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Case Report

Case Report: FIU Pedestrian Bridge Collapse (Miami, 2018)

Baraa Elmoussa

Faculty of Science and Technology, Department of Mechanics, Université de Lille, Villeneuve-d'Ascq, France.

E-mail: baraa.el-moussa.etu@univ-lille.fr

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Abstract

This technical report presents the findings of an engineering investigation into the March 2018 Florida International University (FIU) pedestrian bridge collapse, which resulted in the loss of six lives, numerous injuries, and significant damage to vehicles and surrounding facilities. The bridge was constructed using an accelerated bridge construction (ABC) technique as a concrete truss structure; however, it failed due to fatal design mistakes, most notably underestimating the load applied to the joint and incorrect estimation of its shear strength. The National Transportation Safety Board (NTSB) investigation revealed several fundamental engineering failures, including a lack of structural redundancy, poor independent peer review, and the weak response to the warnings prior to the collapse. The incident gave rise to substantial legal and regulatory ramifications, encompassing financial penalties imposed by the Occupational Safety and Health Administration (OSHA), a $102.7 million civil settlement encompassing 23 stakeholders, and a decade-long prohibition on FIGG Bridge Engineers from participating in federal projects. The report's conclusions entail several direct technical recommendations, including the necessity of implementing effective peer reviews during all design and implementation stages, the incorporation of structural redundancy into construction systems, the conducting of nonlinear finite element analysis for complex structures, and the adoption of immediate response protocols when indicators of structural failure are detected. This enhancement in safety measures is a significant development in the realm of future infrastructure projects.

Keywords: *FIU Bridge; Structural Collapse; Bridges.*

*** Correspondence Author**

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Background of the Project

The FIU pedestrian bridge was conceived as a conduit to link the FIU campus, situated within Miami-Dade County, with the adjacent city of Sweetwater. This initiative was a component of the federally funded University City Prosperity Project, which aimed to enhance pedestrian safety and mobility within the designated area (National Transportation Safety Board, 2019). The planned structure was a single 174-foot (53 m) span concrete truss bridge (Figure 1), designed in an ABC process. The main span was prefabricated near the site and transported into place over an eight-lane roadway (SW 8th Street) in March 2018 (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.). This method was implemented to minimize traffic disruptions, as the span was installed during a brief road closure on March 10, 2018, just five days before the collapse (Culmo et al., 2011; Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; National Transportation Safety Board, 2019).

Key project participants included FIGG Bridge Engineers, Inc., serving as the design consultant (and Engineer of Record), and Munilla Construction Management (MCM), acting as the design-build contractor (National Transportation Safety Board, 2019). FIGG's design incorporated an unconventional concrete truss, eschewing the conventional use of steel girders. This distinctive aesthetic was intended to evoke the structural characteristics of a cable-stayed bridge, with the addition of a faux central pylon intended to be incorporated at a later stage. However, from a structural standpoint, the design functioned as a concrete truss, lacking redundant load paths, thereby exhibiting a non-redundant, isostatic design. (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; Management Philosophy Shifts | Professional and Career Topics, n.d.). The bridge deck and canopy were connected by diagonal and vertical members, all of which were constructed of concrete post-tensioned with internal steel rods. An independent peer review of the design was a contractual requirement, and FIGG hired Louis Berger to perform this review (National Transportation Safety Board, 2019). Construction commenced in 2016, and by early 2018, the main span had been completed and relocated into position. At the time of the collapse on March 15, 2018, the bridge was still under construction and not yet open to pedestrians, with work ongoing to finalize the structure (National Transportation Safety Board, 2019).

