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PROMOTING SEISMIC SAFETY IN THE HOUSING SECTOR IN INDIA

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ABSTRACT

Rural to urban migration is extensive in India and across many other emerging economies as cities and peri-urban areas are growing rapidly creating a huge demand for urban housing. Migrant populations are concentrated in highly vulnerable, unsafe locations and slums grow faster than their host cities. In India, according to the last Census (2011), 68.8% of the population live in rural areas while 31.2% reside in urban areas.

India is on the brink of a massive housing boom, with a goal of construction of 30 million new housing units by 2022. It has to be ensured that all constructions under this upcoming construction boom be built with seismic resistant features in design and construction with adequate technical expertise. The rural housing segment remains the more vulnerable as rural areas do not fall within the ambit of regulations and building bye-laws. The slum improvement programmes in the urban areas are emphasizing on vertical expansion, which will result in medium to high-rise 'improved' slums. Structural safety needs to be incorporated in all such vertical expansion programmes for developing disaster resilient housing especially in the high earthquake hazard prone areas.

This paper addresses some of the challenges in improving the seismic safety of future housing in India. Unsafe building stock is a complex issue and simplistic prescriptions for capacity building or assigning the blame on corruption will not address the problem. Mechanisms to provide and/or improve the technical expertise of those involved in housing design and construction need to be in place because this is clearly a weak link in the system. A formal structure for accountability of those in the building process, particularly the architect as the lead professional responsible, needs to be developed. Finally, a culture of safety has to be built into the delivery system for housing.

Keywords: Safety; Seismic; Housing; Developing countries; Awareness

1. INTRODUCTION

The built environment has in general performed poorly in recent earthquakes in India and the main contributor to fatalities in earthquakes has been building collapses. This has been the case not only with non-engineered buildings in rural areas but also with buildings in urban areas that fall within the ambit of some municipal controls. With a documented housing shortage of 40 million housing units in urban and rural areas, the government plans to add 30 million new housing units within the next five years. The country is thus on the brink of a massive housing boom. In addition to new constructions, the Government is also considering the in-situ improvement of slums through vertical expansion.

2. HOUSING IN INDIA

2.1 The Numbers

The Census of India (2011) calculated the total number of houses in urban India as 110.14 million and out of a total of 330 million housing units in the country overall.India has witnessed a steady growth in housing construction, recording a 33% rise in the number of houses from 2001 to 2011. The Census

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exercise in India is undertaken at intervals of a decade and the number of Census houses rose from 250 million to 330 million between the last two Census exercises conducted in 2001 and 2011. Even though a huge percentage of the housing stock is in rural areas, India has a rapidly growing urban population. In 2001, about 286 million people were living in urban areas across India, the second largest urban population in the world. The Census of India (2011) shows the urban population had increased to 377 million, thereby registering a growth of around 32 %. The urban areas have also seen a rise of 53.8% in the number of houses built, a reflection of the increasing demand for housing across the country and the easy access to housing loans from banks and other lending institutions, especially amongst the urban households. These staggering numbers are overlaid on a land with a high exposure to seismic hazard with 60% of the Indian landmass exposed to shaking intensities of VII to IX and above (BMTPC, 2006).

2.2 Prevalent Typologies

The building stock in India is comprised of a range of different building materials used in different combinations in buildings. The two commonest typologies prevalent in India are masonry buildings and reinforced concrete frame buildings. While the masonry unit may be built with burnt or un-burnt brick, stone (coursed or un-coursed) and concrete block, reinforced concrete frame buildings have columns and beams of reinforced concrete with the infill panels made up of unreinforced masonry units, usually burnt brick. The quality of these materials varies widely across the country as do construction practices and workmanship. About 71 million households have houses with concrete roofs; nearly 76 million with tiled roofs(handmade and machine made tiles, burnt brick), 21 million with stone/slate roofs and another 37 million have 'Grass' thatch, etc, as the material for the roof. Thus, about 150 million households live in houses that have no roof diaphragms, are therefore vulnerable to damage, and even collapse in even moderate earthquake shaking.

