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Structural Integrity and Safety of Building

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Abstract

In recent years we come across the increased number of fire accidents in the society. To understand the current scenario of this fire behaviour towards the building's context, a background study was started. The existing adequate measures were recommended for future adoptability. The not existing measures and inadequate measures were not recommended for future adoptability. The future adoptability recommendation column from the inferences table was considered as findings column. The findings were segregated from the inferences table. Two sub parameters were not exists. All other major, sub parameters were exists. The findings were summed up as per the requirements order. These results were discussed with the research requirements objectives towards the future perspective. Interpretation were given towards the not existing parameters. Codes provisions numbers and its objectives were given in the interpretation. The findings were compared with the research objectives. The findings were not supporting to any one of the research objectives. The hypothesis statement was concluded. This research study reveals the study area mall buildings exists with adequate measures and does not exist with two important measures. The existing adequate measures were recommended for future upcoming buildings. The not exists measures were recommended for its implementation to future upcoming buildings. The sample buildings are to be incorporated with not existing measures along with the existing adequate measures to meet the fire and life safety objectives. The research study was concluded. Future research scope was recommended from the same domain to all categories of buildings. New fire safety requirements preparation from these findings and its application towards the future upcoming were recommended. This approach will assure fire free buildings to future generation.

Keywords: Structural Integrity Assessment, Service Safety Structures, Maintenance Repair Failure

I. INTRODUCTION

The city infrastructures of transportations network, systemized communication system, well channelized water supply, uninterrupted electrical power supply, employment opportunities, health care facilities and education systems are providing the higher quality of life to city people. The Mall building concept is also incorporated to city infrastructures. These buildings are offering the quality house hold materials to city people. These buildings are providing variety of shops, indoor entertainment facilities, relaxations facilities, multi cuisine facilities, product launches, promotions, festivals and multi-level parking facilities within the building premises. These facilities are attracting the younger generation in a grater way. They are using these buildings for their formal discussion and gathering. The easy accessibility of

these buildings, internal air conditioning comfort and escalator facilities makes the people to spend their quantity time inside.

In weekends and all festival times these buildings are used as public gathering entertainment buildings by all age group of people. Hence Life safety has become as paramount importance in these buildings.

These multi vibrant activities, the multi storied height and the fixed glass construction for façade treatment of these buildings are required safety and security inside. It is the duty, responsibility of the architects and the construction industry professionals to assure fire safety and life safety to these buildings.

The background study was carried out from numerical data and fire affected buildings. **Numerical Data Study**: The nineteen years (From 2001 to 2018) fire accidents, property loss and lives loss numerical data were collected and displayed in a table. From the display the highest values and minimum values were identified. The total values, average values were calculated. The Graphs were prepared. The table display and the Graphs details are as follows: **(Data Source: Tamil Nadu Fire cum Rescue Department)**

Table 1 Fire Accidents Numerical Data Analysis (period From 2000 TO 2018)

