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New Sections

Features

Repair and Restoration of Maker Chamber VI, Nariman Point

Mumbai, India
Submitted by LeakSeal

Background of the Project

Maker Chamber VI is one of the most iconic commercial buildings located in Nariman Point, Mumbai. It is in the heart of the busiest business districts in India and home to reputed multi-national organizations such as Reliance, State Bank of India and also public bodies such as State Government House of Secretaries. Built in the year 1985, Maker Chamber VI building is a reinforced concrete structure which consists of Basement, Ground floor, Fifteen upper stories and 1 story mast section. The structure gives one of the best scenic views in the city which is sea facing and occupies more than 95 commercial offices to reputed organizations and bodies such as the Austrian Consulate and BMW to name a few. It was also rated as amongst the costliest commercial office building in India as per the Real Estate Value.

Project Conditions and Problems That Prompted the Repairs

Because the structure is a sea facing high-rise building, braving hostile coastal weather throughout the year, especially during the intense monsoon season of Mumbai when wind-driven acid rain attacked the exposed surfaces, conditions from salty water and air, ultraviolet rays and poor maintenance (the buildings was repaired & painted only once in 35 years), the concrete slabs & surface crazing of the external facade which also led to rapid corrosion and carbonation of the steel and concrete of the structure. A mandatory 30-year certification inspection suggested that the management team focus on immediate repairs to the structure's facade. Despite the fact that the building was constructed by one of the most respected contractors in India, poor timely maintenance and extreme weather conditions resulted in severe

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Owner
Maker Chamber VI CSL. Mumbai, India.

Project Engineer / Designer
Sterling Engineering Consultancy Services Pvt. Ltd.

Repair Contractor
LeakSeal India Mumbai, India

Material Suppliers
BASF India
Akzo Nobel India
Ultra-tech Cement
Mumbai, India

Fig 1: Building external conditions depicting damage in concrete elements

Fig 2: Delamination of façade render with corrosion induced macro cracks

deterioration of the structure.

Inspection, Evaluation & Test Results

A professional RCC consultant who had previously designed the RCC elements of this building was brought on board and

Fig 3 Above & Fig 4 Below: Test Results depecting deterioration in Concrete façade elements and canopies

undertook the physical survey of every floor, identified the areas of damage and deterioration by thorough visual inspections of the building. These were documented by mapping on plans, layout and photographs. Locations of leakage points, cracks, spalls & the condition of the concrete were noted in the report. After a detailed study, it was determined that progressive ingress and penetration of carbon dioxide, rainwater, and other moisture into the body of the concrete led to extensive spalling of the concrete. Restoration work was required to treat the reinforced concrete canopy, strengthening of structural members, corrosion protection, shear walls which were found to have non uniform corrosion-induced macro-cracks and the plaster overlay which was delaminated. External joints between reinforced concrete members and masonry cladding panels had also opened up. Overhead water tank on the top was severely damaged from inside which led to exposure of reinforcement bars. Terrace flooring joints had opened up which was yet another factor contributing to heavy leakage on top floor offices during the monsoon. Various nondestructive tests were further carried out to evaluate the adequacy of concrete strength and to determine the appropriate repair and restoration strategies with a proper budget.

Repair System Selection

Keeping in mind the extent of the facade failure and corrosion cracks which were visible at practically every floor level

on canopies and the plaster, it was concluded that an isolated patch repair would be evident and the affected reinforced concrete areas be treated using polymer enriched cement based high performance mortars, high quality polymer additives, fibre reinforced repair mortars & non-shrink high quality micro-concrete. The project consisted repairs of the external facade and exposed portions of concrete elements, such as slab edges and columns. It also needed repair/replacement of concrete members/slabs, jacketing of columns, corrosion control and removing/replacement of the terrace flooring till the old slab and finishing the surface with pre-mixed high performance polymer modified cement based strength mortar. Also, since panel discoloration and several cracks were evident throughout the elevations, the entire facade required specialized elastomeric waterproofing coatings with alkaline resistance and anti-carbonation properties to fight the extreme weather & sea conditions.

Special Challenges

Since repairs had to be executed with the building offices functional at all times, the work had to be designed and implemented in a special manner. Through effective coordination with owner, the engineer and contractor were able to design and install appropriate and successful solutions while overcoming a series of project challenges and unforeseen circumstances. The contractor presented a complete sequence of events for the project in weekly review meetings, including inconveniences to be faced by the occupants of the building so that they would know what to expect during the course of ongoing repairs.