2.3 Condition of Houses

The data on condition of the census houses reveals important information. The condition of census houses was recorded as good or livable or dilapidated based on the perception and response of the individuals occupying them. According to Census 2011, 246 million census houses have been reported to be used solely as residence or residence-cum-other use. The condition of 131 million of these houses has been reported as 'Good', 102 million as 'Livable' and over 13 million as 'Dilapidated'. Figure1 shows that the urban housing stock is in a better condition and is perceived to be so by the occupants as compared to the rural housing stock. With average population of 5 persons per house, 65 million people in India, by their own admission, live in houses that are dilapidated and which could be affected by moderate levels of earthquake shaking.

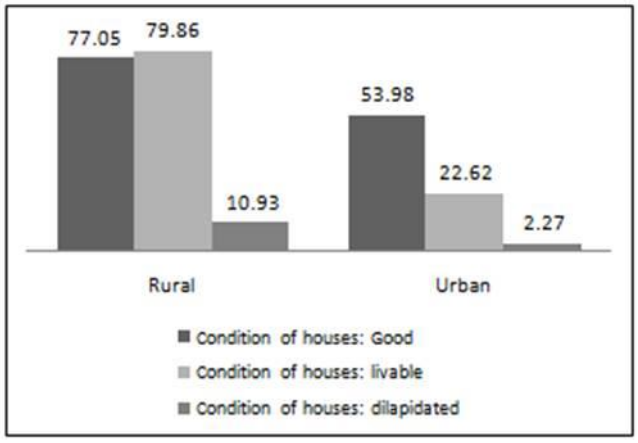

Figure 1: Condition of census houses in rural and urban areas as reported by occupants

2.4 Performance of Housing in Past Earthquakes in India

In the recent past, only two earthquakes have directly affected urban settlements in India.-the 1997 Jabalpur Earthquake (M~6.0) and the 2001 Bhuj Earthquake (M~7.7) and both events revealed the inadequacies of "engineered" constructions in the country. More than 1.1 million homes were damaged or destroyed in the Bhuj earthquake with 13,805 deaths and 167,000 injured. Kachchh district was the most heavily affected with 70% of buildings destroyed (~150,000 sq. km). More than 130 engineered, multistory residential buildings collapsed in Ahmedabad, 225 km from epicenter. Bhuj, a town with a population of 135,000 reported 7000 deaths and 6,500 building collapses, Bhachau, a town with a population of 25,000 lost almost every house, and the town of Anjar saw the destruction of almost all house in the old, central city core. The experience in rural areas has also not been very different. In the Latur earthquake (1993), the death toll was nearly 8000 where at least one village lost 30% of its population due to the collapse of heavy roofs on people sleeping in their homes in the early hours before daybreak (Jain, 2005).

3. THE FUTURE OF HOUSING IN INDIA

In 1991, 215.8 million population were urban dwellers, which increased to 286.1 million in 2001 and to 377.1 million in 2011. About 590 million people are projected to live in Indian cities by 2030. The report of the Technical Group on Urban Housing Shortage (Ministry of Housing & Urban Poverty Alleviation, 2012) states that there is total shortage of 18.78 million houses in urban areas.

3.1 Recent Thrust on Housing

According to the Government of India Ministry of Housing and Urban Poverty Alleviation (Naidu V, 2014), 18.78 million households are facing a housing shortage in urban India, while the housing shortage in rural areas is 40 million (Jaitley A, 2014). In his Budget Speech (The Hindu, 2015), the Finance Minister, Government of India announced a programme called 'Housing for All' by 2022, which envisages that every house in India should have access to basic facilities of 24-hour power supply, clean drinking water, a toilet, and be connected to a road. This shows that despite having a huge problem of unsafe buildings that currently exist, a huge number of new buildings will be added to the building stock. Hence, there is a tremendous urgency to ensure that new constructions are equipped with not only the basic facilities but should also be safe against the effects of natural hazards.

