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SITE SAFETY AND PLANNING FOR BUILDING CONSTRUCTION

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Abstract - ***The present study deals with the assessment of safety measures being implemented at different building construction sites for the safety of the work force. The study was conducted by selecting the 5 large, 3 medium and 4 small buildings and carrying out an extensive inspection of 15 building construction sites by using a standard and detailed developed study tool in the shape of a questionnaire. This tool consists of 363 safety compliance statements under 27 divisions of safety measurement which are considered and perceived to be important from point of view of the safety on a two point scale response (Adhering / Non Adhering). This questionnaire was served to each site engineer of different construction sites and on the basis of the response received on the questionnaire, the score of each building and safety division was calculated. The study reveals that large building construction sites have higher level of safety than medium and small buildings. The study also reveals that level of safety increases with the increase in height of buildings. The overall safety scenario at all building construction sites is alarming.***

Key Words: Safety, planning, building construction sites.

1. INTRODUCTION

In the created and in addition growing piece of the world, development industry is thought to be a standout amongst the most huge commercial ventures as far as its effect on Safety and security of the working populace. Development industry is both financially and socially essential. Then again, the development business, in the meantime, is additionally perceived to be the most perilous. Albeit sensational change has taken in late decades, the Safety record in the development business keeps on being one of the poorest. The aversion of development mishaps for the most part involves foreseeing future mischances and their inclination under given circumstances. The making of such expectations is taking into account learning about past mishaps. The real reasons for mishaps in the development business are identified with the one of a kind nature of the business, human conduct, troublesome work-site conditions, and poor security administration which bring about perilous work techniques and strategies. Development Safety on undertaking destinations is of most extreme significance because of the way of the development business. On the other hand, it is normally an optional concern in a business sector driven society where the primary concern is finishing undertakings at the obliged quality with least time and expense. Therefore, Safety issues are viewed as strictly when a mischance happens at a development site with subsequent measures to enhance working conditions, particularly in creating nations. Safety portrays the surety that the environment that work force or things are subjected to, is free from in heedful or surprising occasions which may bring about harm to staff or harm to the things uncovered.

Safety is a state of being sheltered, flexibility from peril or risks, a keeping of oneself or others safe, particularly from threat of mischances or malady. Security is the condition of being "sheltered", the state of being ensured against physical, social, otherworldly, monetary, political, passionate, word related, mental, instructive or different sorts or results of disappointment, harm, blunder, mischances, hurt or whatever other occasion which could be considered non-alluring. Safety can likewise be characterized to be the control of perceived perils to accomplish a worthy level of danger. This can take the type of being shielded from the occasion or from presentation to something that causes safety or prudent misfortunes. It can incorporate assurance of individuals or of belonging.

1.1 Types of safety

- Normative security

Standardizing security is accomplished when an item or configuration meets material measures and practices for outline and development or assembling, paying little mind to the item's real wellbeing history.

- Substantive wellbeing

Substantive or target wellbeing happens when this present reality security history is ideal, regardless of whether norms are met.

- Perceived wellbeing

Seen or subjective wellbeing alludes to the clients' level of solace and view of danger, without thought of guidelines or security history. Case in point, activity signs are seen as protected, yet under a few circumstances, they can build car accidents at a crossing point. Activity roundabouts have a by and large good security record yet regularly make drivers nervous.

1.2 Significance of Safety in Construction

The development business has customarily been considered as an unsafe occupation, because of the high occurrence of word related wounds and lethal mischances. The quantity of deadly word related mishaps in development everywhere throughout the world is difficult to measure, as data on this issue is not accessible for most nations. The development business, utilizing the biggest work power, has represented around 11% of every single word related injurie and 20% passings coming about because of word related mischances. Global Labor Organization has evaluated that no less than 60,000 fatalities happen at development destinations around the globe consistently. This implies that one lethal mischance happens like clockwork in the area. A large portion of these mishaps are made because of hazardous conduct and risky conditions. In the event that pre-decided security measures in all development operations are legitimately actualized ,it can help in lessening mishaps/harm to the laborers, with peril free environment which not just improves the ethical and certainty of specialists additionally the productivity of laborers which diminishes the general expense of development

2. EXPERIMENTAL INVESTIGATION

The present study was led to build up to measure Site safety and planning on construction sites. The strategy embraced in this work is the gathering of information by the method of survey with a help of questionnaire.

- **Selection of B I S Codes**: The different B I S Codes pertaining to safety at building construction sites were studied.

