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RETHINKING THE STRUCTURAL INTERVENTION TO REVITALIZE URBAN HERITAGES IN THE CONTEXT OF KHULNA

M.R. Khan*[1], N.Sarkar[2] and S.A. Tisa [3]

[1] *Assistant Professor, Department of Architecture, KUET, Bangladesh, e-mail: raihankhan@arch.kuet.ac.bd*
[2] *B.Arch. Student, Department of Architecture, KUET, Bangladesh, e-mail: sarkar1625032@stud.kuet.ac.bd*
[3] *MURP Student, Department of urban and regional planning, KUET, Bangladesh, e-mail: tisa2117502@stud.kuet.ac.bd*

***Corresponding Author**

ABSTRACT

Nowadays, while the strand of accomplishing sustainable solutions to architectural conservation is thriving worldwide, in a developing country like Bangladesh, the urban heritages are getting jeopardized because of vulnerable structural integrity. In numerous cases, the structurally unstable heritages sometimes hold quite valuable, vibrant, and costly urban spaces, also cannot fill up the context needs. Hence, the authority considers traditional and orthodox conservation methods for repairing and maintaining that cannot survive with the contemporary urban environment. At present, adopting technical advancements and structural intervention with contemporary materials such as concrete, glass, and steel will add a new dimension to the revitalization of the city's heritage and makes it as part of the city life. The purpose of the study is to rethink structural intervention in response to conservation principles to achieve structural soundness, incorporate with contemporary resources, such as steel, glasses and tensile materials which will help to revitalize the urban heritage and connect with contemporary city life. This study embraces critical analysis of structural systems, architectural detailing, and materials of different cases located valuable places around the Khulna city. Discussion with conservation related authorities and groups will help to identify contextual limitations and challenges regarding the adaptation of new technology. This discrete deliberation instigates alternative to orthodox perspectives for making the urban heritages more inclusive and consolidated, responding to conservation principles while retaining the ancestral identity as an artistic landmark of the urban landscape. On that note, urban heritages unequivocally possess a distinct individuality of socio-cultural significance but are often treated as mere superfluous objects squandering upon the expensive urban plots. This integrated approach would facilitate the urban heritages bringing out the contemporary nudge while sustaining the structure beyond conventional treatments.

Keywords: *Structural intervention, urban heritage, Contemporary material, Orthodox method*

1. INTRODUCTION

Architectural conservation is, nowadays, a growing concern for evolution of cities across the world of historical, cultural and technological periods. The demographic changes introduce new challenges to its existing fabrics at city level (Amado and Rodrigues 2019). In many situations, structurally unstable heritages might retain highly important, dynamic, and expensive urban places, yet they are unable to meet the context's demands. The historical, cultural, and technical achievements in each geographical region impact the growth of urban areas(Kiruthiga and Thirumaran 2019). As a reaction to the requirements of human activities, population pressure causes changes in the way cities to evolve, necessitating the creation of structural and functional solutions. It is vital to stimulate innovative design methods and strategies to transform today's city, given the development of civilization, the expanding urbanization linked with intense land use, and the inability to the perpetual and continuous change of its demands(Udelsmann Rodrigues 2019). Urban heritage regeneration becomes an important goal in developing context, intending to provide solutions that aid in the rehabilitation and adaptation of urban legacy. There are several obstacles that urban regeneration must overcome in

terms of preserving the identity and memory of locations that are linked to the history of human activities and the specialization of archaeological sites(Sharghi, Jahanzamin et al. 2018). Along with climate change impacts, unplanned development produces high land value, scarcity of historical materials, technological improvement, and to deal with current requirements, constructed heritage becomes more fragile(Hampton 2005). Indeed, from the industrial revolution to the twenty-first century, architects and urban planners have paid more attention to revitalizing urban history to preserve cultural heritage identity(Sharghi, Jahanzamin et al. 2018). The role of urban heritage in developing countries like Bangladesh has been discussed according to its importance. The immense economic, cultural, and environmental changes influence urban heritage to regenerate it with contextual needs by addressing contemporary materials and technology.

