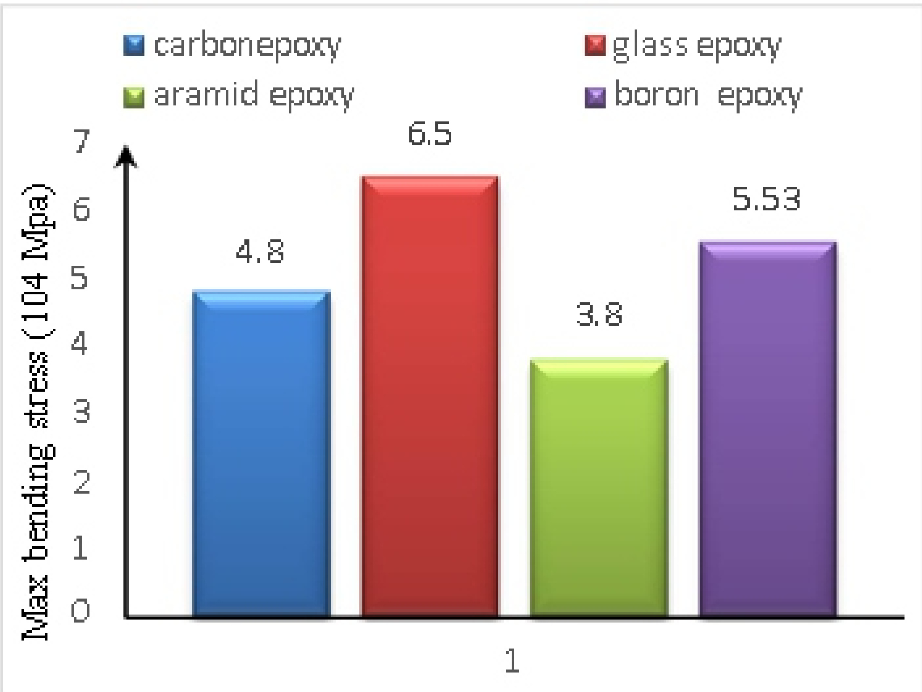

Fig.2. Comparison of max bending stress among the composites for uniform moment of 1 KN-m

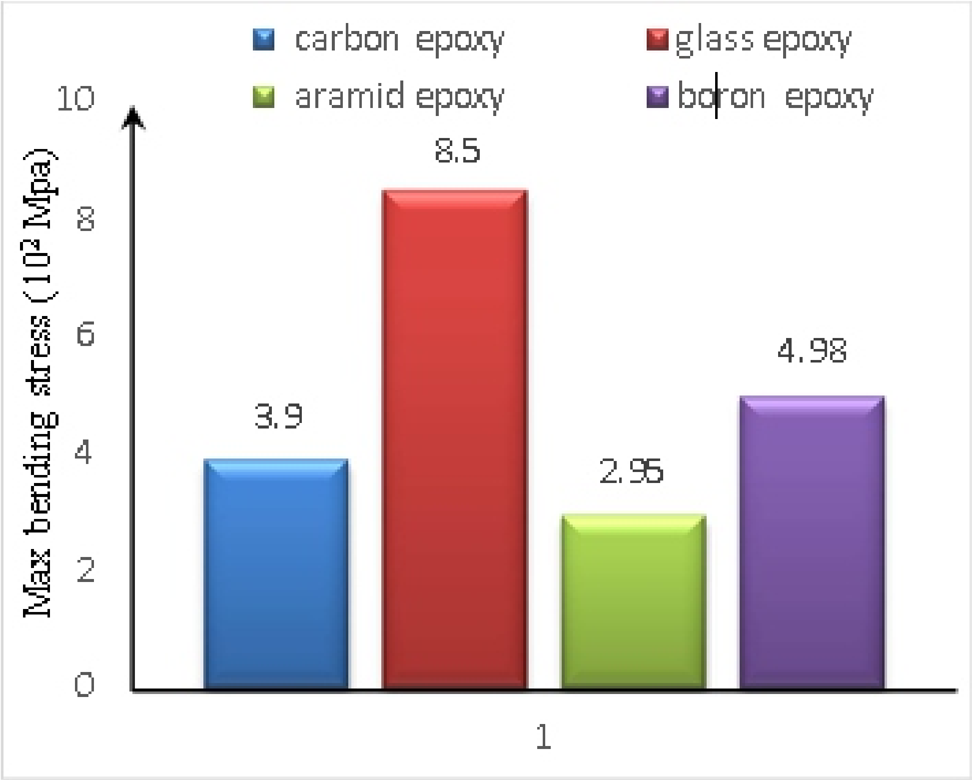

Fig.3. Comparison of max bending stress among the composites for a concentrated load of 10 KN