- **Preparation of study tools**: A study tool was prepared base on various clauses of relevant B.I.S. Safety Codes for building construction. This tool consists of a series of 363 statements as questionnaire and was divided into 27 divisions of safety measurements which are considered and perceived to be important from the safety point of view at a building construction site. After the perusal of all the above statements, it was observed that if some of the safety parameters are not adhered to, can cause death, fatal injuries and other varied injuries. Therefore these parameters were classified into three categories: most critical, critical and other parameters on the basis of potential cause of damage to the work force at the building construction site. There are 14 “Most Critical” and 314 “other” parameters of safety required to be adhered to, at all the building construction sites. All the safety statements under 23 divisions were arranged on a two point response scale (Adhering/ Not Adhering). The respondents tick marked (√) to either adhering or not adhering, depending on the actual conditions at the building construction site.

- **Selection of building construction sites**: The building construction sites were selected on the basis of two parameters:

a. Estimated cost of the building under construction :The buildings were divided into three categories: Large, Medium and Small as shown in the table 3.1

Height of the building under construction: The buildings were divided into three categories: High, Medium and Small as shown in the table 3.2.Five numbers ,each from large ,medium and small buildings construction projects were selected strategically based on the above mentioned parameters and total 15 such sites were selected for this study

Table 3.1 Showing the Categories 0f Buildings Selected on The Basis Of Cost.

S.NO	CATEGORY	ESTIMATED
1	Large Building	More than 15
2	Medium	Between 5 to 10
3	Small Buildings	Less than 5

Table 3.2 Showing the Categories 0f Buildings Selected on The Basis Of Height.

S.NO	CATEGORY	ESTIMATED COST
1	High Building	More than 6 stories
2	Medium Buildings	4 to 5 stories
3	Small Buildings	Less than 4 stories

- **Physical verification of building construction sites and collection of data**: A survey of selected building construction sites was physically done and the persons from project manager to skilled workers were also contacted. The response to the questionnaires was obtained either from the project manager or site engineer of all selected projects. The personal quarry was also made orally to verify the written statements about the various safety parameters being implemented at site of work. The response was received on each of the safety statements. The score was calculated on all divisions of safety measures.

- **Collection Of Additional Data**: Some additional information required from the present study at each selected building construction site, was also collected as given below:

Name of organization, Year of establishment, Turnover of last year (in case of company),Name of project and location ,Date of start of project, Likely date of completion of project, Estimated cost of project, Number of employees employed ,Number of accidental deaths,Number of major fatal injuries and Number of cases of loss of limb

- **Calculation of Scores from the Obtained Data:** The data on the response scale was obtained in the prescribed tabular format as adhered or not adhered as per site conditions. Each 'adhered' statement was given a score of 100and each 'not adhered' statement was given 0(zero). Individual scores for each of the safety divisions was calculated as per the below expression.

- $$\frac{\sum[\text{No. of adhered statements} \times 100 + \text{No. of not adhered statements} \times 0]}{\text{No of applicable statements}}$$

Divisions not applicable for a particular project were ignored and were not used in calculation. The scores obtained for each building for different safety divisions was averaged to a single score. Based on the single score, each building construction project was categorized as poor, fair, good, very good or excellent as reflected in table

- **Analysis of scores obtained through statistical approach**: For all the five large, medium and small building average scores for each of the safety divisions was calculated and on the basis of it average score of all safety division of large ,medium and small building was calculated. Standard deviation was also calculated and on the basis of which the conclusion were drawn.

- **Calculation of standard deviation**: some common terminologies used in this analysis are:

➢ **Mean score**: This is the average score obtained by dividing the sum of score of all the divisions or head by the number of divisions.

$$x=(\sum x) \div n$$

Where x = mean score
∑x= Sum of the scores of all divisions
n= number of divisions

➢ **Standard deviation**: this is the root mean square deviation of all the results. this is denoted by σ. Numerically it can be explained as

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}$$

Where σ = Standard deviation (SD)
N = Number of Divisions
x_i = particular value of divisions
μ = arithmetic mean

➢ **Classification of Buildings:** The building selected for the study were classified according to the safety score of all the parameters on the basis of average scores, most critical parameters, critically parameters and other parameters as shown in table 3.3,3.4,3.5 and 3.6 respectively.

