Scheme for Structural Safety Audit of Lifeline Buildings

IMPLEMENTATION GUIDELINES

Himachal Pradesh State Disaster Management Authority

Government of Himachal Pradesh
Department of Revenue(Disaster Management)

No.Rev(DMC)(F)4-2/2000/SEC Dated the 29 September, 2018

NOTIFICATION:

The Governor, Himachal Pradesh is pleased to notify Scheme on "Structural safety audit of life line buildings" as per the Annexure enclosed spelling out the role of Stakeholders on the recommendations of State Executive Committee constituted as per provisions of Disaster Management Act-2005 to build a safer and disaster resilient State by initiating proactive prevention, mitigation and preparedness to ensure minimize loss of life, livelihood and property with immediate effect.

All concerned stakeholder departments will implement the scheme in their respective departments in letter and spirit and send action plan and requirement of funds to the Revenue (DM) department within a month's period.

By order
Manisha Nanda
Additional Chief Secretary(Rev-DM) to the 27.9.18
Government of Himachal Pradesh.

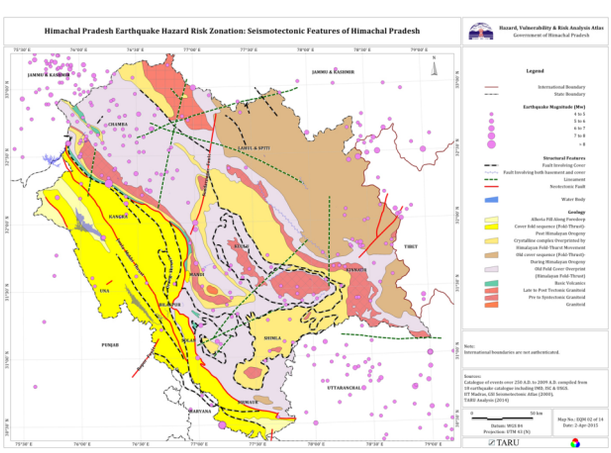
To
1. All Administrative Secretaries to the Government of Himachal Pradesh.
2. All Heads of Departments in Himachal Pradesh.
3. All Deputy Commissioners-cum-Chairman, DDMAs in HP.
4. The Commissioner, Municipal Corporations Shimla and Dharamshala.
5. The Secretary (GAD) to the Government of Himachal Pradesh w.r.t. item No.15 of Cabinet decision held on 14.8.2018 for information.
6. The Director of Town and Country Planning, Himachal Pradesh, Simla-2.
7. The Director of Rural Development and Panchyati Raj, HP Simla-9
8. The Director, HP Institute of Public Admn, Fairlawns, Simla-12
9. The Controller of P&S, HP for publication in Gazette.

(Milap Chand),
Under Secretary(Rev-DM) to the
Government of Himahal Pradesh.

I. CONTEXT

The State of Himachal Pradesh lies in the Himalayan Region. There has been an increase in both the population and infrastructures within State, in the last few decades. The fragile ecology and geology of the State coupled with large variations in physio-climatic conditions renders the state vulnerable to the vagaries of nature in one way or the other. Rapid urbanization and unplanned development has put lakhs of people in the state at risk of earthquake.

The Indian Standard code of practice for earthquake resistant design of structures, IS 1893 (2002), has identified 7 Districts of the region in Zone of most severe (Zone V) seismic hazard with the design peak ground acceleration as 0.36g. Remaining 5 Districts lie in zone of high seismic hazard (Zone IV) with design PGA as 0.24g. This region has felt large earthquakes in the past and the Seismotectonic maps prepared by State has shown some regions that are more active and entire state is at risk of being affected by a severe seismic event.



Seismotectonic Features of Himachal Pradesh

Earthquakes don't kill, unsafe buildings do.

As per Hazard Risk and Vulnerability Analysis Atlas developed by the M/s TARU for the state, most of the buildings in Himachal Pradesh can be divided into 5 types of construction. These are RC frame, Brick Masonry, Stone Masonry, Mud Houses and Hybrid Construction. Construction of RC frame structures has gained momentum in recent years. The masons were however not trained in the use of the new building material & construction methods. This is enough to highlight structural vulnerability of the built environment, particularly to seismic tremors to which the State is highly vulnerable.

Hasty population growth and lack of awareness of earthquake risk and scanty building performance has been singled out as the most important constituent source of the ever-increasing earthquake risk within the State. Therefore, improving seismic performance of new constructions and improving the same for the existing buildings should become one of the main thrusts towards earthquake safety in Himachal Pradesh. Promoting safer building construction is an objective necessity for Himachal where urban population is increasing faster.

