Management and Governance matters: Status of the SEA Regional Office Building

During its Sixty-eighth session in Dili, Timor-Leste, in September 2015, the WHO Regional Committee for South-East Asia reviewed and noted the preliminary report on the status of the South-East Asia Regional Office (SEARO) Building in New Delhi, India.

In response to the concerns raised, the Ministry of Health and Family Welfare of the Government of India invited the Central Public Works Department (CPWD) to perform a comprehensive analysis of the facilities. CPWD had constructed the SEARO Main Building and Conference Hall Block more than 50 years ago. Their report, titled “Seismic strengthening of buildings at WHO-SEARO campus”, delivered in January 2016, agrees with previous structural studies of the same buildings conducted in 2001 and 2010 inasmuch that in their current condition, the buildings are not safe for use, in particular the annexes that present the most immediate structural weaknesses.

While the Main Building and Conference Hall Block can be potentially repaired or rehabilited, they were constructed before seismic earthquake codes were enforced in India and are, therefore, not designed for a seismically vulnerable area such as New Delhi. The situation is exacerbated by the unsuitable ground conditions at the site, particularly during the monsoon season when the water table is high.

As a result of the findings of the study commissioned by the Government of India, the WHO Regional Director for South-East Asia discussed the issue with the WHO Director-General and government representatives and decided to start the process of moving the Regional Office for South-East Asia to alternative premises temporarily to ensure the safety of WHO staff at work.
This matter was presented to the High-Level Preparatory (HLP) Meeting for its review. Following constructive and supportive discussions, the HLP Meeting made the following recommendations:

**Actions by WHO**

1. Explore the inclusion of the discussions on the SEA Regional Office Building reconstruction as procedurally appropriate at the 140th Session of the Executive Board.

2. Follow the recommendations of the CPWD study on building a new, seismically safe, cost-effective, green and emblematic “signature” building.

3. Revise the Regional Committee Working Paper in line with the discussions of the HLP Meeting and include any updates as they emerge until the Sixty-ninth Session of the Regional Committee.

This Working Paper and the HLP Meeting recommendations are submitted to the Sixty-ninth Session of the WHO Regional Committee for South-East Asia for its consideration and decision.
Background

1. The buildings housing the WHO Regional Office for South-East Asia in New Delhi, India, are now more than 50 years old and reaching the end of their useful life. The Main Building along with the Conference Hall 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 1 details the general layout of the buildings at the current site.

2. It is to be noted that the land was leased to WHO in perpetuity for a token annual fee of Indian Rupee 1. The Main Building was constructed by the Government of India and sold to WHO at one third of the construction cost (then approximately US$ 350 000).

3. The Sixty-eighth session of the Regional Committee in September 2015 in Dili, Timor-Leste, was informed about the deteriorating status of the buildings. In addition, the Main Building is now more than 50 years old, necessitating greater investments to maintain the property fit for the purpose.

4. 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 the 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 ground water 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 are next to a tributary. Furthermore, all buildings are found to be inadequate with reference to current building code provisions on withstanding significant seismic activity. There is evidence that the SEA Regional Office Building campus would sustain serious damage, imminent settling, tilting or collapse in the event of a strong earthquake and/or sustained saturation due to floods in the area.

5. The Sixty-eighth session of the Regional Committee was informed that, in collaboration with the Ministry of Health and Family Welfare (MoH&FW) of the Government of India, the WHO Secretariat had invited the Central Public Works Department (CPWD) of India to perform a comprehensive study of the building premises and the ground conditions. With this information, the Regional Committee would be able to make a better and more informed decision as to all options for safe housing of SEA Regional Office staff and operations, including whether it would be appropriate and more financially viable to demolish all the buildings on the site and rebuild.

6. It is important to mention here that in line with the UN Security Management System Framework of Accountability, WHO, through the SEARO Management, has the duty of care to ensure that staff employed by the Organization are not exposed to unacceptable risk and that all measures are taken to mitigate such risk at all times. 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.
Recent structural studies

7. To analyse the current condition of the Regional Office campus, the Ministry of Health and Family Welfare, Government of India, invited the CPWD to perform a comprehensive analysis of the facilities. Their report, titled “Seismic strengthening of buildings at WHO-SEARO campus, New Delhi”, delivered in January 2016, agrees with two previous structural studies of the same buildings conducted in 2001 and 2010 inasmuch that in their current condition the buildings are not safe for use, in particular the building annexes. The highlights of this study – which was carried out in 2015 – are described in Annex 2 and the structural studies carried out in the past are described in Annex 3.

