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Predictive Structural Health Monitoring for Large Bridges Using Sensors

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Abstract

Bangladesh is a developing country where bridges are a crucial part for daily transportation. Unfortunately, Bangladesh's geological location makes it a hotspot for various natural calamities which can eventually compromise the longevity of various infrastructures over time. Therefore, structural health monitoring becomes a crucial factor for improving the longevity of structures and avoiding disasters of large magnitudes. Thanks to the emerging advancements in technology, there are various tools and sensors which allows for monitoring of specific factors which can help predict distress within a structure. Such integration can help engineers to monitor the conditions of structures and can allow them to intervene at the correct time to avoid collapse and further damage. The case studies reviewed in this research paper which used predictive structural health monitoring solutions like the Geumdand Bridge of South Korea and the Tamar Bridge in United Kingdom (UK) showed significant improvement of longevity, safety and condition monitoring. With the correct integration of appropriate structural health monitoring sensors like tilt sensors, orientation sensors, strain sensors, temperature sensors etc. can gather appropriate data which can be processed using a capable machine learning algorithm like Random Forest or similar algorithm to give accurate readings of structural integrity status and give early warnings regarding possibilities of a structural collapse. This research papers explores this integration in a more dynamic manner by integration an EWS system and hopefully sheds light in the importance of structural health monitoring for large complex bridges and implementation of an early warning system (EWS).

Keywords

Structural Health Monitoring (SHM); Early Warning System (EWS); Structural integrity; Machine learning algorithm; Structural integrity; Transportation; Public safety; Random Forest (RF); IoT (Internet of Things) sensors; Thermal stress; Predictive maintenance; Bridges; Dynamic monitoring

1. Introduction

Structures like bridges and buildings have a tendency to weaken over time. Environmental factors and proper integration of architectural techniques are crucial for developing a sound foundation for long lasting structures. Bangladesh is unfortunately lagging behind in modern technological and sustainable implementations compared to other countries. Although, Bangladesh has recently started to adopt modern tools like Artificial Intelligence (AI) to promote improved sustainability and production practices; structural health monitoring remains widely unexplored. Bridges tend to weaken as time passes by. As bridges are often used by people from all walks of life, a disaster from a weakened bridge falling apart can cause devastating loss of lives and can weaken the economy based on importance of trade route [1]. Throughout history, there have been many structural failures of bridges that took lots of lives and caused severe economic and even political concerns. The insurance of structural integrity of structures like bridges should be given high importance especially in Bangladesh. Advancements in IoT sensor technologies and AI algorithms have paved the way for modern and dynamic solutions in this regard. Although, the implementation of structural health monitoring systems can be expensive; it can widely guarantee the safety of bridges which can greatly improve its durability and longevity. IoT sensors like strain gage, tilt sensor, pressure cell etc. can be used to keep track of various aspects of the bridge. These sensors can give real-time information about the condition of the bridge. Thus, allowing engineers to tend to repairs as soon as an issue is detected [2]. For monitoring various aspects like corrosion, structural strain, water damage, structural cracks etc. an appropriate sensor can be used. Such data transmission can be significantly improved with the implementation of wireless sensors. There are several manufacturers which produces and deploys all sorts of structural health monitoring sensors, allowing a variety of options to choose from. Coupled with an early warning system or EWS; the effectiveness of structural health monitoring could be increased even further. Such implementations can greatly help improve the longevity and quality of bridges in Bangladesh; hence decreasing the possibility of loss of lives and adverse economic impact.

1.1 Background and Context

The safety of transportation and the public are a great concern if proper structural health monitoring is not implemented. Bangladesh has a population of at least 175 million people with a growth of approximately 1.22% every year. Bridges in Bangladesh are a crucial part of daily life as literally millions of people are dependent on them. A disaster of a well-known and widely used bridge can take the lives of many people. Bangladesh is not new with bridge disasters as many of the bridges in Bangladesh are poorly engineered, usage of low quality / subpar materials and lack of structural health monitoring sensors. The collapse of a widely used Bailey Bridge in Tongi was recent which took place in December 21, 2024. According to reports, a truck fell in the Turag River as a result of the collapse. Another disaster was the collapse of Hasanhat Bridge (also a type of Bailey Bridge) in 2022 which also caused severe problems as the route was widely used by locals [3]. These structural failures of bridges cause huge problems as lots of funds are required to make repairs and compensate for the casualties. The lives lost in such incidents are often high in number. However, the previous 2 Bailey Bridge examples faced no reported losses of lives. It would seem that an integration of structural health monitoring could be very effective as it can notify engineers about early stages of structural failure signs. Bridge collapses can be extra dangerous in populated countries like Bangladesh; as it often collapses during peak usage [4]. Although there has not been a large number of casualties from bridge collapses, the lack of structural monitoring systems could lead to a massive disaster in the future. In June 23, 2024; a busy bridge collapsed in Bangladesh's Amtali, Barguna which killed at least 9 people. The collapse of the bridge could have contributed to far worse circumstances. The primary goal of SHM is to monitor and detect the condition of bridges in real-time, which could have easily averted the previously mentioned disasters. At the very least, could have contributed in lessening the casualties and economic losses.