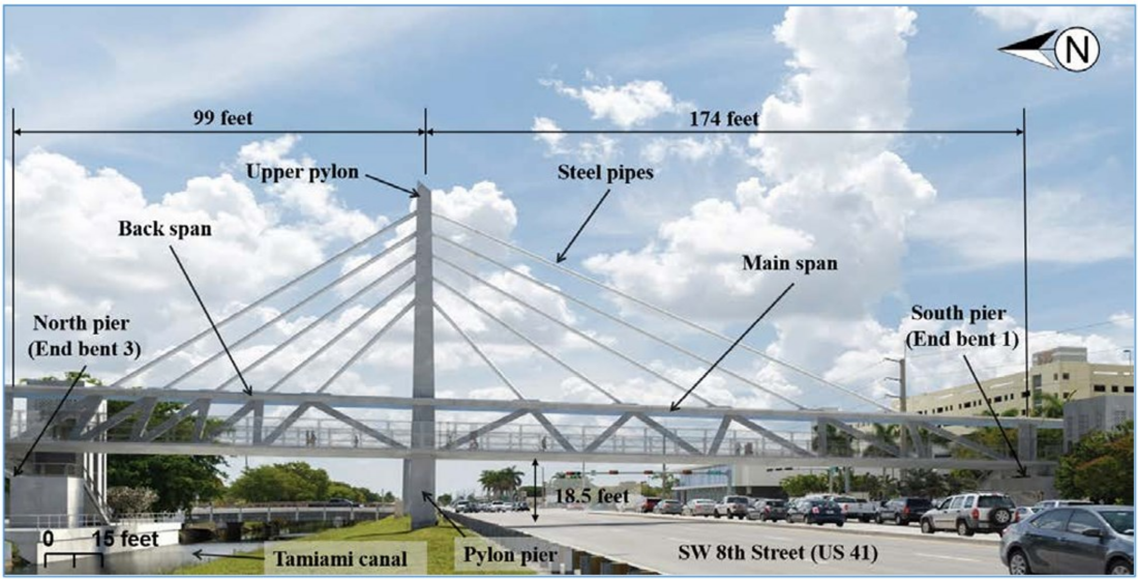
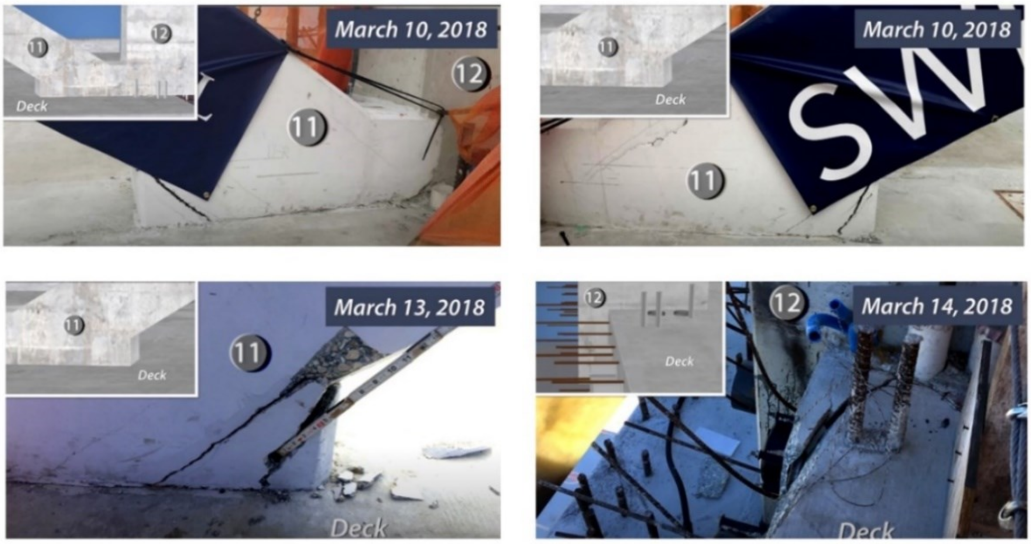


Figure 1. Elevation View of the Bridge (Source: FIU, Annotated by NTSB (National Transportation Safety Board, 2019)).

