University of Mumbai

Restoration of the Convocation Hall

Abha Narain Lambah Associates: Conservation Architects & Historic Building Consultants

Acknowledged among the finest Grade I heritage Victorian structures in India and arguably one of the finest examples of Victorian Neo Gothic architecture in the world, this handsome structure along with the university library and clock tower, shares the distinction of being the only buildings in India designed by the famous British architect, Sir Gilbert Scott. The Sir Cawasjee Jehanghier Convocation hall, began in 1869 with the generous contribution of Rs. 1 lac from the Parsi philanthropist, cost a total of is Rs, 400,000 when it opened in 1874.

While requesting Gilbert Scott in London for a University Hall, the Registrar Sinclair, at the instance of the Syndicate, instructed him that the hall should have a floor area of 6,000 square feet, an apse, galleries for the use of the public and students, a loft for an organ, fenestrated corridors, seating capacity for about 400 candidates for examinations, a committee room, an office for the Registrar and space for a fire-proof records room. As Gilbert Scott never visited India, Sinclair supplied the celebrated architect with all details of the climatic conditions and direction of winds in Bombay.

In February 1866, after repeated reminders from the University, Gilbert Scott submitted the drawings of the Convocation Hall. His 14-page letter dated 2nd February, 1866, mentions "*In designing the University Hall, I have followed as nearly as I was able the directions contained in your letter. The great exception has been in the positions of the several offices of business; which I failed to find space for in the manner suggested and consequently have placed in a separate building connected with the Hall by a cloistered passage.*"

Archival 19th Century photograph by Raja Deen Dayal showing the University Convocation Hall with the Rajabai Tower in the backdrop

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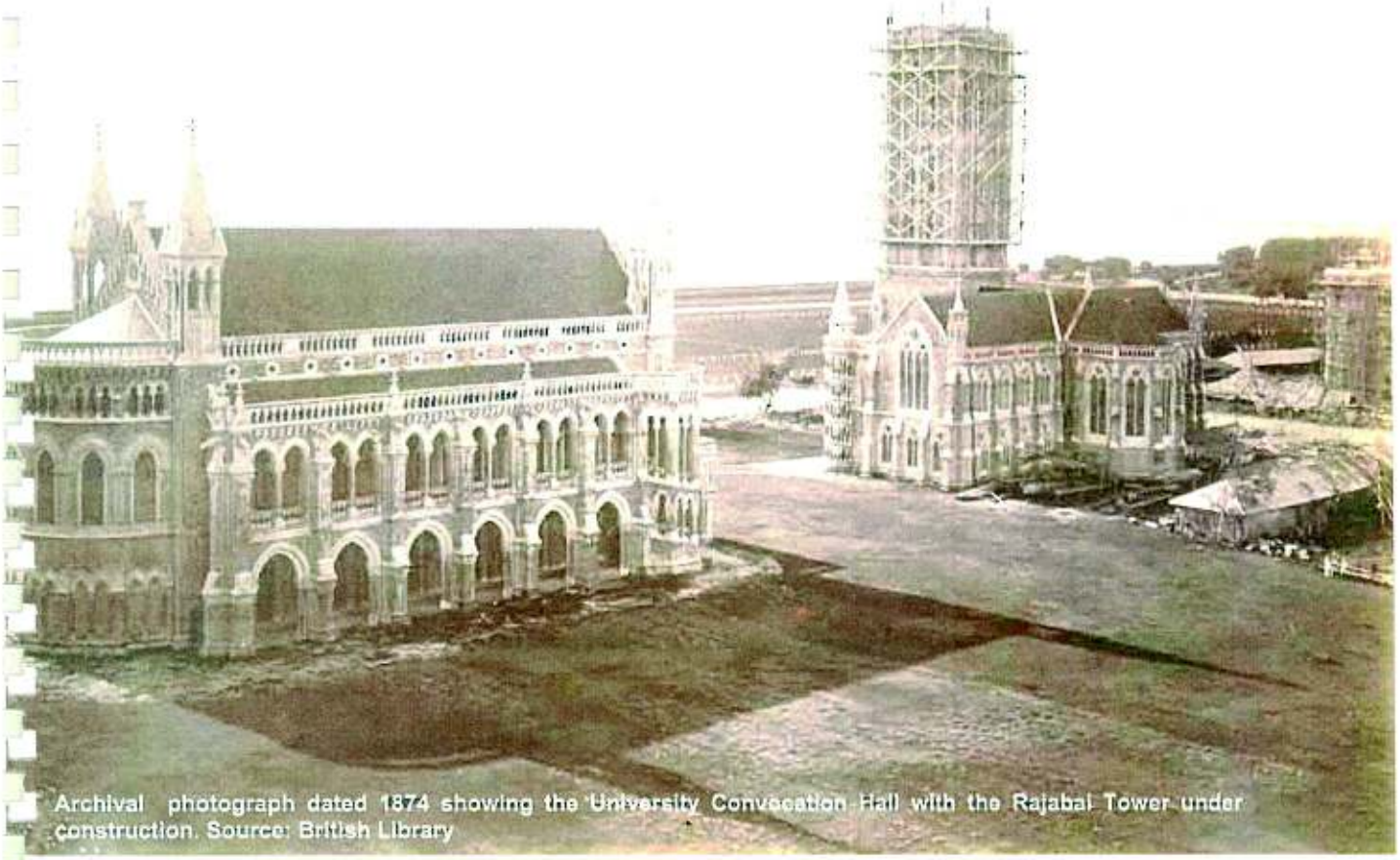
Sir Gilbert Scott went on to add "*Besides the usual precautions against heat such as the guarding of the windows and doorways by means of cloisters or verandahs, I have added the further defense afforded by a double roof, the inner one being vaulted vaulted in brick or other material and the outer one of timber covered with the usual material. The space between these roofs would be thoroughly ventilated so that the heat of the sun could not possibly be communicated to the interior through (the) roof.*"

"*You mention the intention of introducing at the northern end a large stained glass window — I have ventured to substitute for this several windows as one cannot exist in a circular end and is perhaps undesirable, especially in a hot country ...In designing the Library I have had much less to guide me than in the Hall. I have, therefore, acted very much upon my own supposition of what might be necessary* ...The Tower I have so placed that its lower storey becomes the portico under which carriages may draw up at the entrance of the Library.



Archival photograph dated 1874 showing the University Convocation Hall with the Rajabai Tower under construction. Source: British Library

The Bombay firm of architects Scott McLelland and Co. estimated the cost of construction at Rs. 27,50,000 and the University then commissioned Messrs Paris and Molecey to suggest cost cutting methods. Paris, who is credited for the design of the Telegraph Office along the Oval Maidan and Molecey who went on to design the JJ School of Art building, were successful in achieving a reduced budget of Rs. 4,15,804 for the Convocation Hall, allowing the construction to finally begin under the supervision of Lt. Col. J.A.Fuller, Architectural Engineer to the Government who was also responsible for the brooding Neo Gothic High Court building.

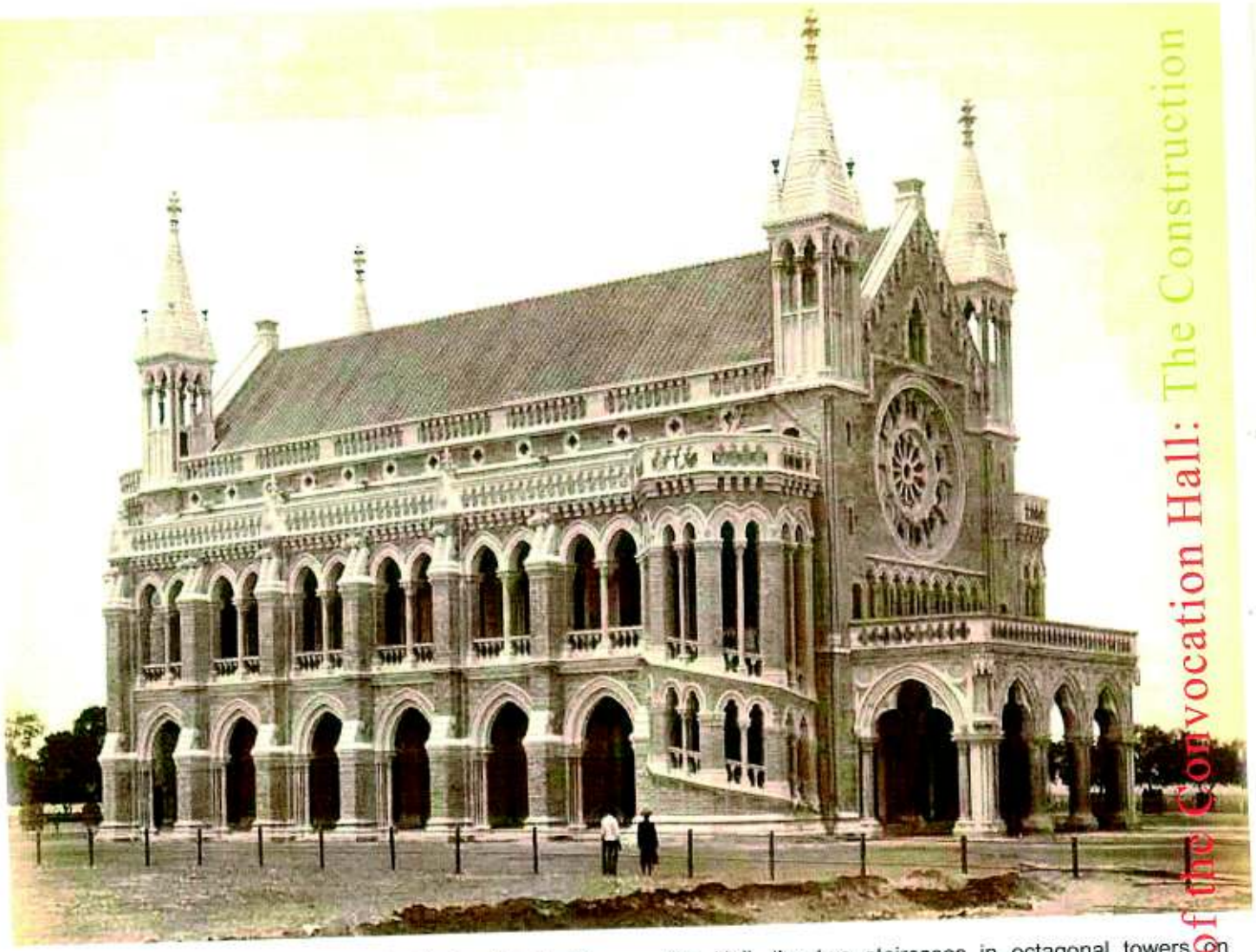
Fuller was assisted in the supervision of the work by a local engineer Muckoond Ramchunder, the local contractor Nagoo Sayaji. The fantastic stone carvings and gargoyles were crafted by students of the JJ School of Art under the supervision of Lockwood Kipling. Mukoond Ramchunder later went on to work on the carvings at Elphinstone College at Byculla and St.Thomas's Cathedral. The Senate Hall, thus was a collaboration of many local engineers and craftsmen. The final cost of construction was Rs. 379,093 against the estimated amount of Rs. 415,804.