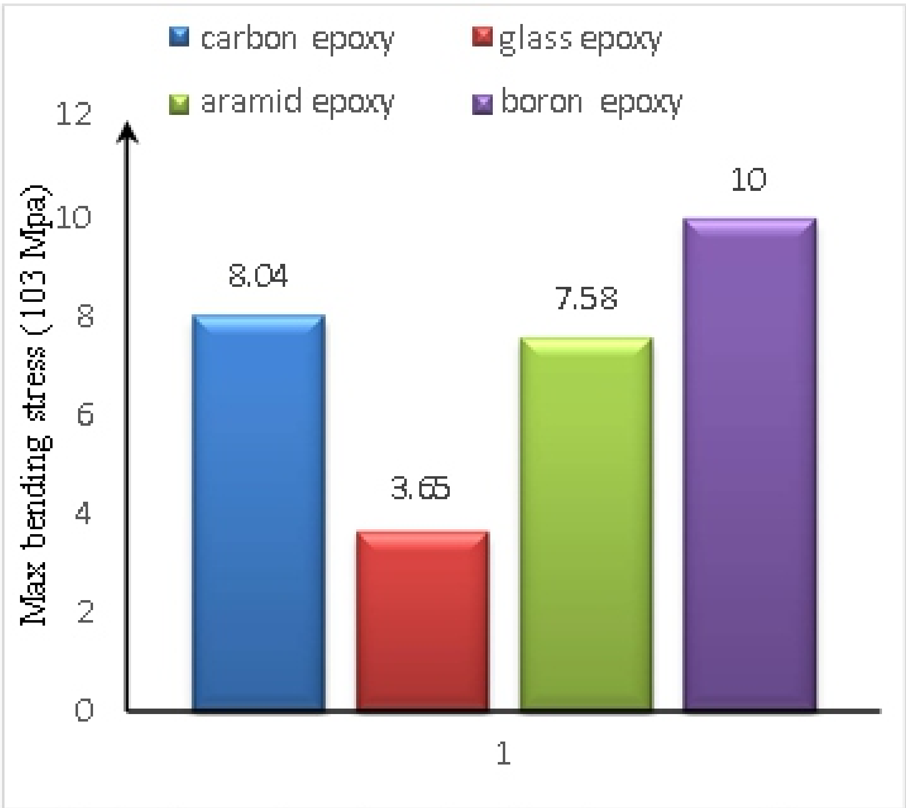

Fig 4 . Comparison of max bending stress among the composites for auniformly distributed load (udl) of 1 KN/m2

3.2. Maximum Deformation

Deformation is one criterion that plays a significant role for any composite to be selected for a particular case [16].

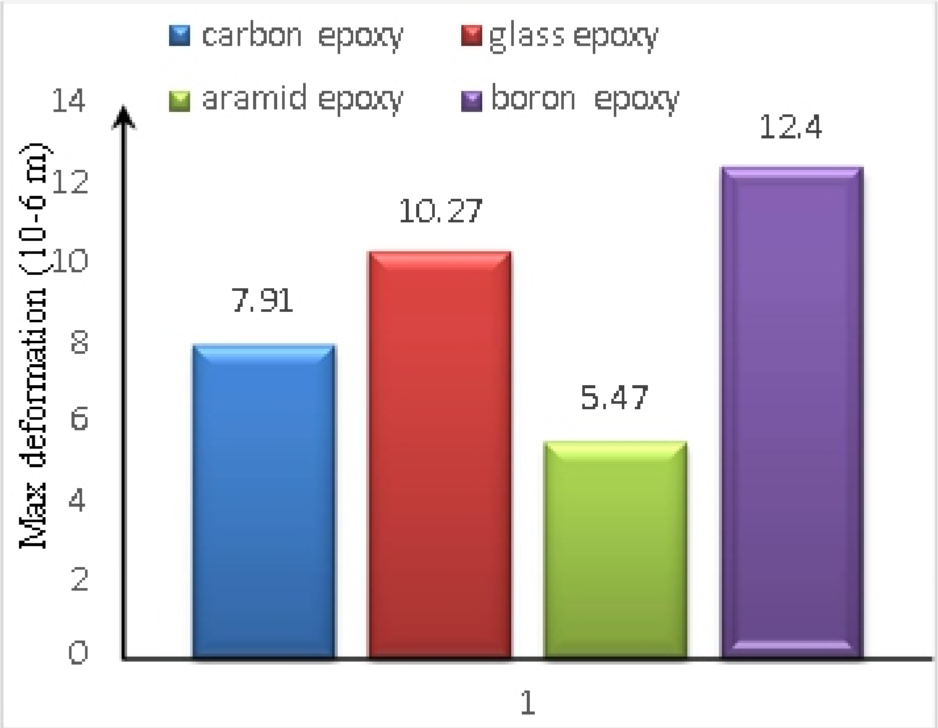

Fig.5. Comparison of max deformation among the composites for uniform moment of 1 KN-m