Description of the Failure Event

On March 15, 2018, at approximately 1:46 PM, the bridge, which was nearing completion, experienced a sudden and catastrophic failure. Earlier that day, workers were re-tensioning (tightening) the post-tensioned steel rods in one of the truss diagonals (member 11 at the north end of the span [Figure 2]) as part of remedial work to address cracking (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; National Transportation Safety Board, 2019). The nodal connection between diagonal member 11 and vertical member 12, which intersected the bridge deck at the north pier end, abruptly failed without prior indication (see Figure 2). According to the National Transportation Safety Board (NTSB) and Peng et al. (2019), eyewitnesses and a security video documented a loud bang or "whip crack," which was identified as the concrete at that node shattering. This incident involved a blowout of the concrete at the interface between members 11 and 12 and the deck. Instantly, the truss's geometry collapsed: the north end of the span dropped, and the entire 950-ton bridge span pancaked down approximately 18 feet onto the roadway below (National Transportation Safety Board, 2019). The collapse was characterized by its extreme rapidity. Subsequent analysis of video frames revealed that the sequence from initial failure to the span making contact with the ground occurred in a time frame measured in fractions of a second (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.).

(a)



(b)

Figure 2. (a) Nodal Connections Between the Truss Members and the Deck (National Transportation Safety Board, 2019), (b) Structural Damage Occurred at Joints 11 and 12 (National Transportation Safety Board, 2019).

The bridge's failure occurred concurrently with the partial opening of traffic on SW 8th Street beneath it. At the moment of collapse, one westbound lane and all eastbound lanes were active, with vehicles stopped at a red light under the span. The collapse of the concrete and debris resulted in the entrapment of several drivers and passengers within the vehicles that were crushed on the roadway (National Transportation Safety Board, 2019). A significant number of individuals engaged in labor in proximity to the bridge also sustained injuries as a result of its collapse. The accident site was enveloped in a cloud of dust and debris, while bystanders and members of the nearby construction crew hastened to offer assistance before the arrival of emergency medical personnel. Emergency crews from the Miami-Dade Fire Department and police units responded promptly, conducting search and rescue operations amidst the rubble. This structural failure resulted in a tragic toll of deaths and injuries.

Technical Causes of Failure

An investigation into the FIU bridge collapse revealed a series of engineering failures, ranging from fatal design mistakes to poor judgment in making critical decisions under dangerous construction conditions. The National Transportation Safety Board (NTSB) identified the primary cause of the failure as a critical error in the joint load calculations (connecting elements 11 and 12 with the deck) and the joint bearing capacity. This error was attributable to FIGG, the project's designer (National Transportation Safety Board, 2019). The loads the bridge would have to withstand were underestimated, while the design overestimated the horizontal shear capacity of the joint (National Transportation Safety Board, 2019; Shaver, 2021). A thorough analysis revealed that the joint had been subjected to excessive stresses since its partial construction, leading to the formation of internal weak zones that undermined the stability of the entire system. The absence of structural redundancy served to exacerbate the situation, as the absence of an alternative load-bearing path upon the failure of a node rendered the collapse of Member 11 a direct cause of the collapse of the entire bridge (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; Management Philosophy Shifts | Professional and Career Topics, n.d.) (see Figure 3). The cold joint itself lacked the necessary structural details to provide sufficient roughness and effective shear friction. Furthermore, the drainage channel intersected with the member's reinforcement, further weakening the joint and causing it to fail under load (Management Philosophy Shifts | Professional and Career Topics, n.d.). The situation was further exacerbated by the implementation of a loosely coupled post-tensioning system, coupled with inadequate structural bonding, which diminished the node's capacity to resist cracking after the onset of cracking (Management Philosophy Shifts | Professional and Career Topics, n.d.).