The building was constructed on the eastern edge of the Oval Maidan, sited to the south of the University Library and Clock Tower, also designed by Sir Gilbert Scott. George. The structure was built of locally available stones such as the buff trachyte Malad and grey Kurla basalt with ornamental details crafted in softer Porbunder limestone. Ornamental details employed red sandstone collonettes and balusters for the staircases and upper level verandahs as well as green serpentine stone resembling Purbeck marble popular in England. The Minton tiles used extensively in different patterns in the central hall and the outer verandahs were imported from England, inset with Chinese grey marble.

At the upper level were wooden galleries, supported by beautifully crafted iron work brackets in blue and green, ornamented with gold gilding. Supporting these brackets were carved stone heads depicting exquisitely sculpted Indian and European faces in Porbunder stone.

The grand vaulted roof of the central hall was supported on stone ribs. Over the vaulted roof of the main hall, were Burma teak trusses holding up a sloping tiled roof to create a thermally insulated space for the central hall. Carved stone gargoyles spouted rain water from the roof. The ceiling of the porte cochere had a set of three groined vaults.

Historical Source: *The Cloister's Pale*, Dr. Arun Tikekar



The Convocation Hall stands 104 feet in length and 44 feet in breadth, with a height of 63 feet from the floor to the apex. A semi circular apse, with a diameter of 38 feet, is separated from the Hall by an imposing arch. The front corridor is 11 feet wide while the side corridors 8 feet each. A gallery 8 feet wide, supported on ornamental iron brackets, runs round three sides of the Hall, the two staircases in octagonal towers on either side of the entrance porch, providing access to the gallery. At the north end is a fantastic circular window, 20 feet in diameter, the outer ring of which has the twelve signs of the Zodiac in stained glass. The Gothic vaulting in the porch is remarkable for the absence of cross groins.

The Stained Glass

Perhaps the finest collection of stained glass in India, the Convocation Hall has nearly two and a half thousand square feet of beautifully crafted stained glass panels from the London studios of Heaton, Butler & Bayne, one of the leading firms in the production of Victorian stained glass. The stained glass is dated to 1873 and was shipped in all the way from England to Bombay for the University Convocation and Library buildings. The stained glass panels consist of a wheel window on the north gable end, a set of seven lancets in the southern semi circular apse, six bays of windows at the lower east and west sides.

The most remarkable among this is the heraldic stained along the length of the East and West traceries. The lights on the upper traceries consists of the Arms of Sir Cowasjee Jehangir Readymoney; Lord Elphinstone, Sir Bartle Frere, Sir Seymour Fitzgerald, Sir George Russell Sir Philip Wodehouse and the Arms of England, Ireland, Scotland, Wales and those of the University Bombay.

The northern gable end has the circular rose window with twelve divisions and a diameter of 24 feet, with a total area of 453 square feet. Its stained glass depicts the months of the year, with the signs of the zodiac represented on the outer ring. The composition is characteristic of Rose windows, depicting the sun at the centre of the universe and the Zodiacal Signs along with the Seasons portrayed spinning movement of the rainbow. The design, painting and execution are of a high order (the best example of this being the "Virgo" plate) and the colours are well-suited for its location on the west side. The seven lancet windows along the southern apse end are composed in repetitive geometric-foliate design, framing the backdrop of the stage at the apse end. The heavy grisaille work together with the ruby-red and blue cleverly filters the light. The stained glass as been assessed by the team's specialist Consultant, Swati Chandgakar and restoration has been undertaken by a team of conservators led by Rohinton Arethna and Parveen Mistry under the guidance of Swati Chandgadkar.

The Project Team

After 132 years of its construction, the Sir Cawasjee Jehangier Convocation hall, began in 1869 and completed in 1874 at cost a total of is nearly Rs. 400,000 was set to undergo a major restoration exercise projected to restore this magnificent neo Gothic structure in time for the 150th year celebrations of the University of Mumbai.

Abha Narain Lambah Associates, Conservation Architects & Historic Building Consultants were the principal architectural firm appointed for this project. The architectural team comprised of a large group of consultants and specialists working together on this fantastic piece of Mumbai's architectural legacy. It included structural engineers, electrical consultants, lighting specialists, acoustical and sound consultants, stained glass conservators, architects and skilled craftsmen for specialized skills such as lime mortar repair, stone carving, gilding and carpentry to roof repairs.

With such a large and diverse group of people, and a deadline of exactly 1 year for inspection, diagnosis, tendering and execution, this was quite like a grand orchestra of varied musicians that takes months of careful tuning and rehearsals before the final opening night, which in this case would be the inauguration of the newly restored hall by the President of the nation to mark the 150th Year of the Foundation of the University of Bombay.

Consultants

Principal Conservation Architects
Abha Narain Lambah Associates

Project Architects
Abha Narain Lambah
Shalini Mahajan
Aishwarya Tipnis
Krishna Iyer
Mekhla Chauhan

Structural Consultant
Arup Sarbadhikary

Electrical & Services Consultants
Vikas Joshi Associates

Lighting Consultants
Available Lights N.Y.

Stained Glass Consultants
Swati Chandgadkar

Acoustic Consultants
Jhaveri & Jhaveri

The Project Team

Advisors

Advisor for Specialised Stone Restoration
Dr. Michael O Connor

Advisor on Historical Information
Dr. Arun Tikekar
Ms. Sharada Dwivedi

Advisor on Stone Geology & Petrography
Dr. Avasia

Advisor & Source for Base Documentation
Rahul Mehrotra

University Panel for Peer Review
Dr. Gupchup
Mr. Deodhar, PWD
Ms. Sandhya Savant

Contractors

Civil Contractors
Savani Heritage

Stained Glass Conservators
Rohinton Aretina
Parveen Mistry

Gilding Master Craftsman
Ghanshyam Nimbarak

Investigating the Vault

The team of consultants began assessing the condition of the building in June 2005, undertaking a series of non invasive tests for establishing the structural condition as well as material testing such as lime tests and petrography to establish the typology of stone and mortars employed in the original construction. A detailed mapping the fabric condition assessment was drawn up as a set of architectural drawings of the structure to clearly establish the restoration strategy of the building.

Detailed investigations were carried out to examine and assess the condition of the roof. These included Ultrasonic Pulse Velocity tests at various points on the vault, Endoscopic examinations at selected points to assess the condition of sections of embedded wood rafters and trusses and laboratory analysis of samples of lime mortar from different sections of the vault to establish whether the lime content in the vault had been leached away over the decades.

The acoustics of the hall being critical to its use, a series of acoustical tests were conducted to check the resonance levels and reverbration time.

Pull out tests were conducted on the acoustic layer on the under side of the vault and this was found to be an asbestos based fibre, that as later records revealed, had been introduced in the building in the 1940s.

This was not only considered a major health hazard, but had to be removed with extreme caution to restore the building.

Top Right: Incessant leakage through the roof had created distinctly visible patches of discolored plaster along the underside of the vault. Bottom Right: Peeling paint on the underside of the vault exposed the fibrous grey asbestos lining on the entire vault surface; Bottom Left: This asbestos fibre was seen along the vault and wall surfaces. Top Left: Consultants examining the flaking 'plaster' found this to be hazardous asbestos fibre.

Roofs The years had taken their toll on the structure and the condition of the building as inspected in 2005 was found to be extremely deteriorated and in need of urgent repair.

Extensive roof leakage had resulted in substantial damage to the structural system of the roofs, with the timber trusses and rafters exhibiting wet rot and deterioration and in some cases such as the southern apse roof, severe structural distress. The constant leakage from the roof had leached away at the lime binders holding up the stone vault, raising concerns about its structural integrity.