Khulna, the 3rd largest city of Bangladesh, is growing rapidly for its welcoming features to the peripheral area, and people migrate and put pressure on the physical growth of the city. As consequences, the historical fabric needs urgent intervention, where modern structural integration could a way to preserve and makes this as a cell of contemporary city. Cultural heritage has been referenced in the international agenda for development and sustainability, namely with Goal 11, Target 4, of the Sustainable Development Goals (SDG) regarding the action to strengthen efforts to protect and safeguard the world's cultural and natural heritage(Petti, Trillo et al. 2020). Profit-oriented approach can be effective for promoting social and economic development through heritage regeneration(Barillet, Joffroy et al. 2006). Historic structures, archaeological sites, and monuments their contents and collections, their intangible features, are a legacy from our past that gives local communities a feeling of place, identity, and aesthetic wellbeing(Orbasli 2002). Maintaining these according to architectural conservation principles would unequivocally be efficient but requires additional resources and supervision that might not be easy to avail. Considering all these stages of maintenance and interventions, the concerned authority, most of the time, plumps for proceeding with the easiest that implies demolition and constructing a new one. Therefore, this scenario compels tearing down old buildings erecting the mainstream glass and steel structures. Nevertheless, these acts endanger the way of sustainability and particularly our ancestral urban identity. Here arises the demand of retaining the history incorporating current structural solutions into them(Knippschild and Zöllter 2021).

This paper presents an illustration of how structural intervention gives a new life to historical and makes it as a cell of contemporary city. The city provides a valuable case study for the discussion of how the urban regeneration process can influence contemporary materials and technology in metropolitan scales. Nevertheless, the city has a unique and remarkable heritage, with historical buildings from the 17th century to the 20th century with the Modern Movement. After becoming independent in 1971 several buildings have become a reference for their social, cultural and political significance and symbolism. In this framework, the proposed approach puts heritage in focus, aiming to demonstrate how its conservation and valorisation in for-profit-use can contribute to urban heritage regeneration in fragile territories by using contemporary materials like steel, glass, concrete addressing contemporary technology.

2. LITERATURE REVIEW

Several investigations have led to the most sensitive architectural conservation technique, the structural intervention of heritage structures to revitalize urban landscapes. It includes a variety of gradations elemental, materialistic, technical, and substantial socio-cultural evaluations. , various structural components and materials demand unique methods and interventions to renovate historical buildings. Architectural, structural, economic, historical, and social conjugations and tenors all play a role in historic building structural rehabilitation. Besides, it is an amalgamation of a bunch of diverse techniques and cultures (Santos, Modena et al. 2010). Land value appreciation and property development frequently conflict with the preservation of urban history. Objection to heritage property classification stems from the belief that it lowers property value, places an unfair burden on landowners, and undermines private development, among several other things (Hampton 2005).

This study will illustrate, property concerns are not as hampered as they may seem by categorization and social objectives of urban heritage. Moreover, being a developing country, Bangladesh has been noticed a more intense and prompt population growth rate for the past few decades, particularly from the post-independence period. This context has been encountering the most cardinal phases of development and demolition of ancient structures throughout this period that it is going through to date. These drastic development movements in spatial and economic characters certainly demand an evaluation and implementation approach towards urban heritages seeking survival in this very city. Because many urban heritages are located in the core of cities, they attract a lot of substantial urban redevelopment by the constant pursuit of valuable land. As a result, the equilibrium between historical building preservation and urban redevelopment appears to conflict, though they do not always contradict(Ercan 2011). It contributes to conservation-redevelopment concerns (Zhong and Chen 2017), the fundamental theoretical challenge of assessing the reciprocal interactions of entities and components engaged in heritage preservation and urban transformation (Zhong and Chen 2017).