8. As per the recent studies, the design of the Annex Buildings were found to have several deficiencies, which led to structural concerns, and the Main Building and Conference Hall Block were also found to show signs of distress in certain areas. While these can be potentially repaired or rehabilitated, the buildings were constructed before the earthquake codes were formulated in India and, as a result, are not designed for a seismically vulnerable area such as Delhi and are not in compliance with current Indian standards for seismic resistance. The situation is exacerbated by the ground conditions at the site, particularly during the monsoon season when the water table is high.

9. The following two options were recommended in the latest assessment by the CPWD:

   a) Reinforce/retrofit the Main Building and Conference Hall Block with pertinent mitigation measures. Given their design, this was not found to be economically or structurally viable for the Annex Buildings, which would have to be demolished and additional buildings built to accommodate the full requirements of the Regional Office.

   b) Demolish all buildings and construct a new, green, seismically safe building. The expected useful life of a newly constructed building is 75 to 100 years as opposed to 5 to 10 years of useful life if only retrofitted.

10. Without renovation or reconstruction of the buildings, Regional Office activities could be jeopardized and the well-being of Member State representatives and the Organization’s staff put at risk. The assessment report of the CPWD found that option (b), i.e. demolition and reconstruction of all buildings, was the most cost-effective option. In such a case, temporary relocation of the Regional Office and its staff to alternative facilities in New Delhi would be required.

11. In view of the findings, the SEARO Management proposes to consider a comprehensive approach to the SEARO campus. Based on the available information, discussions are being held with the Government of India on whether it is appropriate and more financially viable to demolish the entire complex and rebuild.
Progress made

12. Following receipt of the study from the CPWD, the Regional Director consulted with WHO building experts and the WHO Director-General. The clear documentation of the risks to WHO staff was recognized and a decision taken to find alternative safe premises to move the offices in the shortest time possible.

13. As a result, the Regional Director and the Assistant Director-General for General Management called a meeting at WHO headquarters in Geneva on 27 January 2016 with the representatives of the Government of India to highlight the urgency and importance of this situation, and to inform of WHO’s decision to temporarily move operations to an alternative location in New Delhi. During the meeting, Host Government representatives confirmed their full cooperation in finding the best way forward for the SEA Regional Office’s safe continued operations, and stated their preferences for finding a solution at the current premises.

14. In recognition of the practical, administrative and logistical challenges associated with these decisions and commitments, a Joint Standing Committee of WHO-SEARO and the Ministry of Health and Family Welfare, Government of India, has been established to provide strategic direction, coordination and facilitation of any relocation and reconstruction project.

15. In their first meeting on 18 February 2016, the Committee discussed the need for the immediate relocation of the Regional Office to temporary accommodation and decided to engage CPWD anew to provide financial implications related to options available for SEARO’s safe business continuity in the longer term. The committee decided to meet again once viable options for the temporary move and a financial analysis of the options for the current premises were available.

16. Tasked with exploring viable options for meeting SEARO requirements at the current site, CPWD engineers conducted another survey and communicated their findings to the members of the Standing Committee in their letter dated 31 May 2016. This report indicated that the usable land area on the site was limited to the space occupied by the Main Building and Conference Hall Block, further confirming that the only viable option is to demolish the existing buildings and build a new efficient and green building.

In-depth analysis of potential options

17. In parallel to exploring options for the present site, SEARO Management has engaged the services of an international real estate consultant company to conduct a market search for suitable facilities in central New Delhi to temporarily house the Regional Office for a tenure that will cover the duration of works – currently estimated at 3.5–5 years – depending on the scenario. At the time of writing this report, the owners of a number of likely available properties had submitted proposals, and SEARO is evaluating best options to meet the requirements.

18. Due diligence will be carried out in selecting appropriate and cost-effective temporary office premises, including review by the Joint Standing Committee. Important factors being considered are the continued representational and convening potential critical for SEARO activities as well as effects on staff. The temporary move will entail building fit-outs for which SEARO will contract an
architect and a contractor through full competitive processes. The existing contract with the real estate consultancy company includes project management for this process to ensure the proper and timely relocation of SEARO staff and operations.

