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ASSESSMENT OF EMERGENCY ESCAPE ROUTES FOR A BUILDING USING PATHFINDER - A CASE STUDY

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ABSTRACT

Evacuation planning is critical for important applications to evacuate affected populations to safer places in the event of natural disasters, fire, industrial and constructional accidents. Currently, evacuation plans are often hand-crafted using table-top exercises and these methods time consuming and labour intensive as well as expensive limiting the number of scenarios during planning and adjustments to unanticipated events during emergency response. Computerized tools help to resolve the issues in least possible time and can be applied in complex scenarios. In addition, the tools recommend novel escape routes and assist with alternative strategies. The tool adopted in the current study is pathfinder software. To expose the principle, the graphical representation is applied to the optimization of building evacuation. The main purpose of the study is to perform an analysis of the factors determining the architectural configuration of buildings for the mobility of people and finding out the shortest distance for an effective evacuation.

KEYWORDS: Emergency, evacuation time, occupants.

INTRODUCTION

A wide variety of emergencies both man-made and natural may require a workplace to be evacuated. These emergencies include - fires, explosions, release of toxic material, radiological and biological accidents, civil disturbances and workplace violence. The extent of the damage depends on the type of emergency and the building's construction. Employers plan to identify a secured location inside the premises to utilize for assemble of employees in event of any type of emergency. The plans must identify when and how employees are to respond to different types of emergencies and identifying a secured location is crucial while preparation of emergency plans. Designate assembly areas or areas, both inside and outside workplace, where employees assemble after evacuating. The assembly area has sufficient space to accommodate all the employees. Exterior assembly areas, used when the building must be partially or completely evacuated, are typically located in parking lots or other open areas away from busy streets.

Most employers create maps from floor diagrams with arrows to designate the exit route assignments. The maps should include locations of exits, assembly points, and equipment needed in an emergency. Exit routes should be clearly marked and well lit, wide enough to accommodate the number of evacuating personnel, unobstructed and clear of debris at all times, and unlikely to expose evacuating personnel to additional hazards.

Any discrepancy in the assembly areas can lead to delays in rescuing anyone trapped in the building, or unnecessary and dangerous search-and-rescue operations. When designating an assembly area, consider the possibility of employees interfering with rescue operations; establish procedures for further evacuation in case the incident expands.

The models and algorithms which can be applied to evacuation problems were studied. Considering time as the main parameter mathematical modelling of evacuation problems was done, also distinguish between macroscopic and microscopic evacuation models which are able to capture the evacuees movement over time was done[1].

The basic principle for solution of the building evacuation problem was formulated. The ideal distribution of the occupants towards the exits, with minimal evacuation time was done by considering three cases. Observation was

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made that to manage the minimal evacuation time of an enclosure, if the outflows are independent, its necessary to achieve the distribution that produces identical times of evacuation. Graphical procedure was adopted which helps to determine what would be the result of the problem with change in the number of the occupants, the width of the exits, the ways of evacuation or response variations to the alarm sign. It is very useful tool for the person who designs and manages the buildings safety[2].

A study was conducted in a construction organization involved in construction of a thermal power plant in India to optimize the emergency management system by adopting shortest route algorithm, transportation model and minimal spanning tree. The shortest route for a specific assembly point using minimal spanning tree technique was found. A model based on minimal spanning tree was used to formulate form evacuation which is effective and takes minimum response time[3].

The development of simulation model of occupants with behavioural attributes in emergency evacuation of high-rise building fires using EvacSim was done. EvacSim is a building evacuation model which is developed based on a discrete event simulation concept. It can simulate a complex variety of human behavioural activities, both deterministically and probabilistically or a combination of both. An occupant may be modelled to respond to cues from the physical environment, or to interact with other occupants, in a manner which depends upon the level of severity perceived by the occupant. EvacSim forms part of a greater model for assessing life safety in high-rise building fires. The final conclusion was to integrate EvacSim with fire model [4]

MATERIALS AND METHODS

In this study, pathfinder software was adopted to assess the minimum response time for evacuation. The key features of path finder software are as follows,

PATHFINDER

Pathfinder is an agent-based egress simulator that is designed to meet the practical needs of emergencies to those who work with increasingly complex building models. Pathfinder's simulation model takes advantage of advances in agent-based approaches to movement modelling that make it possible to capture more complex behaviour and interactions between occupants.