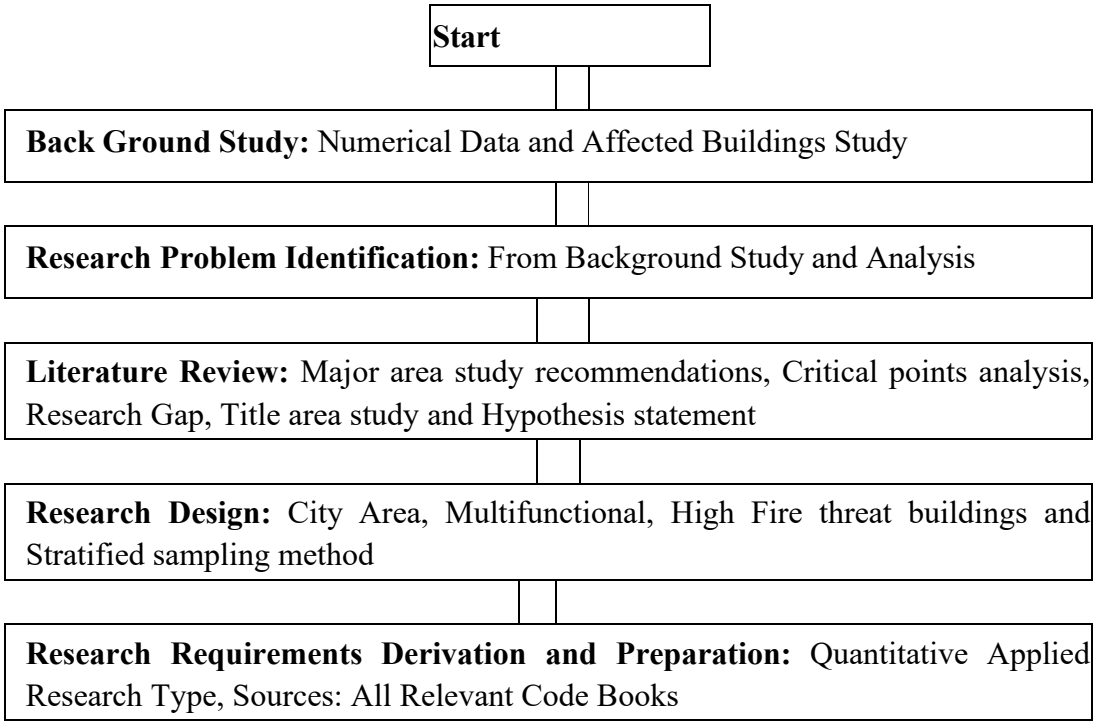
Year	Number of fire Accidents	Property loss in Crores	Human loss in numbers
2000	16987	13.64	47
2001	17697	15.79	112
2002	18264	14.10	79
2003	16109	24.57	89
2004	16136	13.07 **Minimum value**	**249** **Highest value**
2005	15093 **Minimum value**	14.20	99
2006	17442	27.74	65
2007	21224	26.87	72
2008	17433	53.17	69
2009	21840	53.17	127
2010	18311	24.60	75
2011	22273	27.59	84
2012	32,273 Highest Value	27.02	87
2013	25109	42.55	75
2014	24398	46.13	70

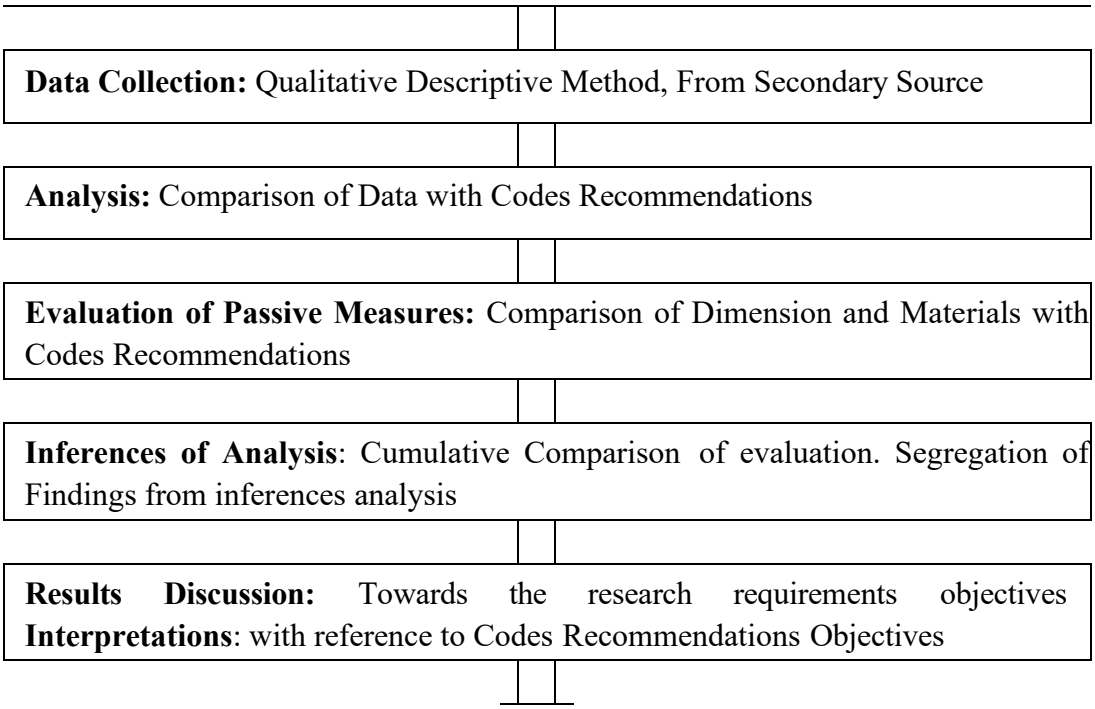
2015	19866	22.47	38
2016	25897	43.04	72
2017	21047	97.87 Highest Value	67
2018	22601	58.83	36 Minimum Value
Total Values	3,90,000	646.42	1612
Average Values	20,526.32	34.02	84.84