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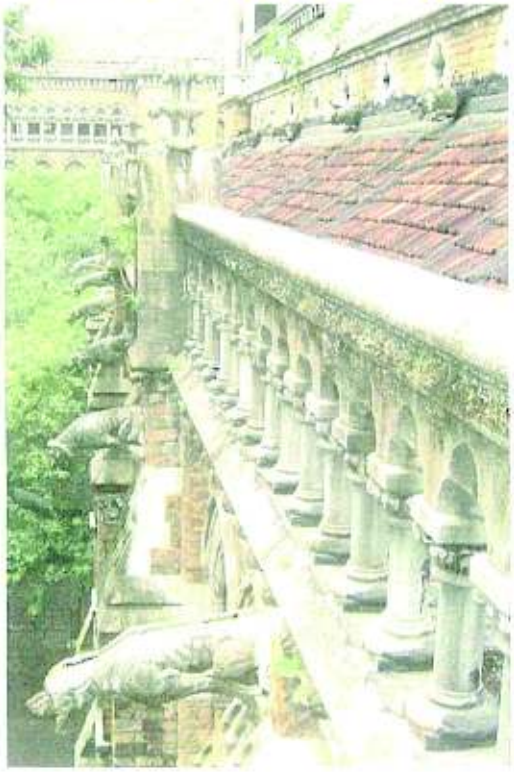
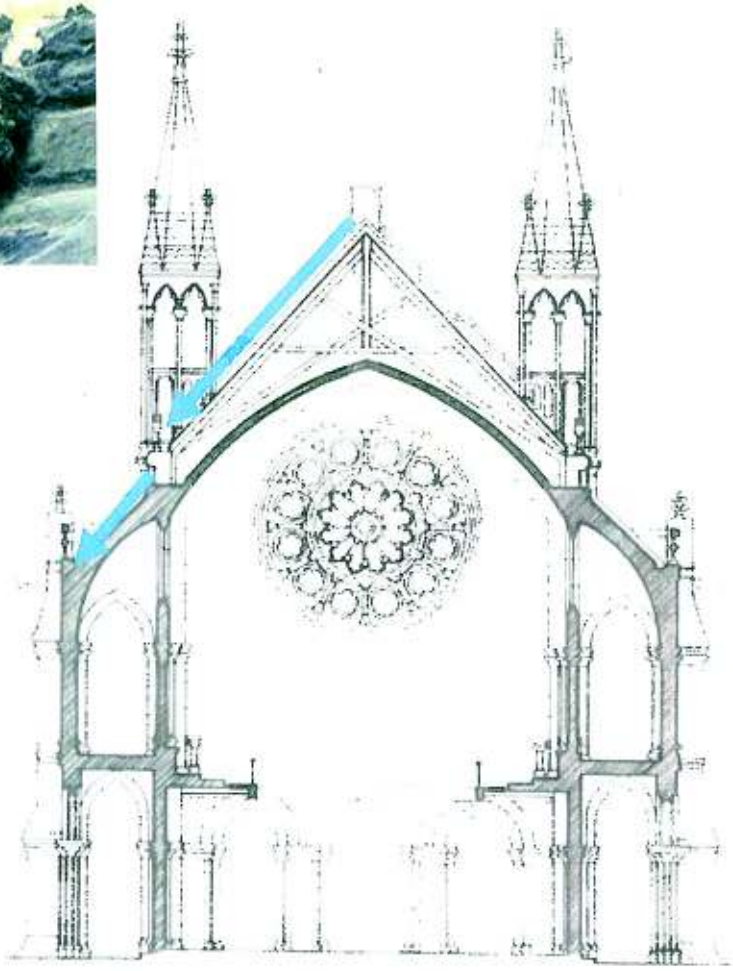
1. Gable end over Rose Window
2. Roof tiles over timber truss
3. Upper verandah cluttered
4. Extensive damp & termite seen along flying buttress
5. Incremental layers of tar felt have choked the water outlets
6. Vault and stone ribs under wooden truss roof

Roof Drainage & Water Ingress



Images showing stone gargoyles at the upper and lower roofs choked with layers of bitumen, rendering them ineffective

Below: The drainage system of the roof indicated on a section through the building.



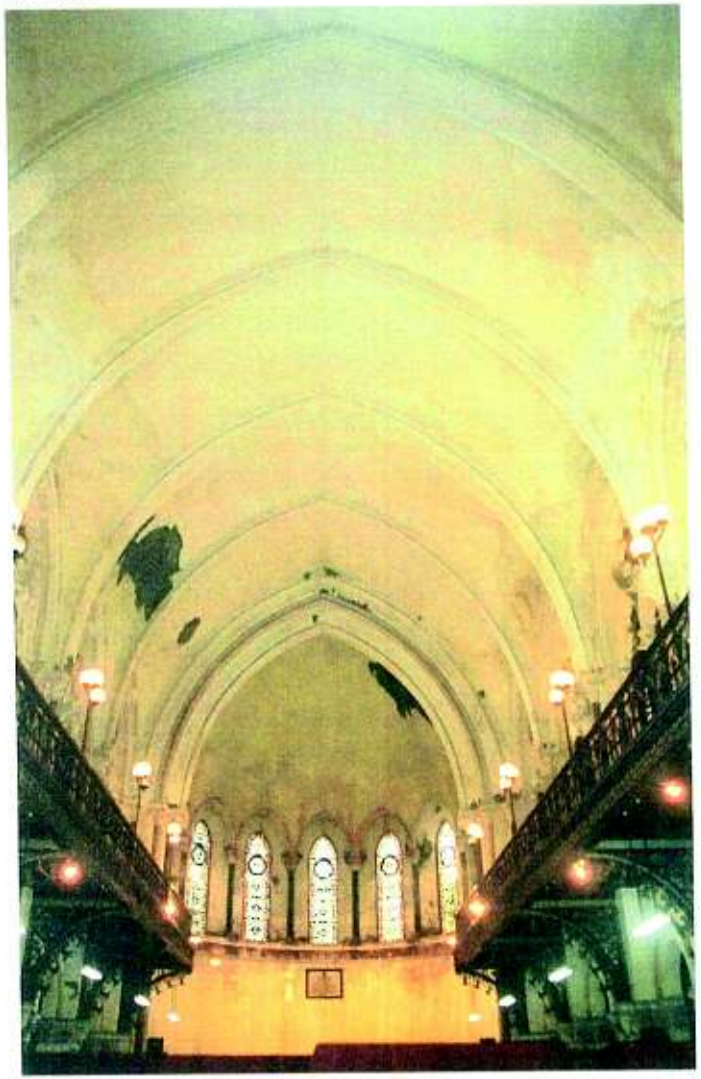
The original drainage system designed for the roof was routed from the upper gable roof to the lower level of roof though a series of stone gargoyles and then from the lower roof through another level of stone gargoyles, to the fall to the ground.

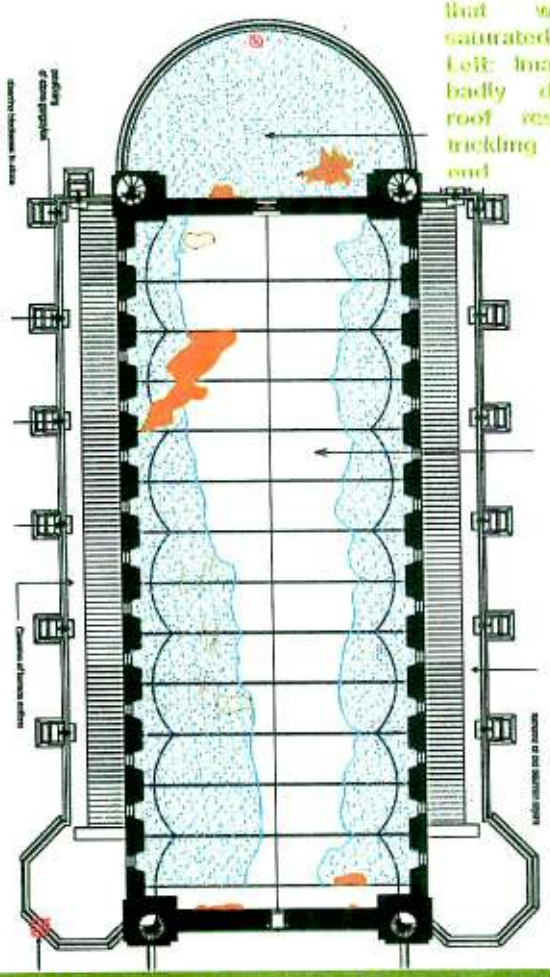
As the roof was layered with bitumen felt each year after the monsoons to prevent water ingress without properly addressing the roof, the layers of bitumen clogged the gargoyles, thus choking the drainage outlets. This caused water to collect at the roof levels, finally percolating through the vaults into the building and showing up as extensive peeling off of the internal plaster and paint in the interiors.

Roofs & Vault

A major point of leakage was the southern apse roof that had been been reduced to a layer of bitumen tar felt over timber planking, wholly inadequate for the monsoons. This tar felt too had greatly deteriorated, resulting in the apse roof leaking badly during the rains.

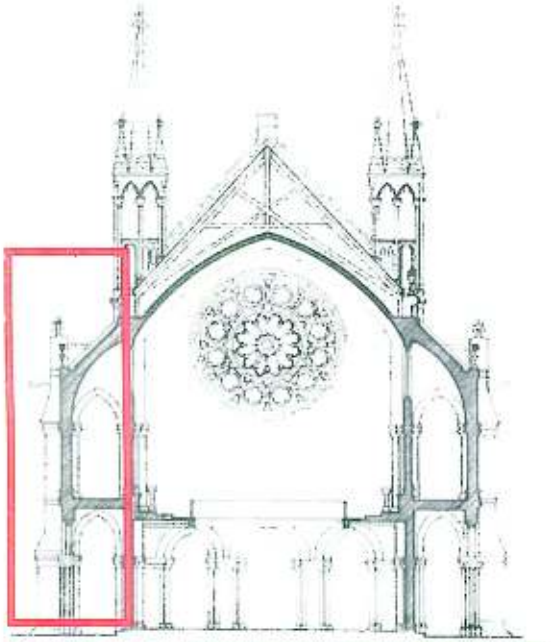
Moisture meter tests conducted during the assessment indicated that nearly 2/3rd of the roof vault was saturated with water during the monsoons. This caused serious concerns about its structural safety as chemical analysis of lime mortar samples in the vault showed that the ratio of lime to sand in the lower reaches of the vault had reduced to ½ of what it had been in the dry sections, indicating its loss of integrity over decades of leaching, reducing the lime content to half of the original composition. It was thus critical to restore the structural stability of the vault and undertake grouting and strengthening of the vault as well as addressing the root cause of leakage from the roof above the vault and south apse.





Below: Fabric inspection drawing indicating the sections of the vaulted roof that were completely saturated with moisture. Left: Images showing the badly deteriorated apse roof resulting in water trickling down the apse end

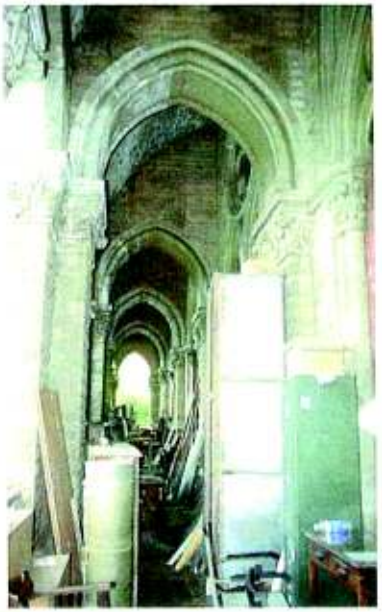
Verandahs & Staircases



With years of neglect and improper maintenance, the circulation spaces as well as the phenomenal verandahs at the upper level between the flying buttresses, had been reduced to dumps for old disused furniture.