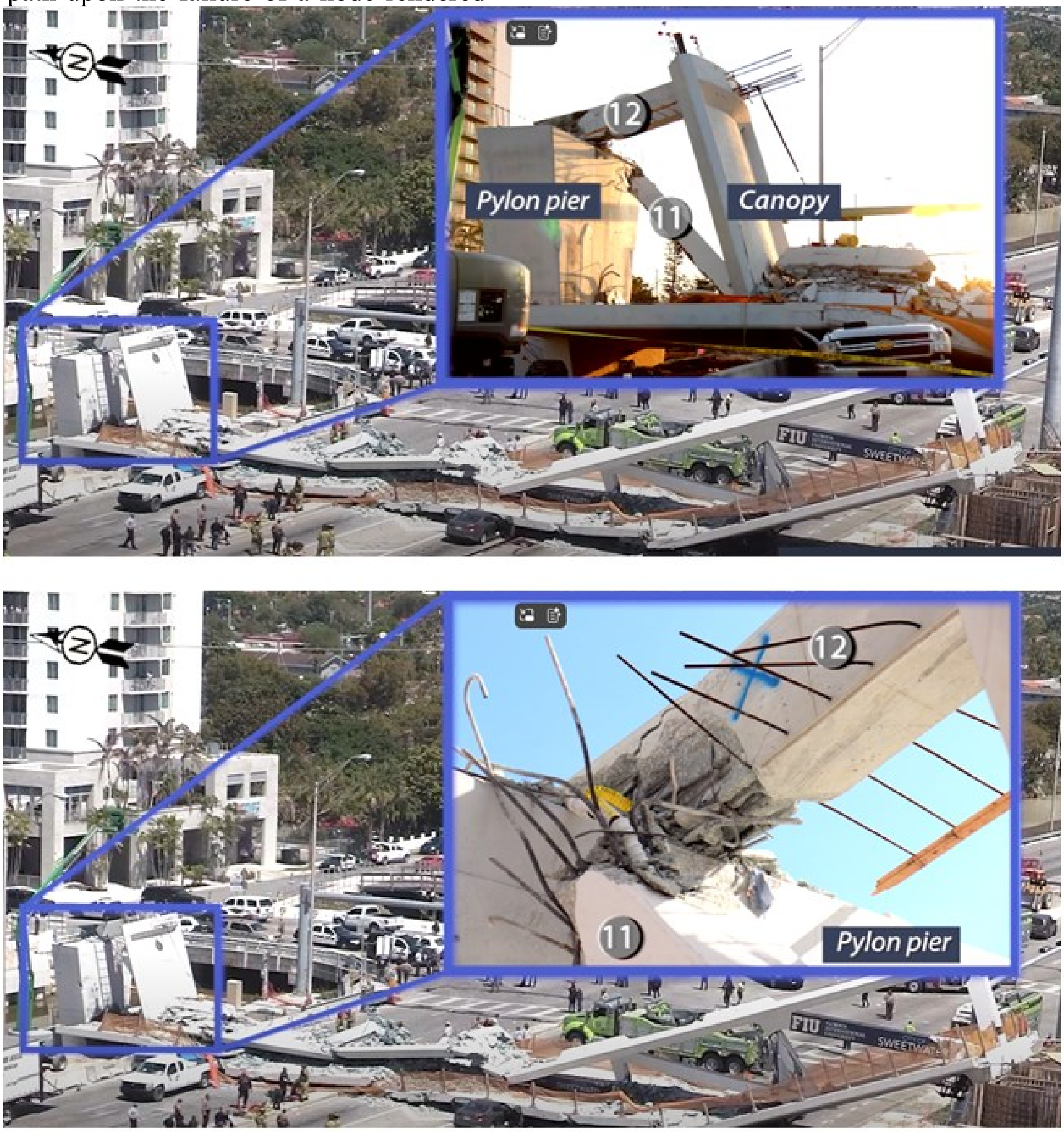


Figure 3. Members 11 and 12 After the Collapse (National Transportation Safety Board, 2019).