1.2 Scopes and Objectives

According to various sources regarding structures and buildings, Bangladesh has at least 4,500 bridges spanning across the country. Out of those bridges, there are at least around 500 Bailey Bridges. Structural integrity failure is a crucial concern with the large number of bridges present in a small country like Bangladesh [5]. Not to mention the poor practices of construction of bridges alongside poor quality of raw materials, structural health monitoring is of crucial importance. This research paper aims to reach some objectives in the context of structural health monitoring of bridges using IoT sensors. They are given below accordingly:

1) Explore a solution using structural health monitoring or SHM sensors for real-time dynamic monitoring of large bridges.

2) Understanding the effectiveness of structural health monitoring or SHM in predicting structural damage and failures.

3) Integration of structural health monitoring or SHM with an early warning system or EWS.

The above scopes and objectives mentioned can shed light about how Bangladesh can implement predictive structural health monitoring in large bridges to avoid disasters. Furthermore, it can help formulate insights into how effective structural health monitoring is when it is coupled with an early warning system.

1.3 Rationale and Novelty of the Research

The research conducted in this paper is to explore the effectiveness of predictive structural health monitoring in large bridges. In Bangladesh, there are lots of bridges and application of appropriate solutions in this regard is vital in securing the longevity and predictive maintenance of widely used bridges [6]. Although the research conducted in this regard is qualitative, it is sourced from verified and tested data which is reliable. Furthermore, the IoT sensors that can be used for predictive structural health monitoring or SHM can be capable of giving real-time data and dynamic monitoring. Using an appropriate algorithm to process that data, an early warning system or EWS can be integrated for warning notification. In the methodology section of the study, the dynamic nature of the suggested solution can hopefully be appreciated. Bangladesh needs a dynamic solution that can adapt to changes as structural health monitoring or SHM can be very effective in averting and predicting structural failures.

2. Literature Review

Bridge construction can be tricky and the application of proper architectural techniques combined with high quality materials is crucial for constructing a sound bridge infrastructure [7]. Bridges are essential for physically linking one place to another. There are several places in Bangladesh where people cannot pass without large bridges. A notable example would be the *Padma Bridge*. Widely regarded as the bridge without which the Padma River cannot be crossed, it is a vital bridge for transportation which connects Bangladesh's southwest region with the capital (Dhaka City). Many other places where Bangladesh remains separated geologically by large water bodies, bridges remain an important access point. In terms of economy and transportation, bridges have a severe impact on facilitating trade and business according to a verified report sourced from *Al Jazeera*. Bangladesh faces bridge collapses regularly. According to a report sourced from *The Daily Star*, at least around 10 iron reinforced bridges over several canals have collapsed from 2024 to 2025 in a span of only 8 months; roughly affecting the lives of at least 65,000 people approximately. Since, there are more than 4,500 bridges in Bangladesh; the risk factor remains high, further highlighting the importance of structural health monitoring for predictive maintenance and avoidance of structural failure [8]. There are several factors that can cause structural compromise of bridges. Often times the issues remain undetected and continues to get worse over-time, resulting in an unavoidable disaster. Environmental factors, continual accumulation of load, lack of maintenance, poor engineering designs etc. are all factors that can greatly contribute to a collapsing bridge or a soon-to-be collapsed bridge. According to another report presented by *The Daily Star* in April 14, 2024; 3 out of 5 Bailey bridges in Kalihati upazila are in terrible condition and it's a disaster waiting to happen. More than approximately 3,000 vehicles of different masses are crossing the bridges every day. Which indicates that thousands of students are using those bridges as well. The supporting structure of the *Meghakhali Bridg*e have been reported to be damaged in at least 3 locations and continually gets worse as time passes by. The signs of damage are so severe that it is visible even to an untrained eye. It is easy to understand that the integration of structural health monitoring sensors could have long ago notified the early signs of damage and corrosion [9]. Bailey bridges in general should be replaced with a proper bridge as soon as possible as they are meant to be used temporarily. It seems Bailey bridges are prone to collapse as they are not meant for permanent usage, but Bangladesh has over 500 of these types of bridges. There are many factors which can contribute to structural failure of large bridges. A 3D pie chart has been given below in the mentioned context.

