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The Visionary Need Of Bim In Fire Safety Of Shopping Complex

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Abstract

A significant number of injuries and losses happen annually because of fires in structures. The foreseeing use of fire safety measures at the planning stage can potentially conduct to a significant. There's enhancement in decreasing fatalities by assisting habitants in a secure evacuation. During this study, a frame is developed to achieve a collection of applicable fire safety measures while considering safe evacuation (i.e., adding the possibility of survived inhabitants) and budget limits. BIM is utilized present in fire protection system and how its usage can be developed to build up the effectiveness of fire protection. Fire safety may be a concern for firefighters' lives and therefore the structural lifetime of buildings. As the usage of BIM raises and is acquirable for further and further structures, it could potentially similarly become an implement for the fire departments. The 3D- model in BIM could assist firefighters amplify their situational knowledge and They deliver more information about the structures in which they intercede. There are bounds to the functional execution of this,but it could conceivably assist to save lives.

Key words: - BIM, safe evacuation, fire safety measures, planning stage

1. Introduction

Building information modeling (BIM) is one of the most optimistic recent evolutions in the architecture, engineering, and construction (AEC) industry. With BIM technology, a proper virtual model of a building is digitally constructed. This model, known as a building information model, can be applied for planning, design, construction, and operation of the installation. It helps engineers, architects, and constructors imagine what's to be constructed in an atmosphere of imitation to distinguish any possible design, construction, or functional issues. BIM represents a replacement paradigm within AEC, one that encourages integration of the functions of all technology into a design. In BIM, current trends, benefits, possible hazards, and coming challenges of BIM for the AEC industry are discussed. The judgments of this study give useful facts for AEC management exponents considering applying BIM technology in their designs. A Building information model (BIM) identifies the shape, spatial alliances, geographic data, measures and properties of structure fundamentals, expense estimations, material supplies, and design schedule. The model can be utilized to show the exclusive structure life cycle. As a result, volumes and mutual properties of materials can be readily deracinating. Scopes of work can be fluently insulated and defined. Systems, assemblies, and chain can be displayed on a comparative scale within the all installation or set of installations. structure documents like as sketches, procurement details, submittal procedures, and distinct specifications can be fluently interrelated. BIM can be inspected as a virtual procedure that encompasses all phases, disciplines, and complexes of an installation within a single, virtual model, green-lighting all design squad members (proprietor, engineers, architects, contractors, subcontractors, and suppliers) to unite further exactly and efficiently than exercising conventional procedures.

2. Geometry and specification

The shopping complex building is selected as it is complex and can indicate the applicability of the proposed framework. The shopping complex building has four stories and a basement for parking, with a floor area of 533 square meters for each story. This building is located in Hyderabad, India. The shopping mall's main exit is located on the ground floor. Figure 1 illustrates the sample plan of the building, which is similar to other stories. To separate large compartments without a wall and to increase accuracy, the room separator feature of Revit is used, and its result is shown in the figure. Regarding the building plan, the ground floor exit is connected to the remaining upper floors by two staircases. Also, the 3D view of the model of the shopping complex building is shown in Figure 2, which illustrates the plan of the shopping complex building's design.

A fire can be initiated from each of the defined shops with the separate fire launch probability. Thus, fire ignition in each shops defines a fire scenario. In this document, all of the fire scenarios with their situation fire ignition probability are looked in optimization.

(b)

Figure 1a. The Gross Floor Plan area of $514m^2$ and 1b. Description of floor area for utilization

Figure 2. 3D View of the model

3. Analysis of fire safety

3.1 Sprinkler system

A fire sprinkler system is an active fire protection system that consists of a water supply system that provides suitable pressure and flow rate to a water distribution pipe system, which is connected to fire sprinklers. Fire sprinklers have become required safety equipment in most regions of India, as well as in specific occupancies such as newly constructed hospitals, schools, hotels, and other public buildings, industries, and other occupancies subject to local construction codes and enforcement. Sprinklers may be required to be installed in order to lessen the risk of property damage or business interruption. When the predetermined heat level is attained, each sprinkler operates independently. As a result, the number of sprinklers that activate is limited to those closest to the fire, increasing the available water pressure over the fire's source. Fire Sprinkler Systems are the most significant advancement in fire protection in the last century. Sprinklers are the most effective way to protect people and property from fire [1]. Sprinkler systems are now widely accepted as being so effective that they are required in many situations. Every structure should be classed as light hazard, ordinary hazard group, or high hazard group in terms of fire danger. The material used in construction, the occupancy level, the materials stored in the building [2], the processes performed in the building (and whether these processes include flammable liquids), ceiling heights, ease of egress, and the number of floors and rooms are all factors in determining a building's hazard level [3].