In the context of Khulna, most heritage buildings are brick-built and have a post-lintel load-bearing system where the columns are decorative according to the then historical timeline that holds the significance trace of that period and architectural style. Increasing relevance in construction and property management, these buildings urgently require structural intervention, not only to preserve their history but also to promote waste mitigation and help the building stock's downstream flows meet the demands of the setting. When the accentuation initiates to modify from a perspective of construction, only based on the creation of new buildings to a more stock-oriented one, the number, causes, aims, and contextual factors for building losses turned to be a problem (Ercan 2011).The majority of the structures in concern were built when there was little traffic, natural and man-made catastrophes, and seismic occurrences. How the material and structure would react to the current climatic and environmental influence might play a cardinal role in deciding the introduction and selection of new materials and techniques. Structures that are currently in a dilapidated state or hardly surviving, structurally and socially both, an intervention to revitalize them through contemporary practices is rare in this context. Therefore, today there arises a scope and demand for a massive effort to retain and reinvigorate these buildings while configuring an acceptable level of safety and usability. Careful consideration to remove the cause of structural damage might encourage further design interventions to regenerate the soul of urban heritages (Ercan 2011).

The majority of historical structures are made of stone and brick. Because masonry constructions are incapable of sustaining any tensile forces, or only insignificantly, structure should have particular load-bearing systems. As a rule, masonry constructions should have load-bearing systems in which tensile forces in the structure are either absent or minimal for dead and live loads. Unfortunately, many historical buildings do not have the most optimal load-bearing systems where only compression forces occur or dominate in structures, namely, the preferred load-bearing systems of masonry structures are arches, vaults, domes, massive walls, and massive columns, should be of such size that, even in the case of small tensile forces (cracks), the stability and safety of such elements are ensured, as well as the stabilization of such elements.

3. METHODOLOGY

To understand the physical urban environment the conceptual and observational techniques take into consideration, historical, social, cultural, and economic processes. The three pillars of sustainability: economic, environmental, and social, were addressed in a literature review on urban regeneration and its connection with heritage. Furthermore, urban heritage is at the heart of this method, socio-cultural values are analysed in greater depth. This research initiates with the collection of information, photographic surveys, and surface analysis on the urban heritage of the Khulna region. A mixed investigation is performed throughout Khulna to select and assess the regarded cases that resemble this particular approach. After that, based on the characters and surrounding attributes, the study proceeds for further evaluation and consideration of the concerned urban heritages. Cardinally

correlated internal and external factors were observed to determine the stream and state of the existing structures. All the imperative factors influencing the heritage, the site get surveyed according to materialistic, structural, and contextual attributes.

The current condition of the structure is evaluated physically as per these factors. Eventually, after preliminary inspection and diagnosis, this study advances towards a qualitative scheme through questionnaire surveys, individual interviews, and focused group discussions with stakeholders, local authorities, historians, and scholars to comprehend economic, social, and cultural values public policy outcomes. A conceptual approach based on the delimitation of "Heritage Sets," rather than individual structures, was subsequently selected to provide an operational link between the framework and the complexity of the city scale. This study embraces critical analysis of structural systems, architectural detailing, and materials of different cases in Khulna city. Discussions with conservation-related authorities and groups will help to identify contextual restrictions and difficulties to emerging technology adaption. This solitary debate promotes alternative conventional viewpoints for making urban heritages more inclusive and consolidated while adhering to conservation standards and preserving ancestral identity as an artistic landmark of the cityscape.

4. FINDINGS AND ANALYSIS

Urban fabric has substantial amplitude to absorb changes. Khulna city is no exception. The development started to flourish from the river and kept spreading gradually. British Colonial period was the era of a cardinal transformation in architectural history. The British architectural policies and characteristics emphasize spatial adaptations and structural features. Besides, the consecutive historical periods remarkably kept that specific style in practice.