The Figure 1 below in the mentioned context represents the most common factors that contributed to large bridge collapses from 2012 to 2022 respectively. The diagram clearly shows that the leading cause of bridge structure collapse is during construction (28.70 %). Following the correct construction steps are crucial and usage of proper high-quality materials is a must as it is closely related with public safety and transportation [10]. Factors like design flaws, construction mistakes and other unpredictable circumstances can all contribute to a bridge falling apart during construction stage. According to another report from *The Daily Star*, a concrete reinforced bridge in Narsingdi Sadar Upazila's Chardighaldi union collapsed during construction stages in December 18, 2023. The investigation revealed that the collapse occurred mainly due to usage of low-quality materials. Furthermore, the tides near the bridge supports weakened the bridge even further; contributing to the eventual collapse. The damage of the bridge affected at least 20,000 people from 7 different villages and remained unrepaired for half a year.

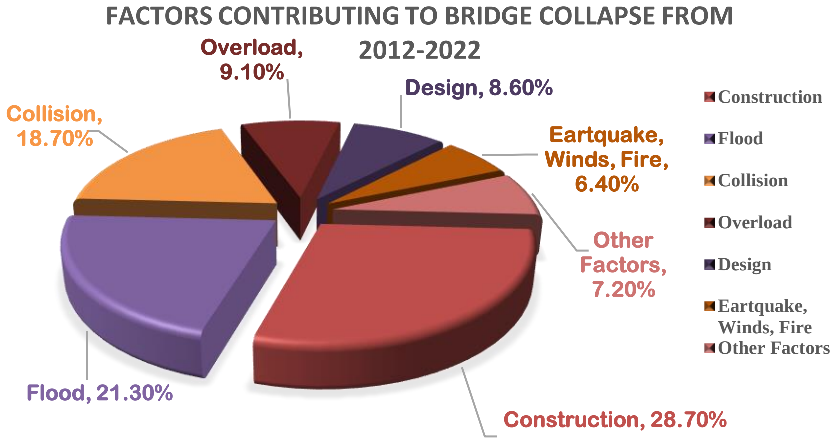


Figure 1. Factors Contributing to Collapse of Bridges Around the World (Source: ResearchGate.net, 2022).

The Figure 2 shows the impact of humans in contrast to natural factors in terms of bridge collapses. It is clear that human activities contribute to bridge collapses far more than natural causes. Even though the previously discussed Figure 1 indicates Floods (natural factor) as the second largest contributing factor to bridge collapses with 21.30 %, other factors like construction, collisions, overload, design etc. are all man-made causes. Hence, strongly suggesting that natural causes are NOT the primary reasons for bridge collapses [11]. Therefore, monitoring of structural health of bridges is of outmost importance. It can help track of both natural and human activities on the bridge via sensors. Almost all of the factors mentioned in the previous Figures 1 and 2, could be monitored via sensors (preferably wireless).

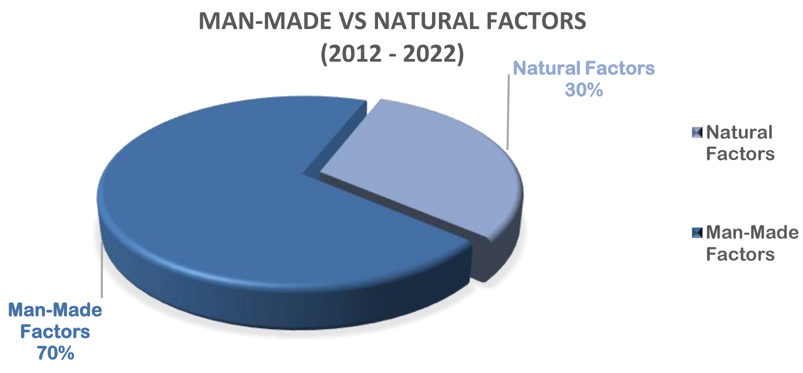


Figure 2. Contribution of Man-made VS Natural Factors in Bridge Collapses (Source: Researchgate.net, 2022).

