The World Health House, as the buildings housing the WHO Regional Office for South-East Asia in New Delhi, India, are collectively known, is over 50 years old, necessitating greater investments to maintain the property fit for purpose.

The results of two seismic vulnerability studies of the campus buildings in 2001 and 2010 independently agreed that in their current condition, the buildings present certain concerns in the event of seismic activity - particularly during the monsoon season when the groundwater table is high. The situation is exacerbated by the ground conditions of the site and the seismic vulnerability of the Delhi area in general. The following actions were recommended:

- Demolish and rebuild the annexes, as the cost to reinforce and/or retrofit such buildings is economically unviable. The long, thin, footprint of these buildings, combined with an unorthodox foundation and structural design, bring into question the ultimate success of any strengthening works programme.

- Reinforce/retrofit the main building and conference block with pertinent mitigation measures including slab repairs and reinforcing of horizontal and vertical structural supports.

The High-Level Preparatory (HLP) Meeting for the Sixty-eighth Session of the WHO Regional Committee for South-East Asia held at the WHO Regional Office in New Delhi on 29 June–2 July 2015, reviewed the attached working paper and noted it.

In view of the findings, and in collaboration with the Ministry of Health, the Secretariat has invited the Central Public Works Department (CPWD) to perform a more comprehensive study of the facility. With this information, a more informed decision may be taken as to whether it is appropriate and more financially viable to also demolish the main block and rebuild. A report on the condition of the campus will be presented to Member States incorporating the findings of the CPWD assessment in due course.
The working paper is submitted to the Sixty-eighth Session of the WHO Regional Committee for South-East Asia for its information.
Background

1. The buildings housing the WHO Regional Office for South-East Asia in New Delhi, India, are now over 50 years old and reaching the end of their useful life. The main building along with the conference block was constructed by the Government of India in 1962. The annex buildings were constructed by WHO in 1971, 1982 and 2000. The sketch attached as Annex I details the general layout of the buildings in the current site. The aim of this paper is to summarize the current state of the buildings and ascertain the way forward in order to make the Regional Office safe and secure for use by WHO staff and guests well into the future.

2. New Delhi falls in the critical Zone IV of the Seismic Zoning Map of India; and in that light, the Regional Office commissioned two consulting firms in 2001 and 2010 to assess the structural integrity of buildings within the WHO premises in the event of significant seismic activity. Both firms independently agreed that the buildings in their current condition are not safe for use, especially during the monsoon season when the groundwater table is high. The situation is exacerbated by the ground conditions of the site and the seismic vulnerability of the Delhi area in general. The premises are built on the flood plains of the Yamuna river and next to a tributary. Furthermore, all buildings are found to be inadequate to withstand significant seismic activity with reference to current building code provisions. There is evidence that World Health House would sustain serious damage, imminent settling, tilting or collapse in the event of a strong earthquake and/or sustain saturation due to floods in the area.

Recommendations from structural studies

3. Both structural studies by consulting firms St. AR. Consulting Engineers, in contractual partnership with Goetests Consultants, in 2001 and SEEDS Technical Services, in partnership with AECs Engineering and Geotechnical Services Pvt. Ltd. in 2010 also highlighted that the main building and conference block require significant structural strengthening measures, while the annex buildings were not economically viable for implementing strengthening measures due to their footprint and structural state. Copies of these studies are available for review upon request.

4. In 2013, a thorough review of the above documents and on-site inspection of the facilities was conducted by the Central Design Bureau for Medical & Health Buildings, New Delhi, and the Indian Institute of Technology, Jodhpur. Their overall conclusions also state that the buildings comprising World Health House are at serious risk in case of a significant seismic event, given their current structural condition stemming from poor construction standards in place at the time of construction, the soft composition of the ground where they are built and construction materials used.

5. The following main actions were recommended:
• reinforce/retrofit the main building and conference block with pertinent mitigation measures including slab repairs and reinforcing of horizontal and vertical structural supports;

• demolish and rebuild the annexes, as the cost to reinforce and/or retrofit such buildings is economically unviable.

6. The long, thin, footprint of these buildings, combined with an unorthodox foundation and structural design, bring into question the ultimate success of any strengthening works programme.

7. In view of the findings, it is appropriate to consider whether it is more financially viable to also demolish or gut out the main block and rebuild from the base up. In order to accomplish the above, the Secretariat further recommends to:

• discuss the issue with the host government, Member States from South-East Asia and WHO headquarters, as appropriate;

• hire a competent firm/agency to provide expert, turnkey solutions; and

• find alternative office space and relocate staff from both main and annex buildings.