Termite runs were rampant along the inner walls of the verandahs, found to be eventually leading to the timber framing members of the inner acoustical treatment in the main hall. Water leakage from the lower roof levels had led to staining of the inner lime stone in the vaulted surface of the verandahs and led to extensive deterioration of the lime mortar in the masonry joints. Stairways were jammed with furniture and the entire wiring along the east stairwell was a mess of electrical conduits and meter boxes.

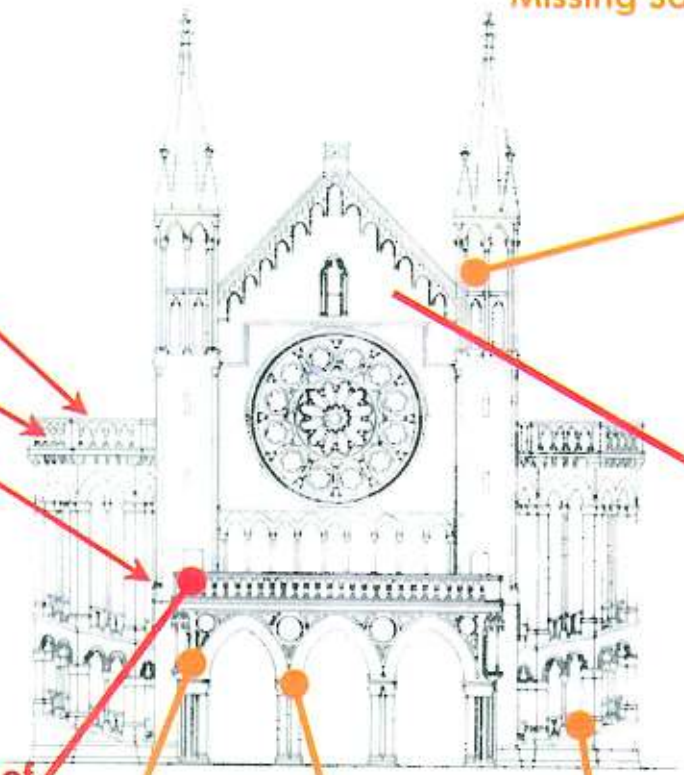
Below: Images taken in July 2005 showing the grand verandah spaces, passages and corridors jammed with old furniture and the staircase strewn with tools and furniture.



Restoration of the Convocation Hall: Fabric Inspection

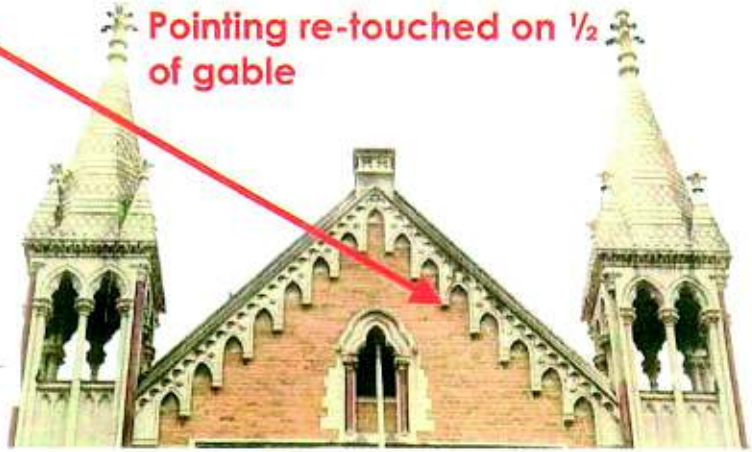
Exterior Facades

Structural cracks and displacement was observed in the parapets of the upper roofs due to ficus growth. Visible signs of rising damp were also noticed, indicating ingress of ground water from the foundation, causing issues of delamination and peeling off of stone layers in areas that had been subsequently pointed over with hard cement pointing. This called for re-pointing using lime mortars to match the original composition of mortars, slaking the lime in a lime pit on site to constantly monitor the work.



Missing Sandstone column shaft

Pointing re-touched on ½ of gable



Splitting & Cracks in column shafts

Issues facing the north façade ranged from displacement of the upper level parapet wall (top left) due to a plant growth, insensitive routing of electrical cables, ad hoc installation of rain water pipes and deterioration and cracking of stone columns in the front porch. The gable end had been re-pointed using hard epoxy pointing and missing sections of sandstone columns had been repaired in a cement mortar

Exterior Facades

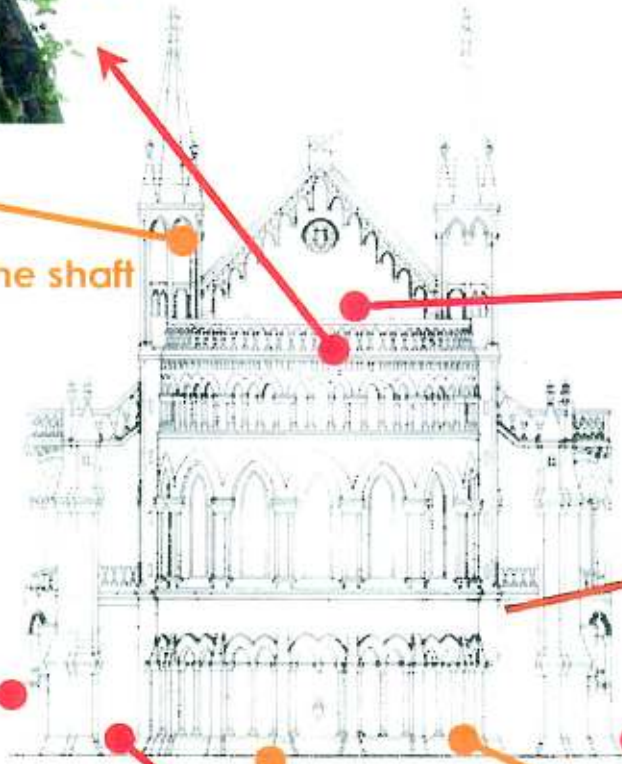
Apart from the issues of stone staining, rising damp and deterioration of pointing, the one major issue with the south and east facades was the addition of incongruous sheds, water tanks, fencing and such unsightly additions that had been constructed in the 1960s – 1990s. The consultants proposed that these be removed to clear the building of all such

Issues facing the south façade ranged from ad hoc additions of sheds, water tanks and ugly fencing, to a large *peepal* tree growing into the foundation of the building. The upper level apse roof on the south face too was in a greatly deteriorated condition, resulting in extensive roof leakage.

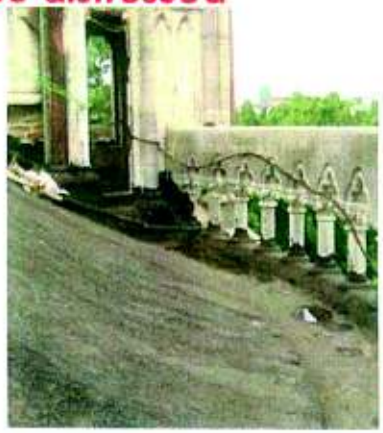
1 Ficus Growth

Missing stone shaft

Insensitive location of Tank



2 Roof over Apse distressed



Stairwell masonry in need of pointing

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Gate & fencing design

Incongruous Sheds

6 Ugly Wire mesh

5 Stone Staining & Damaged Mouldings

Ornamental Stone Details & Columns

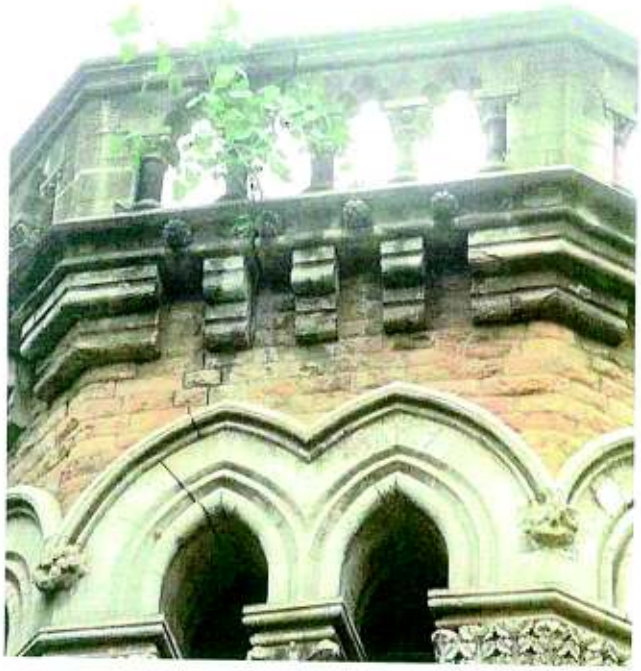
Many of the carved stone freizes, colonettes and mouldings were damaged or broken, requiring careful restoration employing plastic repair in lime mortar for deteriorated sections of limestone, or in cases of missing or cracked stone column shafts, complete replacement in like material with Dutchman repair techniques after establishing a match in terms of stone geology and petrographic sampling.

Restoration of the Convocation Hall: Fabric Inspection

Ficus, Algae & Stone Staining

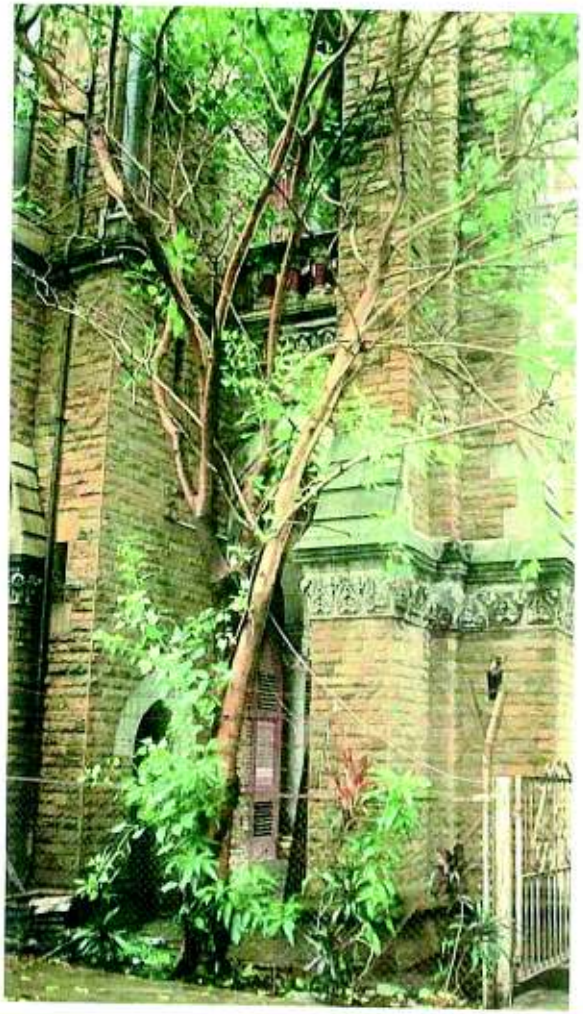
The buff coloured Malad stone was subjected to extensive petrographic analysis and specialist help on the geology and stone petrography was obtained from the University's Geology Department and in particular Dr. Avasia, a leading geology expert. The stone was found to be a Trachyte, softer than a basalt, but a Deccan trap stone available in and around Malad. Being more acidic than basalt , this stone was more prone to mineral changes and was also partially hydrous, thus being more vulnerable to staining and delamination.

