ISSN No:-2456-2165

Dynamic Strategy for the Evacuation of Occupants in Different Occupancies – ASET RSET

Vineet Banodha[1]
Assistant Professor
[1]Fire Technology & Safety Engineering Department, IPS Academy, Institute of Engineering & Science, Indore, India

Tushar Jhakra[2], Vaibhav[2], Sankalp Shree[2], Sahil Sangwan[2]
U.G Students
[2]Fire Technology & Safety Engineering Department, IPS Academy, Institute of Engineering & Science, Indore, India

Abstract:- Our aim in this project is to determine the safe egress time in the two occupancies i.e. Business and Institutional Buildings. Safe evacuation in an occupancy depends on the several factors such as building design parameters, human psychological behaviour and fire & safety facilities installed within a premises. The scope of this project is limited to Business and Institutional Buildings where occupant load is low as compared to Assembly building. Furthermore, the safe egress time is completely based on two factors i.e. ASET and RSET. Coming to the term ASET stands for Available Safe Egress Time. ASET is defined as the time period between fire initiation and onset of life threatening conditions. The ASET is determined from the time the effects of fire reach the defensive limits for the safe evacuation. On the other hand RSET is Required Safe Egress Time. It refers to the duration of time required for safe evacuation after the signalling of the fire. RSET is calculated as the sum of three separate components the alarm time, evacuation delay and movement time. ASET depends on a variety of variables associated with the fire scenario, including the intensity of the fire and the geometry of the fire (distribution of fire load), fire protection measures and building spatial environment. However, in any case ASET should be reasonably greater than the required safe evacuation time (RSET) for a successful building evacuation during fire emergencies.

I. INTRODUCTION

Suppose you stuck in building where fire emergency occurs and you want to evacuate the building with in short period of time but there are many factors which are delaying our evacuation process.

To overcome this situation our project on **Dynamic Strategy for the occupants in different occupancies by ASET RSET** simplifies by the comparison of time required for the escape **(RSET)** with the time available for escape before conditions become indefensible **(ASET)** often the basis of the life safety assessment.

This whole project is based on the performance based life safety which balances both ASET and RSET on the scale of time required for escape (Required Safe Escape Time) and the time that elapses after the ignition of fire and before the production of smoke, heat and poisonous gases that create untenable conditions (Available Safe Egress Time).

The rapid evacuation of people from a threatening area before the onset of fire-induced untenable conditions is a necessary requirement for people safety. The maximum time available to people to move away from the threatening area is defined as Available Safe Egress Time (ASET) and this time is usually used to evaluate the egress system performance. An egress system is correctly designed if people can evacuate before the ASET is reached.

A. ASET

The term ASET stands for Available Safe Egress Time. ASET is defined as the time period between fire initiation and onset of life threatening conditions. The ASET is determined from the time the effects of fire reach the defensive limits for the safe evacuation.

B. RSET

The acronym of RSET is Required Safe Egress Time. It refers to the duration of time required for safe evacuation after the signalling of the fire. RSET is calculated as the sum of three separate components the alarm time, evacuation delay and movement time.

ASET is defined as the time period between fire initiation and onset of life threatening conditions. ASET depends on a variety of variables associated with the fire scenario, including the intensity of the fire and the geometry of the fire (distribution of fire load), fire protection measures and building spatial environment.

ASET should be reasonably greater than the required safe evacuation time (RSET) for a successful building evacuation during fire emergencies. In the absence of adequate fire safety measures, smoke and hot gases may spread to evacuation routes (for example, lift lobbies, lift shafts and stair shafts) and occupants at the fire-affected floor and other floors may expose to hazardous conditions leading to psychological and physiological effects. The parameters such as smoke visibility, CO, CO_2 and O_2, temperature and radiant heat exposure are used in evaluating hazardous conditions. Such parameters can be obtained from fire tests or computational models. The time to untenable conditions that may lead to Incapacitation or death is predicted from the combination of smoke toxic products and heat exposure.