8. A total of 293 staff members, as of May 2015, 108 contracted personnel and numerous visitors may be present in the premises on any given day. These figures include 118 staff occupying offices in the less stable annexes. Based on the two structural studies, there is enough evidence to substantiate the findings. Therefore, the Regional Office management believes there is no viable option but to relocate the staff until a permanent solution is found.

9. At present, the options for the Secretariat are to:

• temporarily relocate the Regional Office to commercially available space for the duration of a renovation/construction project on the current site; and

• permanently move the Regional Office to commercially available properties.

10. Either of the above options carries a significant financial cost in excess of the existing annual maintenance and repair costs of the present facilities.

Regional perspective

11. In line with UN Security Management System Framework of Accountability, WHO, through the Regional Office management, has the duty to ensure that staff employed by the Organization are not exposed to unacceptable risk and that all measures are taken to mitigate such risk. Negligence on the part of the Organization could lead to serious institutional, personal and financial liability, not to mention reputational risks for the entire UN system.

12. At this juncture, the Regional Office management, in informing Member States of the status of the World Health House, further requests the Regional Committee for its
comments, guidance and recommendations on moving forward in relation to the relocation or renovation of the premises.
Annexes

Annex I: Site plan of the WHO Regional Office campus
Annex II: Due process followed to date
Annex III: Highlights from the relevant structural studies
Annex IV: Construction history in WHO Regional Office premises
Annex V: Current make up of WHO Regional Office campus
Annex VI: Major challenges with the buildings
Annex VII: Initial cost estimates for immediate remedial options
Annex I: Site plan of the WHO Regional Office campus
Annex II: Due process followed to date

Structural integrity studies:
- 2001 by St. AR. Consulting Engineers, in contractual partnership with Goetest Consultants (India).
- 2010 by SEEDS Technical Services, in contractual partnership with AECS Engineering & Geotechnical Services Pvt. Ltd.
- 2013 review by Adhar Consultancy and Infrastructure, a branch of AECS Engineering and Geotechnical Services Pvt. Ltd. for strengthening floor slab, main building.
- 2013 review by Central Design Bureau for Medical & Health Buildings and the Indian Institute of Technology, Jodhpur.

Environmental & Power Quality Audit (PQA) Assessment
- 2012 by EPI India & Singapore – ICT & telecom infrastructure.
Annex III: Highlights from the relevant structural studies

For analysis purposes, the studies categorized the buildings comprising World Health House as follows:

- Main building (1962)
- Conference building (1962)
- STC annexe building (1962)
- Old annexe building (1972)
- New annexe building (1983)

I. The 2001 study was conducted by ST. AR Consulting Engineers, in contractual partnership with Goetest Consultants (India). They concluded as follows.

A) Main building and conference block (1962):

- The India code provision IS-13920 providing for extra ties (confining reinforcement of vertical bars) as defined in clause 7.4 is not satisfied.
- The horizontal deflection of the building during an earthquake is 32 mm, which is within the permissible limit. However, the most disturbing aspect is the type of foundation provided. Isolated foundations have been adopted on saturated loose sand conditions (water table is 1.5 below the natural ground level as per soil report.)
- The soil condition and the isolated foundation used could cause differential settlement or soil liquefaction as the foundations are very close to each other. The foundations are subjected to full capacity already from static load considerations. Depending upon the intensity, an earthquake of moderate to severe intensity can cause the building to settle or tilt.

Remedial measures proposed:

- Any strengthening measures will be very expensive and uneconomical to adopt, as the foundations are at a depth of 3.0 m below the ground floor level. Strengthening could be carried out only if the use of the building is stopped and the whole ground floor excavated to provide a raft foundation over the existing foundations.

B) Annex buildings:

Old annexe building (1972)

- The reinforced concrete frame structure is very flexible and the beams do not fit into the columns on both sides i.e. the columns are not tied effectively at each slab level. The columns at the rear of the building are on the weaker axis, which is the reason why the horizontal deflections are
large and exceed the permissible values. The horizontal deflections are 47 mm.

- The requirement of providing additional ties is again not satisfied and similar strengthening measures will be required as stated for the main building.

- The soil conditions are the same and similar consequences can occur during a moderate to severe earthquake as stated for the main building.