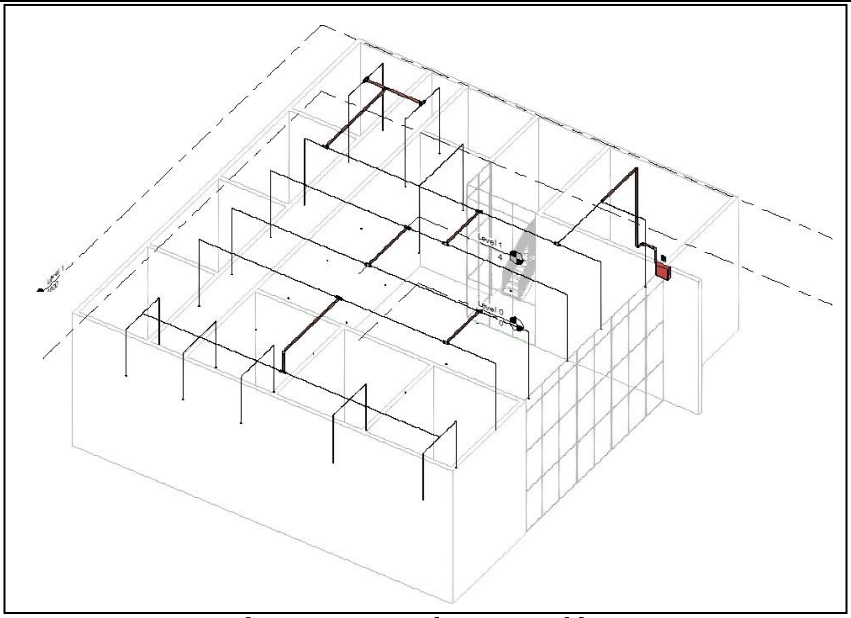

Figure.4 Typical arrangement of Fire Sprinkler system

3.1.1 Operation of Sprinkler System

An automatic sprinkler system is designed to detect, regulate, and extinguish a fire while also alerting the building's occupants. Fire pumps, water storage tanks, control valve sets, sprinkler heads, flow switches, pressure switches, pipe work, and valves are all part of the installation. The system works without the need for human involvement. A glass bulb or a fusible link is found in each sprinkler head. A liquid and a large amount of vapour are contained in the bulb. Heat causes the liquid, as well as the fusible link heads, to expand. When the temperature reaches a specific point – usually 68 degrees Celsius – the liquid expands and the bulb or fusible connection breaks, releasing water directly onto the fire's seat. The sprinkler will be activated by the hot gases produced by a fire [5]. When a fire burns, a small plume of hot air and gases rises to the ceiling and spreads out. The sprinkler head is activated at the proper temperature by these hot gases. The most frequent kind of installation is seen below, using a standard sprinkler.

(b)

Figure.5a. Fire Sprinkler and 5b. Fire Hose Wall Mounted

3.2 Smoke detectors

A smoke detector is an electronic fire-protection equipment that detects the presence of smoke, which is a significant indicator of fire, and alerts building occupants. As part of a building's central fire alarm system, commercial and industrial smoke detectors send a signal to a fire alarm control panel [6][7]. Every business is required by law to have a smoke detection system. Household smoke detectors, often known as smoke alarms, emit an audible and/or visual alarm when they detect smoke. They can be standalone battery-powered equipment or a network of hardwired (mains-powered) devices with battery backup. The latter is required in all new construction and large renovations.

3.2.1 Smoke detector types

Photoelectric (optical) and ionisation are the two most common forms of passive smoke detectors (physical process). For best protection from both fast burning and long shouldering fires, a combination of the two types of detectors (dual sensor smoke alarm) is advised. There are also visual smoke and heat alarms, as well as smoke and carbon monoxide alarms. When smoke enters the detection chamber, a photoelectric detector detects abrupt dispersion of light, triggering the alarm. Photoelectric smoke detectors respond 15 to 50 minutes faster than ionisation alarms to fire in its early [8], shouldering stage, before it erupts into flame. They can be placed next to kitchens. There are few dual optical variants available. Ionisation smoke alarms are particularly sensitive to microscopic smoke particles and respond 30 to 90 seconds faster than photoelectric smoke alarms to fast blazing fires, but not to shouldering fires. If they are placed too close to kitchens or garages, they may be easily set off [9]. Ionisation alarms transport a little quantity of radioactive material between two electrically charged plates, causing the air to be ionized and current to flow between them. When smoke enters the chamber, it interrupts the ion flow, reducing current flow and triggering the alarm.

3.3 Heat alarms

Although they are insensitive to smoke, heat alarms detect a rise in temperature caused by a fire. They're fine in a kitchen, garage, or dusty room, but they shouldn't be relied on only for fire detection.