Rehabilitation Sequence

Because the structure has large, densely populated offices, the repair sequence was designed with very careful implementation to cause minimum inconvenience to the occupants and to further ensure successful repairs within the time schedule.

1. Tubular steel scaffolds were carefully erected at calculated heights for lateral stability. The entire scaffolding was covered with protective hessian cloth to arrest any falling debris during repairs. Working at such height was very challenging and risk to one's life. Hence, working platforms at convenient locations were erected to facilitate safe working conditions with faster progress.
2. Large glass windows on the exteriors, existing costly floor finishes & water fountains near the building entrance were protected & covered using thick foam sheets with further covering of 12 mm wooden plywood sheets to prevent damages during the breaking of concrete.
3. The existing cement mortar rendering on the external walls was carefully removed without undue damage. The deteriorated concrete was removed with 15 lb (6.8 kg) chipping hammers and sandblasting corroded reinforcing steel. Exposed steel was coated with a corrosion inhibitor with added admixture to the repair mortar. The exposed corrosion-inflicted reinforcing steel was cleaned with a pre-treatment to loosen the rust scales and passivated against corrosion with epoxy-based formulations.
4. Falling debris was collected over the protected platforms and lowered down through construction debris chutes to the ground level for disposal. Necessary additional precautions were taken in view of the increased wind velocity for labors to work safely with safety belts, goggles, netting, and platforms.

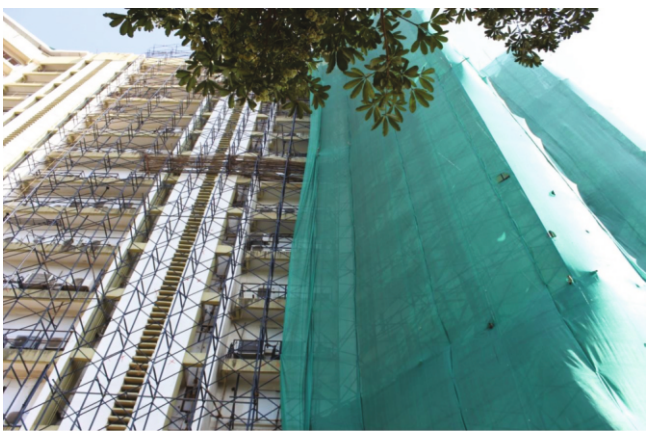

Fig 5: Tubular Scaffolding with arresting safety nets and platforms for safe working conditions with complete glass window covering.

Fig 6: Chipping of damaged external plaster

Fig 7: Repair/Replacement of Reinforcement bars.

Fig 8: Casting of new concrete with thermal insulation & waterproofing on canopies and drop pardi

5. Custom details using concrete, waterproofing materials, carbon fiber-reinforced polymer (CFRP) rods and sheets were provided to replace & strengthen deteriorated concrete and reinforcing bar on the structure. The fireproof intumescent coating applied will protect the carbon strips from heat/flame in the event of a fire.

6. Mortars used were properly proportioned, batched and machine mixed. Fine aggregates were chloride-free river sand, prewashed at the site to ensure silt contents of less than 3%. The measures of washing the sand, the machine mixing addition of an anti-shrinkage polymer and a high degree of workmanship resulted in the effectiveness and durability of the treatment carried out. Level screeds and leveling strips were fixed to ensure correct line & level to follow the original aesthetic lines of the building.

7. The shear walls were treated with high performance ready mix cement plaster which had in mixed high quality polymer additives with well graded sand & fillers. It gave an excellent finish after its application in two coats of upto 25 mm thick with negligible wastage on site and met the required technical parameters of the engineer with com-

Fig 9: Final finish of new concrete with false checkered lines to minimise cracking.

pressive strength of 8-9 Mpa when tested after 28 days of its application.

8. M25 Grade Concrete Mortar of 1:1:2 mixing ratio i.e (1 bag of cement 50 kg : 1 bag of chloride free sand 50 kg, 1 bag of metal 1 aggregates 50 kg & 1 bag of metal 2 aggregates 50 kg) was used for concrete members/slabs and the box type canopies which were rebuilt at many places after breaking.
9. Non-Shrink, cementitious, pourable micro-concrete in the prepared formwork were used for jacketing of RCC members and columns where the thickness was more than 45mm since it had high flow, high strength formulation to repair complex profiles easily thereby reducing the time for repairs.
10. Similarly, a single component trowelable polymer mortar which had a dual shrinkage compensated, fibre reinforced thixotropic high strength formulation was used for the repairs of RCC members and columns where the thickness was within 25mm and upto 45 mm. It was simple installation factory made single component system with only addition of water & uniform predictable performance with less likely chances of human error even in remote situations thereby again reducing the time for repairs.