4.1 Location and Context

The city of Khulna is situated in the southern region of Bangladesh, adjacent to the great Bay of Bengal. The initial approach for this study begins with a pilot survey leading along a heritage trail of Khulna that incepts from Dakbangla More and wraps up via Gagan Babu Road and south-central road traveling along the Cemetery road and meets the origin. This trail contains a notable chain of British Colonial structures. Figure 1 shows the location map of Khulna city which carries 200 years British history.

Unfortunately, many have already been demolished, the majority are being conserved ineffectively and unfocused, some are in danger of collapse, and the rest are going undiscovered. Structure and materialistic interventions must be implemented following different lines of study to revitalize such heritages in a succession of attractions and re-engage the community. Following that, a specific instance encompassing the majority of the traits is carefully explored and studied. Table 1 illustrates 7 historical buildings details with significant structural elements which reflects the ideology of colonial period. Some of them are preserved carefully but rest of them losing their pried for lacking of patronization and awareness of the concern authority. Figure 2 identified the location map of those historical buildings which covers certain heritage trail.

Figure 1: Location map of Khulna city (Author constructed)

Table 1: The structural and materials details of surveyed heritage buildings in Khulna (Author constructed based on field survey, October 2021)

Serial	Building Identification and timeline	Ownership and land value	Previous VS current function	Structural System and Elements	Materials
1	Sunflower school (Colonial*)	DC Office, High Land Value	Residence to School	Regular flat roofing, Post-lintel structural, Rectangular Columns, Semicircular arches	Brick wall, Brick columns, Lime-surki Mortar, Wrought iron railings, Wooden Door-Windows
2	Khulna Circuit House (Colonial*)	Government, High Land Value	Administration to Government Guest House	Kori-borga roofing, Post-lintel, Rectangular Columns, Semicircular arches	Brick wall, Brick columns, Lime-surki Mortar, Wooden sections, Wooden drop walls, Wooden Door-Windows
3	Ispahani House (Colonial*)	Ispahani Limited, High Land Value	Residence to Ispahani Limited Branch Office	Kori-borga roofing, Post-lintel, Rectangular Columns, Semicircular arches	Brick wall, Brick columns, Lime-surki Mortar, Plastered railings, Wooden Door-Windows
4	Agroni Transport Limited (Colonial*)	Private Ownership, High Land Value	Residence to Agroni Transport Limited(Courier Agency Office)	Kori-borga roofing, Post-lintel structural, Double Corinthian Columns, Shouldered arches, Cantilevered Verandah or Corridor as the envelope	Brick wall, Lime-surki Mortar, Wooden sections, Plastered railings, Wooden Jalousie Window, Floral motifs in screen railings, Drop walls and Peaks, Wooden Door
5	Shohoj Path Shisukanon Colonial Period (Colonial*)	Bangabandhu Trust,High Land Value	Residence to School	Kori-borga roofing, Post-lintel structural, Corinthian Columns, Segmental arches	Brick wall, Lime-surki Mortar, Wrought iron railings, Wooden Door- Windows, Wooden drop walls
6	Sans Souci Heritage building (Colonial*)	Private Ownership, Middle High Land Value	Residence to Residence	Kori-borga roofing, Post-lintel structural, Corinthian Columns, Ogee and semicircular arches, Cantilevered balconies	Brick wall, Lime-surki Mortar, Wooden sections, Wooden drop walls, Wrought iron railings, Wooden Door-Windows
7	Old House (Colonial*)	Private Ownership, Middle High Land Value	Residence to Residence	Kori-borga roofing, Post-lintel structural, Rectangular Columns, Semicircular arches	Brick wall, Lime-surki Mortar, Wooden sections, Wooden drop walls, Plastered railings, Wooden Door-Windows
Colonial* (1757-1947), Pakistan period**(1948-1971), Post-Independence***(1972-present)					