2.1 Case Study 1: SHM Integration of Geumdang Bridge in South Korea

South Korea has made rapid advancements in structural monitoring and construction technology. The Geumdang Bridge location in Icheon is vital for South Kerea's economy and transportation. The bridge consists of mainly 2 structural systems which are called northern span and southern span respectively. The northern span is supported by 4 pre-cast concrete beam sections and the southern span consists of 3 concrete piers. In order to monitor the condition of the bridge, several wireless PCB Piezotronics 2801 accelerometer sensors with 0.7 V/g sensitivity were installed strategically throughout the bridges.

The Figure 3 below shows the placement of the mentioned sensors for structural health monitoring of the bridge. The sensors have been placed along the length of the bridge and can wireless emit data for real-time monitoring. Allowing engineers to tend to repairs and adjust accordingly. Making the SHM solution highly reliable due to data gathered using 14 low-cost sensors. This not only lowered maintenance costs, but also greatly improved the safety of the bridge. Due to accurate readings and dynamic condition monitoring, the bridge has experienced Zero damages which highly reduced costs by up to 40% within the last five years respectively [12].

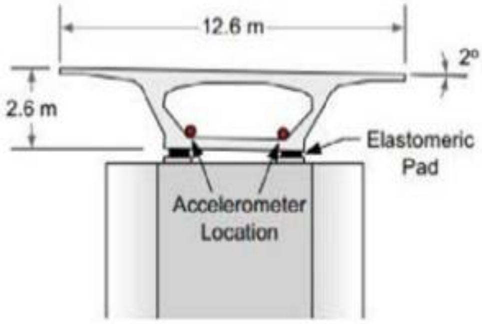


Figure 3. Geumdang Bridge Accelerometer Placement Locations (Source: Researchgate.net, 2022).

2.2 Case Study 2: SHM Integration of Tamar Bridge in England (UK)

England is also highly advanced in terms of monitoring technology. The iconic Tamar Bridge situated in Southwest England has all sorts of sensors monitoring various factors about the bridge [13]. Structural health, cable tension/loads, temperature readings and wind speeds are all monitored using SHM monitoring technologies developed by Fugro Structural Monitoring Engineering Company.

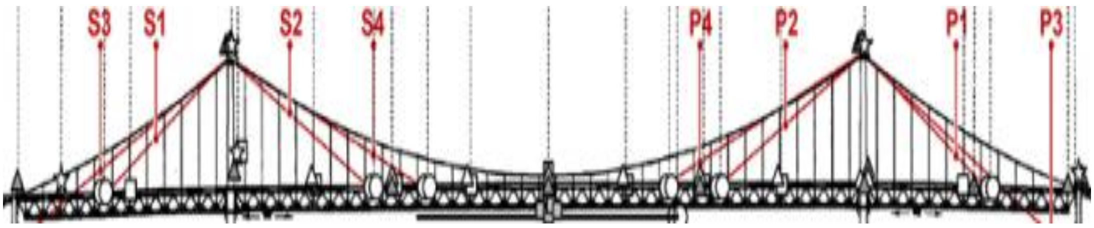


Figure 4. Sensors Placement in Tamar Bridge in England (UK) (Source: Researchgate.net, 2022).

The Figure 4 above shows the placement of sensors used for SHM, which was part of an IoT-based dynamic monitoring system project called "BridgeWatch" [14]. The data gathered by sensors are also mostly done wirelessly. There are 4 main sensors used in Tamar bridge for predictive SHM. A vertical displacement sensor to monitor any unnatural displacement, a temperature sensor for the main cable and steelwork deck, extensometers for measuring loads exerted on the bridge and a tower displacement measurement sensor to detect any unnatural swings or movement of the bridge. All these sensors help the engineers to perform dynamic maintenance which greatly mitigates risk and extends the lifespan of the bridge.

The case studies and literary reviews of bridge collapses and SHM integrated monitoring shows the effectiveness of IoT sensors to keep track of various aspects of bridges. Bangladesh can adopt some of these ideas to ensure public safety and proper transportation system throughout the country [15]. The Bangabandhu Bridge of Bangladesh utilized SHM sensors to detect cracks, however; there are various other large bridges which remain devoid of SHM technologies. Furthermore, integration of EWS with SHM could help prevent a disaster before it happens.

2.3 Research Objectives

Upon the review of literature, it is easy to realize that bridge collapsing is a severe problem that requires a dynamic solution for improved public safety and transportation. The solution can be easily obtained via IoT sensors that can monitor and detect the condition of the bridge in real-time. In the context of predictive structural health monitoring with EWS integration for large bridges; some research objectives have been given below accordingly:

1) Integrate a dynamic solution using SHM IoT sensors which can be used for a large bridge in Bangladesh.