Fig 10: After image of repaired shear wall plaster & new constructed concrete canopy and drop pardi.

11. The concrete layer was cured for 10 days by continuous wetting through a sprinkler system created especially for this purpose and was then rendered with cement mortar overlays in two coats with a sponge textured finish. To achieve waterproofing and thermal insulation of the top of box sections, a layer consisting of small brick pieces (as thermal insulation) fixed in cement mortar bedding was first laid with the correct slope and then overlaid with a jointless screed coat with polymer-modified rich cement float, finished with false checkered lines to minimize map cracking and shrinkage.
12. Special attention was paid to the joints of the masonry and concrete. A “V” groove approximately 2 in. (5 cm) deep was made by chiseling at the joint, and after cleaning, a cement mortar was pressed in. Dry aggregate pieces were then pressed firmly into the mortar. Nozzles for grouting were placed every 5 ft (1.5 m). The cement slurry mixed with an expandable additive was injected under pressure into the nozzle. This helped ensure that the joint would not reopen in the future.
13. The window joints were sealed with high graded Polysulphide sealant along the junction of window frames and the wall, to make the joints water-tight.
14. Synthetic texture of upto 2mm and specialized elastomeric coating of 250 micron was applied over the exterior facade to give it a uniform look. The elastomeric coating used had alkaline & anti-carbonation properties of upto 558 mtrs which are generally used on road and sea bridges.

Terrace Repairs

The building had two terraces, one on the 15th floor level and the other on 16th floor.

The entire flooring surface of the terrace was removed till the slab and was then covered by a rich cement slurry, followed by a layer of mortar with a ratio of 1:5 cement: sand. Brickbat pieces were laid on the mortar to serve as thermal insulation to absorb heat from the direct sunlight that reached temperatures of 120 ^{o}F (50 ^{o}C). These pieces also served as keys for the subsequent waterproofing screeding, which was float-finished. Care was taken to ensure correct detailing, especially at the joints of the old slab and the newly laid mortar. A haunch made of brick pieces was sealed with hand-packed brick aggregate fixed in mortar so that the joints would not open up. A subsequent layer of render was laid over and above the haunch to ensure that water would not penetrate

Fig 11: Removal of damaged concrete flooring till the old slab

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Fig 12: Laying of new concrete mortar with waterproofing finish on top section.

Fig 13: Final finish of terrace after application of Polyurethane coating on top.

through. The flooring was finished with false checkered lines to minimize map cracking. A wearing coat of 600% elongation single component polyurethane coating was applied on the entire terrace to make it cool roof and leak free.

Project Schedule

The time schedule was closely monitored with weekly review meetings on site location. The entire project was categorically repaired in 3 different phases. Since repairs had to be executed with the building offices functional at all times, the workers were limited to work for three hours in one shift, thereby having three different shifts in a day. Outstanding planning, sequencing, logistics and staffing with a dedication to safety and quality by the contractor, in conjunction with committed teamwork from the owner and the engineer, enabled this large and complicated project to be completed on time and within budget. The rehabilitation also dramatically improved the overall aesthetics of the building and making it landmark structure amongst the other buildings in the vicinity.

Fig 14: Final finish of the building after synthetic texture and elastomeric paint application.

Shreeji Heights Parking Garage Repair & Podium Waterproofing Rehabilitation

Navi Mumbai, India
Submitted by LeakSeal

Background of the Project

Shreeji Heights located in Palm beach road of Nerul, Mumbai city is one of the most iconic and luxurious residential complex in terms of real estate value. The complex is sea facing and has apartments which are not less than 3000 sft in size & still remains the most luxurious structure with multiple amenities in the vicinity almost after a decade of its construction.

The structures are reinforced concrete (RCC) framed structures, constructed during the early 2008. It is a complex of 25 storied three towers & 18 storied 2 towers. It further adjoins a ground floor stilt parking garage for approx 200 cars & 70 commercial shops. On the top of the parking garage there is a huge podium/garden area of 100000 sft (93,000 sqmt approx) which has multiple amenities such as basket ball

Owner
Shreeji Heights CHSL. Navi Mumbai, India.