The number of fire accidents, property loss, lives loss and the failure measures of fire affected buildings from the background studies are indicated here that, the fire accident in buildings are increasing in recent past years and it has become a current thrusting problem among the society. Solutions are required to solve this problem.

II. RESEARCH METHODOLOGY

Passive Measures Code Provisions Details: The following code books provisions and its recommendations were used to drive the comprehensive research requirements. These Passive Measures comprehensive requirements are applied upon the sample buildings. Research type: The Quantitative Applied Research Type was used for Research Requirement Derivation. National Building Code of India (1997, 2005 & 2016): From Part - 4, Title is, “Fire and Life Safety”. Provisions Number from 2.00 to 4.17. Passive Measures elements details considered from Provision number 2.00 and all its sub divisions. Fire Zone details, occupancy and structural member’s details were considered from Provision number 3.00 and all its subdivisions.





III. DATA COLLECTION AND ANALYSIS

This chapter discusses the data collection, analysis of data collection inferences of analysis and segregation of outcomes from the inferences table.

Data collection: CMDA Approved drawings were used for data collection. The length, breath, height and its construction materials data were collected in all directions. The dimensional measurements and the materials details are given in the research report in qualitative description method. The relevant drawings were enclosed at required places. The Site plan, Basement Floor Plans, Ground Floor Plan with all Upper Floor Plans and Sectional Elevations are enclosed for references.

The check list was used for identifying the measures and confirming the measures existence and non-existence from the sample buildings.

Analysis: The analysis was carried out in a table the parameter name, the collected Physical dimensions of that parameter, the codes recommendations about that parameter, the comparison of that parameter with codes recommendations and result of that measure were placed in adjacent columns of a table. All columns were correlated to relevant parameters. If the physical dimensions were equal or above the codes recommended dimensions, that parameter was considered as adequate measure. If the physical dimensions were less than the code recommended dimensions that parameter was considered as inadequate measure. If a measure does not exist, that parameter was also considered as inadequate measure. The adequate and inadequate two types of results were obtained from this research analysis.

Inferences Table: The data collection and the analysis were carried out for all six sample buildings**.** Inferences are prepared from these six analysis tables details. The parameters and all sub parameters were placed in a column. The existing adequate measures, existing but inadequate measures and non-

existing measures were placed in adjacent column. The recommendation of future adoptability was given in the last column.

The existing adequate measures were recommended for future adoptability. The existing with inadequate measures and non existing measures (NOT EXISTING) were not recommended for future adoptability. The recommendation column of inferences table was considered as findings column. All the findings were segregated from this column.

Accessibility by Road and Reach Ability of Building: The building is accessed by 40m wide high road on its north side and 30m wide road on its west side. These roads are connecting the main parts of the city. Other two sides are surrounding with commercial buildings.