19. Following the July 2016 HLP Meeting, the Secretariat requested the same firm to carry out a comprehensive study of the options available for the SEARO Building, including detailed financials. This work is ongoing, with further due diligence necessary to determine the accuracy of the cost estimates, and will focus on an analysis of the following three options that take into consideration a 40-year period:

**Option 1: Refurbishment of the existing Main Building:** This entails the retrofitting of the Main Building and Conference Hall to render them compliant with current building standards, and demolition of the three Annex Buildings. During the refurbishment period, all staff would be required to be relocated to a temporary premise. Upon completion of refurbishment of the Main Building and Conference Hall, two thirds of the staff members would be relocated back to the refurbished SEARO building with one third of staff continuing to reside in an alternate rented facility on account of space limitations. This option would extend the life of the building by 15–20 years only after which reconstruction would be required.

**Option 2: Redevelopment of the whole campus:** This would require relocating the present staff to temporary premises during the dismantling of all building structures on the current site and new construction in accordance with all safety and structural building codes. This option would cater to the current as well as long-term operational staffing requirements.

**Option 3: Part redevelopment and part refurbishment:** The third option is a hybrid of Options 1 and 2. It entails a similar procedure as Option 2, whereas the entire Main Building and annexes would be demolished and redeveloped, while the Conference Hall Block would only be retrofitted to current building codes, increasing the lifespan of that part of the campus by 15–20 years only after which reconstruction would need to be considered.

20. The draft report evaluated the three options according to criteria requested by WHO, with a clear outcome that reaffirmed the recommendations of the CPWD report and HLP recommendation that the most suitable option is the full redevelopment of the site, as outlined in the table below:

<table>
<thead>
<tr>
<th>Comparison of 3 options</th>
<th>Parameter</th>
<th>2016 Status quo</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solution description</td>
<td>Current situation</td>
<td>Refurbishment of the existing campus</td>
<td>Redevelopment of the whole campus</td>
<td>Part redevelopment and part refurbishment</td>
</tr>
<tr>
<td>Security</td>
<td>Neutral</td>
<td>Neutral</td>
<td>Very satisfactory</td>
<td>Neutral</td>
<td></td>
</tr>
<tr>
<td>Health &amp; safety</td>
<td>Unsatisfactory</td>
<td>Neutral</td>
<td>Very satisfactory</td>
<td>Satisfactory</td>
<td></td>
</tr>
<tr>
<td>Financial consequences</td>
<td>-</td>
<td>Unsatisfactory</td>
<td>Very satisfactory</td>
<td>Neutral</td>
<td></td>
</tr>
<tr>
<td>Environmental concerns</td>
<td>-</td>
<td>Satisfactory</td>
<td>Very satisfactory</td>
<td>Satisfactory</td>
<td></td>
</tr>
</tbody>
</table>
### Reduction in long-term operational costs

<table>
<thead>
<tr>
<th></th>
<th>Unsatisfactory</th>
<th>Unsatisfactory</th>
<th>Very satisfactory</th>
<th>Satisfactory</th>
</tr>
</thead>
</table>

### Enhancement in Flexibility of operations

<table>
<thead>
<tr>
<th></th>
<th>Unsatisfactory</th>
<th>Neutral</th>
<th>Very satisfactory</th>
<th>Satisfactory</th>
</tr>
</thead>
</table>

Next steps

21. Given the condition of the SEARO buildings and the potential consequences to WHO staff and operations thereof, it is incumbent on WHO and its Governing Bodies to ensure the safety of staff and visitors.

22. The first priority is to move forward immediately with the relocation of the Regional Office to temporary premises. The Secretariat will also move in parallel to develop a reconstruction strategy for the existing compound in order to minimize rental costs. Accordingly the Secretariat will finalize the analysis of suitable and feasible reconstruction or renovation strategies for the Regional Office, including a sustainable financing plan. The financing plan will take into consideration the costs for both the construction project and the move to temporary space, which initial estimates provided by the consultants amount to US$ 49.7 million. These costs are based on four years’ rentals in alternate locations and would reduce or increase by approximately US$ 4.5 million per year depending on the duration of the construction project.

23. The Secretariat is engaged in constructive dialogue with the Government of India, who at the time of writing this report are exploring appropriate mechanisms and modalities to support the temporary relocation and reconstruction projects.