Project Engineer / Designer
Rohan Ventures Consultants

Repair Contractor
LeakSeal India Mumbai, India

Material Suppliers
BASF India
Covestro India (Bayer Chemicals)
Akzo Nobel India
Mumbai, India

court, Swimming pool, Gymnasium with attached guest rooms and Spas, Amphitheatre for 100 people sitting capacity, A temple, Playing park for children and major garden area with walkways & Gazebos.

Project Conditions and Problems That Prompted the Repairs

As with many buildings in the area, the parking structure too has been subjected to the marine environment and monsoon leakages ever since its constructions. Small repairs and failed waterproofing efforts to stop leakages were conducted periodically, but due to restrictive access from the top of the parking area, large-scale restoration/waterproofing had been avoided which led to severe deterioration in the concrete. Overall damaged parking ceilings with exposed reinforcement bars and constant dripping of water seepage during the monsoons were significant enough to warrant a full-scale investigation for much needed waterproofing and observable repairs.

Fig 1: Deteriorated concrete with exposed reinforcement bar due to severe water leakages from the top.

Inspection, Evaluation & Test Results

Throughout the years, many temporary waterproofing solutions were adopted which not only failed but also demoralized the owner to approach a waterproofing expert. It is only after observing severe corrosion and deteriorated concrete at many places, which was not only a serious threat to the resident but also to the cars parked below, an expert I.I.T (Indian Institute of Technology) Consultant specializing in the field of waterproofing and expansion joint was brought on board who undertook the physical & documented survey of the structure. Locations of leakage points, cracks, spalls & the condition of the concrete were noted in the survey report. After a detailed study, it was determined that the expansion joint treatment which was done by the earlier contractor was made rigid (unable to accommodate expansion and contraction due to temperature variation) due to the fact that the podium slab was overlain by garden soil which did not allow present configuration to function structurally according to the design. This lead to stresses at joints and leading to leakages from it. Furthermore, the garden & chambers near the swimming pool & various other locations on the podium were all leading to leakages and thereby damaging the structure. Also, there is a temple whose surrounding area is tiled using marble/stones etc. The joinery of the stones was also suspected to cause leaks below. The Guest House Rooms located on the podium also had leaking toilet/bathrooms. The shops below the periphery of the podium also exhibited monsoon leakages from the garden soil above.

Fig 2: Leakages coming from the expansion joint collected in drain outlet pipes as a temporary solution.

Repair System Selection

Keeping in mind the extent of the leakages and the nature of the work, it was determined that a single component polyurethane anti root waterproofing treatment & Dual Component Epoxy injection resin Mortar Grout will be best suitable for the surface below the garden soil exhibiting leakages to the shops/parking garage after careful excavation. Also, the expansion joint which was travelling from one end to the other end & center portion of the podium/parking garage required restoration for the flexibility of the joints and replaced with new compressible sealants and sealing membrane. After restoring the flexibility of the joints, the cracks induced in the adjacent beams/columns/brackets needed to be grouted under pressure by appropriate grout material which will restore the integrity of the concrete material in the cracked structural members. The joinery of the tile on the temple also required refilling & a protective layer transparent coating. The leaking zone from the toilet/bathroom portion near the gymnasium area required treatment from the negative side by low viscosity injection resin grouts & polyurethane injection foam grouts followed by ultra rapid setting mortar to plug active water leaks in concrete & masonry.

Lastly, to repair the concrete members/columns, corrosion control, plaster overlay and finishing the surface at damaged areas. Also, several exterior cracks visible on the parking structure required repairs and finished with specialized elastomeric waterproofing coating.

Fig 3: Removing the soil excavation above the shops/parking garage to do cleaning followed by repair & waterproofing.

Special Challenges

Since the rehabilitation had to be executed considering privacy of residents, kids playing on the garden area and the cars parked below near the repair oriented zone the work had to be designed and implemented in a special manner. Through effective co-ordination with owner, the engineer and contractor were able to design and install appropriate and successful solutions while overcoming a series of project challenges.

Waterproofing & Rehabilitation Sequence

1.Garden Area/Landscaping/Swimming pool chambers waterproofing:

Treatment: The garden area and the chambers near the swimming pool which were seeping leakages down to the parking/shop area were carefully excavated till the surface level by clearing away vegetation trees of all girth, bushes, underground roots including shoring, strutting and all safety provisions, by providing adequate slopes for drains. After proper washing/cleaning the surface, the cracks were sealed with dual component epoxy injection resin mortar grout. The unsound concrete was also repaired/replaced by new mortar with proper slope provision and drain system to maintain proper water flow.