II. OCCUPANCY/INDUSTRY INTRODUCTION

➢ *List of Industries/ Systems in which Project will be Carried out*

In this project we will target on the following occupancies:

- *Business Occupancy*

This type of occupancy shall include any building or part thereof which is used for transaction of business for keeping of accounts and records and similar purposes, professional establishments, service facilities, etc. City halls, town halls, courthouses and libraries shall be classified in this group so far as the principal function of these is transaction of public business and keeping of books and records.

According to the NBC Part IV, Business occupancy is further classified into five sub divisions.

Buildings under Group E (Business Occupancy) shall be further subdivided as follows:

- ✓ Subdivision E-1 - Offices, banks, and professional establishments, like offices of architects, engineers, doctors, lawyers, post offices and police stations
- ✓ Subdivision E-2 - Laboratories, outpatient clinics, research establishments, libraries and test houses
- ✓ Subdivision E-3 - Electronic data processing centres, computer installations, information technology parks and call centres
- ✓ Subdivision E-4 - Telephone exchanges
- ✓ Subdivision E-5 - Broadcasting stations, T.V. stations and air traffic control towers

In this project we will focus on the following building of the above occupancy:

- *Corporate Office Building*

III. RESULT AND CALCULATION

➢ *ASET/ RSET Calculation*

In order to consider a realistic situation, fire detection time, pre-movement time (response and coping) and movement time are added to determine the time to arrive to an exit. This is called Required Safe Evacuation Time (RSET). However, occupants may also arrive without engaging themselves in pre-movement response and coping activities. The occupants arrive between the minimum and maximum times. These times are considered as random variables. Fire detection time can be determined with the help of models. The evacuation time for the number of evacuees (N) in a building can be expressed as:

$$te = t1 \cup t2 \cup t3 \ldots\ldots\ldots\ldots\ldots\ldots \cup tn$$

Where te is the building evacuation time (s).

While the evacuation time of an individual can be expressed as:

$$ti = tFD + tPM + tM + tS + tl$$

Where, **ti** = individual evacuation time (s)

tFD =fire detection time

tPM =pre-movement (coping and response) time for an evacuee

tM =movement time for an evacuees

tS =travelling line for an evacuee in stairs

tl = evacuee intermittent floor movement time through stairs

Building designs incorporate numerous features that direct occupants to the street or grade level. The fire protection and life safety systems installed in high-rise buildings are designed to control a fire and to lessen the need to evacuate all occupants to the street level. Some fires clearly showed the vulnerability that high rise buildings had, in spite of having careful control of construction material. A number of factors contribute to the loss of life and property including a delay in activation of the building fire alarm. The fire safety introduces a systematic process that is normally associated with passing a public education message about emergency procedures in a tall building environment. If one person can potentially slow, the progress of what could be many hundreds reflected in due course. The occupants are likely to use nearest exit for safe evacuation.

The time required for escape is the time required for occupants to travel from their location at the time of ignition to a place of safe refuge. Times relating to fire detection, pre-movement, movement and stair evacuation are required to establish the RSET. The occupants of the fire floor, and floors immediately above and below it, should immediately use the exit stairs to descend to street level or a floor level that is at least a few floors below the fire floor. The occupants can then re-enter the occupied space on those safe floors to await further instructions. While a fire is the most likely emergency scenario, they are likely to encounter, other perils that may require total or partial building evacuation, exist for other natural and man-made disasters. A deliberation is needed whether the occupants near to top floors should go to terrace or to the grade level during the outbreak of fire. A helicopter may also not come for rescue, thus, it is recommended that descending to grade level may be much useful instead of ascending to the rooftop. This needs to be considered as a standard procedure. Occupants are prepared to take action for any emergency and building employer should be encouraged to stage a mock drill once a year. It must be emphasized that ultimately every individual is responsible for his or her own safety. The occupants should be confident to reach outside safely from the hot smoke filled environment.

➢ *Calculation by Pathfinder*

Occupancy type:	Business Building
Version:	2019.1.0508
Mode:	Steering
Total Occupants:	350
No. of Floors = 7	Nos.