Rapid growth of urban population demands a very high rate of building production, which, in the absence of proper building permit process, and a general lack of the knowledge and skills for earthquake resistant construction, end up in shanty construction that are extremely vulnerable to earthquake. Most residential buildings, even in urban areas of Himachal Pradesh, do not receive any rational design for strength.

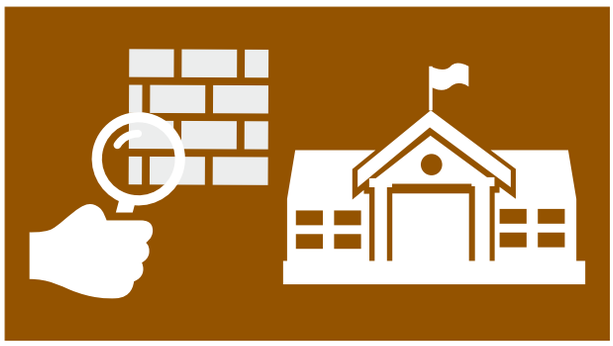
Even though most municipalities do have a system of building permits, there is no provision in the process to check strength criteria. The building permit process takes into account only the compliance related to planning such as the ground coverage, floor-area ratio (FAR), and the stipulations of the building bylaws (height, provision of toilet, sewer and solid waste disposal etc.). There is poor institutional and technical capacity within the local authorities for implementing strength-related provisions if they were to be introduced into the building permit process.

II. PURPOSE OF STRUCTURAL SAFETY AUDIT

The norm according to the model bye-law No. 77 for co-operative housing societies, it is mandatory that if the age of a building is 15 to 30 years, a structural audit must be carried out once in five years and for buildings older than 30 years it should be carried out once in three years. One may, however, go for it even earlier if one suspects the condition of the building to be bad.

The main purpose of the structural safety audit is an overall performance checkup of a building like a doctor examines a patient. It ensures that the building and its premises are safe and have no risk. It analyses and suggests appropriate repairs and retrofitting measures required for the buildings to perform better in its service life. Structural Audit is done by an experienced and licensed consultant:

- To save human life and building.
- To understand the condition of building.
- To find critical areas to repair immediately.
- To comply with statutory requirements.
- To enhance life cycle of building suggesting preventive and corrective measures like repair and retrofitting.
- To pro-actively assist the residents and the society to understand the seriousness of the problems and the urgency required to attend the same.



III. PROMINENCE OF STRUCTURAL SAFETY AUDIT

Structural Audit enables the organizations to address the issues by identifying the following:

i. To recognize the types of structural defects.

ii. To identify any signs of material deterioration.

iii. To identify any signs of structural distress and deformation.

iv. To identify any alteration and addition in the structure, misuse of structure which may result in overloading.

v. Structural Audit is an important tool for knowing the real status of the old buildings.

vi. The Audit highlights & investigate all the risk areas, critical areas and whether the building needs-

- Immediate attention. It should also cover the structural analysis of the existing frame, and
- Pinpoints the weak structural areas for static, floods and earthquake loads.

IV. SAFE LIFELINE BUILDINGS

W. J. Hall (1991) states, "Within a broad definition lifeline can be defined as those utilities, facilities, structures and equipment that support & enables people to survive or to continue doing something, often by providing an essential connection at the time of disaster." Whereas, D.C Hopkins (1991) believes that physically it should be any engineered system which we rely on and which is of vital importance in sustaining the physical and economic life of a community.

It is always said "Earthquake don't kill people, buildings do". Buildings have two important components: structural and non-structural. Structural components are the load-bearing elements of the building, like the foundations, columns, beams and walls etc. The Non-structural components include architectural and design features like doors, windows, false ceiling etc. and services include features like electrical and plumbing fixtures. Buildings fail in the event of earthquake when major damage occurs to structural systems.

Case Studies on Failure of Lifeline Buildings

(a) Bhuj District Hospital Building

The Bhuj earthquake of 26 January 2001 was one of the most severe disasters in recent times. The earthquake, measuring 6.9 on the Richter scale, destroyed over 12 lakh houses across Gujarat, but the worst hit was Bhuj, 60 km from the epicenter at Bhachau. Some of its landmark buildings, like the nine-storey Sahajanand Towers came crashing down, district hospital, collector office etc. and over 38,000 homes were collapsed in the city, killing 2,370 people. The only civil hospital in Bhuj was damaged, killing more than 200 persons including doctors, nurses, patients, visitors and staff. On the other hand, the District Collector office which is the most important official for handling emergencies and development activities of the district collapsed. The situation was similar for many other district-level offices and those at sub-divisions and talukas.