**Remedial measures proposed:**

- Strengthening measures in the form of an additional column on the outside and steel ties at column locations on each typical floor will have to be provided. This will reduce the horizontal deflections in the old Annex building.

**New annex building (1983)**

- This building is slightly more rigid than the old annex building, as the beams frame into the columns on both sides, i.e, the columns are effectively tied. The columns at the rear of the building are on the weaker axis, but are bigger in size than the columns in the old annex building. The horizontal deflections are lesser than in the old annex building, although it is suggested that the columns be strengthened in the same way as in the old annex building.

- Other comments on confining reinforcement and foundations remain the same as for the old annex building.

**STC annex building (1962)**

- The exact construction date is uncertain. It is included as servants’ quarters in the drawing of the plot attached to the Deed of Sale.

- The building structure is poor and the original usage of the building was for residences of essential duty staff, such as drivers, cleaners, etc.

- The usage of the building has been changed from residence to office which requires heavier design loading. The building is designed as a load-bearing structure. Alterations have been carried out in the building to suit office use. The effect of a moderate to severe earthquake on this building could be disastrous.

II. **The 2010 study was conducted by SEEDS Technical Services (STS) in partnership with AECS Engineering & Geotechnical Services Pvt. Ltd.**

**Methodology adopted**

- The buildings were analyzed through soil testing, liquefaction analysis and most importantly, non-destructive testing. The test results were input into a seismic structural analysis to identify weak spots and weak members of the
buildings in the event of significant seismic activity. Since the upgrading of the zone calls for a higher design factor under Building Code provisions for safety of the structure, the buildings were analyzed against changed loads.

**Findings**

- The structural integrity of the building connections of the smaller built additions like fire escape, staircase, and fitness centre, that have been integrated into the existing structure are inherently weak, even if designed and constructed according to the building codes.
- Removal of walls between the columns for fixing of large-scale glass windows to improve aesthetics and functionality of the space is a matter of concern.
- Liquefaction condition is not anticipated in the foundation soil of the premises during an earthquake; the safety factor is reduced if the ground is inundated with water and the soil is completely saturated. Therefore, the drainage system should always be functional.
- The value of standard penetration resistance 'blow count' is less than 15 in the top 6-metre depth of ground, and below 6m the value increases.
- Non-destructive (condition survey) testing: Extensive non-destructive tests carried out for condition survey of the buildings have indicated that the strength of concrete has reduced significantly with the aging of the structures.

**Structural analysis**

- Seismic structural analysis clearly indicates the requirement of strengthening and enhancing ductility of the members like beams, columns and junctions for making the building earthquake-resistant.

**A) Main building and conference building**

- The structural members – columns and beams – are found to be inadequate, especially at the junctions, to sustain the design earthquake forces as per seismic zone IV and applicable code.
- Under present condition and applicability of Indian Standard Code, the building structural members (columns and beams) fail to meet the structural design requirement for resistance against earthquake at the junctions and all the columns are inadequate to meet the requirements of safe structure. All the columns need complete strengthening for axial loads as well as for bending moments.
- The slab design indicates that in general, it meets the design requirements. However, there has been increased loading at some locations where some partitions, stacking of book cupboards, etc., have been provided and these loads have slightly overstressed the slabs at those locations.
The space usage pattern in the building has undergone a deep change as the requirements from the building structure in present day conditions are vastly different from six decades ago when this building was designed. The slabs in some parts of the building need to be repaired with epoxy grouting and strengthening as per the details provided in the report.

B) Annex buildings

- The structural members are found to be highly inadequate – especially the columns are highly stressed beyond the maximum capacity, to sustain the design earthquake forces as per seismic zone IV and applicable code.
- As per the non-destructive test results and findings thereof, the concrete is very poor in strength and consistency in quality.
- Under the present conditions and applicability of Indian Standard Code, the structural members (columns and beams) fail to meet the structural design requirements for resistance against earthquake at the junctions and all the columns are inadequate to meet the requirements of safe structure.
- The structural analysis and design clearly indicate that the Annex buildings are deficient in strength to meet the structural requirements of an earthquake-resistant building.

