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SULTAN MIZAN ZAINAL ABIDIN STADIUM ROOF COLLAPSE, KUALA TERENGGANU, MALAYSIA (LACK OF SAFETY ISSUES)

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Abstract:-

This study provides a national profile of major work safety accidents in Malaysia, There have been many major incidents over the years, causing the loss of hundreds of lives. We intended to provide scientific basis for prevention measures and strategies to reduce major work safety accidents and deaths.[1, 2]

Methods: *This is one of the shocking accident in Malaysia beside the "the highland tower collapse". It remembered us that the project costing millions of dollar does not guarantee safety to the public as long we do not adopt the entire security before starting construction, Data from 2008-2015 Census of major work safety accidents were collected International Business Times. We analyzed the frequency of accidents and deaths, caused by insufficient safety measures. Additionally, we discussed the causes and prevention by types of accidents.[2]*

Results: *Throughout this case study the cause of the roof collapse was a failure on all levels of the project from the owner to the designer and to the contractor? The answer to this question lies in the structural design, construction and Safety measures of the building.[3]*

Conclusion: *Fifteen years' major work safety accident data indicate that the frequency of accidents and number of deaths was declined and several safety concerns persist in some segments.[3, 4]*

Keywords:-*Structure Safety, Construction Building Safety, Major accident, Prevention.*

INTRODUCTION:

Sultan Mizan Zainal Abidin Stadium is a multi-purpose stadium in Kuala Terengganu, Malaysia, constructed by a South Korean construction firm. Together with the adjacent Mini Stadium, it forms the centre piece of Terengganu Sports Complex. It was used mostly for football matches. The stadium holds 50,000 people and is named after the reigning Terengganu Ruler, Sultan Mizan Zainal Abidin.[5] Billed as the pride of the state, the RM300mil Sultan Mizan Zainal Abidin Stadium in Gong Badak suffered a major blow when its roof collapsed - just a year after it was opened. No one was injured in the 9am incident; [6] it was then that massive steel roof over half of the stands collapsed, being destroyed completely. There was no-one inside, but the failure could have easily harm many people since the capacity of the stadium is 50000, so only a few cars parked outside were destroyed, but the stadium, which was the venue for sukma (Malaysian Games), last year has been declared unsafe.[6] The roof on the stadium's left wing was ravaged after the iron frame structure supporting the 300m-long roof destabilized, causing it to fold. The affected zones were the main entrance, royal podium and the public seating area.[5]

The damage at the east wing has been estimated at RM25mil.[6] the stadiums main usage would be to host the states football matches in the Malaysia Super League and was meant to replace the old Sultan Ismail Nasiruddin Shah Stadium.[7] Four years after the collapse, the fallen roof had been removed and workers were dismantling the rest of the roof that had not fallen. As they were working on February 20th 2013 the rest of the roof came crashing down this time injuring five workers. The workers had taken down almost all of the roofing and were working on taking down the steel space frame structure of the roof. Finally in spring of 2015 the stadium roofs were all gone and the stadium was partially reopened for football matches with only half of the stands open for seating. The games can also only be played during the day because the lights for the stadium were attached to the roof. The government hopes to redesign and construct the roofs to bring the stadium back to the standard that they had hoped for in 2008 when it was completed.[7]

Leads to the Collapse of Stadium Roof:

The design and construction of the building had been on an extremely fast passed schedule to insure the stadium was ready for the 2008 Sukma Games. The roof structure design was also changed to the light frame steel structure very late in the design meaning the time spent designing it was questionable at best. Prior to the collapse problems with the structure of the roof had already begun. Damage in the frames of the roof along with bang like noises coming from the roof had been observed. Ironically repairs for the roof were actually scheduled for the exact day in which the roof fall down.[5, 7]

Collapse:

At 9am in the morning workers were doing their normal cleaning and maintenance when they heard a huge crashing sound. The supports at the outside of the stadium that held up the enormous cantilevered roof had failed and the roof had fallen on to the stadiums seating below. Luckily the workers in the stadium were not under the roof and no one was hurt

in the collapse. A few vehicles outside the stadium were damaged by the debris. The collapse started at the almost 100 foot span from the edge of the stadium to the concrete buttress holding up the end of the crescent shape. This caused the supports attached to the outside of the stadium then proceeded to fail, resulting in the entire half of the roof to fall and cover the entire seating area below. The collapse of the roof not only damaged seating but also the main entrance to the stadium and the royal box.[5, 7]


The cause of the collapse like many collapses can be linked back to many causes adding up to the failure including, inadequate design, poor quality control, and improper materials among others.[7, 8]