- *Completion Times for All Occupants (s):*

Min:	7.4	"00054"
Max:	312.1	"00133"
Average:	123.9	
Standard Deviation:	75.8	

- *Travel Distances for All Occupants (m):*

Min:	8.7	"00054"
Max:	117.4	"00188"
Average:	49.3	
Standard Deviation:	27.0	
[Components] All:	211	
[Components] Doors:	120	
Triangles:	2916	
Startup Time:	0.5s	
CPU Time:	46.1s	

➢ *Door Flow Rates:*

Door	First_In (s)	Last_Out (s)	Last_Out_Name	Total_Use (pers)	Flow_Avg (pers/s)
Door06	50.4	251.7	00125	24	0.12
Door06	0.0	0.0	0		
Door06	0.0	0.0	0		
Door06	209.5	219.1	00145	7	0.73
Door06	171.9	173.4	00150	2	1.38
Door06	116.6	125.8	00146	7	0.76
Door06	20.1	76.9	00166	8	0.14
Door07	49.8	294.2	00133	31	0.13
Door07	0.0	0.0	0		
Door07	257.2	267.0	00173	7	0.72
Door07	218.8	221.6	00185	3	1.07
Door07	165.5	174.5	00135	7	0.77
Door07	77.2	85.4	00156	7	0.85
Door07	18.7	26.8	00156	7	0.87
Door00	2.9	22.9	00063	25	1.25
Door01	4.3	11.7	00025	6	0.81
Door02	5.8	5.8	00085	1	
Door03	2.6	11.2	00063	6	0.70
Door04	1.3	5.2	00095	4	1.01
Door05	4.1	13.6	00057	7	0.74
Door08	3.6	5.1	00043	2	1.36
Door09	1.3	260.6	00125	39	0.15
Door10	3.8	302.3	00133	41	0.14
Door11	13.2	35.2	00090	25	1.14
Door12	0.0	0.0	0		
Door13	7.4	312.1	00133	325	1.07
Door14	0.0	0.0	0		
Stair01 door 1	11.8	232.8	00141	127	0.57
Stair01 door 2	8.2	227.2	00141	127	0.58
Stair02 door 1	6.2	223.0	00141	126	0.58
Stair02 door 2	2.6	216.9	00141	126	0.59
Stair03 door 1	14.6	224.9	00168	118	0.56
Stair03 door 2	11.1	222.0	00168	118	0.56
Stair04 door 1	9.1	215.4	00178	119	0.58
Stair04 door 2	5.6	211.3	00178	119	0.58
Door15	1.3	1.3	00131	1	
Door16	3.1	10.6	00131	6	0.79
Door17	0.0	0.0	0		
Door18	4.7	13.1	00195	6	0.71
Door19	0.0	0.0	0		
Door20	1.0	4.0	00195	4	1.32
Door21	1.6	1.6	00188	1	
Door22	3.8	8.6	00191	4	0.82
Door23	1.7	7.2	00198	4	0.72