The Government of India in the Union Budget 2014-15, has proposed an allocation of 0.62 billion USD to set up a mission on low cost affordable housing, that will be anchored in the National Housing Bank. The Government has also announced the Sardar Patel Urban Housing Mission with a mandate to build 30 million houses by 2022, mostly for the economically weaker sections and low income groups. "In-situ" slum rehabilitation using land as a resource with private participation for providing houses to eligible slum dwellers is an important component of the "Housing for All" mission.Here, vertical expansion, is being encouraged as the way forward, where the emphasis is on a "safe and healthy environment, affordable transport and energy, safe and clean drinking water, employment and empowerment" . INR 80 Billion has been allocated for the National Housing Bank with a view to expand and continue to support rural housing in the country.

3.2 Improvement of Slums

According to the Census of India 2011, a total of 13.75 million households live in slums. The Census of India defines slums as "a compact area of at least 300 populations or about 60-70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities." The vulnerability of such environments stems from unsafe and poor construction practices and use of unsuitable and vulnerable materials that are likely to perform poorly during earthquakes and may also be liable to be vulnerable to earthquake-

induced fires. Moreover, the congestion in slums would likely render rescue and relief operations difficult by compromising accessibility within the built environment.

4. REGULATORY CONTROLS ON HOUSING IN INDIA

The earthquake risk is exacerbated by the vulnerability of the built environment, and the collapse of buildings and of lifelines contribute to loss of lives and huge financial losses. The design and construction of buildings in urban areas come under the purview of the building bye laws and the regulatory mechanisms in place there. The components of a development regulation system of which the building bye laws are a part, include enabling mechanism, standards, enforcement agency, enforcement protocol and accreditation systems.

4.1 Inadequate Regulatory Footprint

Assuming, the best case scenario, if all houses were built in compliance with regulations (and it would be rather simplistic to make this assumption) this would still constitute less than a third of the housing stock in the country—the urban building stock. The truth is that a significant number of houses even within this group are likely to be deficient due to a number of reasons, namely, lack of capacities of stakeholders in the building delivery process, a poor enforcement regime, and lack of awareness in aspiring homeowners, where the demand for safe housing is simply not present. The municipal regulations lack teeth and it is not unusual, particularly in semi-urban and rapidly urbanizing peri-urban areas for constructions to happen without receiving building applications, providing no opportunity even for enforcement of building rules.

4.1.1 Construction in Rural Areas

There is hardly any regulation in rural areas in India and rural housing is largely owner driven. In government supported rural housing programs such as the erstwhile Indira Awas Yojana, the house owner receives financial support and builds the house with the help of local masons in the informal sector. In the semi-urban areas, house construction remains within the informal sector with the engagement of local masons and small contractors. Mass housing schemes, if any, would receive minimal formal architectural and engineering inputs. Therefore, in reality, there is very little regulatory footprint outside of urban areas and about two thirds of the housing stock in the country which is in the rural areas are completely outside the purview of any building regulatory systems.

4.1.2 Construction in Urban Areas

In urban areas, most of the building activities fall within municipal regulations. However, in many municipal bodies in India, low-rise buildings (height below 10 m) need not go through the rigor of regulatory controls, and many will go below the radar of safety concerns, adding a significant number of unsafe buildings to the building stock, thereby increasing risk substantially. In these cases, it is common practice for the owners to procure the building materials and then to hire contractors who provide the skilled and unskilled labour force for the execution of the project. Even within Municipal limits, slum housing, comprising about 16% of the urban housing stock fall outside the ambit of any kind of regulatory controls. Thus only about 84% of the urban housing stock in India, that is about 28% of the overall housing stock currently falls within the jurisdiction of municipal bodies.

4.2 Weakness in Regulatory Mechanisms for Seismic Safety

Municipal Building Rules in many cities do not have adequate provisions for ensuring seismic safety of constructions. Even in situations where the Rules are robust, there is often no mechanism for enforcement, due to lack of trained technical personnel to physically check structural design, analysis, and drawings for compliance.