Main Entry and Exit Gates Width: The north side the building is provided with 12meters wide main gate for pedestrian entry. The west side it is provided with 20m wide main gate for vehicle entry. Both the entries are located at the midpoint of the building. On west side two entry cum exit gates are provided at both ends. Its width is 7.6m

Building Set Backs: The building is having 20 m wide set backs on its north and west side including open space reservation. An 8m wide setback is provided on east and south side of the building.

External Stair Cases: one external stair case is mentioned as fire escape stair case and is provided nearer to North West corner of this building.

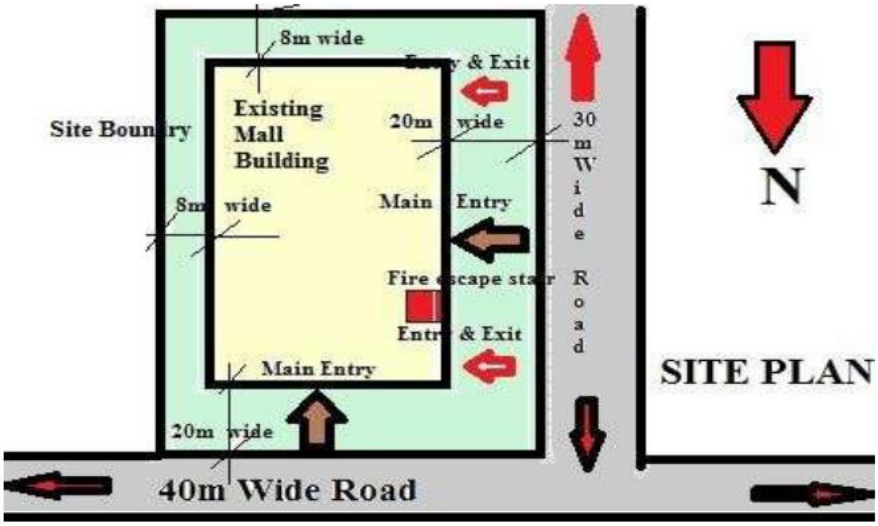


Figure 1 Site Plan – Sample One

Findings: This building is provided with good accessibility and reaches ability from its two sides of the main roads. Two main entry gates and two numbers of entries cum exits gates are provided with adequate width. The firefighting vehicle and ambulatory services can enter the building premises and exit smoothly.

The building is having adequate setbacks widths in all four sides. The number of fire fighting and ambulatory services vehicles can stand around the building for fighting and rescue operation. Required free spaces are available for the fire brigades to run around the building for fighting operation. One

external stair case mentioned as fire escape stair case with adequate width is provided in this building. This will facilitate the fire fighting professionals to get themselves inside of the building and the stair case will be used for ascending and descending purposes during fighting operation.

(b) Building Planning Parameters:

The total area of the site is 12460 sqm. The built-up area on the ground floor is 3599 sqm. The average plot coverage of the building is 40 %. Floor space index is 2.25.

Space planning: The details are given in the Table below;

Table 1 Space Planning Details of Sample One

Floor	Built-up area. Sqm	Service area sqm	Parking area sqm	Four-wheeler in nos	Two-wheeler in nos
Second basement	88.00		6301	142	200
First basement	95.00	116	6178	138	200
Lower ground	3599.00	694	1372	30	300
Ground floor	3599.00		1372	30	100
First	4793.40	33	1372	30	-
Second	4135.31	33	1372	30	-
Mid level			1372	30	-
Third	4184.00	33	1372	30	-
Fourth	4314.47	76.76	1372	30	-
Fifth	2145	39.46	1372	30	-
Mid-level			1372	30	-
Mezzanine	621.97	20.83	1372	30	-
Sixth	3868.19	127.51	1372	30	-
Terrace	94.00	4794		170	-
Total	27938.34	1373.56	30905	780	800