ISSN No:-2456-2165

Stair01_1 door 1	11.8	211.3	00141	97	0.49
Stair01_1 door 2	8.0	204.1	00141	97	0.49
Stair02_1 door 1	6.2	196.8	00141	99	0.52
Stair02_1 door 2	3.2	187.8	00141	99	0.54
Stair03_1 door 1	12.3	206.0	00178	98	0.51
Stair03_1 door 2	9.0	200.9	00178	98	0.51
Stair04_1 door 1	7.1	194.9	00178	96	0.51
Stair04_1 door 2	4.3	190.7	00178	96	0.52
Door15_1	0.0	0.0	0		
Door16_1	4.1	5.4	00150	2	1.54
Door17_1	0.9	0.9	00107	1	
Door18_1	3.1	10.9	00195	6	0.76
Door19_1	3.9	5.8	00133	2	1.05
Door20_1	1.2	3.3	00195	3	1.41
Door21_1	2.3	2.3	00188	1	
Door22_1	3.9	11.6	00162	7	0.92
Door23_1	2.2	7.3	00198	5	0.98
Stair01_2 door 1	19.4	181.7	00182	68	0.42
Stair01_2 door 2	10.5	173.0	00182	68	0.42
Stair02_2 door 1	7.9	153.6	00188	71	0.49
Stair02_2 door 2	3.1	149.8	00188	71	0.48
Stair03_2 door 1	14.2	180.0	00195	84	0.51
Stair03_2 door 2	10.4	169.8	00195	84	0.53
Stair04_2 door 1	8.5	165.2	00182	81	0.52
Stair04_2 door 2	5.0	154.2	00182	81	0.54
Door15_2	0.0	0.0	0		
Door16_2	1.8	11.7	00176	5	0.51
Door17_2	1.0	1.0	00107	1	
Door18_2	3.6	10.9	00141	5	0.69
Door19_2	0.0	0.0	0		
Door20_2	1.2	1.8	00141	2	
Door21_2	0.0	0.0	0		
Door22_2	3.6	11.1	00191	5	0.67
Door23_2	1.5	8.3	00109	5	0.74
Stair01_3 door 1	14.6	129.1	00178	55	0.48
Stair01_3 door 2	10.5	122.5	00178	55	0.49
Stair02_3 door 1	8.5	111.3	00165	53	0.52
Stair02_3 door 2	5.0	108.3	00165	53	0.51
Stair03_3 door 1	10.2	139.2	00182	57	0.44
Stair03_3 door 2	7.8	121.9	00188	57	0.50
Stair04_3 door 1	6.1	117.8	00178	59	0.53
Stair04_3 door 2	3.8	111.4	00178	59	0.55
Door15_3	1.0	1.0	00131	1	
Door16_3	2.6	6.8	00176	4	0.95
Door17_3	0.0	0.0	0		
Door18_3	3.1	11.0	00167	7	0.88
Door19_3	2.8	2.8	00118	1	
Door20_3	1.0	3.2	00141	3	1.38
Door21_3	0.0	0.0	0		
Door22_3	3.1	6.7	00162	5	1.42
Door23_3	1.0	8.6	00153	7	0.93
Stair01_4 door 1	10.0	81.3	00145	34	0.48
Stair01_4 door 2	7.1	72.5	00145	34	0.52
Stair02_4 door 1	5.2	66.0	00165	39	0.64
Stair02_4 door 2	2.6	60.8	00165	39	0.67
Stair03_4 door 1	10.0	94.7	00165	37	0.44
Stair03_4 door 2	6.6	75.2	00165	37	0.54
Stair04_4 door 1	4.6	63.0	00141	32	0.55
Stair04_4 door 2	1.3	54.7	00141	32	0.60
Door15_4	1.3	1.3	00131	1	
Door16_4	2.3	10.1	00176	7	0.90

ISSN No:-2456-2165

Door17_4	1.0	1.0	00107	1	
Door18_4	2.7	6.6	00193	4	1.01
Door19_4	2.6	2.6	00153	1	
Door20_4	1.9	1.9	00195	1	
Door21_4	0.0	0.0	0		
Door22_4	3.3	8.9	00188	6	1.08
Door23_4	1.1	7.6	00109	5	0.77
Stair01_5 door 1	12.3	51.6	00145	17	0.43
Stair01_5 door 2	8.2	43.3	00145	17	0.48
Stair02_5 door 1	6.2	37.6	00145	18	0.57
Stair02_5 door 2	2.6	31.3	00145	18	0.63
Stair03_5 door 1	8.4	50.7	00141	18	0.43
Stair03_5 door 2	5.6	44.7	00141	18	0.46
Stair04_5 door 1	3.9	39.3	00141	17	0.48
Stair04_5 door 2	1.2	33.2	00141	17	0.53