Prior to the collapse, there were indications of potential failure, as evidenced by the emergence of substantial cracks in Member 11 and the surrounding area. However, these signs were not given the requisite seriousness they deserved. The FIGG engineer overseeing the project initially classified the cracks as superficial and repairable, proposing re-tensioning without conducting an independent engineering review (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.). Louis Berger, the firm assigned to conduct the independent audit, was not consulted regarding this pivotal decision, constituting a grave infringement on the purported technical review mechanisms (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; National Transportation Safety Board, 2019).

On the day of the disaster, the re-tensioning operation was carried out while traffic was still active under the bridge. No preventative measures were taken, such as road closures or additional reinforcement. This was in blatant disregard for safety standards and engineering precautions (National Transportation Safety Board, 2019). While investigations confirmed that the materials used in construction were in accordance with specifications, the fundamental issue lay in the design itself and in the lack of a rapid response from the relevant parties despite clear indicators preceding the collapse. This incident exemplifies the unfortunate consequences of the accumulation of engineering and managerial errors, underscoring the potential for disastrous outcomes even in projects intended to epitomize progress and modern infrastructure.

Consequences of Failure

The collapse of the FIU bridge resulted in substantial human casualties, material damage, and economic losses (see Table 1). The incident resulted in the fatalities of six individuals, including one construction worker and five civilians who were present beneath the bridge at the time of the collapse. Additionally, ten other workers and drivers sustained injuries. Among the victims was Alexa Duran, an 18-year-old student, whose death elicited widespread reactions and immediate demands for engineering and institutional accountability. The bridge, which cost $14.2 million to construct, completely collapsed and crashed into eight vehicles (National Transportation Safety Board, 2019). Due to the presence of debris, SW 8th Street, a major traffic artery, remained closed for a period exceeding seven days prior to its reopening on March 24, 2018, subsequent to the conclusion of rescue and evacuation operations (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.). The incident had profound psychological ramifications for the university community and the surrounding area, as a project intended to symbolize progress became a national tragedy. The project was terminated, and the bridge was never rebuilt. The confidence in accelerated construction techniques was completely eroded, and extensive engineering reviews were conducted. The contracting company MCM encountered legal and financial ramifications that culminated in its bankruptcy declaration, prompting a change in its trade name ("PP&S FIU Bridge Collapse Victims to Receive Settlement of $102.7 Million - Panter, Panter & Sampedro," 2024; Shaver, 2021). Consequently, FIGG Bridge Engineers experienced substantial reputational losses, resulting in their exclusion from future projects.

Table 1. Summary of Human, Structural, and Legal Losses Resulting from the FIU Bridge Collapse

Category	Details
Human Losses	Six fatalities Ten injuries
Property Damage	Complete destruction of the bridge Eight vehicles were crushed under the bridge
Traffic Impact	The SW 8th Street was closed for over a week
Legal and Financial	$102.7 million civil settlement involving 23 stakeholders $86,7 OSHA fines against 5 entities (including FIGG and MCM) Bankruptcy of MCM Construction
Reputational and Regulatory	10-year federal project ban for FIGG Bridge Engineers (2021–2031) Investigation by Florida Board of Professional Engineers FIGG excluded from future projects due to reputational damage

Legal and Regulatory Outcomes

The collapse of the FIU pedestrian bridge prompted extensive technical and legal investigations, with a focus on design, construction, and safety failures. The Occupational Safety and Health Administration (OSHA) found five entities—including FIGG Bridge Engineers, MCM Construction, and three subcontractors—liable for seven violations related to failing to take adequate preventative measures despite the presence of visible structural cracks, and imposed fines totaling $86,658 (U.S. Department of Labor Cites Five Contractors for Safety Violations Following Florida Pedestrian Bridge Collapse | U.S. Department of Labor, 2025).