Ficus growth along crevices of the stone masonry were an issue that required addressal, as also the sulphate skins that were formed on the stone surface and gave a blackish residue on the stone. Other staining on the stone was found to be the result of a variety of causes



such as rust stains, bitumen staining and due to salt deposits as a result of water runs and rising damp. This was specially severe in the case of the limestone gargoyles where the sulphate skin build up was choking the spouts and interfering with the roof drainage.

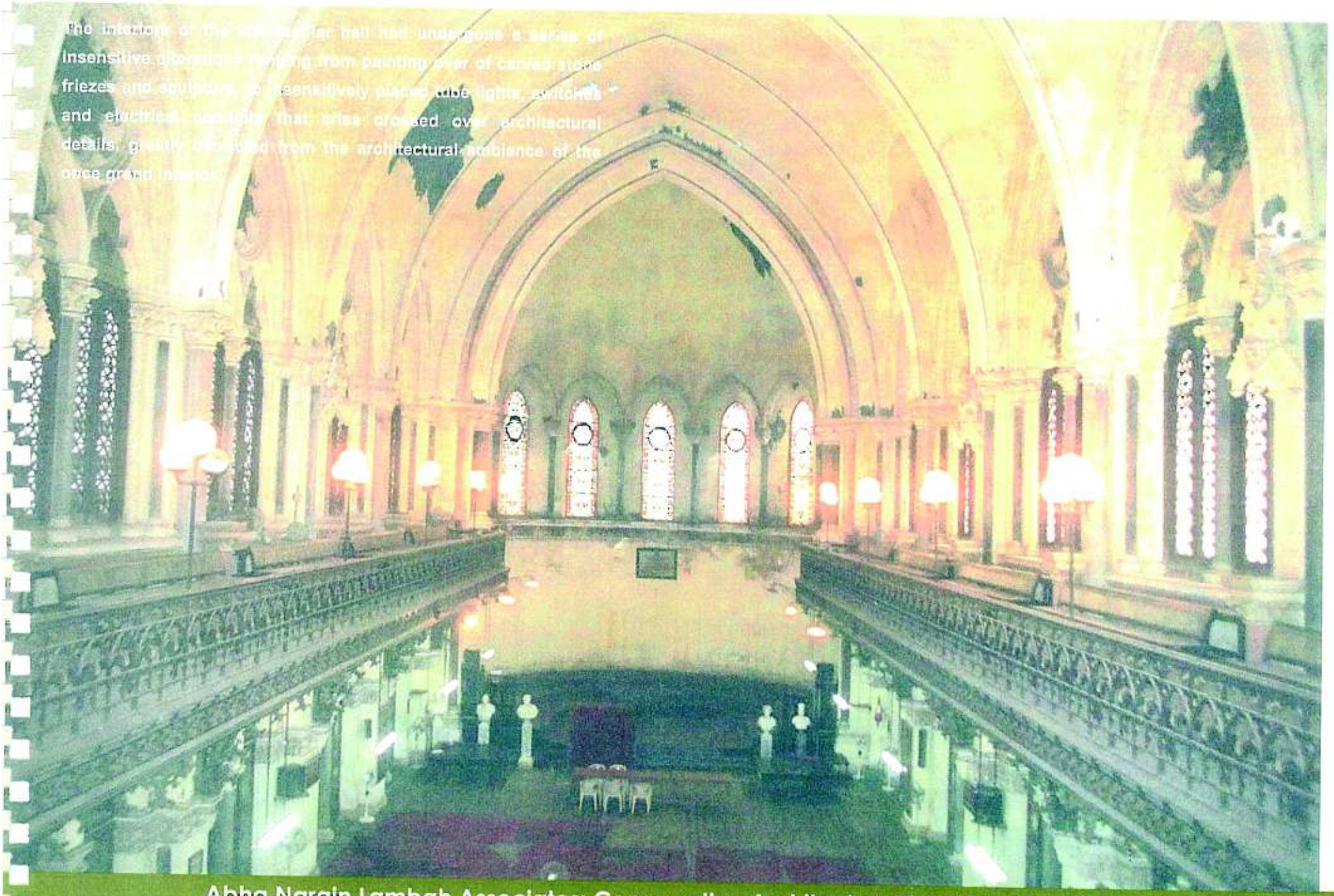
At the north east terrace level, there was a substantial crack along the masonry, with visible dislodging of the stone parapet. This was also true of the northern porch that had a similar problem. This was the result of a large *peepal* plant growing at the terrace level, with its root system embedded into the masonry down to a depth of over three meters. The solution to this was to cut the ficus plant, pull out the root system and carefully dismantle and re-set the parapet level stones to restore the original level and line. Similar but much larger growths of full grown ficus trees was seen in the south east and south west ends where the root system was too close to the foundations, threatening settlement and cracks.



Doors & Windows

The Convocation Hall had used in its construction, some of the finest Burma Teak available. It had two sets of doors on each of its arched openings along the east and west, with louvered shutters on the outer verandah face and glass paneled doors with an intricate geometrical design. Along the front entrance porch, were heavy carved teak wood doors with fretwork panels in teak wood. These had been subsequently painted over and even filled with plywood over the years.

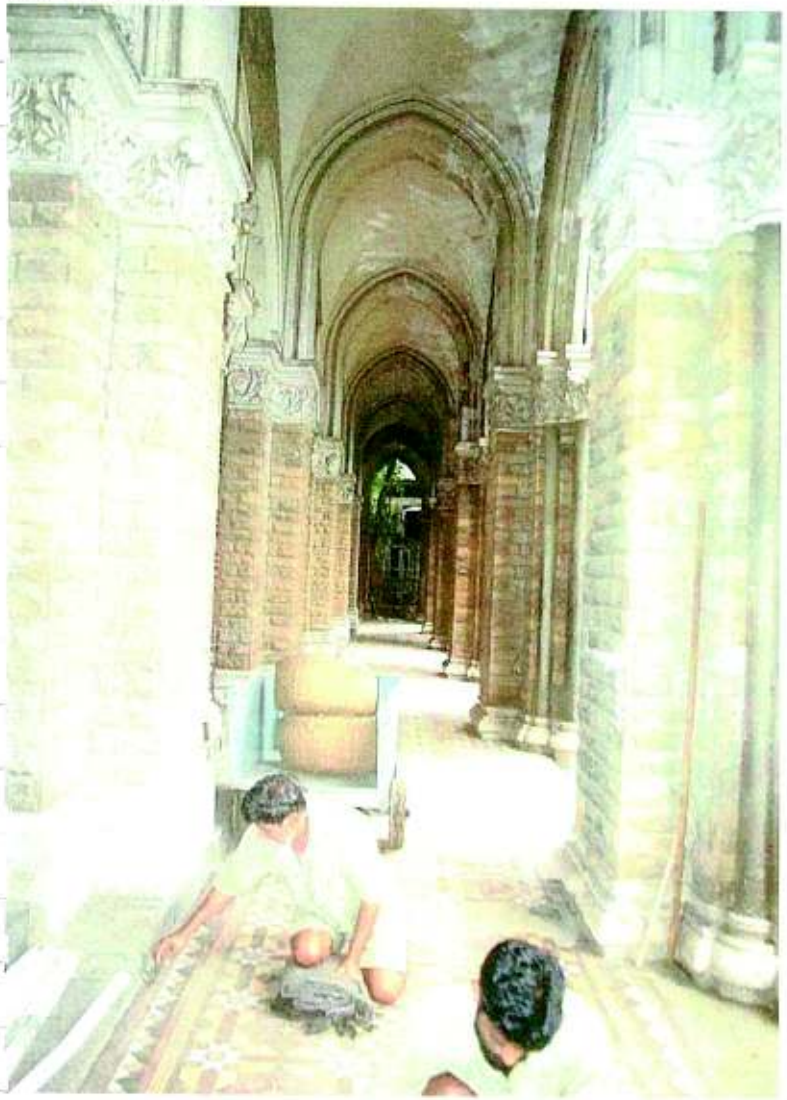
Interiors

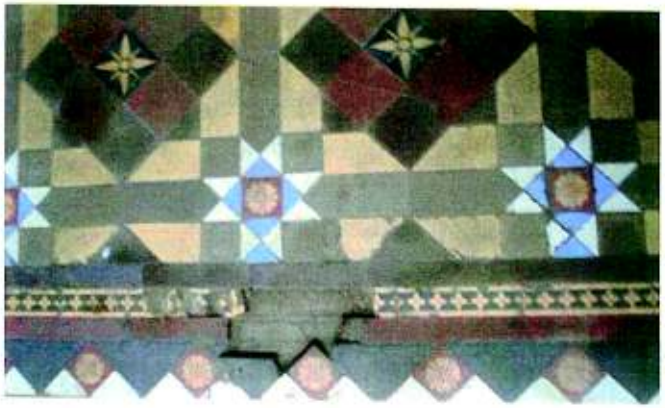


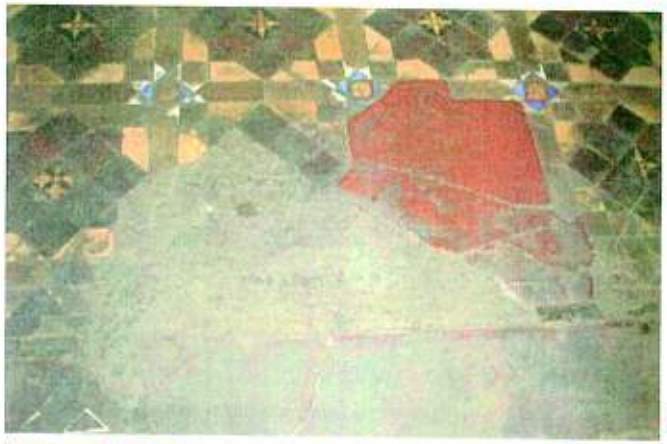
Restoration of the Convocation Hall: Fabric Inspection

Interiors: Flooring

The many rich patterns of Minton tile floor imported from Minton Tile Co. in England, had been damaged at places, with bulged sections or entirely missing sections of tilework infilled with cement patchwork repairs.