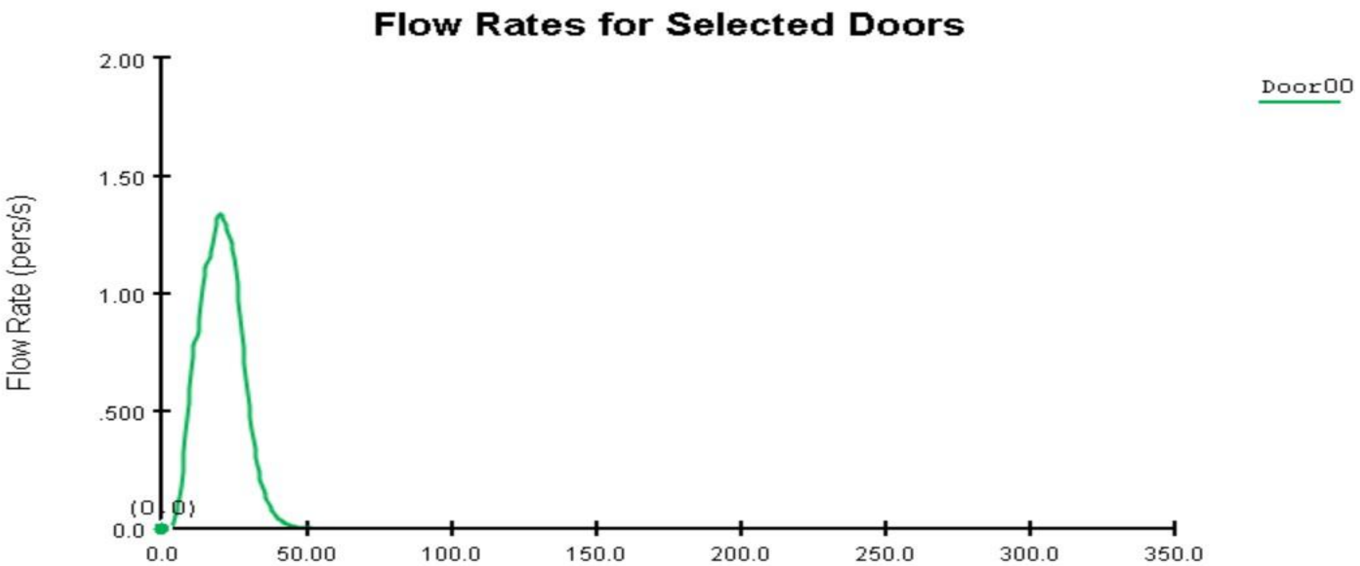

Fig 1 Flow Rates for Selected Doors

➢ *Room Usage:*

Room	First_In (s)	Last_Out (s)	Last_Out_Name (pers)	Total_Use
Level 0.0 ft	49.4	251.7	00125	24
Level 10.0 ft	0.0	0.0	0	
Level 20.0 ft	0.0	0.0	0	
Level 30.0 ft	209.5	236.9	00180	7
Level 40.0 ft	171.9	192.4	00150	2
Level 50.0 ft	116.6	146.0	00106	7
Level 60.0 ft	20.1	98.3	00166	8
Level 0.0 ft	48.2	294.2	00133	31
Level 10.0 ft	0.0	0.0	0	
Level 20.0 ft	257.2	283.5	00123	7
Level 30.0 ft	218.8	239.4	00185	3
Level 40.0 ft	165.5	193.5	00125	7
Level 50.0 ft	77.2	105.6	00153	7
Level 60.0 ft	18.7	48.2	00106	7
Room001	0.0	11.7	00025	6
Room001	0.0	11.2	00063	6
Room001	0.0	13.6	00057	11
Room001	0.0	5.8	00085	3
Room00	1.3	312.1	00133	350
Room001	0.0	302.3	00133	105
Room02	6.2	227.2	00141	245