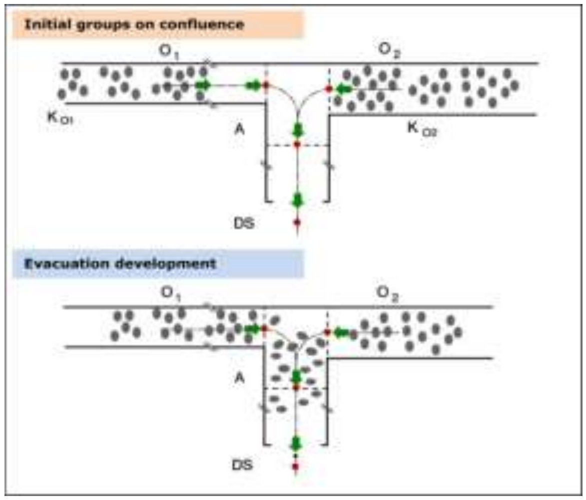
MOVEMENT MODEL

Pathfinder uses agent-based artificial intelligence. This approach attempts to model the behaviour of large groups by simulating the behaviour and interactions of individual occupants. Each occupant has individual traits, goal, and perceptions and can take unique actions based on that data. Such systems allow realistic behaviour to emerge as occupants move and self-organize. Pathfinder moves occupants in continuous 3D space using a triangulated mesh. This movement mesh represents area where occupants can walk, and the triangulated geometry

USER INTERFACE

Pathfinder provides several tools for creating the mesh need by the movement system. It is possible to create the mesh directly using drawing tools within the software. Alternately, users can import geometry from DXF files, PyroSim models, and FDS input files. An automatic floor extraction tool makes it possible to extract the mesh from imported geometry using a flood fill technique technique. In cases where the imported geometry contains 3D solid objects or background images, that data can be displayed along with occupant movement visualization when viewing animated results shown in Fig.1.

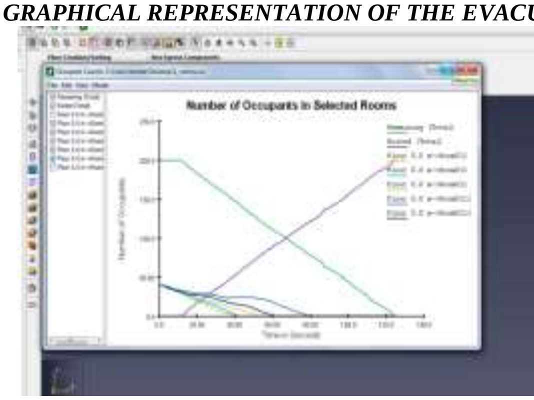
Figure. 1 ANIMATED VIEW OF RESULTS



To make it easier to manage occupant parameters, Pathfinder includes a profile system that control settings for speed, initial delay, size and appearance for groups of occupants. Each occupant refers to its profile to establish default values for these settings. All settings can also be overridden for specific occupants.

Pathfinder provides real-time output visualization for 3D results. It operates much like a video player in that it allows users to play, pause, and stop playback as well as providing additional playback features. This output visualization allows users to navigate through models and change view settings in ways that analysis of complex structures more convenient. A live recording feature makes it possible for users to create video files based on what they see during results analysis. Graphical representation of the evacuation can also be done by using this software as shown in Fig. 2.

Fig: 2 GRAPHICAL REPRESENTATION OF THE EVACUATION



RESULTS AND DISCUSSION

The assessment of emergency escape routes was conducted in a college building as a pilot study by

FEATURES OF PATHFINDER

3D AND 2D VIEWS

The 3D and 2D views are the main views in which drawing is performed in Pathfinder. Both views contain tools to draw egress geometry and navigate in a model. The main difference between the two views is that the 3D view allows the model to be viewed from any direction, whereas the 2D view only allows viewing from one, orthographic direction. In addition, the 3D view contains no snap grid, whereas the 2D view does.