2) Analyze the effectiveness of the proposed methodology in terms of predictive structural health monitoring or SHM in the mentioned context.

3) Formulate some recommendations to further improve the findings and concepts.

The above-mentioned research objectives can help reach a possible solution which can be used practically to successfully monitor bridge health in Bangladesh and prevent disaster and improve public safety and transportation.

3. Research Methodology

Advancements in various realms of technology has paved the way for development of highly efficient monitoring technology. It has been established that the public safety and transportation of Bangladesh remains uncertain due to lot of factors as previously discussed. With the aid of proper monitoring technologies and processing algorithms, the safety of large bridges in Bangladesh can be secured [16]. This methodology will adopt a qualitative approach, using verified data to perform analysis which can ensure effective results. The methodology has been proposed in the context of Meghna Bridge (also referred to as Japan Bangladesh Friendship Bridge) for acute monitoring of factors that are crucial for bridge health and longevity. The proposed methodology suggests the usage of wireless IoT sensors to gather data about temperature and tilt axis values of the bridge [17]. The data is then wirelessly sent to a server where it is stored and monitored. Additionally, an integration of an EWS alarm can be added for notifying about a disaster in a timely manner to minimize loss of life and overall damage. The data gathered can be processed by an appropriate machine learning algorithm like Random Forest.

3.1 Data Collection

The Megna Bridge is iconic in Bangladesh and considered as one of the most important bridges in the country. Being such an important factor for public transportation and business, a dynamic solution using SHM can be implemented for predictive structural health monitoring [18]. For keeping the solution simple and effective, the proposed methodology suggests using 2 sensors for gathering data: a temperature sensor and a tilt sensor. More details regarding these sensors and their implementation have been given below:

Figure 5. Temperature Sensor (Encardio Rite Model ETT – 10V) (Source: Encardio.com, 2025).

The above sensor shown in Figure 5 is a highly accurate temperature sensor specifically made for structural health monitoring of concrete reinforced structures. Which is excellent for gathering crucial data of Meghna Bridge. The sensors must be placed along the internal cross-section of the bridge for accurate monitoring [19]. Temperature is a crucial factor for monitoring bridge health as expansion/contraction, internal stress and deformation can cause a large bridge like Meghna Bridge to collapse. The temperature sensors can be coupled with a wireless data transmitter to send data to the main server for monitoring, processing and storing.

Figure 6. Wireless Tilt Sensor (Encardio Rite EAN – 95MW) (Source: Encardio.com, 2025).

The sensor shown in the above Figure 6 is a high precision tilt sensor capable of sensing unnatural changes in tilt orientation of structures, especially bridges. The Meghna Bridge is 930 meters long and was built to last a long time. As bridges get used, some small deformation or other unpredictable factors can cause the bridge to slowly incline which can remain unnoticed until a disaster happens. Therefore, a tilt sensor can collect valuable data about the bridge wireless and can notify engineers about a progressively declining angle. Furthermore, the damages from an aftershock of an earthquake can be easily assessed thanks to this sensor.

3.2 Data Pre-processing

The data gathered by the 2 sensors must be pre-processed before data analysis:

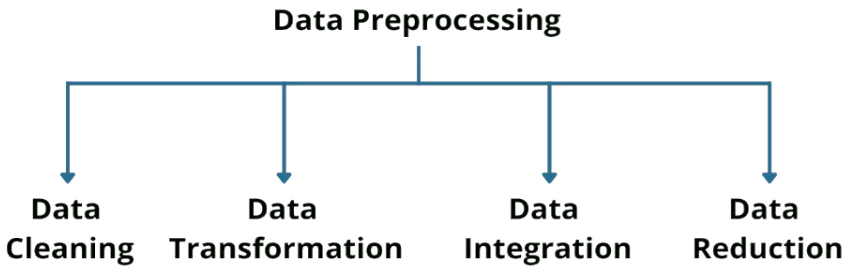


Figure 7. 4 Steps of Data Pre-Processing (Source: DataBaseCamp, 2024).

The Figure 7 from above shows the 4 crucial steps of data pre-processing. As SHM system will be combined with an EWS alarm, refined data is required to avoid false alarms and improve accuracy [20]. In the first step of data pre-processing, the data needs to be cleaned by removing potential duplicate data and omitting missing values. Then the data can be transformed by applying scaling and encoding techniques to make the data readable by a machine learning model. The next step is to join and merge the data for more efficient processing; a step commonly known as data integration. And finally, the filtered data is reduced for maximizing efficiency by sampling and dimensionality. These steps ensure the integrity of the gathered data which results in accurate outputs.