Mitigation measures proposed:

A) Main building and conference building

- Based on the findings of the non-destructive tests and structural analysis, it may be concluded that the building under consideration in its present condition is expected to experience heavy damage during a severe earthquake.
- The conservative cost of mitigation measures, in 2010, for strengthening of these buildings can be summarized as follows: Main building: `65–70 million (US$ 1 530 000 at 45.7258x1 - in 2010), Conference building: `22.5–27.5 million (US$ 601 000 at 45.7258x1 – in 2010)
- The above numbers are indicative budget figures only. In order to arrive at an estimated cost, mitigation measures would need to be designed for each structural member and detailed bill of quantities (BOQ) needs to be worked out. The costs of architectural works, finishing and miscellaneous interior works are additional.

B) Annex buildings

- The annex buildings can be expected to experience severe damage during an earthquake. The strength of concrete is much below the acceptable limit with medium to doubtful quality. The corrosion of reinforcement would continue to increase, as the carbonation depth is quite high. Therefore, it is apparent that consideration for the strengthening of the buildings, which
have been designed with older codes and presently under distressed conditions, merits attention.

- As a general practice, any retrofit/strengthening or rehabilitation might be considered acceptable/feasible if the cost does not exceed 35% of the new construction or dismantling of old structure. The buildings under the present condition would require multiple treatments to their structural members that would include removal of all loose concrete, protection of existing reinforcement steel from further corrosion, based on detailed structural design/structural strengthening using concrete jacketing/steel jacketing/carbon fiber reinforced polymers and/or combination of these.

C) **STC annex building:**

- This building was originally designed as Ground + 2 load bearing structure meant for residential purposes, the load bearing arrangement could not be verified.

- A new floor was added on top of this building with independent external steel columns and beams. Visual inspection reveals that the external system was not found to be robust and might cause large deflection of the top floor. This would make the behaviour of the annexe building totally unpredictable during any earthquake.

- The buildings in the present condition are expected to experience heavy damage during severe earthquake.

D) **Mitigation measures proposed:**

- The structural arrangement of the new and old annexe buildings is a regular space frame. Column orientations are not appropriate and the frame arrangement is not supportive for any seismic or storm conditions.

- The foundations would also require to be thoroughly strengthened because of excess bearing pressure on the soil. **The cost of strengthening is expected to be considerably high (might exceed 40% to 50% of the cost of new construction)** and would require a lot of alterations to the building structural system.

### III. Environmental and power quality audit (PQA) assessment, by EPI India & Singapore – ICT & telecom infrastructure

Notwithstanding the overall need for a structurally sound building to house all WHO staff, multiple failures and gross deterioration of critical IT equipment in the data centre were observed due to adverse environmental factors in the building. As a result, in addition to the above mentioned structural studies, in 2012, an environmental engineering study was conducted, which showed high levels of sulfite in the server and hub rooms at ISA class rates from G3 (severe) to GX (harsh). This is considered to be a “severe” to “harsh” computer environment and five times higher than the G1 level acceptable in the industry. Such unacceptable environmental factors were found to have a direct impact on equipment failure
and refusal of vendors to provide any additional service and support, specifically replacement of parts, which show clear signs of severe corrosion.

IV. Review by Adhar Consultancy and Infrastructure, a branch of AECS Engineering & Geotechnical Services Pvt. Ltd.

In 2013, during retrofitting works on the second floor of the main building, it was discovered that cracks crossing the entire length of the slab were prominent in several locations of the floor. These cracks follow the same pattern of cracks created after the installation of the photovoltaic system on the rooftop in 2010. The most revealing aspect of the discovery was that while repairs were being attempted to close the gaps, the materials used (epoxy) leaked to the floor below. Similar cracks have been observed in other floors at the exact same locations. This puts in doubt the reliability of the slab throughout the main building and strengthens the concern of maintaining the main building vs demolishing it along with the annexes. The consultant invited confirmed the findings.

Mitigation measures proposed

- wrapping the member with unidirectional fibre in double layer complete after rounding the edges of the column beam junction from the two faces of the beam;
- levelling the surface with thixotropic epoxy levelling mortar;
- priming the substrate with low viscous epoxy;
- coating of viscous epoxy saturate across the area without links and air gaps;
- cleaning corroded reinforcement and applying corrosion treatment;
- providing and erecting steel props as required;
- dismantling brickwork along the pillars;
- dismantling and repairing the plaster; and
- strengthening the weak and deteriorated concrete with epoxy pressure grouting, etc.
Annex IV: Construction history in the Regional Office premises