CREATING MOVEMENT SPACE

Pathfinder is built on the idea of creating floor space on which occupants can walk. Every navigation component drawn in Pathfinder is some piece of flooring that can be travelled on, which can range from floors, to doorways, to

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stairs. Obstructions exist as holes in the floor. The main egress components include rooms, which are empty floor spaces bounded by walls, doors, which connect rooms on the same level, stairs/ramps, which connect rooms on different levels, and elevators, which connect multiple levels.

The summary report file contains information about the simulation geometry, simulation performance, and usage information for each room, stairway, and door. This file is saved in the simulation directory and given the name namesummary.txt. To view it, under the Results menu choose Show Summary File. The first section shows the mode the simulation was run in, the total number of occupants, and statistics on the evacuation time.

using Pathfinder. In the assessment, three scenarios were considered. Each scenario having different number of emergency exits. In the college building, there are four class rooms and one library with one main entrance which is also used as an exit and the total number of occupants in each room is 40.

Scenario 1: Fig: 3 indicate the position of occupants before evacuation and this is the current status of the building, with one entry point. The exit and entry into the building is through entrance only, at present. It shows that in each room there are 40 occupants and a combined total of 200 occupants.

Fig.3. Before evacuation with one exit

Table:1 shows the basic information about scenario 1, which includes the total number of occupants, number of exits, number of occupants in each room etc.

Table 1 : Details of building with one exit

ITEM	NUMBERS
Total number of occupants	200
Total number of rooms	5
Number of occupants in each room	40
Number of exit in scenario 1	1

Fig 4 indicates that the occupants have been evacuated from the building by pathfinder sofware and the total time required for evacuation is 124.81 seconds.

Fig.4. After evacuation through a single exit

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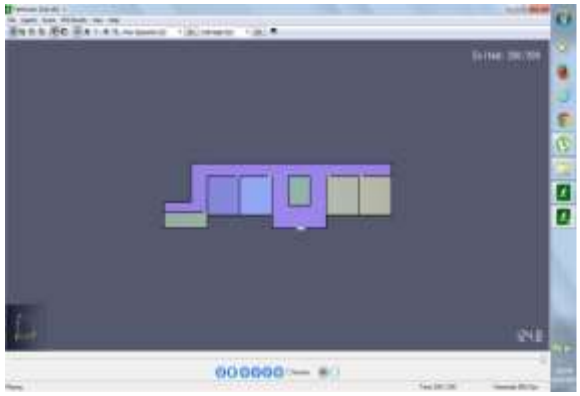
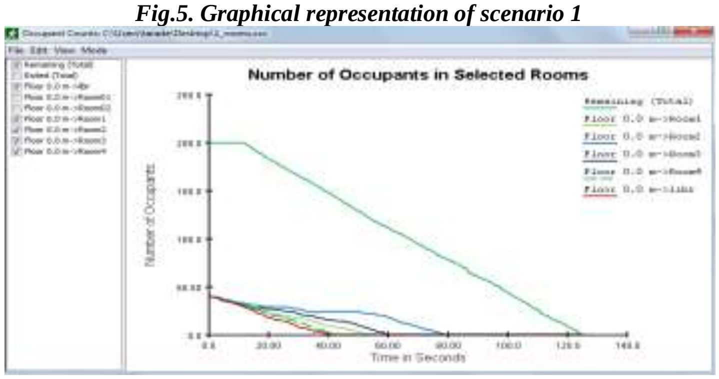


Fig 5 represent the graphical representation of time taken for evacuation of 200 occupants inside the building when there is only one exit from the building.

Fig.5. Graphical representation of scenario 1



Scenario 2

Fig: 6 indicate the position of occupants before evacuation. In this scenario also there are 40 occupants each in each room and a combined total of 200 occupants. But there are two exits provided in this scenario, which is shown in the top left of the building plan.

Fig.6. Before evacuation with two exits.

Table:2 shows the all the information about the scenario 2, which includes the total number of occupants, number of exits, number of occupants in each room etc.

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Table 2 : Details wit two exits.