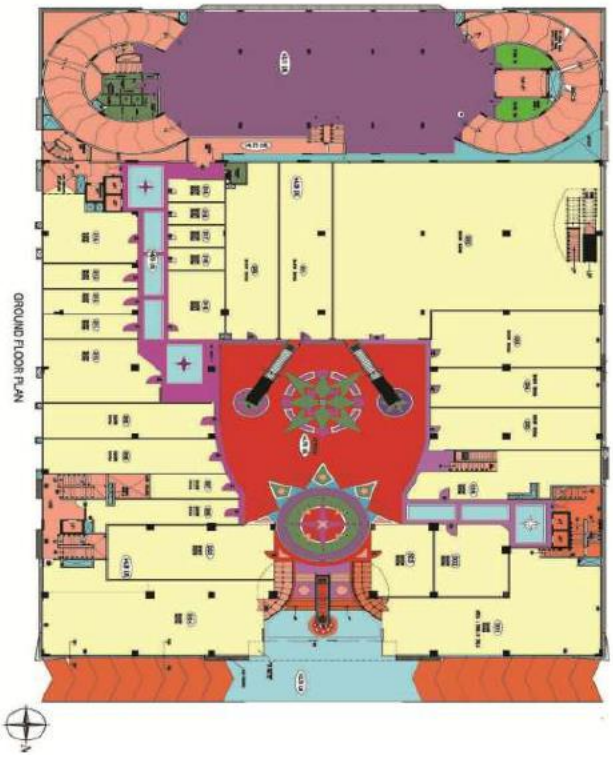


Figure 2 Ground Floor Plan – Sample One

Figure 3 Lower Ground Floor Plan – Sample One

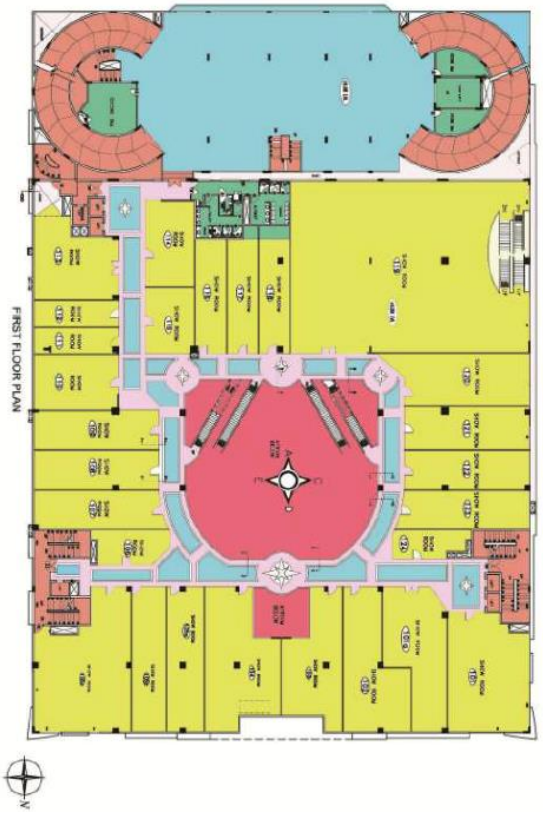


Figure 4 First Floor Plan – Sample One

Figure 5 Second Floor Plan – Sample One

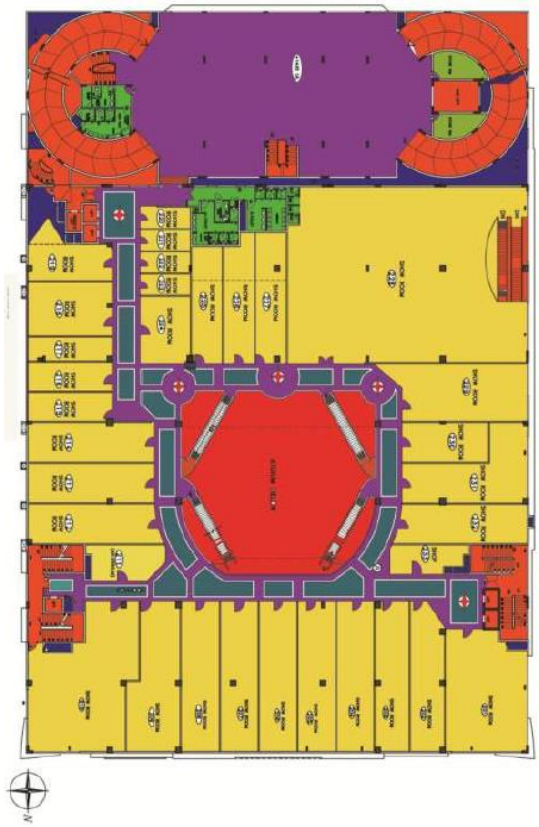


Figure 6 Third Floor Plan – Sample One

Figure 7 Fourth Floor Plan – Sample One

