

**WHE-PAGER PROJECT: BUILDING CONSTRUCTION VULNERABILITY AND INVENTORY**

This form is divided into 3 parts:

- Part I: Contributors' Information**
- Part II: Summary of Construction Types, Vulnerability and Population**
- Part III: Colleagues Consulted, Additional Sources of Information Used**

**PART I: Contributors' Information**

1. Country or Region (if you are only responding for part of a country, please indicate which geographic region.  
 Note: the WHE strongly prefers national estimates, unless you have data that clearly apply to only one region):

Country

2. Name(s) of Contributors  
 Dr. Kishor Jaiswal

3. Affiliation (Organization)  
 U.S. Geological Survey, Golden, Colorado

4. Mailing address (include city and country)  
 1711 Illinois st, Golden Co 80401

5. E-mail  
 kjaiswal@usgs.gov; kishorjaiswal@earthquakeinfo.org

6. Your self-rating of expertise or confidence: On a scale of 1=low and 5=high, please estimate your level of expertise:

**Part II: Summary of Construction Types, Vulnerability and Population**

Construction Material (choose from drop-down list)	Construction Subtype (Choose from drop-down list--refer to Table 1 in the instructions to see complete list)	Probability of collapse (%) of building type when subjected to the specified shaking intensity				Fraction of population who LIVES in this building type		Fraction of population who WORKS in this building type		Peak average # of occupants per building	
		IX (-0.65-1.24g)	VIII (-0.34-0.65g)	VII (-0.18-0.34g)	VI (-0.092-.18g)	urban	rural	urban	rural		
		Night									
1 Masonry	Rubble stone in mud or lime mortar or without mortar	25 to 80	11 to 24	6 to 10	0 to 5	5	11	2	2	5 to 7	RS2
2 Masonry	Unreinforced brick masonry in mud mortar with vertical posts	25 to 60	6 to 24	2 to 5	0 to 1	4.5	15	2	4	5 to 7	UFB2
3 Masonry	Unreinforced brick masonry in cement mortar with reinforced concrete floor/roof slabs	25 to 40	6 to 24	2 to 5	0 to 1	42	27	30	45	5 to 7	UFB5
4 Masonry	Unreinforced concrete block masonry in lime/cement mortar	25 to 52	6 to 24	0 to 5	0 to 1	1	0	1	0	5 to 7	UCB
5 Masonry	Adobe block walls	41 to 90	21 to 40	11 to 20	0 to 10	4	28	0	1	3 to 5	A
6 Structural concrete	Concrete moment resisting frames designed for gravity loads only	11 to 40	6 to 10	0 to 5	0 to 1	22	6	32	20	20 to 100	C4
7 Structural concrete	Concrete moment resisting frames designed with seismic features	6 to 24	0 to 5	0 to 1	0	2	0	10	1	20 to 200	C1
8 Structural concrete	Concrete moment resisting frames with unreinforced masonry infill walls	11 to 30	2 to 10	0 to 1	0	17	0	20	25	20 to 150	C3
9 Wood	Load-bearing timber frame thatch	11 to 50	6 to 10	0 to 5	0 to 1	0.5	2	0	0	2 to 5	W3
10 Wood	Load-bearing timber frame walls with bamboo/reed (wattle & daub)	25 to 80	11 to 24	6 to 10	0 to 5	0.5	5	0	0	2 to 5	W5
11 Wood	Load-bearing timber frame with stone/brick masonry infill	25 to 40	11 to 24	6 to 10	0 to 5	1	1	0	0	4 to 7	W6
13											
14											
15											
16											
17											
18											
19											
20											
For other combinations, use blank fields below:											
21 Steel	Light Steel Frame (Usually for work/warehouse facilities)	6 to 10	0 to 5	0 to 1	0	0	0	2	0.5	5 to 20	S3
22 Masonry	Rubble stone in lime mortar with timber (Gable) roofing	25 to 60	11 to 24	6 to 10	0 to 5	0.5	5	1	1.5	4 to 7	RS3
23											
24											
25											
26											
27											

**Part III: Colleagues Consulted, Additional Sources of Information Used**

1 Name

Affiliation	
Mailing address	
e-mail	

2 Name	
Affiliation	
Mailing address	
e-mail	

3 Name	
Affiliation	
Mailing address	
e-mail	

4 Sources of information you used (websites, publications, etc.) Please provide as much detail as possible.

<b>Inventory</b>	Housing Census of India 2001 Vulnerability Atlas of India (BMTPC) 2005 WHE's Housing Prototype reports specific to India ( <a href="http://www.world-housing.net">http://www.world-housing.net</a> )
<b>Vulnerability</b>	EMS-98 Intensity based fragility function for D5 damage grade (Lagomarsino and Giovinazzi, 2006) Personal Judgment for other building classes not available in EMS class

5 Additional comments

<p>Proposed building specific collapse probability estimates to given EMS intensity represents average response for large number (of similar types) buildings and are provided in ranges (lower and upper bound). Mean and Upper bound estimates of fragility were first derived using EMS-98 Intensity definition for D5 damage grade using Lagomarsino and Giovinazzi (Bull Earthquake Eng 2006, vol. 4 : 415–443) and then later modified using expert judgment to reflect expected building response for future Indian earthquakes.</p> <p>The upper bound estimate of EMS based fragility function for Mud, Rubble stone and concrete gravity frame constructions appeared to be much lower than observed damage data in recent Indian earthquakes (e.g., Latur 1993, Jabalpur 1997 and Bhuj 2001) hence needed modifications.</p> <hr/> <p>Data on housing distribution by material and vulnerability class is obtained from India's Housing Census Survey and BMTPC Vulnerability Atlas publications respectively. However, Census data in India does not provide building distribution by structural system rather, it only provides information on total units (and not buildings) by material of construction (wall, roof and floors). Additional information were sought from WHE's reports available for India. Classification of mud, rubble and brick into detailed EERI classes has been done using a) distribution of housing by roof material, b) WHE reports, and c) personal judgment. The Census data on res. cum other use, work force by sector of employment data were used to approximately estimate the population exposure for non-residential buildings.</p>
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