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Correlation between Rat Trap Bond Mass and Seismic Zone Factor in context to India

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ABSTRACT

Technology in construction industry is changing at a magic speed now days. Technology is providing facilities in respect to save labor, time and money. Modern technology available is though applicable in different climate and land types yet many traditional construction techniques (Rat Trap Bond, Filler slab, Jack Arch Roof etc.) by way of vernacular architecture are still in use for specific purposes. All techniques developed and executed by Laurie Baker are very effective and needs more experiments in different locations with different climatic and topology conditions. Four different seismic zones in India demands different construction techniques. Disaster management can be worked out by providing construction with rat trap bond in different seismic zones. This paper is particularly concerned about the construction technique of rat trap bond and its relationship with different seismic zones categorized in India. Derivation of this correlation will provide thumb rule for calculation of rat trap bond mass to with stand in a specific seismic zone.

Keywords: Rat Trap Bond Mass, Seismic Zone Factor, Correlation

INTRODUCTION

Rat trap bond is a low construction technique developed by architect Laurie Baker in 1970's which was first implemented in Kerala and subsequently in various other regions. The specific technique provides insulation with a cavity in its design. This efficiently works by reducing (approx 23%) the cost and material requirement comparing traditional solid brick masonry. The cavity technique does not compromise with the strength desired. Use and relationship of this specific technique in any seismic zone is required to be analyzed. This paper deals in establishing the relationship specifically in respect to different seismic zone in India.

India has four seismic zones under the categories II, III, IV and V with different zone factor (Z) defining the risk factor. The division is based on *Horizontal Seismic Coefficient* which depends on different parameters (like soil conditions, geographical area, response reduction factor etc,) and calculations mentioned in IS 1893-2016 in section Ah(cl: 6.4.2 IS 1893 (Part 1): 2016).

RAT TRAP BOND

Compressive strength of Rat trap Bond was tested and compared after a careful selection of raw material like flyash, brick from waste etc. and mortar in two different ratios i.e. 1:4 and 1:5 as bonding material in 2018 [Ullah, Khan and Thaheem]. Comparison was conducted between English bond and Rat Trap bond with three specimens of conventional bricks (based on compressive strength when kept flat and on edge) and mortar ratios of 1: 5 and 1:4.

Table 1: Comparison between strength of English bond and Rat Trap Bond

Strength at Initial Crack of Brick Wall using English Bond and Rat Trap Bond				
Sr No	**Strength at Initial Crack (Psi)**		**Ultimate Strength (Psi)**	
	English Bond	**Rat Trap Bond**	**English Bond**	**Rat Trap Bond**
1	127.92	163.17	194.50	244.82
2	133.87	202.04	226.84	253.42
3	143.73	167.52	227.78	251.03
Average Compressive Strength			**216.37**	**249.76**

Source: https://www.researchgate.net/publication/326915020_Comparison_of_performance_of_rat_trap_brick_bond_with_the_conventional_brick_bond/link/5b6c276ca6fdcc87df700cac/download

It was concluded that "Rat Trap bond decreases the material required to build brick walls by 25% and the air pockets create an insulation barrier that is not only good to save the electricity consumption but also very good in the thermal load reduction".

Another research conducted at Dr MGR University, Chennai 'experimented to investigate rat trap masonry system under shock excitation' in 2013. This experiment investigated on the compressive strength rat trap bond under different loads and mortar strength. It was resulted that average strength of rat trap bond is 0.87 N/mm^2 and 1.30 N/mm^2 for mortar ratio of 1:5 and 1:4 respectively. It was also concluded that bricks kept on edge and flat have compressive strength of 12.7 N/mm^2 and 17.02 N/mm^2 respectively.

Further tests and results on rat trap bond were discussed in 9th Canadian Masonry Symposium, Anna University, Chennai. The investigation was conducted to find initial crack in rat trap bond when kept on edge and flat differently. Following is the table extract after analyzing the extreme values.

Table 2: Comparative analysis between strength and initial crack

Brick strength (N/mm^2)	**Load (KN)**	**Mortar strength (N/mm^2)**	**Initial Crack (N/mm^2)**
>4<5	70	12.75	0.468
>5<8	168	17.02	1.125
>8	120	12.75	0.803

Source: Validation of rat-trap bond for cost effective housing" 9th Canadian Masonry Symposium, Anna University, Chennai.

SEISMIC ZONE

Currently India has been divided into four different seismic zones based on history of seismicity, earthquake etc and tectonic setup of the region.

Source: https://www.mapsofindia.com/maps/india/seismiczone.htm

Figure 1: Different seismic zones in India

Zone Factor

According to earthquake resistant design provisions under IS 1893 (part 1)-2002 of India, the risk factor is given. Following are the zone factors for different seismic zones:

Zone	Zone Factor	Risk
II	0.10	Low
III	0.16	Moderate
IV	0.24	Severe
V	0.36	Very Severe

Source: **https://iisee.kenken.go.jp/worldlist/24_India/24_India_Code.pdf**

RELATIONSHIP BETWEEN RAT TRAP BOND STRENGTH IN A REGION AND SEISMIC ZONE FACTOR IN INDIA

Rat trap bond use as low cost construction technique provides almost near compressive strength. Its use in different seismic zones is a matter of concern. It has been found from table 2 that first crack stress of $1.125X\ 10^6$ N/mm^2 is found on comparatively maximum load of 168 KN with brick strength 5-8 N/mm^2 and mortar strength 17.02 N/mm^2. That is why these figures have been taken for calculation to relate seismic zone factor and rat trap bond mass.

CALULATION

If, Force/ Unit Area on first crack (F) = 1.125 N/mm^2

Lowest seismic zone factor (Z) = 0.10

Now

F = ma

Acceleration (a) = Zg

Therefore, F = mZg => $\frac{F}{Zg}$ = m

=> $\frac{1.125\ X\ 10^6}{Z\ X\ 9.8}$ = m

=> $\frac{1.15\ X\ 10^5}{Z}$ = m => 1.15 X 10^5 = mZ

The calculation shows that if the multiplying result of mass of rat trap bond and Seismic zone factor is less than 1.15 X 10^5 then the construction is safe to be executed in India.

CONCLUSION

Derivation of relation between seismic zone factor and rat trap bond mass is beneficial for quick calculation in construction of rat trap bond structures. This will provide the designer to calculate about total mass to be constructed in different seismic zones of India. The calculations will conclude to provide construction in rat trap bond for disaster management in advance with easy steps.

References

1. Santhakumar, A.R., Sivakumar , A. and Ashok, S., "Validation of rat-trap bond for cost effective housing" 9th Canadian Masonry Symposium, Anna University, Chennai.

2. Seismic Load Application as per IS 1893 – 2016, https://www.sseacademy.com/blog/ seismic-load-application-as-per-is-1893-2016

3. Sivaraja, S. S., and Thandavamoorthy, T. S., 2013, "Experimental investigation of rat-trap bond masonry systems under base shock excitation", Journal of Structural Engineering, Vol. 40, No. 2, June - July 2013 pp. 196-203

4. Ullah, Z., Khan, A. and Thaheem, M. J., 2018, "Comparison of performance of rat trap brick bond with the conventional brick bond" 1st International Conference on High Performance Energy Efficient Buildings and Homes (HPEEBH 2018), August 1-2, 2018, Lahore, Pakistan

5. http://www.RockMass.net, January 2015, accessed on February, 2020

6. https://earthboundarchitecture.com/category/research/, accessed on January, 2020