4.3 Capacities of Technical Manpower in the Building Delivery Process

4.3.1 Masons

As discussed earlier, masons are responsible for guiding the house construction process in rural areas in India, making them the key players for 67% of the housing stock of the country. In India, as in other emerging countries, masons rarely undergo formal training. They typically begin as construction helpers and rise through the ranks graduating to masons and head masons. Many a time, even head-masons do not understand disaster resistant construction. Clearly, there should be systems in place for the skill enhancement of existing masons and for recognizing trained masons.

4.3.2 Architects

The services of a professional architect are restricted to the urban areas and to buildings above 10m. In India, the architecture profession is regulated through the Architects Act, 1972, and architects are registered based on the possession of a Bachelor's Degree in Architecture from institutions recognized by the Council of Architecture, set up in accordance with the Act. However, this does not ensure understanding and knowledge of earthquake resistant architectural design, as the subject is not mandatory in the curriculum in the 480+ colleges offering undergraduate education in architecture. Earthquake resistant architectural design needs to feature as a core subject in the curriculum, and even more importantly, it needs to be built into the mindset and design ethic of the current students as a design parameter of critical priority and not an optional consideration. There is no requirement for continuing education after graduation and indeed very little opportunities exist, and no formal systems for on-the-job training programs. After the Bhuj earthquake in 2001, training of architecture faculty and professionals was held nationwide for about 4 years and then it lost momentum and since then, there have been no efforts in this sphere.

4.3.3 Engineers

Meanwhile, the profession of civil engineering is not regulated in India and neither is earthquake engineering a mandatory subject in the undergraduate curriculum. Many graduate engineers design buildings in earthquake hazard prone areas without basic knowledge of earthquake engineering to deliver safe structural designs. There is a need for Continuing Education for practicing engineers as well.

While urban areas come under some regulatory regimes, the urban local bodies need to be equipped to check for compliance to seismic safety standards. Competence based certification of municipal engineers responsible for checking structural design drawings and calculations would be away forward.

5. RECOMMENDATIONS

It has been a while since the last earthquake struck urban India and public memory seems to have faded. The increased level of all round awareness spike in the aftermath of the 2001 Bhuj Earthquake has come down. It is important to sustain the interest in earthquake safety even after the memories fade and to keep the awareness levels high through ongoing sensitizations, sustained awareness programs, campaigns, and advocacy. The time for awareness is never over, and it needs to be an on-going process, anchored within continuing action items.

5.1 Creating a Culture of Safety

The entire chain of construction industry must incorporate disaster resilience, and this can be achieved only if there are adequate checks and balances and a culture of compliance.

5.2 Improving the Curriculum

Earthquake resistant considerations must be better integrated into architecture curricula. Early architectural design decisions decide the earthquake performance potential of houses. In a country as prone to earthquakes as India, earthquake engineering must be integrated into civil engineering and architecture curricula.

5.3 Promoting Alternative Disaster Resistant Technologies

Unreinforced masonry construction, or the so-called load bearing masonry construction is known to have performed poorly in past earthquakes and is not suitable for larger buildings or taller structures above two or three storeys. In the absence of a viable alternative, reinforced concrete is preferred and used widely. However this typology requires engineering inputs and proper detailing and supervision. Poorly or inadequately designed RC buildings have historically demonstrated poor performance in earthquakes. Alternative approaches which have shown superior seismic performance, such as confined masonry and RC shear wall buildings need to be included in the codes of practice and encouraged particularly in areas with a high seismic hazard exposure.

6. CONCLUDING REMARKS

India's housing sector is one of the largest in the world. The huge construction boom in the housing sector needs to be grounded in a culture of safety, presently absent, in the housing delivery system. The rural housing segment remains particularly vulnerable as rural areas do not fall within the ambit of regulations and bye laws. The slum improvement programmes in the urban areas are emphasizing vertical expansion, which will result in medium to high rise slums. Structural safety needs to be incorporated carefully in all such vertical expansion from the perspective of structural safety in general and seismic safety in particular, especially in the high earthquake hazard prone areas. Finally, it needs to be stressed that housing is a family's aspiration of a lifetime, which they typically acquire with all their life savings. There can be no room for error in such interventions and it is the right of every citizen to have access to safe housing that will not collapse and harm them in future earthquakes.

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