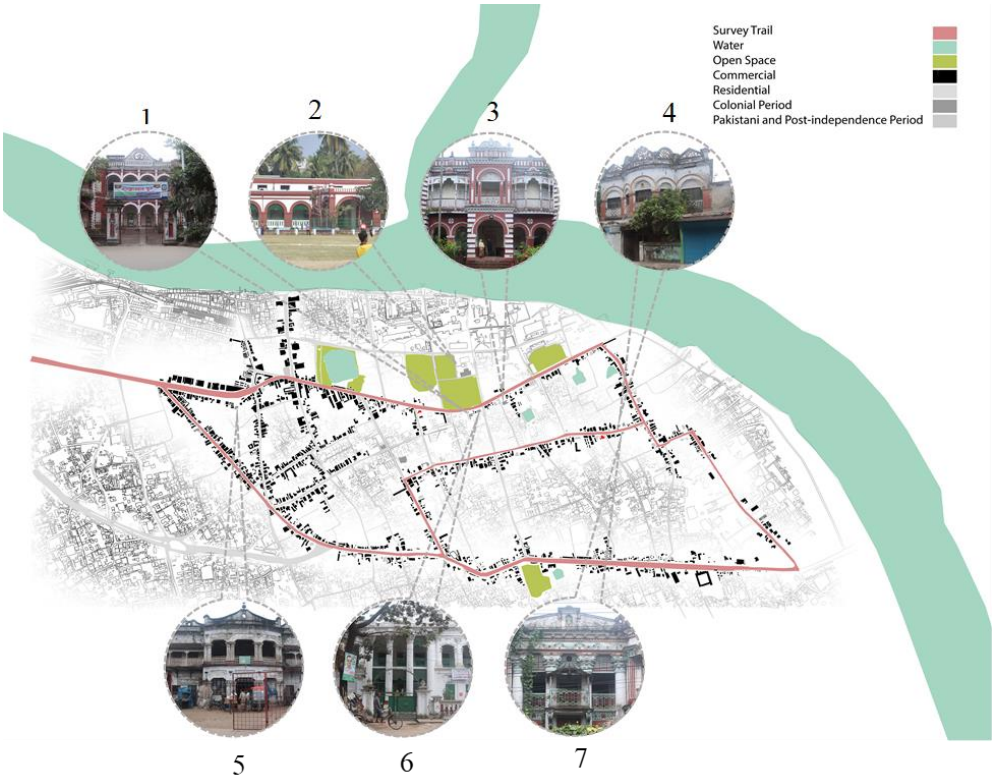

Figure 2: Location map and existing condition views of surveyed historical buildings(Author constructed)

4.2 Case Selection

Inherently this building has been a residential one from the British Colonial period. According to the information collected from the local stakeholders, it was the Dakbanglo previously from which the title of this buzzy and vibrant node originated. Though vulnerable, it still holds the architectural and structural essence of that period resolutely. It is currently under the possession of private ownership. According to survey, a prominent person owned these historical structures and rented them out to agencies and corporations. Particularly, the selected case has been taken as rent by Agrani Transport.

Limited. It located near Dakbangla More, is one of the authentic amalgamations that fully satisfy this method in several aspects, among many others in Khulna city. This structure is positioned as a thriving business district in Khulna. Upper Jashore Road is the main route that connects this site to the rest of the city, creating a hierarchical location within Khulna. It has high land value and tremendous economic and socio-cultural pull due to its location in such a magnet space. This situation warrants more investigation and debate due to its unique significance. Figure 3 shows the location map of Agrani Transport Limited and existing conditions.

Figure 3: Location map of Agrani Transport Limited and existing conditions (Author constructed, October 2021)

4.2.1 Architectural and Structural Features and Materials

The absolute symmetry of this built form provides a geometric feature itself. The principal construction materials are brick, concrete, and wood with a one-way slab, contextually known as Kori-Borga roofing. The lime-surkhi mortar rests on wooden beams in this form of roofing, known as Kori- Borga which is addressed in figure 04. It originated from Kolkata. This system of roofing got applied by the masons of old Kolkata to construct flat roofs. As a result, the masons spaced the Koris (slender wooden pieces) closely together to rest above broader 'Borgas' (wide wooden sections stretched crosswise in opposite or perpendicular directions to the Kori).