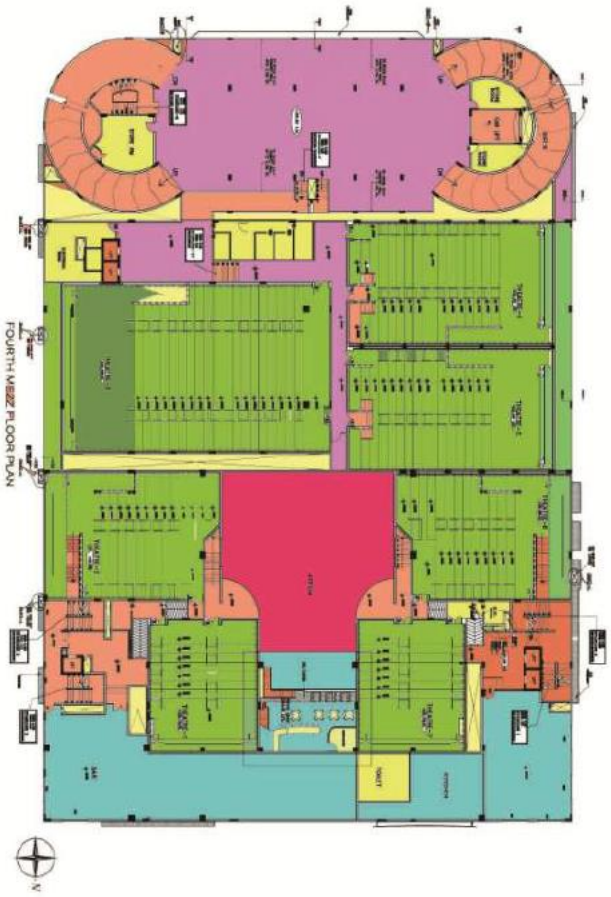


Figure 8 Fourth Mezzanine Floor Plan – Sample One

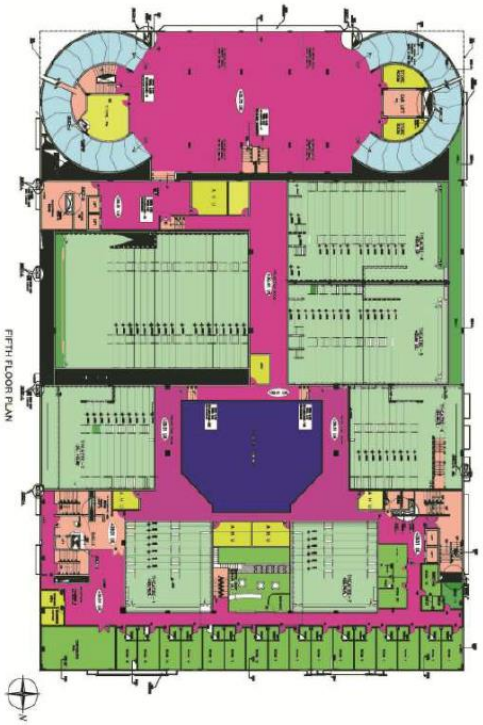


Figure 9 Fifth Floor Plan – Sample One

Building Dimensions: The site gives the dimensions 143m on its west side, 92 m on its north side, 194 m on the east side and 127 m on the south side. The east side site is not straight and it is inclined.