3.3 Data Analysis

As previously stated, temperature plays a vital role in ensuring bridge longevity as it is connected with deformation, internal stress and expansion/contraction. The data gathered can be used to make a monitoring graph. An example from existing data of temperature of Meghna bridge in 2023 during summer has been given below in relation to the context:

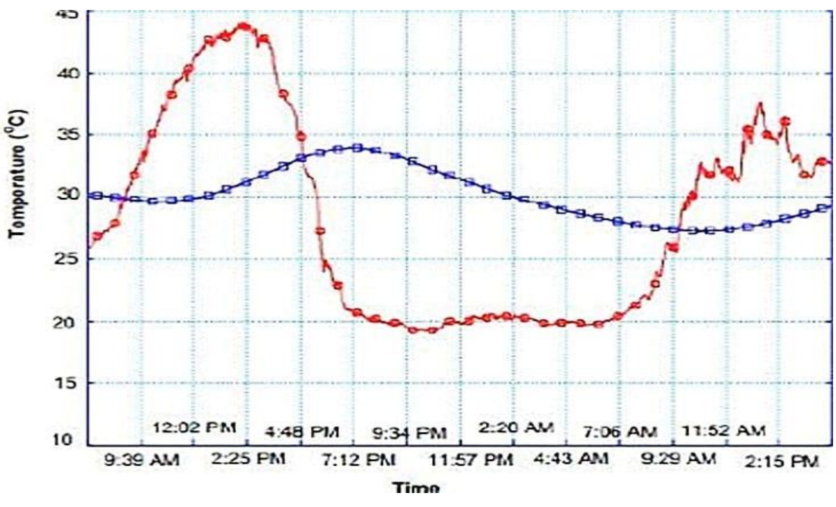


Figure 8. Temperature Analysis Graph of Meghna Bridge Using Temperature Sensors (2023) (Source: ResearchGate.net, 2023).

As the sensors send data from real-time monitoring of temperature as seen from Figure 8, the data can be used to make a graph to record and analyze the structural health of the bridge. Where blue line is the bottom placed temperature sensor and red line is the top placed one. If any anomalies are detected, the analyzed data can suggest if the bridge needs maintenance. The data stored in the server can also be periodically monitored to understand the predictive status of the bridge as heat during summer can cause deformation and stress.

Tilt in bridges can be tricky to monitor, as a decline in the initial angle of the bridge can change very slowly overtime [21]. The proposed tilt sensor can dynamically gather data and keep the engineers and maintenance crew updated about the exact tilt angle of the bridge. The data analysis of gathered data can reveal the tiltmeter threshold value which in denoted by θ angle:

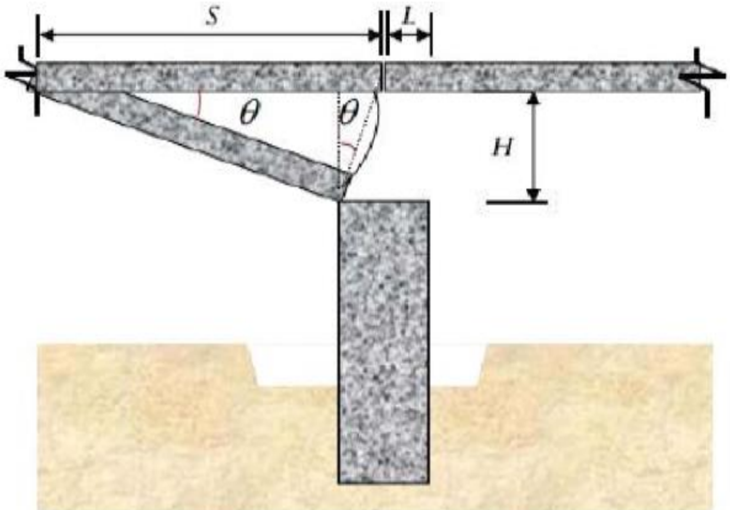


Figure 9. Tilt Analysis of Meghna Bridge Using Tilt Sensors (Source: ResearchGate.net, 2023).