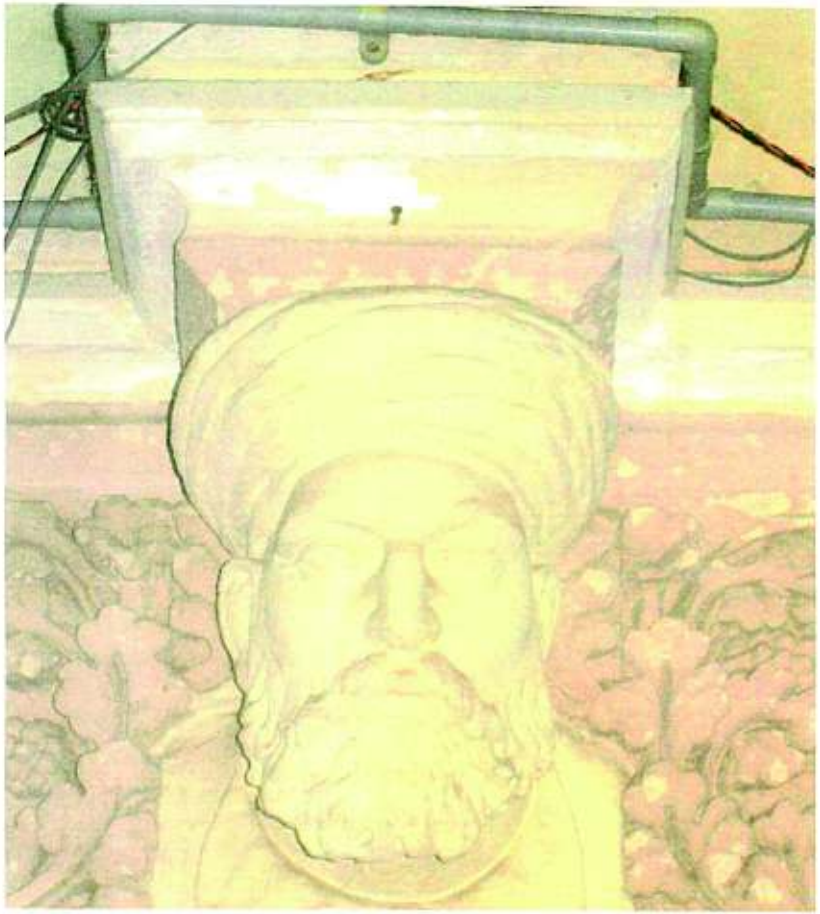


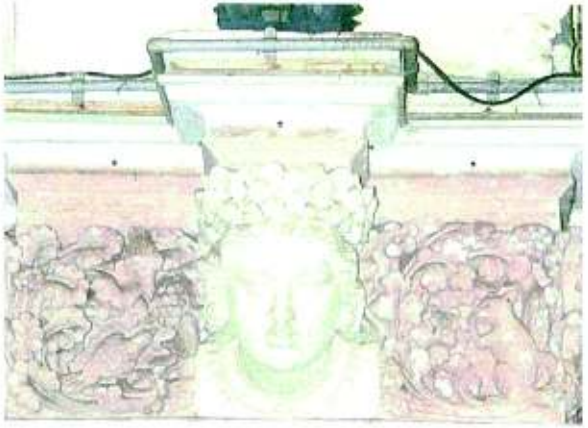


Interiors: Stone Carvings

One of the most endearing features of the interior, are the carved stone heads that form the defining feature of the foliate stone freize at the capital level of the lower columns. These support the decorative iron work brackets that spring from this point, to support the mezzanine balcony above.

Crafted in soft Porbunder limestone by students of the Sir JJ School of Art under the guidance of Mukoond Ramchander, these carvings were insensitively painted over in layers of paint, obliterating the fine details and texture of the stone.