Fig 4.1: Surface after proper cleaning, grouting, laying of mortar to maintain proper slope followed by application of PU Coating

Fig 4.2: Laying geotextile fabric to protect the coating from getting damaged by the further covering of soil.

A single component polyurethane coating with anti root properties was then applied on the ready surface and carefully protected with geo-textile fabric mesh of 80 Gsm to prevent waterproofing treatment from getting damaged. The surface was then backfilled with earth, soft/weathered rock, which includes boulders/ slag/slate /laterite and gravel/ clay thoroughly filled with good quality murum of all kinds, rubble, concrete debris using hard barricading as per OWNER's standards to re achieve the desired garden surface.

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Fig 4.3: Laying & backfilling the soil with layer of earth, rocks and good quality rubble to reachieve the garden surface.

2. Expansion Joint waterproofing:

Since, the expansion joints had rendered rigid due to cement mortar/concrete/soil-topping fills leading to stress build up in adjacent beams/columns/brackets which not only led to severe cracking in these structural members but also had a bearing on the stability of building structure. Also, cursory inspection of expansion joints at some locations indicated that the filler material in the joints has lost its efficacy as the material inserted was fully eroded. Apart from resulting in a loss of movement accommodation capacity of the joints, the joints had become vulnerable to leakages below.

Fig 5.1: Filling of PU Sealant

Fig 5.2: Laying expansion joint sealing membrane to protect the sealant.

Fig 5.3: Laying Geotextile mesh to protect the joints and waterproofing done.

Treatment: The grooves in the expansion joints were carefully opened followed by removing the rigid materials from the joints. The opened joints was thoroughly cleaned and fixed with back up rod to required depth thereafter filling up with compressible and flexible single component moisture

curing polyurethane construction sealant material upto required depth to provide a non-slump elastomeric seal and good weathering characteristics. After carefully sealing the joints, the surface was further covered with a highly elastic, rot-proof and chemically resistant sealing membrane which comes with a two part epoxy compound & establishes a strong bond to various types of substrate. Final covering of sealing membrane was topped by polyurethane coating & fabric protection to receive earth backfilling.

3. Guests House Toilet/Bathroom waterproofing

Since the Guest House Rooms located on the podium had leaking toilet/bathrooms due to which the parking area below was severely affected with algal and fungal residues that were not only damaging the structure but also coupled with a potential health risk. These portion required waterproofing from the negative side i.e from the parking/garage area due to limited restriction/access to work from the top and also avoid unwanted expenses to break the entire toilet/baths.

Fig 6: During drilling nozzles and injecting resin grouts followed by Polyurethane foam grouts.

Treatment: The work was commenced by first identifying the wet areas and then drilling in those leaking areas to carefully fix nozzles (alloy packers - non return type) @ cracks using suitable drill machine at least 75-100mm in depth (With dia of 16mm -20mm) and sealing the nozzles. After sealing the nozzles, single component polyurethane injection foam was injected through high pressure pump to accelerate reaction in moist surrounding & stop water ingress. After a short break, a low viscosity 3 component injection resin grouts based on vinyl ester methacrylate technology was injected with one component pump to plug leakages and avoid blockages. The above material were carefully emptied, mixed and pressured by means of a mechanically piston driven high pressure injection pump to plug active water leaks in concrete & masonry which gave best result whenever it got in contact with leaking water as it increases its volume. The entire procedure was repeated until the crack was completely filled and the resin was seen emerging from the adjacent packers/holes.

4. Temple joints waterproofing

Since the Temple precincts had explicit white Jaisalmer marble which is rare & only found in Rajasthan. Hence, waterproofing of the stone strips required careful attention.

Treatment: Entire joints on the stone were carefully opened with mechanical grinder without undue damage to the stone and filled with a flexible polysulphide sealant to allow for expansion and contraction of the stone slabs that can experience 70 ^{o}F (20 ^{o}C) temperature differentials in 24 h cycles. The top of the marble was coated with clear protective coating to maintain the beauty of the stone and make it waterproof.

Fig 7: After filling the joint and applying protective coating.

5. Repairing the damaged structure after facing 1st successful rains

After careful execution of multiple waterproofing works, the entire parking structure was allowed to pass the leakages test & see the desired results achieved.