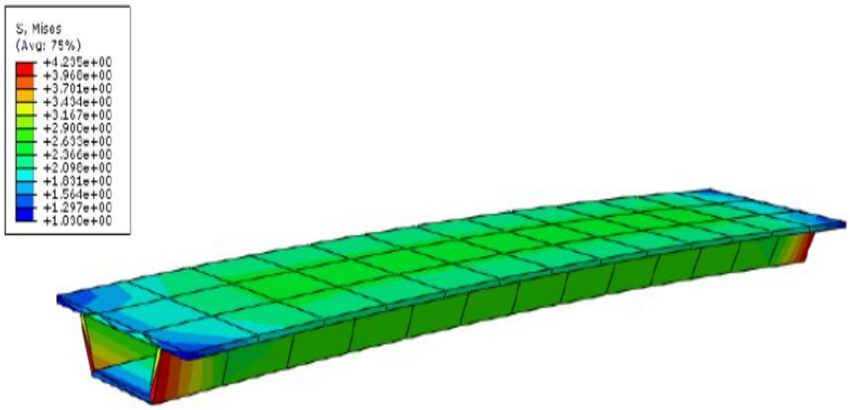
Figure 9 shows how the ideal tilt angle for a sturdy bridge. It is crucial that the angle of inclination is at its ideal spot. The tilt sensor mentioned earlier can monitor this tilt value in real-time to analyze the ideal tilt angle. Meghna bridge is highly used and a gradual decline in tilt angle can happen slowly. The data gathered by the sensors can be analyzed by an appropriate machine learning algorithm like Random Forest to perform predictive analysis of a possible disaster. Coupled with an EWS alarm, the SHM system can possibly save lives and reduce damage done. Random forest has been specifically chosen for the algorithm's ability to outperform other algorithms like decision trees, neural networks etc. in the realm of predictive data analysis. While neural networks are sophisticated and dynamic, random forest still maintains high accuracy without being too complicated to integrate. Random forest is perfect of structural health monitoring and EWS integration as it has the ability to handle vast amounts of data even in real-time; allowing for better dynamic predictive analysis.

4. Results and Discussion

In the context of predictive structural health monitoring, Bangladesh needs to adopt a dynamic solution that can help with predictive and active maintenance of large bridges. Upon the review of literature, it is clear that bridge collapses are a problem world-wide and Bangladesh in particular has low standards in bridge construction and condition monitoring [22]. The proposed methodology suggested dynamic monitoring using only 2 types IoT sensors. The sensors are to be used in multiple areas of the bridge as discussed previously for accurate monitoring. As a result of the proposed implementation, the findings and results have been discussed below in brief based on qualitative data in the mentioned context:

(1) Accurate Temperature Monitoring

The suggested temperature monitoring sensor has the ability to accurately monitor temperature readings of both top and bottom surfaces of the Meghna Bridge. The data gathered can be analyzed to find out abnormal thermal stresses and deformations, resulting in accurate temperature monitoring of the bridge. Using ABAQUS Software, a simulation model can be rendered for in-depth findings:



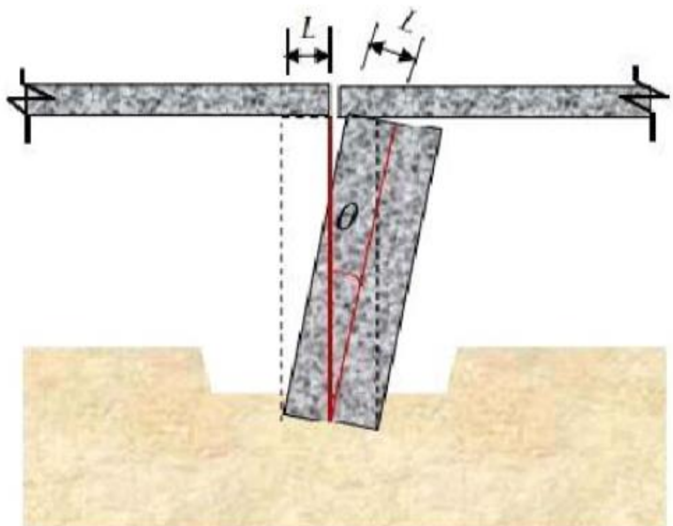
Temperature Range* = *+1.030e + 0O* *to* *+4.235e + 0O

Figure 10. Thermal Stress Findings from Temperature Sensors of Meghna Bridge in Summer Time (Source: ResearchGate.net, 2023).