Table 3.3 Classification of buildings according to safety scores of all the parameters

No.	Category	Range of
1	Poor	0 to 59
2	Fair	60 to 69
3	Good	70 to 79
4	Very Good	80to 89
5	Excellent	90 to100

Table 3.4 Classification of buildings according to safety scores of "most critical" parameters

S No.	Category	Range of Scores in percentage
1	Unsafe	Less than 90
2	Safe	More than 90

Table 3.5 Classification of buildings according to safety scores of "Critical" parameters

S No.	Category	Range of Scores in
1	Unsafe	Less than 80
2	Safe	More than 80

Table 3.6 Classification of buildings according to safety scores of "Other" parameters

S No.	Category	Range of Scores in percentage
1	Poor	0 to 59
2	Fair	60 to 69
3	Good	70 to 79
4	Very Good	80to 89
5	Excellent	90 to100

3. RESULTS & DISCUSSION

- **Calculation of Average Score for Large, Medium and Small Buildings**

The average safety score of 27 divisions as per BIS codes for large, medium and small buildings is shown in Table 4.13 The graphs were plotted by keeping the divisions of safety on X-axis and average score of each division on Y-axis as for large, medium and small buildings shown in the Fig. 4.13. The pattern of graph reflects the level of safety measures being implemented at different building sites. The average safety score of large, medium and small building is 57.66, 61.60 and 61.67 respectively. The graph reflects that the average safety score of more than 60 for different divisions of safety for large, medium and small buildings is 19, 24 and 24 divisions respectively.

Table 4.13 Average Score of Different Safety Divisions of Large, Medium and Small Buildings.

Title of Division of Safety	Average Score	Average Score	Average
Handling and Storage	73.15	71.04	74.34
Qualified and Competent	72.12	63.88	68.74
Fencing / Protective	72.21	62.96	73.60
Ventilation and Lighting	72.22	64.09	69.22
Safety Provisions /Instructions at	68.90	68.96	68.96
Use of Personal Protective	58.45	66.66	61.53
Use of Safety Helmets	76.00	66.66	75.00
Use of Safety Belts	76.00	73.33	77.53
Use of Safety Goggles	56.66	71.42	71.42
Use of Safety Gloves	75.89	74.06	69.43
Use of Safety Shoes	80	73.33	75.00
Piling work atconstruction	0	0	0
Welding at construction Site	63.42	71.42	67.85
Working with Electrical Live	66.72	71.42	69.04
Fire fighting atConstruction	59.99	63.58	65.94
Accident Recording	0	0	0
Use of Scaffolding /Scaffolds at	67.72	69.69	69.49

Use of Ladder aConstruction	64.66	72.30	68.33
Use of Construction	72.30	76.92	64.73
Use of Asbestos Reinforced	0	0	0
Medical / Health Facility / Welfare	63.11	70.83	64.92
Hazard Due to Fall Height at	61.33	73.33	72.08
Hazard Due to Falling Through	58.88	69.44	69.93
Falling Material Hazard at	56.28	62.85	71.06
Hazard Due to Disposal of	73.33	69.57	65.83
Hazard Due to Carpentry at	65.69	72.21	63.81
Provisions for Walkways/	65.33	63.33	67.50
Average Score	**57.66**	**61.60**	**61.67**

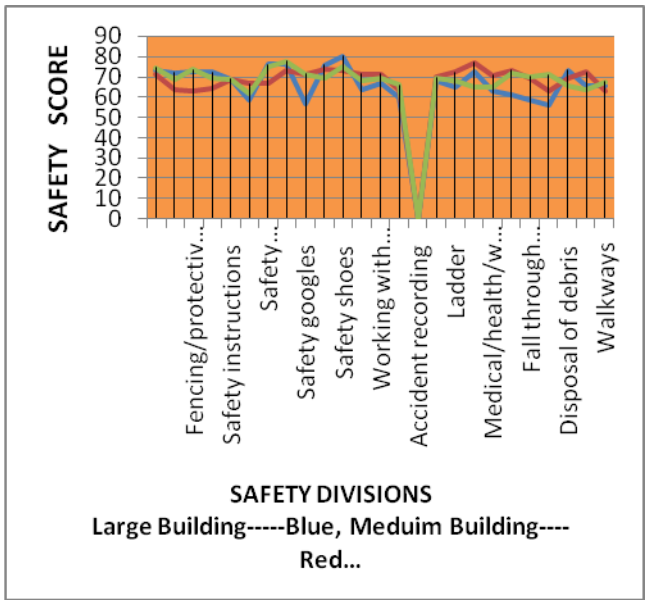

Fig-1 Graph Showing Score of Safety of Different Safety Divisions of Large, Medium and Small Buildings

- **Calculation of Average Score for High, Medium and Low Buildings**

  The average safety score of 27 divisions as per BIS codes for high, medium and low buildings is shown in Table 4.19 The graphs were plotted by keeping the divisions of safety on X-axis and average score of each division on Y-axis as for high, medium and low buildings shown in the Fig. 4.18. The pattern of graph reflects the level of safety measures being implemented at different building sites. The average safety score of high, medium and low buildings is 65.78, 59.77 and 52.04 respectively. The graph reflects that the average safety score of more than 60 for different divisions of safety for high, medium and low buildings is 21, 13 and 3 divisions respectively.