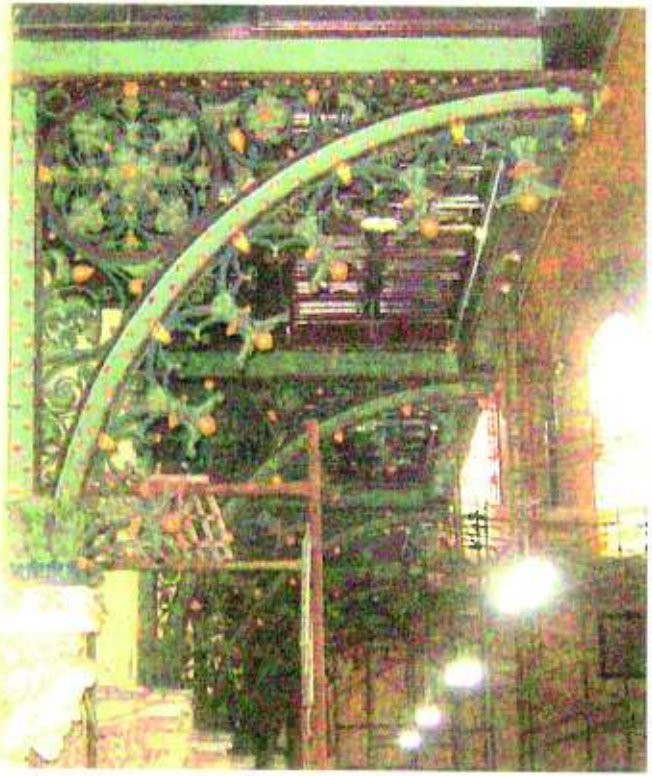


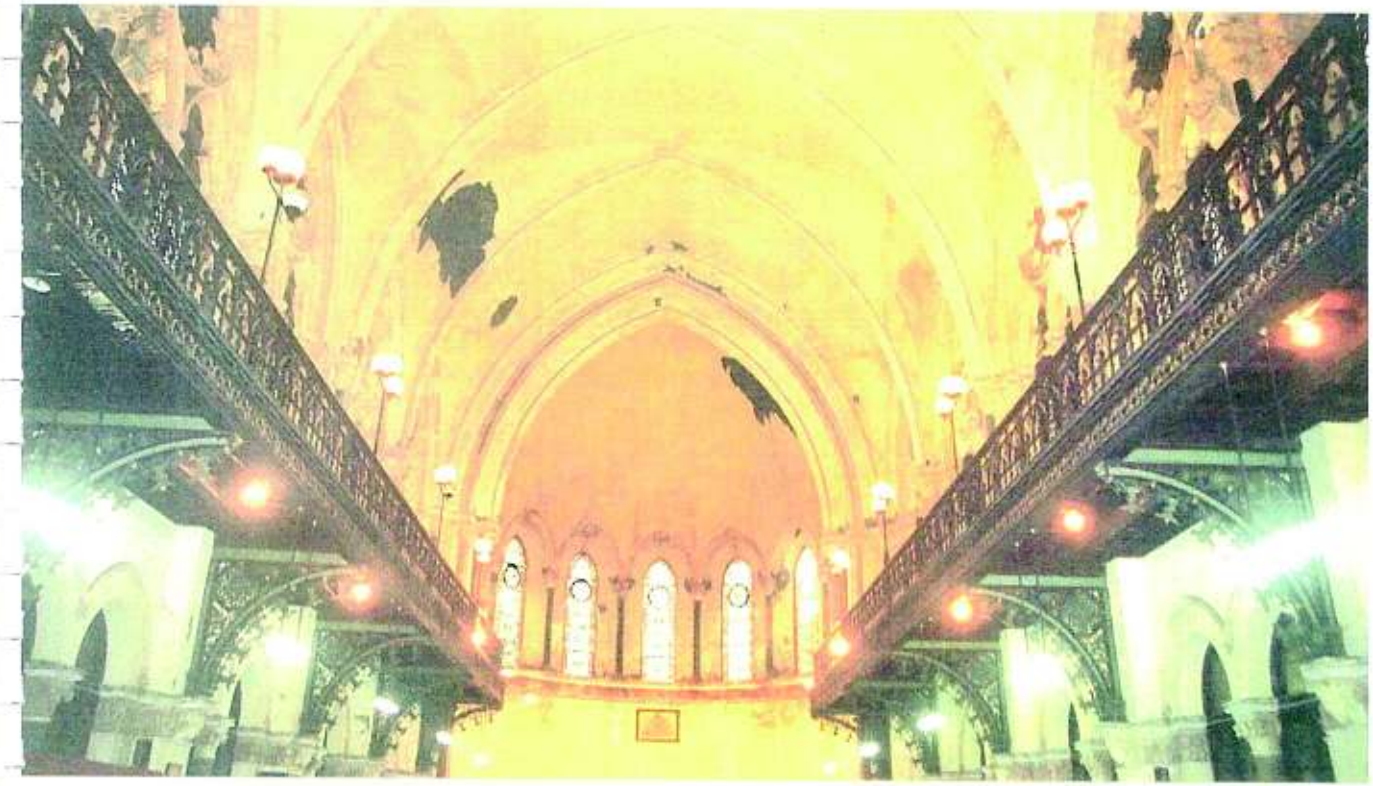


Interiors: Decorative Iron Work

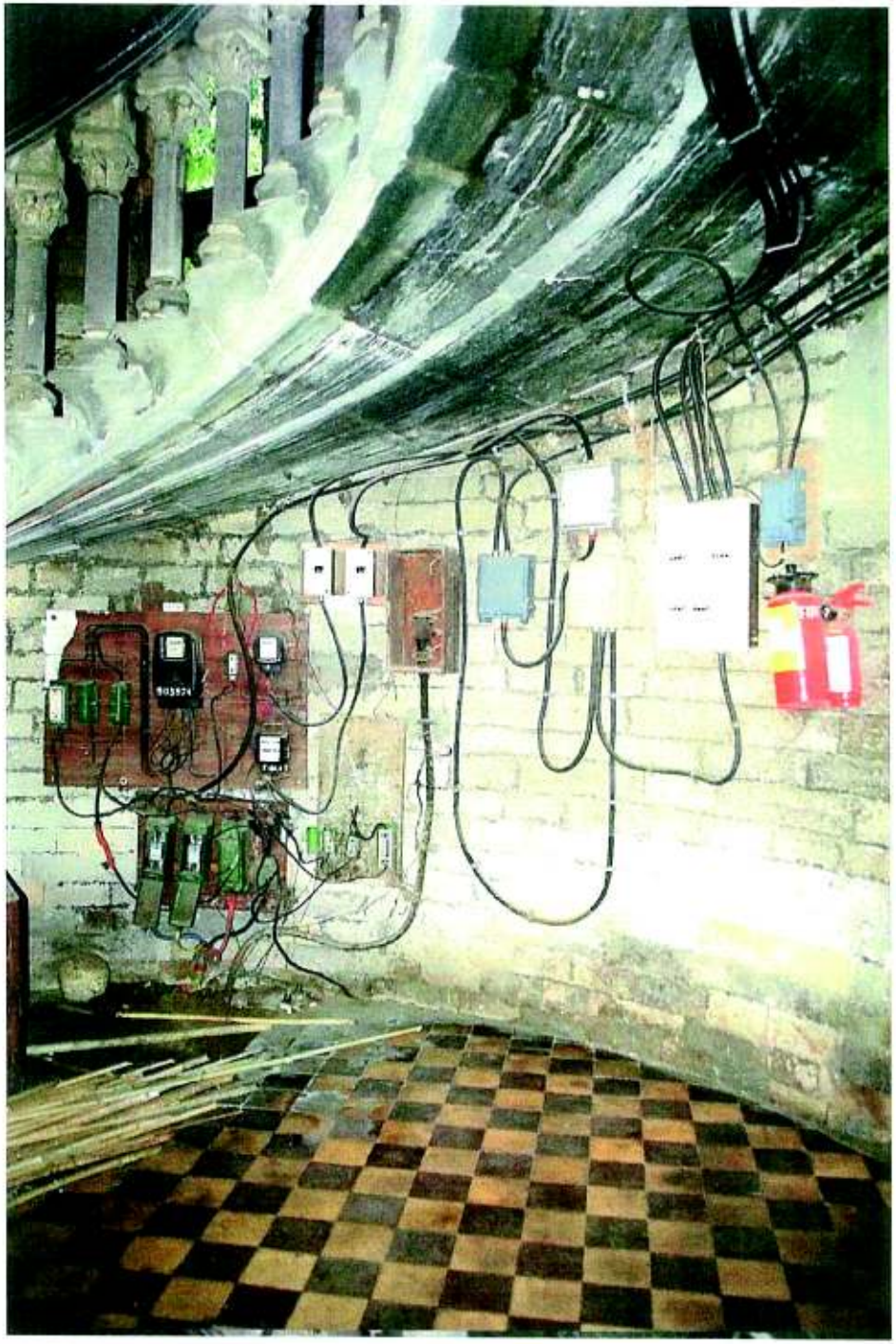
Along this upper viewing balcony at the mezzanine level, are decorated iron work grilles with a floral pattern. The balcony in turn, rests on ornate iron work brackets that are embedded into the walls at one end and spring from stone brackets carved in the shape of human heads.

The iron work brackets are in a colour scheme of green of verdigris and blue, with details picked in gold foil gilding. The upper level balcony railings had the floral petals gilded in gold leaf.





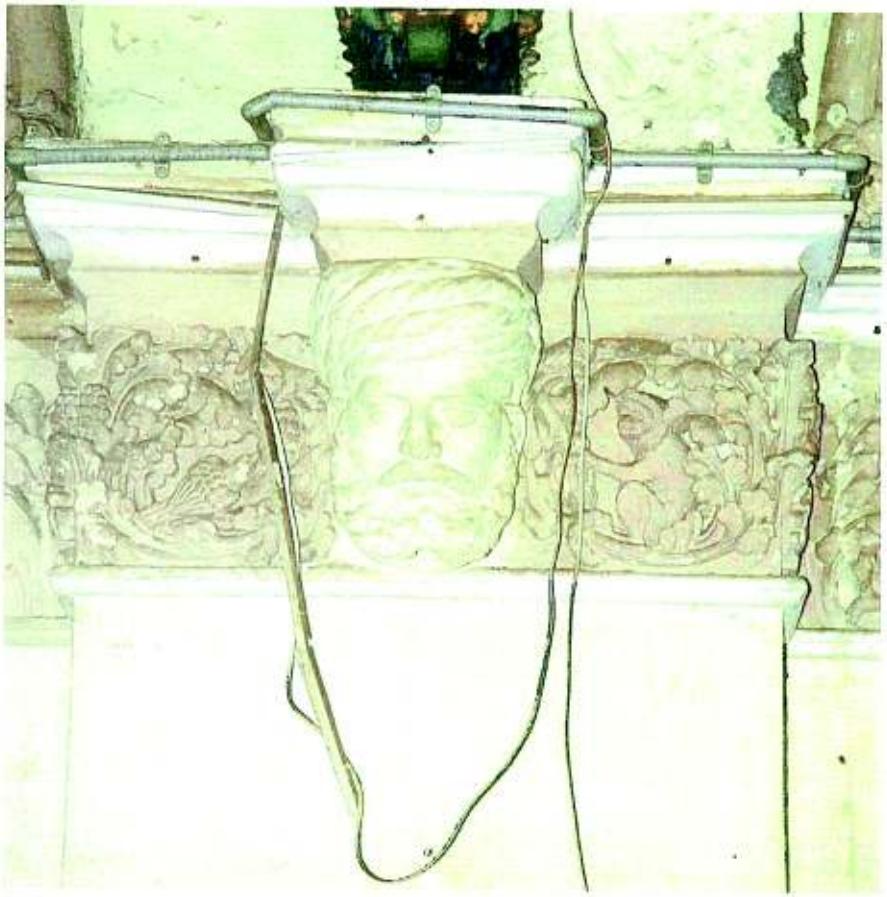
Interiors: Electrical Wiring & Routing



Restoration of the Convocation Hall: Fabric Inspection

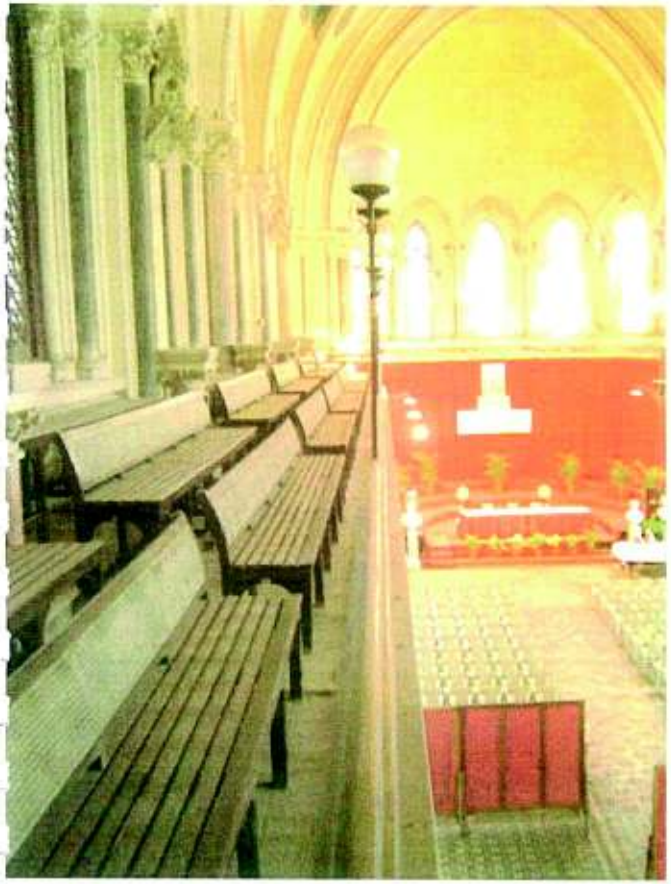
Interiors: Electrical Wiring & Fixtures

The original system for lighting had been based on gas lights, with a gas pipe running between the vault and upper roof, with a provision for chandeliers being hung from the ribs of the vault. The upper level balcony had a series of lights mounted on stands fed from concealed gas pipes. However, with the subsequent electrification of the building, the entire electrical wiring was incorporated in a most unsympathetic manner, criss crossing over decorative details and cutting across arches. Fluorescent tubelights were suspended from the balcony and visually detracting from the stained glass on the lower level. Electric fans and sound speakers too were incongruous.



Interiors: Furniture

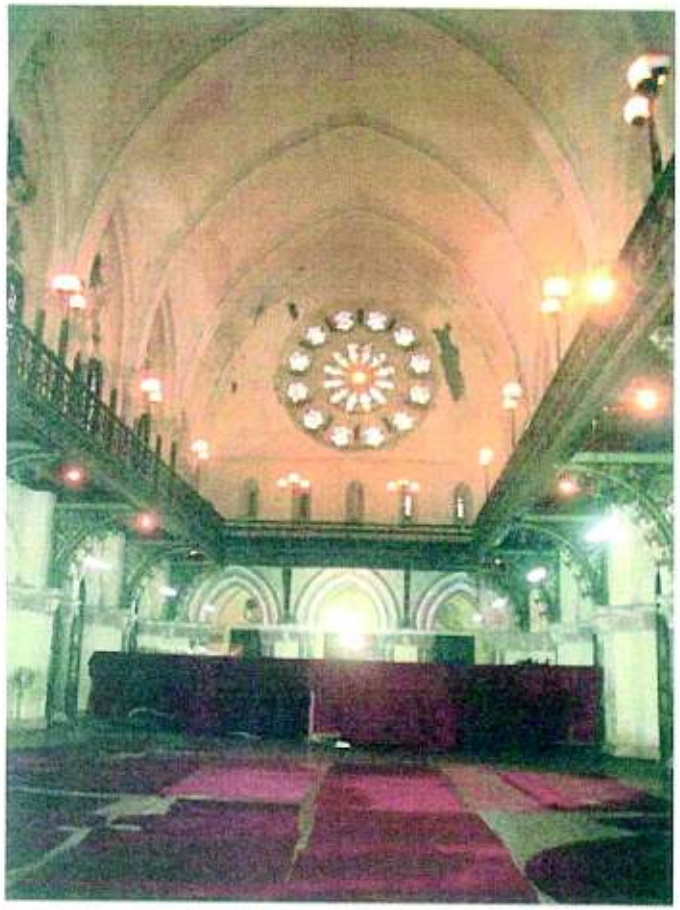
The upper viewing balconies were fitted with teak wood benches and beautifully carved Burma Teak wood furniture of a Neo Gothic design was seen in the stage for the railings, rostrum and speaker's chairs.