3.3.1 Smoke detector installation and maintenance

A qualified electrician or installation professional must install mains-powered alarms. Domestic smoke alarms are significantly easier to install because they don't require any wiring, but they must be installed, maintained, and tested on a regular basis. The average lifespan of a smoke detector is eight to ten years. Detectors should be examined on a regular basis, ideally once a week, and batteries should be replaced as needed, at least once a year. A smoke detector that is hard-wired can last up to ten years.

3.4 The Smoke Detector we used in the mall

The greater the popularity of a mall among tourists and locals, the greater the risk of fire. The greater the popularity of a mall among tourists and locals, the greater the risk of fire. Mall tenants will receive the earliest fire warnings and will have adequate time to safely evacuate if dependable fire detection systems and fire alarms are implemented. When installing fire alarms in shopping malls, high-risk locations must be identified, and the building plan must be reviewed for the optimum escape routes. We also keep in mind the significance of early identification of smoke. By detecting visible and invisible smoke particles, smoke detectors can safeguard shopping malls from devastating fire damage and loss of life. Smoke detectors are especially crucial

in the atria areas, which are difficult to access even with service equipment. Dual smoke detectors are the finest choice for smoke detectors in shopping malls since they are not affected by sunshine, dust, or pests.

Automatic fire detection systems, when paired with other early warning fire systems [10-11], have been shown to dramatically reduce:

- Property damage to a business
- Injuries
- The loss of life in the event of a fire.

Our retail mall's ideal fire safety measures will be determined by the mall's construction and general use.

3.3.5 Dual smoke detectors

Ionization and photoelectric technologies are combined in dual sensor smoke alarms. The sensors work together to provide a comprehensive smoke and fire detection system for the mall. This 10-Year Battery Dual Sensor Smoke Alarm can assist deliver the earliest possible warning, regardless of the type of fire, by combining photoelectric and ionisation technologies. The First Alert 10-Year Battery Dual Sensor Alarm comes with a number of features that make it an excellent choice for our shopping Centre.

Figure 6. Smoke Detector

Smart Sensor- People have a tendency to pull out the batteries or disconnect the alarms when the smoke alarms ring regularly for false alerts, leaving their house and family unsafe. This dual sensor alarm uses sophisticated detecting technology to eliminate false alerts caused by cooking smoke or steam. Intelligent sensing [13] equipment can determine the difference between real fires and nuisances, which helps to reduce false alarms.

Easy Installation- This fire detector is simple to install thanks to its cordless, battery-operated design. Follow the instructions for installation and position the alarm on your ceiling or on the wall, ensuring that the detector is within 12 inches of the ceiling.

Simple Detector Design- There is only one button for testing and silencing the alarm for ease of use. In the case of a fire, the loud 85-decibel alert is designed to be heard readily throughout the facility.

10 Year Sealed Battery- The dual sensor smoke alarm does not require battery replacements because it has a built-in, sealed 10-year lithium-ion battery. It also contains an end-of-life alert that sounds when the fire alarm needs to be replaced. All smoke alarms should be changed and tested at least once every ten years.

3.6 Fire shaft

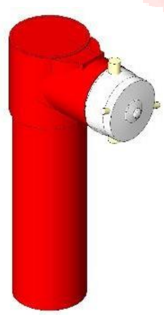

Figure 7. Fire Shaft

Generally, a fire shaft consists of lobby space, fire mains, a fireman's lift, and stairs. These shafts are designed for emergency and rescue purposes. The lift power supplies are backed up, all lift cables are fire resistant, and the whole fire shaft is designed in such a way that it can hold a fire for up to or more than two hours. Through this fire shaft, the firemen can operate the rescue operations, and the fire shaft is made accessible in such a way that the lift can access any floor of the building. It even has access to fresh air. In other words, this fire shaft is meant to be designed for rescue operations at the time of a fire accident [14], and all the properties of the fire shaft are heavily fire-proof and made easily accessible to firemen.Bluetooth sensor method

The current work proposes integrating information on fire-prevention facilities, Bluetooth sensors, and evacuation-and-rescue-route-optimization and disaster-prevention features into a 3D massing model for the building sector using BIM. Using the BIM model to create a framework for an intelligent fire and disaster protection system works like this: When the Bluetooth sensors detect a sufficiently high temperature or smoke level, the system checks for authenticity, sounds the alarm, and then monitors the fire-outbreak locations and evacuation/rescue routes, which are generated by back-end operations in the BIM 3D model. The system then employs an application software programme to automatically activate dynamic evacuation instructions in real time on the devices of users in the fire-affected region [15-16], based on the floor(s) that are affected by the fire and the floor plan of the suspected fire area. The suggested integrated system aims to improve the efficiency and safety of evacuation and rescue operations.One of the superior uses of fire systems is BIM-based 3D visualisation capabilities that incorporate IT techniques that can support fire safety management. BIM coupled with an online building fire monitoring system that used sensors, monitors, and relative spatial information to help owners pinpoint the ignition site so that firefighters could be dispatched effectively to do large-scale fire rescues. BIM for facility management (BIM FM) is a relatively new application of BIM.(BIM FM is a BIM-based framework with safety attribute identification/classification, data processing, rule-based decision making, and a user interface to build safe maintenance and repair methods during the facility management stage.)Wireless sensor networks were used to create a system that identifies fire dangers. These networks are used by the fire prevention system to detect the exact location of a fire and its spread direction, providing important information to stop the spread of fire and save natural resources as well as the lives of mining people. The proposed method might be used to identify fires early on, with an alarm being triggered if an emergency scenario is discovered. During emergency scenarios, the RescueMe system(mobile application) proposes optimal evacuation routes to evacuees using mobile phone devices. By sensing changes in speed in real time, this device assists evacuees in avoiding crowded bottlenecks within a structure.When an evacuee's speed drops sufficiently, the algorithm recalculates the quickest way and sends the evacuee a new routing plan.