1962 Main building  
1962 Conference block  
1962 Staff quarters  
1971 Annex A (GF-3F)  
1982 Annex B (GF-4F)  
*circa 1982 Scooter sheds  
1998 Toe wall with fence – back of the annexes  
2000 Staff lounge (currently Publications)  
2000 Game room  
2000 Stores NW corner  
2000 Stores SW corner  
2002 Fitness room – 1F above Staff Lounge  
*2003, 2005 Generator shed and diesel room  
*2004 Addition 4F EHA – over Annex A  
*2005 addition 3F over Annex C – converted to TIP annex  
2005 In gate – guard room  
2005 Out gate – guard room and ATM room  
2010 Peripheral wall – side and front of the premises  
*circa 2010 Greenhouse  
2010 Car parking and lawn

*Not sanctioned by the GOI as the allowable floor area ration (FAR) has been exhausted.
Annex V: Current make-up of the Regional Office Campus

- Main building, conference block, five annexes and parking
- 430 workspaces, including 72 individual offices/cabin
- Nine meeting rooms, including the Conference Hall
- Eight file rooms (BFU, PER, RDO, ETS, BM, REG)
- 10 storerooms: including cold storage, supplies, IT, building management publication and sales and library
- 52 specialized rooms including: In/out gates, ATM, prayer (2), staff lounge/game room, gym, medical clinic, pandemic (resuscitation) clinic, carpentry, janitorial and cafeteria services offices, drivers’ quarters, cafeteria, kitchen, data centre, library, print shop, ICT hub rooms, machine rooms (2), staff association, VVIP, EPBSX, transformers and pump rooms, indoor garage for RD’s official vehicle
- 27 toilets: 10 male, 12 female, four unisex, one for people with disabilities (PWD)
- Seven showers: two each for male and female (gym area), two for janitors and one for drivers
- 89 parking spaces on site, 55 on service road
- Two motorcycle sheds
- Other: generators, water chillers, compost machine, fuel room, sewer processing plant, storm water pumps, photovoltaic electricity generating system; plus rented external warehouse space
Annex VI: Major challenges with the buildings

- reaching the end of their useful life (over 50 years old);
- structural integrity rapidly deteriorating;
- obsolete electrical wiring system (50 years old in main buildings, 30 years old in annexes);
- obsolete central A/C system (50 years old in main buildings, 30 years old in annexes);
- window and split air-conditioners with serious maintenance requirements (over eight years old);
- obsolete mechanical system (water piping system);
- main electrical panels outlived their useful life (over 15 years old);
- uninterrupted power supply system (UPS 80KVA) for all computers and other sensitive equipment (over 12 years old);
- spare parts for most items above no longer available in the Indian market and servicing very difficult;
- obsolete fire detection and suppressant system (in the process of replacement);
- main firefighting pumps (over 40 years old);
- defective chilled water pipelines for annexes; some have been bursting (over 30 years old);
- obsolete building management system (BMS) to control the air handling units (AHU) and no service back-up is available (over nine years old);
- canopies of both diesel generators leaking and rapidly rusting;
- inadequate/obsolete cold storage facilities (walk-in freezer 29 years old, deep freezers 17 years old).
- waste from dragging the nallah reaching the height of our back contention wall, a health and security concern; and
- constant vibration in all floors created by chilling machines installed on each floor and machine room.
Annex VII: Initial cost estimates for immediate remedial options

**Option 1:** US$ 28 000 000 - for structural retrofitting and repair of main building, demolition and replacement of annexes. Average completion of the project is five years.

**Option 2:** US$ 15 000 000 – if WHO sells its premises and constructs new ones in government owned land as the sales proceeds would be applied to the total construction cost.

**Option 3:** US$ 10 000 000 – for retrofitting costs of new premises, if permanent free land and buildings from host government are obtained.

**Additional funds required:**

- US$ 20 000 000 for rental of commercial office space while construction is underway – average US$ 4 million per year for five years;
- US$ 2 000 000 for security deposit – average six months of yearly rental cost;
  US$ 3 500 000 for renovation and furnishing of swing space;
- US$ 750 000 for average project management contract.

**Other:**

- Estimated market value of current land and building `230 crore or US$ 37 million.
- Prior permission to sell in the open market must be obtained.
- Per host agreement, Government of India has the right of first refusal and the purchase price is set at the same level at the time of sale to WHO in 1962 – roughly US$ 350 000 (1/3 of construction cost).

**NB:** All estimates are based on current general market prices.