ISSN No:-2456-2165

Stair01	8.2	232.8	00141	127
Stair02	2.6	223.0	00141	126
Stair03	11.1	224.9	00168	118
Stair04	5.6	215.4	00178	119
Room011	0.0	1.3	00131	1
Room011	0.0	10.6	00131	6
Room011	0.0	0.0	0	
Room011	0.0	13.1	00195	6
Room0111	0.0	4.0	00195	4
Room011	0.0	8.6	00191	5
Room01	0.0	216.9	00141	245
Room011	0.0	7.2	00198	4
Room02_1	6.2	204.1	00141	195
Stair01_1	8.0	211.3	00141	97
Stair02_1	3.2	196.8	00141	99
Stair03_1	9.0	206.0	00178	98
Stair04_1	4.3	194.9	00178	96
Room011_1	0.0	0.0	0	
Room011_1	0.0	5.4	00150	2
Room011_1	0.0	0.9	00107	1
Room011_1	0.0	10.9	00195	6
Room0111_1	0.0	3.3	00195	3
Room011_1	0.0	11.6	00162	8
Room01_1	0.0	267.0	00173	202
Room011_1	0.0	7.3	00198	7
Room02_2	7.9	173.0	00182	152
Stair01_2	10.5	181.7	00182	68
Stair02_2	3.1	153.6	00188	71
Stair03_2	10.4	180.0	00195	84
Stair04_2	5.0	165.2	00182	81
Room011_2	0.0	0.0	0	
Room011_2	0.0	11.7	00176	5
Room011_2	0.0	1.0	00107	1
Room011_2	0.0	10.9	00141	5
Room0111_2	0.0	1.8	00141	2
Room011_2	0.0	11.1	00191	5
Room01_2	0.0	221.6	00185	162
Room011_2	0.0	8.3	00109	5
Room02_3	6.1	122.5	00178	112
Stair01_3	10.5	129.1	00178	55
Stair02_3	5.0	111.3	00165	53
Stair03_3	7.8	139.2	00182	57
Stair04_3	3.8	117.8	00178	59
Room011_3	0.0	1.0	00131	1
Room011_3	0.0	6.8	00176	4
Room011_3	0.0	0.0	0	
Room011_3	0.0	11.0	00167	7
Room0111_3	0.0	3.2	00141	3
Room011_3	0.0	6.7	00162	5
Room01_3	0.0	174.5	00135	121
Room011_3	0.0	8.6	00153	8
Room02_4	4.6	75.2	00165	71
Stair01_4	7.1	81.3	00145	34
Stair02_4	2.6	66.0	00165	39
Stair03_4	6.6	94.7	00165	37
Stair04_4	1.3	63.0	00141	32
Room011_4	0.0	1.3	00131	1
Room011_4	0.0	10.1	00176	7
Room011_4	0.0	1.0	00107	1
Room011_4	0.0	6.6	00193	4
Room0111_4	0.0	1.9	00195	1

Room011_4	0.0	8.9	00188	6
Room01_4	0.0	125.8	00146	85
Room011_4	0.0	7.6	00109	6
Room02_5	3.9	44.7	00141	35
Stair01_5	8.2	51.6	00145	17
Stair02_5	2.6	37.6	00145	18
Stair03_5	5.6	50.7	00141	18
Stair04_5	1.2	39.3	00141	17
Room03	0.0	76.9	00166	50