3.7 FRAME Systems (Fire Risk Assessment Method for Engineering)

This method is one of the easiest tools for engineers who are working on the development of fire safety. Most people prefer this method over other methods like SIA, FIRE CAM (fire risk evolution and cost assessment model) because of its ability to determine sufficient and cost-effective fire safety concepts. Unlike building codes which work on providing safe evacuation [17] and escape routes for the people in the building, this method aims at protecting the elements of the building, its contents and the activities that take place in the building. It gives a clear, most practical calculation methods which are used to find the fire risk index of the building. This method can be used to evaluate fire risks in the present situation and can compare with the other possible methods in terms of efficiency. This model applies to BIM which inturn replaces human patrol and 2d extraction which are less accurate and less efficient compared to this method. unlike other methods in this method [18], the designer looks first for adequate protection for the property before verifying life safety, and then further he looks over additional fire safety for occupants in already pre-defined highly fire-resistant building design.

Table .1 - Cost estimation

Equipment	No. of items	Price per piece	Cost
Sprinklers system	250 sprinklers	₹ 2500/piece including installation and pipes	₹ 6,25,000
Smoke detectors	70	₹ 1000/piece with installation	₹ 70,000
Fire resistant curtain wall (6mm fire rated)	5014.5 square feet	₹ 300/square feet	₹ 15,04,350
Fire shaft	1	₹ 8.5 lakh	₹ 8,50,000
Hose cabinet	10	₹ 10000/ cabinet	₹ 1,00,000
Water tanks	4 (2000L each)	₹12000/tank	₹ 48,000
Total cost			**₹ 31,97,350**

Results

The geometrical design is an important factor to determine the fire safety measures of building. Building with proper geometric shapes can be used when rapid safe evacuation and pre fire safety measures are needed, as in building these days. It has been determined from the analysis that the shopping mall models have significantly decreased their cost for future life cycle of structure and maintenance but the initial cost is increased by approximately 32 lakhs. The optimum service life has no effect but the minimum service life for modified models has improved significantly. In case of fire accident, this safety system helps to minimize the damage to property as well as minimize the mortal danger. With this system, the recovery of damage can be done by insurance company. Using BIM model we can take pre safety measures before occurrence of any fire accidents and enhance the best safe evacuation path for occupant and firemen.

Conclusion

This paper introduces a BIM- based model directed at enhancing structure breaking point operation. The research focuses on two critical factors for emergency operation safe evacuation and decreasing the fire outbreak. In summary, in the case of fire events, people tend to make a chaotic scene and engage in unsteady actions, consequently this always remains a major difficulty for fire safety engineers in the fire protection strategy procedure. On the other hand, the smoke that arises from the fire makes the situation worse and causes low visibility, which has a bad impact on people behavior too. In such a scene, evacuation is one of the most significant aspects of saving lives in case of fire. But, because of the chromatic types of structures, it's tough to have a correct evacuation plan. Therefore, these different types and frame conditions are impacting the operation of BIM because it facilitates the integration and coordination among all stakeholders in a design, its position of detail, and its supporting functionalities in view of design, construction, conservation, deconstruction, and operation processes due to stakeholders' conditions. Through applying BIM, the real- time evacuation process will be predictable. Also, by combining BIM and erecting a surveillance system, the design stakeholders from different region of the lifecycle can see the applied changes and it facilitates the inflow of controlling and managing parameters. Besides these, BIM can pretend an evacuation plan that was unapproachable before it. Thus, using BIM in a fire accident will address the issues and reduce the casualties and losses. Studying different papers reveals that there are several exploration gaps that, in the future, experimenters can handle. For example, they can probe developing new styles for bringing BIM and serious gaming together to automatically create the game script out of the BIM, study human actions in extreme situations, and human factors regarding the relation between inhabitant- building and inhabitant- fire in a new way. Another area of unborn exploration is the BIM-- controlled signage system for healthcare installations.

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