The Regional Committee is invited to consider the Draft Decision:
Draft Decision

SEA/RC69/  : Management and Governance matters: Status of the SEA Regional Office Building

The Regional Committee,

Having considered the report on the status of the SEA Regional Office Building,

Noting the urgent need for temporary premises pending the establishment and implementation of a sustainably funded reconstruction strategy,

Noting the constructive dialogue with the Government of India on their contribution to such a strategy,

1) Requests the Secretariat to proceed as soon as possible with the relocation to temporary accommodation with due consideration to appropriateness of the premises in relation to SEARO’s convening mandate.

2) Requests the Secretariat to finalize a sustainably funded reconstruction strategy for the SEA Regional Office, considering all available funding mechanisms, including but not limited to: real estate funds, other potential reserves and contributions from the Host Member State to enable due consideration of the issue by the World Health Assembly with the minimum possible delay.
Annex 1

Site plan of the WHO-SEARO campus
Annex 2

Highlights from the recent structural studies conducted in 2015 by the Central Public Works Department (CPWD)

The 2015 study on “Seismic strengthening of buildings at WHO-SEARO campus, New Delhi” was conducted by the Central Public Works Department (CPWD). Their conclusions include:

- The structural system of the Main Building and Conference Hall Building is a regular #D frame structure. The size and reinforcement detailing of various structural members appears to adhere with the prevailing building codes at that period of time. The quality of concrete, as found during physical verification, is good even after 55 years of existence. The distress in the AC plant room of the Main Building and cafeteria area of the Conference Hall Building were related to leakages and seepages from toilets. Damage to reinforced concrete projections and supporting fins are due to water seepage causing corrosion to reinforcement.

- Some of the columns that show vertical cracks along the main reinforcement of columns in the ground floor are due to corrosion of reinforcement occurring because of capillary rise of ground water in columns where the concrete is more porous.

- As these buildings were designed before the publishing of the first edition of the Earthquake Code in 1965, they are not designed for the forces generated during an earthquake and the ductile strength characteristics required for the proper behaviour of the buildings’ beams and columns during an earthquake is absent.

- In the Old Annex Buildings, beams in short directions are not placed at the column location except the outermost one, which creates a situation where the column is connected through beams only in one direction, and including the exception of the four corner columns of the building. This arrangement is not appropriate to withstand the force generated during an earthquake.

- In the case of the first floor in the New Annex Building, the existing slab is connected to beams in the elongated direction, i.e. no beams exist in the shorter direction. The general quality of concrete in this building is fine, except for honeycombed concrete in a few columns on the first floor and including cracks and corrosion along reinforcement concrete structures in some of the new as well as old columns of the old garage.

- The quality of the structural concrete checked in the campus Annex Buildings is found to be slightly inferior to the Main and Conference Hall Buildings; however, it is still determined to be within a “good” level range.
The various unplanned additions and alterations done in the various buildings have resulted in the shifting of the centre of mass and centre of rigidity of the buildings from the original planned locations; thus entirely changing the likely structural behaviour during an earthquake. Also, the various repairs and strengthening measures undertaken in the past have not been based on proper technical guidance.

An open drain (nullah) flows along the back boundary wall of the SEARO campus. The bed level of this drain is higher than the relative ground level of WHO premises, which causes sub-surface waterflows from the nullah to reach below the building foundation. This occasional condition allows water to rise in various columns through capillary action where the concrete is porous; and it causes corrosion, and thus weaker reinforcement characteristics, in some of the columns of all the buildings.

As the relative level of the SEARO campus grounds is at the lowest topographical level in comparison with the surrounding area, this geographical location occasionally causes inundation of the campus when it rains.

The Main and Conference Hall Buildings of the SEARO campus are considered well-planned. Engineered and constructed by CPWD, these are still in a robust physical condition even after the passage of 55 years. Although the buildings are showing some distresses in certain areas, these can be repaired/rehabilitated by following proper technical solutions.

**Recommendations**

Two alternatives can be broadly considered:

- Retrofitting of existing structures, or
- Reconstruction/redevelopment

**Retrofitting option**

- For seismic retrofitting of any building, analysis of the existing structure is done on the basis of actual loads coming over each area and the actual material strength (concrete and steel) present in various structural members.