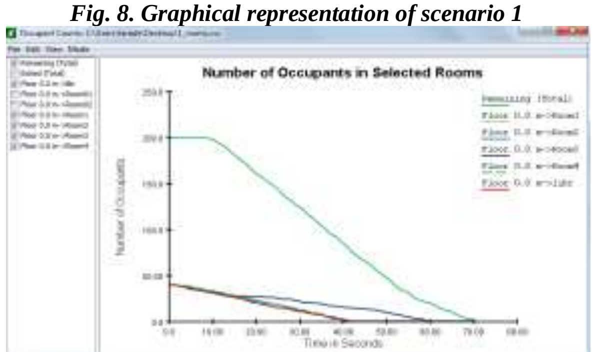
ITEM	NUMBERS
Total number of occupants	200
Total number of rooms	5
Number of occupants in each room	40
Number of exit in case: 2	2

Fig7 indicate that the occupants have been evacuated from the building and the total time taken is shown in the bottom right corner of the diagram which is 70 seconds.

Fig.7. After evacuation through two exits

Fig: 8 represent the graphical representation of time taken for evacuation to total number of occupants inside the building when there are two exits from the building.

Fig. 8. Graphical representation of scenario 1



Scenario 3

Fig 9 indicates the position of occupants before evacuation. In this scenario also there are 40 occupants each in each room and considered a total of three exits, where the third exit is shown in the top right corner of the building plan.

Fig.9 Before evacuation with three exits

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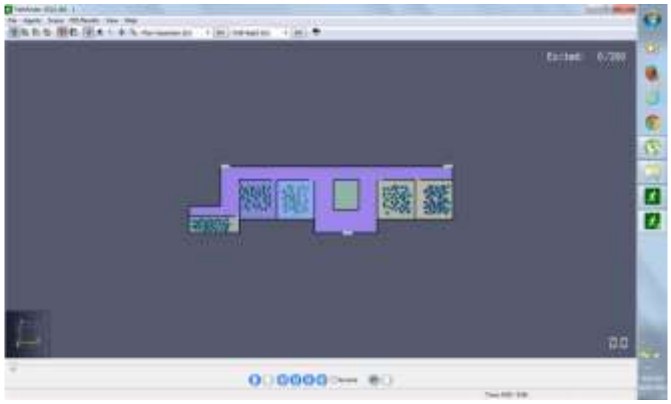


Table 3 shows the information regarding the scenario 3, which includes the total number of exits and number of emergency exits.

Table 3 :Number of eixts three

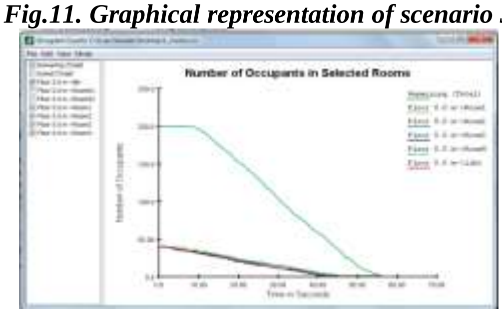
ITEM	NUMBERS
Total number of occupants	200
Total number of rooms	5
Number of occupantsin each room	40
Number of exit in case: 3	3

Fig 10 indicate that the occupants have been evacuated from the building and the total time taken is shown in the bottom right corner of the diagram which is 56 seconds.

Fig 10. After evacuation through three exits.

Fig: 11 represent the graphical representation of time taken for evacuation to total number of occupants inside the building when there are three exits from the building.

Fig.11. Graphical representation of scenario 3



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CONCLUSION

From the analysis, the following conclusions are drawn,

- The time taken for evacuation with existing exit is 124.81 seconds.
- The study was extended by considering one more additional exit arbitrarily and the evacuation time is 70 seconds.
- The analysis was further extended by considering two more exit routes and saving in time for evacuation is 68.81 seconds and 16 seconds respectively while comparing with scenario 1 and 2.
- The model 3 with two exit routes is considered as the best.
- The analysis can be extended to assess requirements of exit routes for commercial building complexes, hospitals, office buildings etc. where the occupants are quite high.

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