Over all site area is 12460 sqm. After the set back the ground floor is giving the dimension of 97m in length wise and67m in breath wise. The shape of the building is rectangle. It is a single unit development from the basement floor to the terrace floor. The building is having two basement floors, one lower ground floor, one ground floor, five upper floors, one mezzanine floor and terrace floor. The each basement floor and lower ground floor height is 2.82m ground floor height is 4.58m,first,second and third each floor height is 4.26m, the fourth floor height is 5.55m, the fifth floor is theatre its foyer, seating, mezzanine, projection room and false ceiling height is 10.81m. Above these the parking parapet height is 3.65m, lightning arrester height is 6.4m and lightning arrester tower height is 2.38m. The height of the basement floor is 5.64m. The overall height of the building from the ground level to tip of the lightning arrester is 46.30m.

Atrium, Circulation and Ventilation: The atrium is located in the middle area of the building; it is semi circular in shape. It occupies 175sqm area on each floor including its corridor space. It is the main focal point of the building. The atrium is covered with transparent material for lighting purpose. The crowed is attracted by this space only. It divides the crowed and directs them for various functions on each floor. The atrium around the corridor serves the building for smooth circulation. It is a centralized air condition building; there are no window provisions except in few areas.

Core design: The parking area is provided along with two ramps. The ramps are for multilevel car parking for up and down driving purpose. One ramp is provided around the lift car and staircase by a separate enclosure. Two cores are provided in the east side of the building. One fire escape stair case is provided on the North West side. The centre distance in between the core is 55m. Single lift without stair is provided for loading and unloading purpose on the south end. Individual single flight stairs are provided in side of the shops for mezzanine floors purposes in all floors.

Open Spaces: Small size shaft openings are provided for cabling, AHU and other services purpose. A long wider duct is provided in between the car lifting, parking area and other functional area, this long duct is used for taking sewer pipe line from all floors. There is no open space provision for interaction or ventilation purpose in the middle of the building.

Compartmentation of Each Floor: The outer walls thickness is 0.23 m. provided with 0.025m thick Cement plastering is on both the sides. The inner walls are constructed with 0.15mthickness. The provision of compartmentation at every 750 sqm as per regulation is not provided in all floors.

Findings: Space allocation, grouping of activities, planning of each floor, circulation, ventilation and Atrium planning with population smooth movements are follows the planning standards. Compartmentations provision is not provided in this building.

(c) Occupancy Requirements parameter (Function of the Building):

First and second basement floors, south wing of the building in all floors and terrace floor allocated for four cum two wheeler parking.

The lower ground floor is allocated for hyper market as well as surface level parking. The ground, first, second and third floors are allocated for shopping. The fourth floor is allocated for food court and family entertainment activities. The fifth floor and mezzanine floor allocated for theatre and related activities.

Findings; The occupancy features are as per the mall's requirements.