Subsequently, the bereaved families initiated legal proceedings in the form of civil lawsuits against multiple project participants. The legal proceedings ultimately culminated in a $102.7 million settlement in late 2019, involving 23 design firms, contractors, and insurance companies. This settlement facilitated the swift resolution of compensation for the victims, thereby obviating the need for protracted legal proceedings ("PP&S FIU Bridge Collapse Victims to Receive Settlement of $102.7 Million - Panter, Panter & Sampedro," 2024; Shaver, 2021). Despite the bankruptcy of MCM, it contributed to the settlement through its insurance coverage ("PP&S FIU Bridge Collapse Victims to Receive Settlement of $102.7 Million - Panter, Panter & Sampedro," 2024).

From a disciplinary standpoint, FIGG Bridge Engineers, the project's design firm, was subjected to an unprecedented penalty from the Federal Highway Administration (FHWA), barring the company from participating in federal projects for a period of ten years, with the stipulated period commencing in 2021. Notwithstanding the company's appeal, the ban remains in effect until 2024 (CBS Miami Team, 2024). The Florida Board of Professional Engineers has also initiated an inquiry into the performance of the engineering team, though no formal conclusions have been rendered.

The Miami-Dade District Attorney's Office initiated a criminal investigation into potential negligence, stemming from the failure to halt work or close the roadway despite the presence of evident structural indicators. However, the complexity of establishing criminal liability prevented the filing of charges (Shaver, 2021).

The NTSB published its final report (NTSB/HAR-19/02), which included crucial recommendations, most notably the implementation of peer reviews during all phases of design and construction, and the establishment of immediate response protocols when any indication of structural weakness or damage is detected (Roads and Bridges, 2019). The report contributed to raising technical awareness and highlighted the need for stricter oversight and accountability in future infrastructure projects.

Lessons Learned

The collapse of the FIU pedestrian bridge is a paradigmatic example of multidimensional structural failure. An investigation revealed fatal design flaws, inadequate review procedures, and the absence of requisite safety requirements. The investigation's findings indicated that the absence of structural redundancy constituted a critical error, as the lack of alternative loading paths resulted in the complete failure of the structure immediately following the failure of the node connecting elements 11 and 12 (Management Philosophy Shifts | Professional and Career Topics, n.d.). This incident stands as a quintessential example of the critical need to reevaluate the design philosophy underpinning complex structures.

A thorough investigation revealed that the bridge's design was founded on an odd node system, a configuration that necessitates the implementation of nonlinear finite element analysis push-pull modeling (Cao et al., 2020). However, the execution of these models was either inadequate or entirely overlooked. Additionally, no independent investigation was conducted to verify the structural model's soundness and the safety of critical joints and connections (Shaver, 2021). This represents a critical oversight in the engineering investigation system and underscores the necessity of a comprehensive peer review that encompasses all design and construction stages, with a particular emphasis on node details, reinforcement, and construction sequencing.

The investigation revealed that the calculation of construction loads, including lifting, transportation, and installation, was erroneous. These loads were not appropriately considered in the structural analysis, leading to visible cracks in the node before the bridge's operational initiation (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; Management Philosophy Shifts | Professional and Career Topics, n.d.). This finding underscores the necessity of incorporating both temporary and long-term loads in any structural analysis conducted on complex structures.

Of particular concern was the failure to adequately address the initial warnings. Prior to the collapse, although significant cracks had appeared in the critical node zone, no actions were considered, such as stopping work or closing the road. This incident exemplifies a clear deviation from the established principles of public safety (Florida International University Pedestrian Bridge Collapse - Wikipedia, n.d.; Roads and Bridges, 2019). The absence of effective oversight by the Florida Department of Transportation further exacerbated the situation by failing to implement the requisite external review mechanisms. Regulatory entities were not granted sufficient authority to engage with these mechanisms (Shaver, 2021).