- A performance level is selected for retrofitting and actual loading on various parts of the building. Actual material strength of concrete and steel is found by testing material extracted from the existing structure. For structure analysis, non-linear static and dynamic analysis procedures are used to find out the gap between demands generated during an earthquake versus the capacity available in the structural system. A structural drawing of all the buildings shall be required to incorporate these to model the actual beams and columns of different buildings in the analysis software.
- On the basis of these findings, various retrofitting schemes are possible, keeping in view the practical feasibility of its implementation in an occupied building. The various retrofitting options could entail the following several approaches, such as a) retrofit various structural members individually; b) provide some additional and stiffer members such as a reinforced concrete shear wall; c) using a steel braced frame system or addition of some energy dissipating device such as dampers/base isolators; or d) a combination of all these.

- Although the construction of the Main and Conference Hall Block Buildings were not originally designed and detailed to sustain earthquake forces due to the absence of an earthquake code, the present health and structural system of these two buildings is quite robust. They can be retrofitted by adopting proper procedures by qualified and experienced structural engineers in this field.

- In the case of the Old Annex Building, the foundation details are not known due to the non-availability of structural drawings. There are structural connectivity deficiencies of the beams and columns between the first and second floors. The retrofitting demands of these structural deficiencies shall be of quite higher magnitude, which can be discovered only after performing a detailed investigation and analysis of the structure. Although the current physical health of this building is satisfactory, the few locations where some physical distresses are appearing can be repaired/rectified by using appropriate techniques and material. However, the seismic retrofitting of this building shall not be a feasible option due to the above inherent structural deficiency.

- The New Annex Building has a good structural system right from the foundation level where it is tied by beams in both the directions – columns are connected by beams in both directions on the second and upper floors, except at the first floor level, where beams are placed only in a long direction and these are connected to a slab from the old garage structure. As a result, the structural behaviour of this building during an earthquake is deemed unreliable at the first-floor level; however, the upper floors and foundation will behave properly. Retrofitting of this building can be attempted. The detailed procedure shall be the same as mentioned for the Main Building and Conference Hall Building. The physical health of this building is also found to be quite good, except for a few distressed structural points, which could be very easily repaired/rectified.

- The general assessment of the expected time schedule, if retrofitting of these buildings is attempted, may be 2–3 years for planning and a similar period for executing the retrofitting scheme. This is because of the fact that not many experts are available in this country who are capable of executing this entire project. Specialized agencies required for its execution are also very few as is the restricted availability of specialized material and component systems in India.

- Relocation of building occupants for the period mentioned above shall also be a crucial determining factor. Detailed planning has to be carried out and a clear strategy formulated to decide whether retrofitting of all the buildings shall be undertaken simultaneously or if it can be done in parts in a phased manner. The cost of phased or full relocation of the occupants should also be taken into account while calculating the cost of retrofitting. The estimated cost of retrofitting
can be assessed only after finalization of a retrofitting scheme, keeping in mind the desired performance level and practical feasibility of its execution at the site.

- Since all the old structural drawings are not available, recreating building structural drawings shall also be a daunting and time-consuming task. The final liquefaction potential scenario shall also reveal whether retrofitting is a feasible option or not.

- The oldest existing building in this campus is 55 years old, which is a major portion of its useful life (75 years in case of reinforced concrete structures). Therefore, by attempting the retrofitting of these structures, we can augment the useful life of these structures by approximately 15–20 years, but the inherent problems, difficulties/complexities and uncertainties associated with retrofitting should be more thoroughly compared with the factors involved in developing a new building.

**Reconstruction/redevelopment**

Redevelopment of the SEARO campus is also quite a workable alternative. The various advantages associated with this option are discussed below:

- The advantage of a higher permissible floor area ratio (FAR: total building floor area/building footprint area) as per current local building codes and regulations may be taken to plan a single new building of larger height in place of all the existing buildings in the campus. This will create an unhindered open space all around.

- A new building can be architecturally planned keeping in mind future space demands. All modern services, amenities and suitably designed spaces can be properly planned for in a more efficient manner, which is always lacking in older building structures such as the SEARO campus.

- Structural design may be done to achieve the desired performance level. All issues relating to soil liquefaction may be addressed properly and efficiently. The flooding/inundation problem of the campus can also be tackled effectively.

- The concepts of green building norms such as to “reduce, recycle and reuse” may also be incorporated.