(b) Secretariat Building Gangtok

The M 6.9 earthquake hit Sikkim on 18th September 2011 with its epicenter located near India-Nepal border, about 68 km NW of Gangtok and at a focal depth of 19.7 km as reported by USGS. Sikkim earthquake caused severe damage to build environment across the state of Sikkim and partly in Darjeeling district of neighboring state of West Bengal.

This earthquake also triggered numerous landslides that caused damage to the buildings in several parts of the state. Secretariat building in Gangtok is one of the most important buildings of Sikkim, which houses the offices of chief functionaries of state government, including the Chief Minister. The building was damaged earlier during the earthquake of February 2006 and similar damage is repeated during this earthquake also. The building has undergone major damage particularly to the columns at the interface of the two blocks, apparently due to pounding. The infills have been badly damaged particularly at the corners of the building. In Sikkim, it is a practice to provide the infills outside the columns.

This makes the corners very vulnerable and the infills fail in wedge type corner failure combined with out-of-plane action.

Therefore, preparedness and mitigation measures should include securing and retrofitting of life-line buildings for not only saving lives of the vulnerable people, but also to ensure prompt and efficient response to disasters. Ideally, buildings should be designed with respect to earthquake in such a way that they survive in moderate earthquakes with non-structural damages and resist collapse with structural damages in strong and major earthquakes and ensure that no life is lost because of the collapse of buildings and also remain functional so that the response in post disaster situation is uninterrupted.

In order to ensure that such instances don't happen within the State of Himachal Pradesh, the Government has decided to launch this scheme to secure and if required retrofit key lifeline buildings.

V. PRIORITIZATION OF STRUCTURES

The initial focus for structural safety audit and retrofitting will be on government and public buildings. In the first phase the lifeline buildings which may be short-listed for Structural Safety Audit would be as follows:

A - State Headquarter

- **i.** Himachal Pradesh Secretariat
- **ii.** The Governor House
- **iii.** Himachal Pradesh Vidhan Sabha
- **iv.** Himachal Pradesh High Court
- **v.** All India Radio
- **vi.** Door Darhsan Shimla
- **vii.** H. P. Police Head Quarter
- **viii.** State Treasury

B - District Headquarters

- **i.** The Collectorate
- **ii.** Office of Superintendent of Police
- **iii.** The Zonal Hospital
- **iv.** BSNL Structure
- **v.** Fire Station
- **vi.** Police Station
- **vii.** Important Water Storage Tanks
- **viii.** Critical Bridges
- **ix.** District Treasury
- **x.** Primary Health Centres