The above Figure 10 shows the thermal stress findings of the Meghna bridge from data collected by the temperature sensors which were analyzed and 3D rendered using ABAQUS Software. The warmer colored sections on the diagram represents hotter temperatures and cooler colored sections represents lower temperatures in degree Celsius (°C), The findings not only allow for accurate monitoring of temperature, but also allows for predictive stress analysis for advanced maintenance. According to the thermal stress readings, the top surface temperature was around 44°C (317 K) and the bottom surface temperature was around 31°C (304 K) in 12:25 PM during April of 2023. The deformation scale factor according to those readings were + 3.807e + 01; which indicates thermal stress was indeed detected.

(2) Acute Tilt Angle Monitoring

The highly sensitive and accurate tilt angle sensors can dynamically send data about the tilt action of the Meghna bridge if implemented. The data can be stored and monitored which can allow for findings of tilt action decline from its initial stages.



θ= Tilt Angle

L= Length from center of the bridge to the initial pillar position

Figure 11. Tilt Angle Deviation Sensed by Tilt Sensors of Meghna Bridge (Source: ResearchGate, 2023).

Tilt angle deviation from the initial value can indicate a possible issue with the structural health of the bridge as seen in Figure 11. The deviation from the initial angle θ means the ideal tilt angle of the bridge is changing. Based on these findings, engineers can tend to the issue right away as a means of predictive structural health monitoring [23]. The decline of θ angle can dramatically worsen during busy hours of the bridge. Hence, the findings can provide valuable insights for the perfect time to do maintenance and repairs.

(3) Improved Cost Effectiveness and Environmental Sustainability

As seen from the review and literature in the context of predictive structural health monitoring, the integration of SHM coupled with EWS can greatly reduce cost and resource consumption. Both of these factors greatly contribute to environmental sustainability by reducing waste production, optimizing efficiency through maintenance only when needed, dynamic condition monitoring and allowing preparedness due to EWS implementation. Damage detection allows for reduced cost and eliminates or at the very least; improved risk management. Early detection allows for timely repairs which is 10 to 100 times cheaper than emergency repairs, coupled with added risk [24].

Based on the findings, results and discussions in the context of predictive structural health monitoring of large bridges in Bangladesh; SHM can be combined with an EWS alarm in case of anomaly detection. This can surely help Bangladesh maintain proper bridge health and improve public safety and transportation.

5. Recommendations

Bangladesh in highly dependent on bridges for business and transportation. Upon the review of literature, it is clear that some practices need to be updated and proper solutions must be implemented for long-lasting bridges. Some recommendations in this regard have been given below:

1) Proper usage of high-grade materials must be used for bridge construction as data revealed that bridges are most likely to collapse during construction stage.

2) Public awareness and transparency regarding bridge health decline of a large bridge should be made clear for minimizing possible damage and loss of lives.

3) Collaboration with international experts of bridge health monitoring and designing can help formulate better bridges.

4) Bangladesh has over500 Bailey bridges in the country which are not meant for long-term usage. These bridges should be replaced with a more permanent bridge for better public safety and transportation.

5) Usage of advanced machine learning algorithms for increased accuracy of predictive structural health monitoring of large bridges [25].

6) Usages of a larger variety of sensors like corrosion monitoring, pressure cells, water damage sensors, weather sensors etc. for more refined data gathering and monitoring.

The above recommendations were formulated on the basis of the conducted literature review and the proposed methodology for predictive structural health monitoring of bridges in Bangladesh. These recommendations can further improve an already simple and effective solution.

5.1 Limitations of the Study

The research conducted on the predictive structural health monitoring of large bridges in Bangladesh was derived from already existing information and data. Although, the data and information used were verified and tested; some personal opinions and visions in the context of the research were also introduced. The methodology, results, discussion and recommendations were formulated from authentic sources mixed with personal thoughts and observations. The conducted research relies on simulated data on Megna Bridge as seen from the review of literature. However, the deployment of SHM and EWS for dynamic monitoring is still relatively in its initial stages. Therefore, the scalability and the challenges of such implementations in the context of Bangladesh requires field evaluation for maximizing its effectiveness.

6. Conclusion

Monitoring technology has vastly improved thanks to a wide variety of IoT sensors, wireless technology and algorithms. Bangladesh is new to advanced and dynamic monitoring technologies. However, modern implementations are becoming more common as the days pass. Bridge health monitoring is of outmost importance as seen from the review of literature and other parts of the research. Using IoT sensors, the conditions of bridges can be monitored, stored and analyzed. Meghna bridge is a vital bridge in Bangladesh, strongly contributing to public transportation and business. SHM monitoring is of outmost importance to ensure the longevity and safety of bridges [26]. The collapse rate and the overall damage done can be greatly reduced with the aid of proper SHM integration and EWS implementation in bridges in Bangladesh.

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