Descriptions:

TMZA Stadium is designed to have two shell-like roofs supported by concrete buttress and space trusses. Steel columns attached to concrete stumps support the space trusses along the roof while at its two ends; a concrete buttress at each is implemented. Between the end of the steel column and the buttress there exists a wide gap spanning more than 30 m. The truss consists of tubular and steel ball joints. Prior to the collapse, they were reports of structure damage and sporadic loud bangs. A structural repair job was scheduled to be done on the day of the collapse. A year after opening ceremony, the roof collapsed during a day of typical Malaysian weather (hot and humid with temperature of about 28 Celsius). Roughly 60% of the roof including the section above the royal box collapsed.[8, 9]


Reasons:

Major issues includes mistakes at design level, inappropriate choice of materials, incompetency of staff involved in construction, poorly constructed roof, and lack of quality supervision. The skills of the staff hired to construct the roof were inadequate as the roof structure was very complex. Subsequently, the quality of work was not up to standard as required by the design.[8, 9, and 17]

Besides that, the long gap between the last concrete stump and the concrete buttress was about 30 m wide. There was not enough support for the large magnitude of force from its own weight. In addition to that, buckling occurred in the inclined members (tube), a sign of load exceeding buckling capacity. Pullout of threaded screws out of the steel ball joints can also be observed after the incident. This means that they have been subjected to load beyond their capacities resulting in failure.[9]

The complex design of the roof and the wide span required more detailed analysis. Other factors that contributed to the stated damage are defective welding in steel components implying poor workmanship and strength of the materials used did not achieve design requirement when tested in preliminary tests thus reducing the mechanical strength of the structure. The roof was also erected poorly causing terrible geometry and thus, catastrophic force distribution along the structure. Non-technical cause includes lack of quality control and safety measures by project management team which causes mistakes to go unnoticed in their early stage.[9, 10, and 11]

Preventions:

- The design was inadequate, insufficient safety measures in design.
- The designer failed to take into account the full consideration of the support conditions of the roof structure.
- The roof was erected poorly resulting in misaligned geometry.
- There was no quality control for safety measures at site.
- Also Materials and quality of workmanship did not meet specifications. The complexity and long spans of the roof structure require a more detailed design consideration into second order design analysis, which was not carried out.
- The sensitivity of the space frame roof structure requires consideration for support flexibility in the design mode, which was not done.

Defective welding in steel components, reflecting the poor quality of manufacturing or pre-fabrication work, poorly conceived erection method in installing the roof structural components, and no checks were conducted during the interim stages in erection. Inadequate temporary supports used. No apparent quality control by the project management team. Alternative design proposals provided by main contractor were adopted without integrated checks. Preliminary testing of materials used show strengths below design requirements, not meeting specification.[11, 12]

The above factors have contributed largely to the collapse by causing a reduction in the safety factor of the structure – which was well below the norms required of such designs. Hence, it can be observed that the quality checks and control system were not properly planned and implemented, not only at the job sites but also in the design and planning office by the management team.[11, 13, and 16]

There are so many small insignificant factors that engineer doing that occur the accident. It may seem that the engineer has no responsibility and not alert about the law of safety and regulation. The method to help analyze and to determine a

project to proceed is risk benefit analysis. This method can summarize that the only ethical way is to implement risk-benefit by sharing the benefit between the [13] engineer and society.Base on the designing for safety, the risk can minimize much more easily. The risk can minimize if the engineer spending more time to recheck the design cycle before sell it. It is because of to make sure that the product safe to use as a conclusion, the product not surely 100% safe, but the engineer must design a [12, 13] product more effectively and follow the ethical law as a guideline.

Summary:

Issue of concern is why so many incidents are happening with a safety problem in construction industry. These reported incidents have brought into question the subject of construction safety which must be looked into seriously by the relevant authority in the interest of public safety.[14, 15] The truly sad part about this collapse is that it was entirely preventable. There was no crazy weather phenomenon or act of god that caused this it was simply a case of complete and total failure from design to construction.[15, 16]

Many of the failure causes can be eliminated if the engineers and workers comply with the ethical guidelines and prioritize the public safety instead of individual importance. More design proposals should be considered and determine whether or not it is within the capacities of the firm constructing the structure. They should also have not done the parts they are not competent and outsource it to specialty companies. The project should be halted and alterations should be made as soon as any sign of weakness is observed during the project as engineers, we should also use suitable material instead of the ones that didn't comply with the design need. Last but not least, quality inspection should be done from time to time to ensure the standards are followed.[14, 17]

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