- The expected project duration for reconstruction/redevelopment may be 1–1.5 years for planning and 2.5–3 years for construction, which may be less than the expected project duration for the retrofitting alternative.

Considering all the above, it is recommended that the WHO buildings may be demolished and a new green and seismically resilient, “signature” building be constructed by CPWD.
Annex 3

Highlights from previous structural studies

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

- Main Building (1962)
- Conference Hall Building (1962)
- STC Annex Building (1962)
- Old Annex Building (1972)

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 additional reinforced vertical structures 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 metres below the natural ground level as per the 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 metres below the ground floor level. Strengthening could be carried out only if the use of building is stopped and the whole ground floor is excavated to provide a raft foundation over the existing foundations.
B)  Annex buildings:

Old Annex Building (1972)

- The reinforced concrete frame structure is very flexible and the beams do not frame 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.


- 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 in the drawing of the plot attached to the Deed of Sale as “servants’ quarters”.

- 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 and Geotechnical Services Pvt Ltd

Methodology adopted

- The buildings were analysed 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 the safety of the structure, the buildings were analysed against changed loads.

Findings

- The structural integrity of the building’s connections with the smaller built-in additions such as the fire escape, staircase and fitness centre that have been integrated into the existing structure are inherently weak, even if designed and constructed according to building codes.

- Removal of walls between the columns to fix large scale glass windows to improve aesthetics and functionality of the space is a matter of concern.

- The 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 the standard penetration resistance “blow count” is less than 15 in the top 6-metre depth of the ground. Below 6 metres this 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 members such as beams, columns and junctions to make the building earthquake-resistant.

A) Main Building and Conference Hall Block

- The structural members – columns and beams – are found to be inadequate, especially at the junctions, to sustain earthquake forces as per Seismic Zone IV and other applicable codes.

- Under the present condition and applicability of the Indian Standard Code, the building’s structural members such as columns and beams fail to meet the
structural design requirements for resistance against an earthquake at the junctions, and all the columns are inadequate to meet the requirements of a 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 those six decades ago when this building had been 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, which are highly stressed beyond the maximum capacity to sustain the design earthquake forces as per Seismic Zone IV and other applicable codes.

- As per the non-destructive test results and findings thereof, the concrete is very poor in strength and in consistency of quality.

- Under the present conditions and applicability of the 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 a 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 Hall Block

- 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: Indian Rupee 65–70 million (US$ 1 530 000 at an exchange rate of 45.7258 in 2010);
Conference Hall Building: Indian Rupee 22.5–27.5 million (US$ 601 000 at an exchange rate of 45.7258 in 2010).

- The above numbers are indicative figures only. To arrive at an estimated cost, mitigation measures would need to be designed for each structural member, and a 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 the concrete is far below the acceptable limit with medium to doubtful quality. The corrosion of the reinforcements would continue to increase, as the carbonation depth is quite high. Therefore, it is apparent that consideration be given to strengthening the buildings, which have been designed with older codes and are presently under distressed conditions.

- 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 the old structure. The buildings under the present condition would require multiple treatments to their structural members that would include removal of all loose concrete and protection of existing reinforcement steel from further corrosion, based on detailed structural design/structural strengthening using concrete jacketing/steel jacketing/carbon fibre reinforced polymers and/or a combination of these.

C) STC Annex Building:

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

- Also, a new floor was added on the top of this building with independent external steel columns and beams. As per the visual inspection, the external system was not found to be robust and might cause large deflection of the top floor of the STC Annex Building. This would make the behaviour of the building totally unpredictable during any earthquake.

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

D) Mitigation measures proposed:

- The structural arrangement of the new and old annex 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 (may exceed 40% to 50% of the cost of new
construction) and would require extensive alterations into the building structural system.

III. Environmental and power quality audit (PQA) assessment, by EPI India and Singapore ICT and 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. This revealed high levels of sulphite 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 is 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 in matters related replacement of parts, which show clear signs of severe corrosion.

IV. Review by Adhar Consultancy and Infrastructure, a branch of AECS Engineering and 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 bolsters the concerns related to maintaining the Main Building as opposed to demolishing it along with the annexes. The consultant invited confirmed the findings.

Mitigation measures proposed:

- Wrapping the member with unidirectional fibre in double layer 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;
- Strengthening the weak and deteriorated concrete with epoxy pressure grouting, etc.