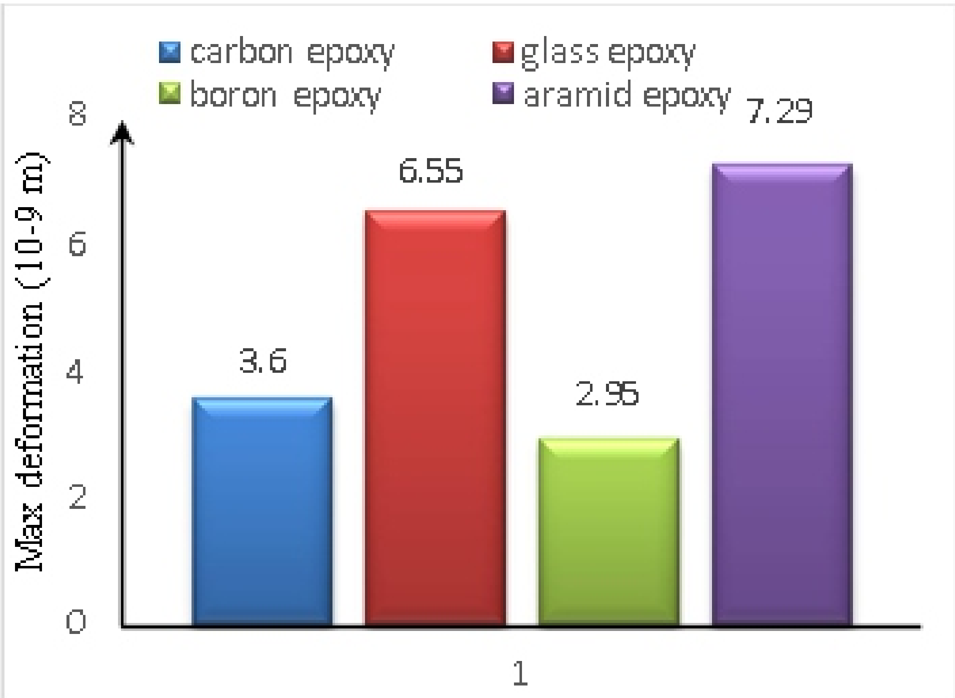

Fig.6. Comparison of max deformation among the composites for a concentrated load of 10 KN

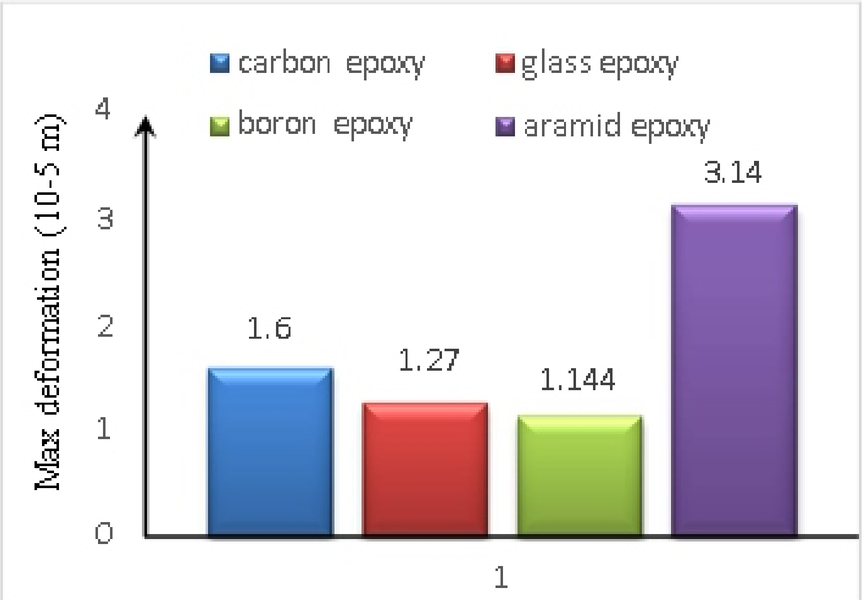

Fig.7. Comparison of max deformation among the composites for audl of 1KN/m2

CONCLUSIONS

Following conclusions are drawn from the results obtained from the numerical analyses:

In the case of bending stress resistance

i) Boron-epoxy combination is found to be most effective for uniform bending.

ii) Aramid-epoxy combination is found to be most effective for concentrated force.

iii) Glass-epoxy combination is found to be most effective for uniformly distributed load.

Plate with Boron-epoxy combination shows least deformation among the composites compared in this study.

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