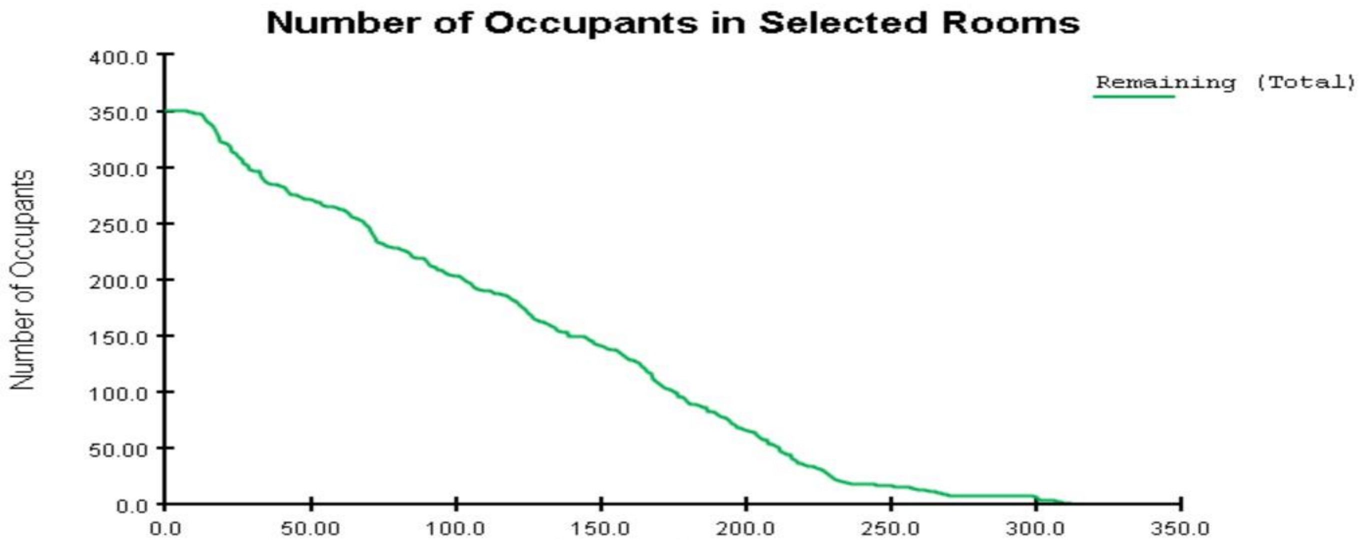

Fig 2 Number of Occupants in Selected Rooms

IV. CONCLUSION

India recently became the fifth-largest economy in the world. This economic perspective ensures the rise in all sectors such as infrastructure, construction etc. This simply means there is a rise in development of various buildings which targets the safety need of the occupants. In this scenario, evacuation planning plays an important role for safe workplace condition. As India is populated country, proper systematic evaluation of mass people working in an organization becomes the need of the time. By doing this project we want to focus on the pre-planning of evacuation, so that we should be aware of the timing of evacuation in the case of emergency. This enables the minimizing of the casualties/ human loss in an occupancy in any kind of emergency.

REFERENCES

[1]. Aset and Rset: Addressing Some Issues In Relation To Occupant Behavior And Tenability – David Purser.

[2]. Calculating Available Safe Egress Time (Aset) - A Computer Program And User Guide By Leonard Y. Cooper And David W. Stroup

[3]. Coupled Fire/Evacuation Analysis Of The Station Nightclub Fire By Edwin R. Galea, Zhaozhi Wang, Anand Veeraswamy, Fuchen Jia, Peter J. Lawrence And John Ewer

[4]. A Dynamic Approach To Aset/Rset Assessment In Performance Based Design By S.L. Poon

[5]. One-Way Coupling Of Fire And Egress Modelling For Realistic Evaluation Of Evacuation Process By He In Cheong And Zhou Wu

[6]. Developing A Swedish Best Practice Guideline For Proper Use Of Cfdmodels When Performing Aset-Analysis By Johan Norén & Daniel Rosberg

[7]. Pre-Warning Staff Delay: A Forgotten Component In Aset/Rset Calculations By S.M.V. Gwynne, D. Purser, And D.L. Boswell

[8]. National Building Code Part Iv 2005 & 2016 (Life Safety)

[9]. National Fire Protection Association 101 (Life Safety)

[10]. BS 9999: Code of practice for fire safety in the design, management and use of buildings

[11]. Jones, W.W., 2001, "State of the Art in Zone Modeling of Fires", International Fire Protection Seminar, 9th. Engineering Methods for Fire Safety. Proceedings. May 25-26, 2001, Munich, Germany, A.4/89-126

[12]. Cooper, L.Y. and Stroup, D.W., 1982, "Calculating Available Safe Egress Time (ASET) – A Computer Program and User's Guide", NIST NBSIR 82- 2578

[13]. Sime JD. Perceived time available: the margin of safety in fires. Fire Safety Science—Proceedings of First International Symposium. Hemisphere: Washington D.C., 1986; 561-570

[14]. Handbook of smoke control engineering / John H. Klote, editor and chief ; James A. Milke, Paul G. Turnbull