Figure 2: Kori-borga roof (left-side),Structural features of Agrani Transport Limited(Captured by Author. October 2021)

The then Zamindars or aristocrats tried to flaunt their influence, financial and political empowerment through this classic architecture. The traders and businessmen from the West-Bengal region started to propagate their trades and power throughout the southern territory of Bengal. Not only that, getting influenced by them, the native southern people of Bangladesh initiated to practice these styles, architecture, and modes of life to a great extent. This specific expression of incorporating western classical elements with the help of local masons, materials, and vernacular architecture grew extensively popular.

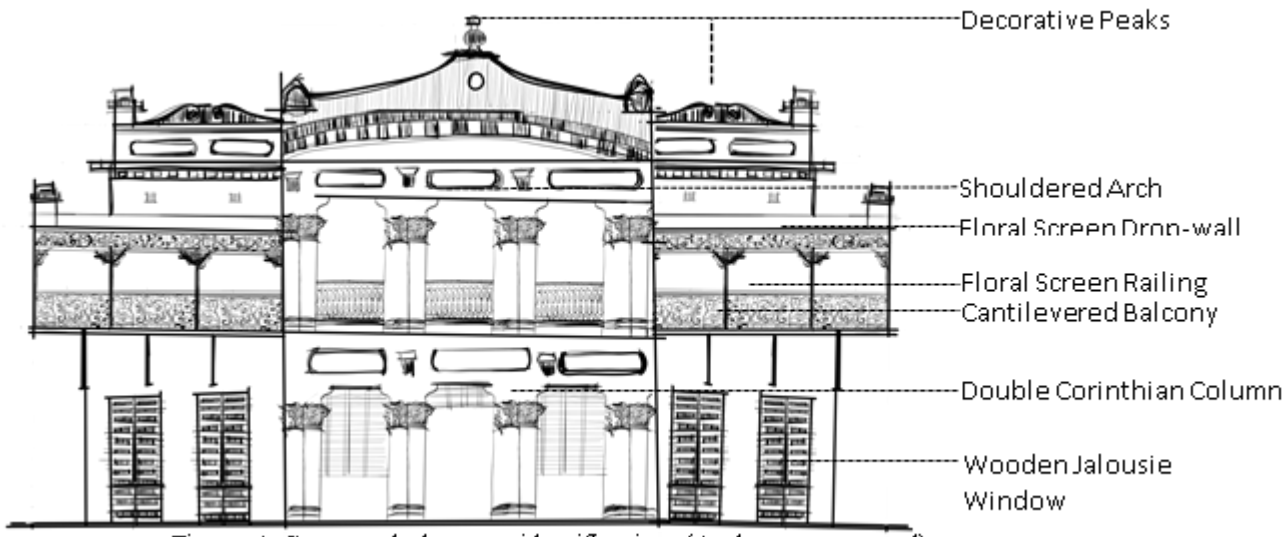

Figure 4: Structural elements identification (Author constructed)

Using double Corinthian columns mechanism of the post-lintel structural system has followed, allowing the regular span to double with the assistance of the breadth of two-column at a point. The conventional one-way slab using Kori-Borga has been holding up the entire built form for years. The decorative double Corinthian columns with minimal shouldered arches, the cantilevered balconies extended outwards the building massing, ornamented with subtly detailed screen railings and drop walls are the instances of that elegant British Colonial timeline. The generic floral motifs are noticed on the screened drop wall, iron railing, peaks, and Corinthian column, conveying a touch of Greek classic orders prominently which shows Figure 6.

4.2.1.1 Biological colonization

Furthermore, the biological colonization cannot go unnoticed. Some random plants keep growing in the cracks and crevices of the building and establish there encouraging the structural vulnerability to a great extent. Therefore, it also promotes other bacteria and fungus to invade the structure. This is surely a perspicuous case of the lack of maintenance.