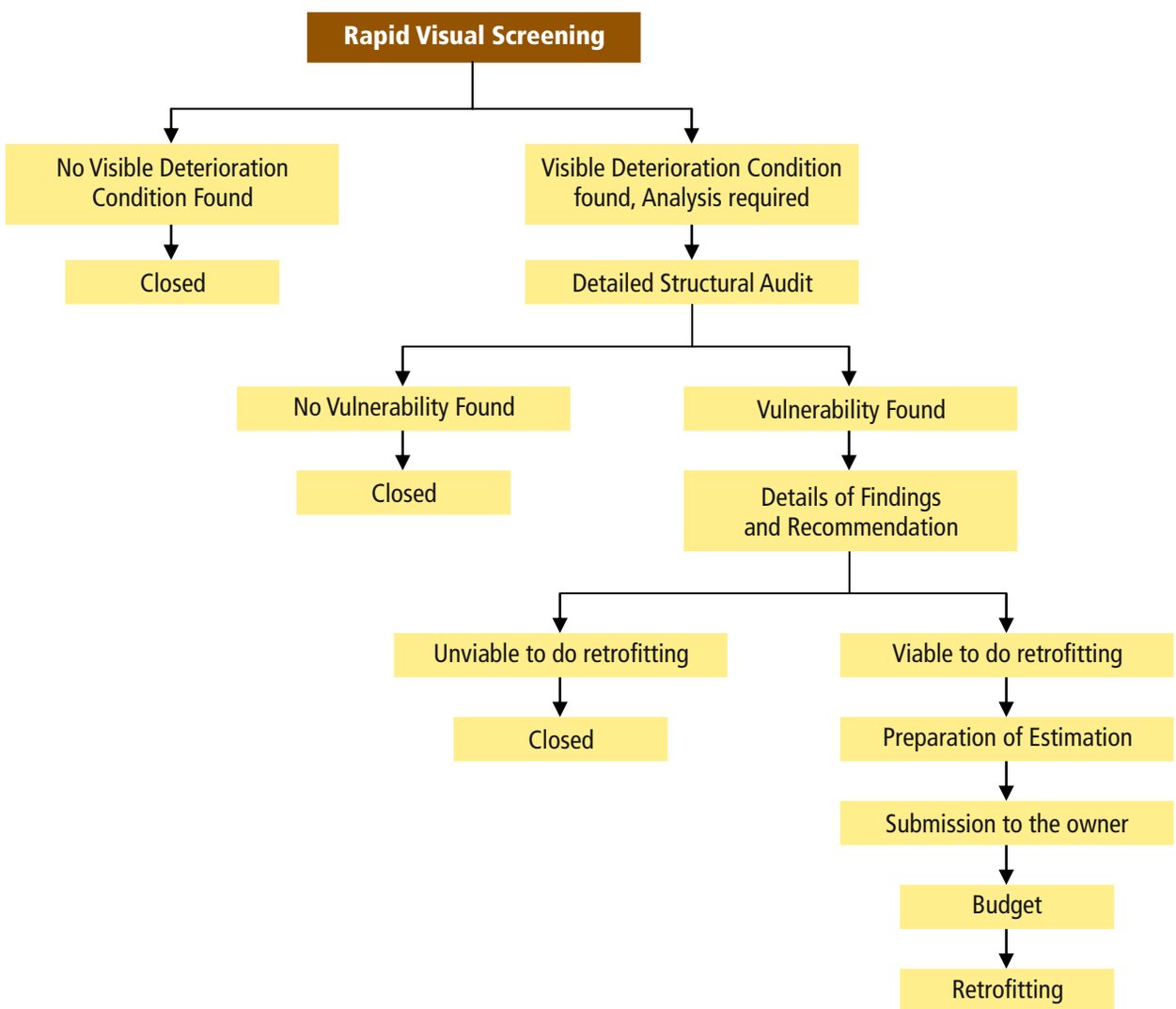
The above list is just indicative and lifeline buildings may be prioritized as per need of the district. 10 structures from all the District Headquarters and 5 - 10 important buildings at State Headquarters may be shortlisted.

VI. SCOPE OF STRUCTURAL SAFETY AUDIT

The detailed Architectural and Structural plans of the buildings must be available to conduct audit. If the Architectural plans and Structural plans are not available, the same can be prepared by any Engineer by measuring the size of the bldg. & locating the position of the columns, beams and size of all such structural elements.

If all the data required for structural audit is not sufficient by Visual Inspection, then Various Non-Destructive Test can be conducted. The critical areas can be highlighted and the method for repairs can be decided. Implementation of suggested repairs and improvements in Structural Audit can be useful.

VII. PROCESS TO STRUCTURAL SAFETY



The Structural Safety Audit will be conducted in different phases as given below:

PHASE-1

The Structural Safety Audit is a purely technical achievement where technically sound personal/ Experienced Civil Engineer will conduct the audit with a few hand held equipment's in following steps:

Step I: Keen observations shall be done for RVS only by technically sound personal/ Experienced Civil Engineer. During Rapid Visual Screening (RVS) period, photographs also have to be taken for further analysis & identification of the building. The visible defects/ damages, disorder and any infirmity have to be keenly observed and list out. Laptop/Tablet will be used as record media for collected data and photographs.

Step II: The Non Destructive Testing (NDT) equipment Schmidt Hammer is to be applied if required to check the quality of concrete used in the building.

Step III: Built-up area and height of the building shall be measured and recorded.

Step IV: Design of structure (if available) and/or building permission will be verified with the compliance of actual structure of the building by the technically sound person.

Step V: For under construction building, quality of materials used has to be checked and inform to builder to check the progress work to get the earthquake resistance stand-ard/safety so that, if any anomaly found, retrofitting can be done immediately. Subsequently, the records submitted to the concern authority i.e. 1st party.

Step VI: The technical report (Phase-1) will be prepared within 7 (seven) days from the date of completion of field works and submitted the same to the 1st party.

Recommendation based on above study for each building.

a. Recommendation will mainly focus on the structural safety assessment of each building examined and suggest corrective/remedial measures, if any.

b. It will also recommend if further NDT is recommended along with reasons for which the NDT is recommended and such test is required to be conducted.

c. If, however as per the Phase-1 study, no further structural assessment and audit is recommended for any building, the same also required to be pointed out by concerned experts.