The surfaces which were treated were checked for complete one monsoon period in Mumbai i.e from June 2018 to October 2018 & were found to have no leakages whatsoever at any place. Also, it was now safe to progress with the repairs of the parking structure which was not possible earlier due to the non-resolved leakages.

a) The existing damaged ceilings of the garage were carefully removed without undue damage. The deteriorated concrete was removed with 15 lb (6.8 kg) chipping hammers and sandblasting corroded reinforcing steel. Exposed steel was coated with a corrosion inhibitor with added admixture to the repair mortar. The exposed corrosion-inflicted reinforcing steel was cleaned with a pretreatment to loosen the rust scales and passivated against corrosion with epoxy-based formulations.

b) The RCC Beams on both side of expansion joints were

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Fig 8: During the repairs of deteriorated concrete

re-casted each of size (200mm x 600 mm deep) by providing and placing of reinforcement both longitudinal and transverse (@ 40 kg/cum of concrete) by drilling holes and anchoring bars with epoxy and casting M-20 grade concrete including formwork shuttering.

c) Further, a single component trowelable polymer mortar which had a dual shrinkage compensated, fibre reinforced thixotropic high strength formulation was used for the repairs of RCC members/columns where the thickness was within 25mm and upto 45 mm.

d) The surface was then rendered with ready mix cement plaster overlays in two coats with a smooth finish. The concrete layer was cured for 10 days by continuous wetting through a sprinkler system.

e) Lastly, an elastomeric protective coating of 250 micron thickness was applied over the exterior facade & columns of the parking structure & Interior acrylic paint for the inner ceilings after allowing for necessary plastic and drying shrinkage.

Fig 9: After final completion of work

Project Schedule

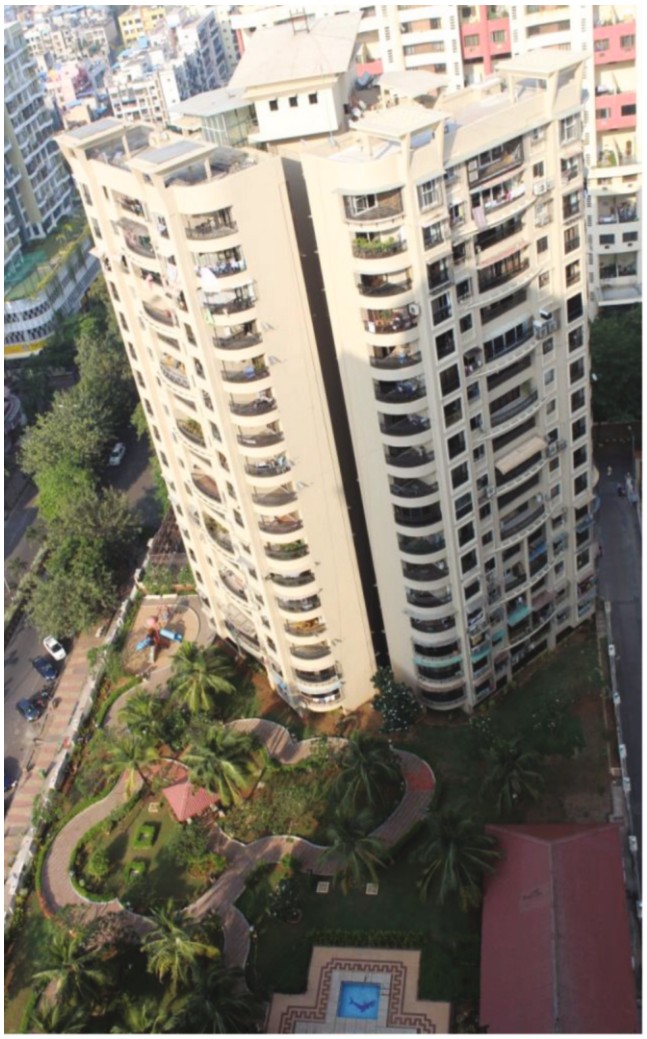

Fig 10: Birds' eye view of the Podium & Parking Garage.

The time schedule was closely monitored with outstanding planning & sequencing with a dedication to safety and quality by the contractor. With the committed teamwork from the owner and the engineer, the contractor was able to complete this large and complicated project on time and within budget. The rehabilitation also encouraged the client to proceed with 2nd phase work for the repair & maintenance of the 5 towers.