Figure 3: Biological colonization (Top), Timber supports on roofing (bottom) (Captured by Author, October 2021)

4.2.1.2 Timber supports on Roofing

Because of the presence of rain water, roof timber elements, particularly in the area of their supports, are the most prone to microbial infection. Caused by water penetration through the walls, the support zones of timber sections on roofing are frequently a source of moisture. Metallic 'I' bars has later been added to support the extended roof. Further issue to consider is the inevitable corrosion of steel and wrought iron components installed in masonry components that might cause such elements to collapse owing to the rise in volume generated by the oxidation.

4.2.1.3 Wooden jalousie windows

Surprisingly, the wooden Jalousie windows are still fine and in use spontaneously. This depicts that in this particular climate, specific types of woods are better survivors than the exposed untreated bricks. The front façade of the building is still giving off a sense of the gigantic British Colonial period. But, in the backyard, there has been some extension in the Pakistani or post-independence period that are already tending to demolish.

Figure 6: wooden windows details (left), backyard condition views (right) (Captured by Author, October 2021)

4.2.2 Current State and Defects

The influencing factors performing here are cardinally the maintenance, construction techniques, materials, masons, availability and lack of concern of the associated authority. The symmetrical structure of this building somewhat facilitating it with a considerable structural stability. Nevertheless, there exists visible structural irregularities that might have influenced the safe structural behaviour. That is why some of the additions to hold the structure are apparent. To proceed into the existing structural state, the building is still functioning assigned to an adaptive reuse, though this building is not dedicatedly allocated or prepared for architectural conservation.

To revitalize this entire site and facilitate the stake holders, it requires to adopt and materialize a new intervention structurally and socio-culturally, thus merging with this consistently growing and buzzy cityscape engaging the people more with this significant site and introduce something contemporary somewhat connected to the whole.

5. DISCUSSION

According to the context of Bangladesh, the stream of increasing land value with the growing population is accentually apparent. It is standing in such circumstances where it demands to protect what already has consisted in this particular urban fabric. Some approaches have already been introduced and are actively in practice. Nevertheless, the appeal and affinity of the urban heritages are somewhat getting lost in the unstructured policies. Though this scenario cogently demands a revitalization of the urban heritages integrating with the city context and the life of the urban residents, the influencing attributes and probable approaches are not addressed efficiently. Lack of authoritative co-operation on technical, financial, and comprehensive policies are some cardinal influencers. Conventional chaos in the ownership pattern has been following up along the entire system. A specific group of people or local magnates possesses heritage buildings as a profit-making scheme that initiates a trail of a hindrance to revitalize the urban heritages.

Considering the abovementioned attributes, certainly, all these do not resemble the style what are being practiced today. The new interventions may require partial demolition that is apparently better than the total eradication of an urban heritage. A bridging can be established between ancient and the contemporary meeting the demands, preferences and limitations of the stake holders, owners, concerned authorities and the investors as well. To bring back the history and revive the functional and socio-cultural significance, it unequivocally demands to seek deeper with properly skilled manpower to mend, regenerate and incorporate the contemporary additions into the current structure. Computer generated modelling with BIM and the other digital documentation might assist to regain the past while adjoining the further interventions. Some of the most substantial principles to adopt and proceed with this approach might be the following: Assurance of structural protection, Consolidation across the entire structure, Minimal, adaptable and adjustable stream of interventions, properly skilled manpower, Preservation of the socio-cultural significance of the site, Compatible rapport of the original and newly incorporated materials, and lowest possible costing. Besides, the masonry and structural elements should be treated effectively so that they get merged yet produce a contemporary attire with the ancient built form, regaining the structural safety, of course.