PHASE-2

After recommendation of Structural Safety Audit and structural inspection in Phase-I Non-Destructive Testing (NDT) service may have to be done for checking overall quality & safety of buildings with the help of NDT equipment's. Accordingly, the data shall be sorting & analyze for proper identification of weakest points and safety level of the

building that Retrofitting can be done as the remedial measures taken by the owner of the building. However, the consultancy of retrofitting is not covered within the scope of this proposal. In case of under constructed building, the Structural Safety audit shall be in phased manner. The NDT equipments are also applicable in this type of audit.

i. Following are the function and features of usable NDT equipments in both new and existing building:

a. Pile Integrity Test (PIT)**:** PIT is a Non-Destructive Testing equipment shall be used for Technical Audit of foundation of the building especially for pile foundation whereas the parameters like Length of the Pile, Quality of pile, any Crack, break, voids inside the pile etc. can be determined.

b. Rebar Detection: The compact, lightweight Profometer 5+ rebar detection equipment shall be used to detect the position of Rebar (Reinforcement), Concrete Coverage, Span and diameter of rebar.

c. Corrosion Analyzing: The Canin+, the corrosion analyzing instrument shall be used for assessment of conductivity of concrete and presence of corrosion of steel inside concrete.

d. Ultrasonic Crack detector: Tico- an ultrasonic instrument shall be used to detect the uniformity of concrete, cavities, cracks & defects, the modulus of elasticity and compressive strength.

e. Compressive Strength of Concrete (Quality Test): The Schmidt Hammer (Digi-Schmidt) is one of the modern & sophisticated nondestructive Testing equipment shall be used to determine the compressive strength of any type of concrete. It is the prime equipment for evaluating the quality of concrete.

ii. Basic Technical Requirement and Specification

a. Nature of Structural Safety Audit: Nature of audit will be the Structural safety audit of all Ground+2, G+3 R.C.C. buildings.

b. To use up-to-date technical machinery and know how without damaging existing buildings.

c. The firms/institutions should have technical knowledge, adequate qualified technical manpower and equipment for conducting safety audit.

The consultant may also suggest and engage any other method as may be suitable to arrive at a definite conclusion with prior approval. Recommendation based on the NDT and testing report should consist of the report of overall quality of the building indicating the weakest points for safety and prospective remedial or retrofitting measures for sound condition. All report and documents shall be in English with 3 (three) hard copies and 1 (one) soft copy.

iii. Test data Collection and record:

Before testing the work piece (RCC Building), the test point shall be prepared by rubbing and cleaning that actual data can be obtained by applying the NDT equipment's. The test data shall be properly collected by equipment automatically and subsequently manually recorded. Further, the data shall be sorted and categorized for preparation of Technical audit report.

iv. Technical Audit Report:

A Structural Inspection Report (Phase-2) shall be prepared performing the Non Destructive Testing of the building. This report consists of categorized Test data, Photographs of the building along with the expert view (suggestion) and shall be submitted to DDMA & HPSDMA respectively.

VIII. ENGAGEMENT OF KNOWLEDGE INSTITUTION

Improvements in structural and non-structural measures for earthquake risk reduction will improve only if building can be made safe against earthquake by retrofitting and for this, HPSDMA will engage knowledge Institution i.e. National Institute of Technology (NIT), Hamirpur and Indian Institute of Technology (IIT), Mandi. These institutions will play role of Knowledge Partner to conduct Training for engineers from PWD, IPH, RD and ULBs, conduct Rapid Visual Screening, Detailed Structural Audit, to make recommendations for retrofitting of buildings and to prepare the estimates for retrofitting and will also provide Technical assistance and supervision for retrofitting within the State.

IX. FINANCIAL IMPLICATIONS

The expenses for training of engineers and consultancy charges of National Institute of Technology (NIT), Hamirpur and Indian Institute of Technology (IIT), Mandi will be borne by the Disaster Management Cell. Whereas, the Cost of Retrofitting will be borne by the concerned department.

X. PROPOSED BUDGET

A budget of Rs. 50 lakhs is approved (Training and Consultancy Charges) for this scheme to be met out of 14th Finance Commission Grand in Aid or other funds available with DMC. Funds may also be obtained from other source such as Govt. of India Scheme(s), Corporate Social Responsibility, other donor agencies, etc.

XI. MONITORING AND EVALUATION

Monitoring and Evaluation of the scheme will be done by the Disaster Management Cell, Department of Revenue.

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