This incident exemplifies a fundamental principle inherent in the civil engineering profession: As such, the primary concern is public safety. This necessitates that engineers exercise sound judgment in making critical decisions when confronted with indications of a crisis, undertake rigorous and unquestioning scrutiny of their own designs, and solicit independent evaluation when the situation warrants. This failure has become a recurring theme in civil engineering education programs, serving not only as an illustration of technical failure but also as a foundation for inculcating the principles of responsibility, liability, and safe design in engineering practice.

Engineering Recommendations for Future Prevention

The FIU Bridge failure was a significant accident that exposed substantial flaws in the design, construction, and inspection of contemporary bridges. The investigation further revealed deficiencies in design processes, construction methodologies, technical perception, and the implementation of safety regulations. This prompted the relevant authorities to formulate a comprehensive set of recommendations, aimed at recalibrating the foundational principles that would govern future infrastructure projects. The primary recommendation is the urgent need for an independent and comprehensive review of complex or unconventional designs. This review should be conducted by highly experienced engineers and should cover not only analytical models but also all demanding assumptions and components. This is especially true in cases where advanced systems, such as complex connections and cross-beams, are adopted. (Roads and Bridges, 2019).

These recommendations underscore the necessity of enhancing structural redundancy and durability as an engineering imperative to ensure safety and property protection. The proposed code amendments underscore the necessity of incorporating diverse load paths and augmenting reinforcement in vulnerable regions. This involves ensuring adequate support for the structure during its fabrication and escalating the reinforcement ratio at pivotal joints and connections (National Transportation Safety Board, 2019). In the same context, the importance of using advanced analytical modeling, such as nonlinear finite element analysis, was highlighted, especially in areas of structural focus, to ensure that the structure's expected behavior matches the reality of extreme load conditions, including shear and tensile forces in failure-prone areas (Management Philosophy Shifts | Professional and Career Topics, n.d.).

The accident review revealed that the flaw was not confined to the final design, but also included an insufficient understanding of the temporary conditions during the implementation phases. The design models overlooked the effects of pouring, transportation, and erection, resulting in premature functional failures that could have been prevented if these phases had been incorporated into the comprehensive structural analysis, accompanied by explicit plans for the utilization of temporary supports when necessary (Shaver, 2021). The recommendations also emphasized the importance of strict response protocols for construction emergencies, including immediate actions such as halting work when danger indicators appear—primarily cracks—and evacuating the site pending an independent engineering assessment. The guidelines underscored the necessity for contracts to incorporate explicit clauses that delineate responsibilities in such circumstances, with the objective of averting conflict and expediting critical decision-making processes (Roads and Bridges, 2019).

The National Transportation Safety Board (NTSB) has identified the absence of autonomous oversight and the efficacy of communication among project stakeholders as pivotal factors that contributed to the worsening of the incident. Consequently, the NTSB has proposed the implementation of a participatory monitoring system that is both effective and participatory. This system would ensure prompt and transparent reporting of any detected defects, in addition to systematic documentation of all corrective measures implemented. The overarching objective of these measures is to ensure transparency and accountability at all stages of the implementation process (National Transportation Safety Board, 2019). Finally, the recommendations did not neglect the ethical and educational aspects, as they called for the establishment of a professional culture based on accountability and continuous learning. This was achieved by integrating failure studies, most notably the FIU case, into engineering education and vocational training curricula. This enhanced the awareness of new engineers and established the principle that public safety is the primary pillar of every responsible engineering practice (Roads and Bridges, 2019).

Declarations

Author Contribution

B.E. was responsible for the conceptualization, methodology, Investigation, writing of the original draft, review & editing and visualization.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Declaration on the Use of Generative AI and AI-Assisted Technologies

No generative AI or AI-assisted technologies were used in the preparation of this manuscript.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgement

The authors declare that there is no acknowledgement to be made.

Ethics

This study did not involve human participants or animals; hence, no ethical approval was required.

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