Table 2 Heat Resistance Evaluation of Sample One

Ref	Element	Existing dimension (Column –A)	Recommended dimension, (Column –B)	Evaluated dimension (From Column A- B)	Resistance Adequacy details
(a)	**Site Planning Parameters Evaluation**				
	Road width	North – 40m West = 30m	18m 18m	22m more 12m more	Adequate
	Entry point	North - 12m West - 20m	4.5m 4.5m	7.5m more 15.5m more	Adequate
	Exit point	North 7.6 South 7.6 m	4.5m 4.5m	3.1m more 3.1m more	Adequate
	Set backs	North&West20m South & East 8m	8m 8m	12m more Sufficient	Adequate
	External Stair case	4m wide stair case is provided in north side	4m wide stair case with separate enclosure must provided	stair case provided as per the requirement	Adequate
(b)	**Building Planning Parameters Evaluation**				
	Outer Brick wall thickness	0.23m thick wall	0.17 m thick	0.06m More	Adequate
	Inner brick wall thickness	0. 15m thick	0.17 m thick required	0.02m thick less	Inadequate
	Compartmentation	Not existing	750sm once provision	Not existing	Inadequate
	Type one construction	Compartmentation provision is not existing.	Compartmentation construction is considered as type one construction	Not existing	Inadequate
(c)	**Occupancy Requirements Parameters Evaluation**				
	Occupancy Features of different activities	Shops, food court, entertainment, relaxation and parking activities are existing	Shops, food court, entertainment, relaxation and parking activities are recommended	Activities are existing as per mall`s recommendations	Adequate

(d)	**Life Safety Elements in the Escape Routes Planning Parameters Evaluation**				
	Parking drive ways width in Basement & ground floors	7.2m	7m,for two way	0.2m more	Adequate
	Ramp width	3.7m	3.5m	0.2m more	Adequate
	Corridor width &head room height	4.2,3.2 ,2.5m Headroom height 3.2m	2.4m & 2.4m	1.8, 0.8, 1m& 0.8m more	Adequate
	Means of egress Exit Width	2.5m	2.4 m	0.1m more	Adequate
	Stair case width	4m wide ,each flight 2m width is existing	4m wide, each flight 2m width are to be provided	Stair case width is provided as per the requirement	Adequate
(e)	**Structural Stability Parameters Evaluation**				
	R.C.C. Column size	0.6X0.9m and 0.6X1.2m	0.54 x 0.54 m	0.06 x0.36 and0.06x 0.66more	Adequate
	R.C.C. Beam	0.5 mX0.6 m in size	0.42X0.42m	0.08 x0.18 m, more	Adequate
	Brick wall	0.23m thick wall	0.17 m thick	0.06m More	Adequate
	R.C.C. Roof slab	0.375m thick	0.280 thick	0.095m More	Adequate
	R.C.C.column cover	0.12m in all sides	0.04min all four sides	0.08m more	Adequate
	R.C.C. Beam cover	0. 12m	0.07m in all sides	0.05m more	Adequate
	Plastering	0.025m on both sides	0.025m in both sides	Sufficient	Adequate
	R.C.C. Roof slab cover	0.12m on both the	0.055m in both the sides	0.065m More	Adequate
(f)	**Fire Rated Recommended Materials Construction Parameters Evaluation**				
	Foundation, Column, Beam & floor and roof slabs	R.C.C. work with cement cover provided	R.C.C& brick works are recommender	Recommended materials used	Adequate
	Outer & Inner wall	Brick work withCement plastering provided	R.C.C, hollow blocks, brick are recommender	Recommended materials used	Adequate
	Floor finishing	Grand Marble stone	Hard rigid materials used	Recommended materials used	Adequate

	False ceiling & egress area	Gypsum, board, plaster of parries, Stainless steel frame	Gypsum, Plaster of parries	Recommended materials used	Adequate
	Interior finishing & Atrium top Coverage	Plastic emulsion paint finish on the interior &The atrium 10mm thick transparent fiber glass, rested on beam by holting	Less fire spread materials allowed Transparent light weight materials allowed	Recommended materials used	Adequate
	Elevation finishing	Wired fiber glass & exposed aggregate finish on the block work	Aggregate finish allowed	Recommended materials used	Adequate

IV. Conclusion

This research finding reveals the passive measures condition of mall buildings in the study area. These buildings are existing with adequate measures and inadequate measures (not existing measures). The existing with adequate measures are recommended for future adoptability. The inadequate measures (not existing measures) construction should become mandatory for future upcoming buildings. In all sample buildings inadequate measures (not existing measures) are to be constructed and are to be incorporated with the existing adequate passive measures. These full-fledged implementations of fire and life safety passive measures will meet the objectives in future.

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