5.1 Scope for revitalization

Taking all these things into consideration, all the drawbacks and opportunities are referring towards a new structural intervention leading to the incorporation of contemporary materials into this heritage structure that might revitalize this site to reincarnate with new functional and structural attire. Figure 07 highlights the structural challenges faced historical buildings revitalization method. The most accentuating challenges to intervene this approach can get sorted into two simplified categories:

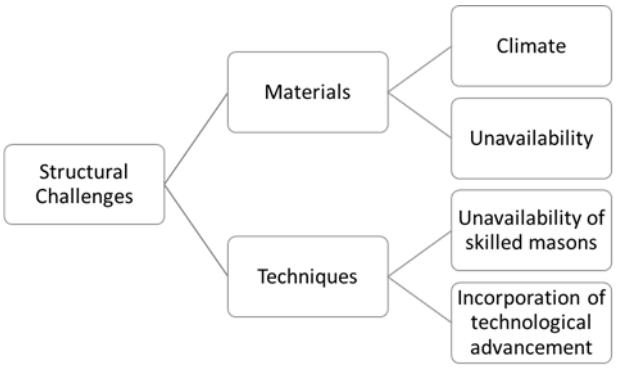

Figure 7: The structural challenges faced historical buildings revitalization method (Author constructed)

5.1.1 Contemporary materials and technology VS structural safety

Throughout the last century, the climate and geography of this region have gone through a drastic change. Therefore, the impact on the structural materials due to climatic causes has been modified to a great extent. The climate nowadays acts differently or more acutely on the materials. Another drawback is the unavailability of the materials that used to be applied in the then period. It is apparent that those materials somewhat had longer lifespan than what is available and being used today. Contemporary materials such as glass, steel along with wooden panels could be incorporated to produce a modern characteristic along with a dedicated conservation policy. Overall, there exists a whole heap of scopes to revitalize this particular site through structural intervention that would certainly facilitate the local community economically, socially and culturally indeed.

It has already been mentioned that those architectural and structural configuration had been constructed by the skilled masons of Bengal. As these structural systems are no longer in practice, nor are the masons. Technological advancement such as BIM modelling could be a way of digital documentation. But, before proceeding digitally, manual data would be required to extract fundamental attributes.

It is imperative that whichever intervention would be taken must ensure the structural safety most prominent while merging the existing and newly added element. Drastic modifications or demolition would not be expected as that would be almost the same as a whole new construction which is not accepted at all and does not satisfy the objective of this study. This is to retain the history through contemporary techniques after all. This discussed site is located a magnet spot of a vibrant social and commercial hub. So, restaurants, cafes or food courts could be a feasible preference to hold the

significance, at the same time, revitalize this place through retrofitting as well as generate economic opportunities creating a local community involvement. Figure 8 demonstrations a possible prototype of urban heritage has been created to depict this particular method after analysing the critical architectural elements and vulnerable components to revitalize it. It illustrates the prominent structural features and additions and addresses the structural integrity while preserving the historical significance. The major vulnerable elements found are the roof slabs and the cantilevered balconies. The walls are working as non-structural components. Therefore, a series of steel trusses might assist the floor slabs to hold and survive. Besides, the steel ribs continued along the cantilever join the trusses and lead to stable structural behaviour.

Figure 8: Prototype modeling for structural revitalization (Author constructed)

6. CONCLUSIONS

The suggested strategy prioritizes urban heritage regeneration in terms of current structural intervention, trimming technology, and materials such as glass, steel, iron, fabrication materials and tensile elements. The findings reconfigure the importance of cultural and historic preservation in sustaining identity and local culture, as well as its worth in terms of supporting urban regeneration. Indeed, highlighting the inherent link between the social and economic benefits through building transformation and sustainable utilization. The development of mixed-use models is a significant goal of the future Khulna city's regional planning strategy. Furthermore, high-density constructed forms and efficient and intense land use, while without sacrificing the quality of life in the Historical Areas' surrounding regions, will be critical in realizing the full potential of the suggested approach to urban regeneration. The findings of this study show how the geographical urban delimitation of Heritage Sets can help to integrate technical and functional measures into public policies and local planning, as well as serve as a platform to launch for future analysis and design interventions that lead to more comprehensive proposals.

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