Table 4.16 Average Score of Different Safety Divisions of High, Medium and Low Buildings.

Title of Division of	Avera ge	Averag e Score	Average Score
Handling and Storage	73.15	71.06	59.47
Qualified and Competent	72.12	63.88	54.99
Fencing / Protective	72.21	61.10	59.99
Ventilation and Lighting	72.22	71.79	50.76
Safety Provisions	68.90	68.96	55.16
Use of Personal Protective	58.45	64.10	50.76
Use of Safety Helmets	76.00	73.33	56.00
Use of Safety Belts	76.00	73.33	62.02
Use of Safety Goggles	56.66	66.66	59.99
Use of Safety Gloves	75.89	74.06	55.55
Use of Safety Shoes	80.00	66.66	64.00
Piling work at construction	NA	NA	NA
Welding at construction	63..42	66.66	57.13

Working with Electrical Live	66.72	68.25	57.13
Fire fighting Construction	59.99	64.87	52.02
Accident Recording	0	0	0
Use of Scaffolding /	67.72	66.66	57.41
Use of Ladder at Construction	64.66	70.00	55.99
Use of Construction	72.30	71.79	54.86
Use of Asbestos Reinforced	NA	NA	NA
Medical / Health Facility	63.11	64.35	55.83
Hazard Due to Fall froHeight	61.33	66.66	61.66
Hazard Due to Falling	58.88	72.22	54.28
Falling Material Hazard	56.28	66.66	54.56
Hazard Due to Disposal of	73.33	66.66	54.40
Hazard Due to Carpentry	65.09	66.66	54.38
Provisions for Walkways/	65.33	60.00	56.00
Average Score	**59.99**	**60.24**	**50.16**

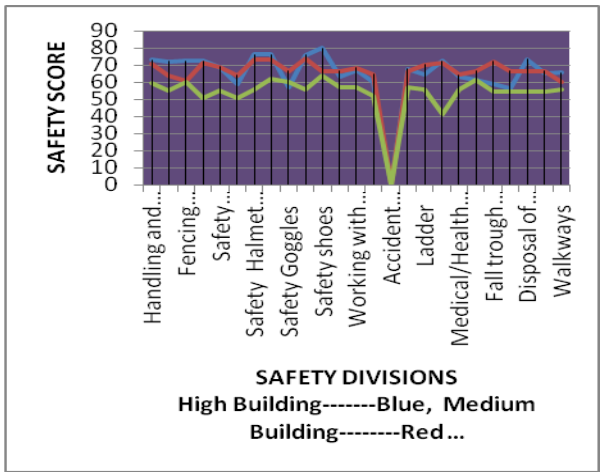

Fig. 2 Graph Showing Score of Safety of Different Safety Divisions of High, Medium and Low Buildin

3. CONCLUSIONS

- Accidents are taking place at construction sites and some are fatal. The workers get permanently disabled and fight for this menace. This study was taken in hand to find solution of the problem i.e. safety a construction sites in States of North India except Ladakh. Keeping in mind the predetermined objectives the following conclusion can be drawn from the analysis of data.
- Large buildings reflect better level of safety than medium and small buildings.
- There is very less variability in level of safety at construction sites.
- Increase in height of building increases the level of safety.
- Most Critical" parameters of safety reflect higher level of safety than "Critical" and "Other" parameters of safety.
- 16% buildings are safe and 84% buildings are unsafe as per "Most Critical" parameters and 8% buildings are safe and 92% buildings are unsafe as per the "Critical" parameters.
- 20% of the buildings ranked good, 70 % as fair and 10% as poor.
- The standard deviation for large, medium and small building construction sites is 22.57, 22.52 and 22.52 respectively which indicates that there is very less variability in level of safety at different construction sites.
- The Four divisions of safety: "Fire fighting at construction site" , "Use of Personal protective equipments", "Hazards Due to Fall from Height at Construction Site", "Falling material Hazard" and "Provisions of Walkways and Passages at Construction Site" need immediate attention due poor rating at most of the construction sites.
- The overall scenario of safety in all such buildings in States of North India is miserable and requires immediate attention.
- Most of the sites observe safety regulations for "Most Critical" and "Critical" parameters but ignore the "Other" parameters which are equally important form safety point of view.
- The adaptability of safety measure also depends upon the awareness and motivation level of workers at site.

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