Interiors: Stained Glass

1

1. Zodiac Rose Window with damp on north gable end. Acoustic felt de-lamination
2. Centre piece of Rose Window by Heaton Butler & Bayne
3. Detail of Rose window showing Cancer and Leo
4. Iron Brackets designed by George Twigge Molecey
5. Insensitive installation of Tube lights



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5

Interiors: Stained Glass

Over the decades, the fine stained glass panels too had developed issues ranging from soot deposition and loss of paint to more severe issues of cracks and shattering of glass, damage to the leading, visible cases of bulging or entirely missing sections. All this required specialized restoration by trained conservators.

Restoration of the Convocation Hall: Fabric Inspection

Project Preparation & Tendering

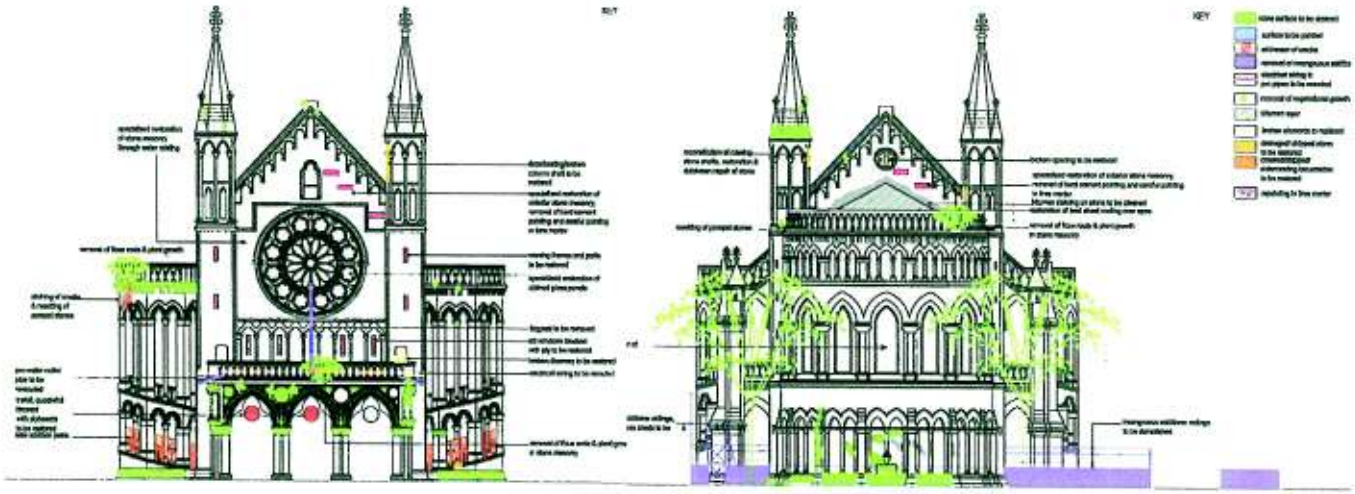
Being the first project of its kind involving restoration of a Grade I building directly undertaken by the University, the procedure for tendering had to conform to government Public Works Department rules. However, as most of the specialized conservation items such as restoration of limestone, stone cleaning and consolidation, lime grouting, stained glass works etc were not in the Schedule of Rates of the Public Works Department the architects had to prepare detailed rate analysis and detailed specifications that would be then subjected to government scrutiny before approval.

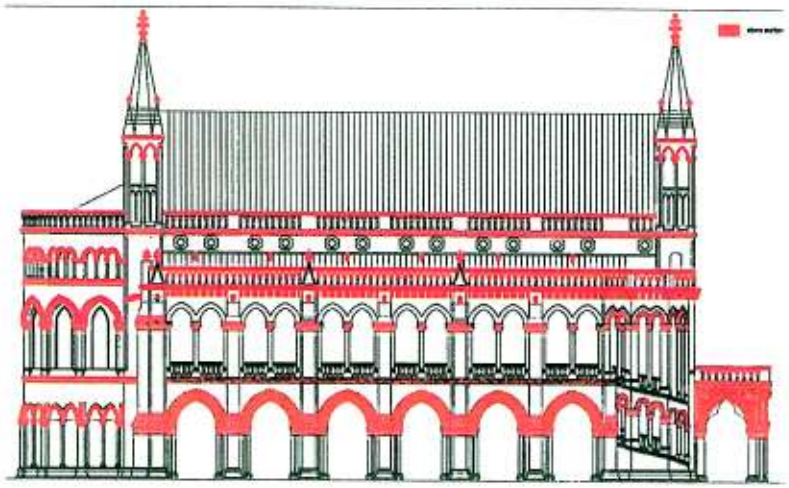
Heritage Committee Permissions were obtained as the building is a Grade I prime heritage structure and only then were the tenders floated. A system of prequalification of contractors with past experience in restoration work was undertaken and the financial bids were only opened after the technical requirements were met.

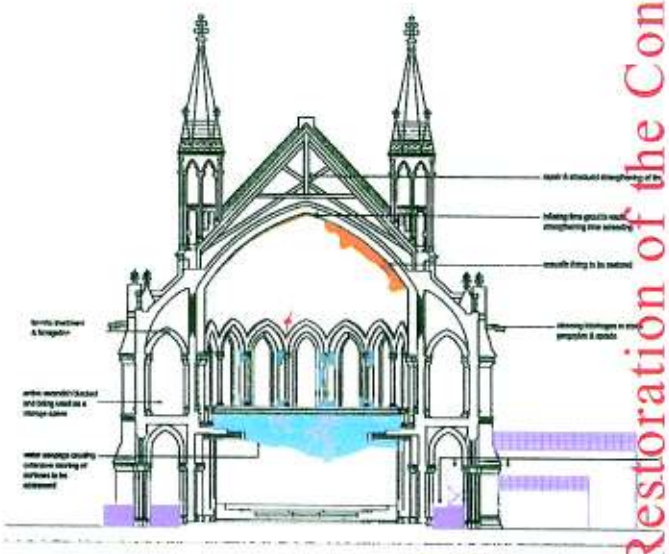
The work of the Civil Work Restoration was awarded to M/s Savani Heritage and separate tenders were floated for Stained Glass Restoration, Sound Systems, Lighting Systems etc.

The project work on site began on 1st November 2005 and was completed on 15th July 2006, taking a total of 7 ½ months to restore the building in all its entirety, complete with Structural and Architectural Restoration, Restoration of Stained Glass, Woodwork and Carpentry Repairs, Restoration of Furniture, installation of Bose Sound Sytems for the comprehensive restoration of the University of Mumbai's Convocation Hall in time for its inaugural address by the President of India.

A sample of Tender drawings prepared for the project, mapping each area for poulticing, consolidation and all acoustical and electrical upgradation items in a comprehensive tendering process

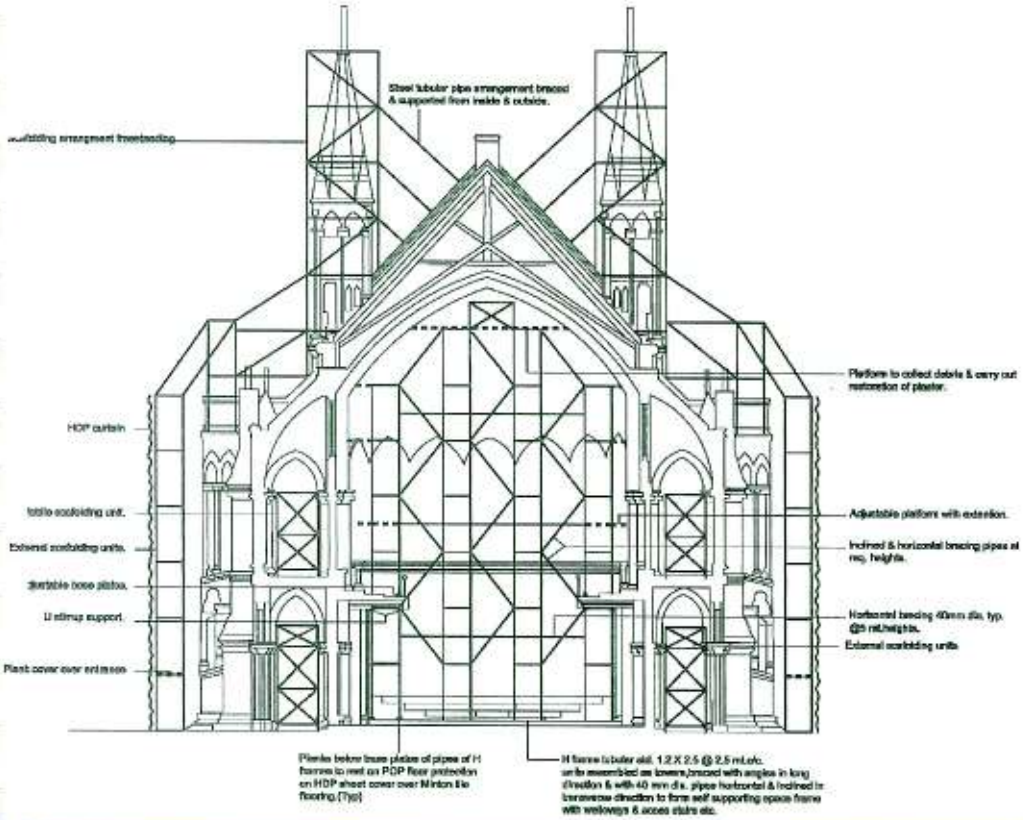


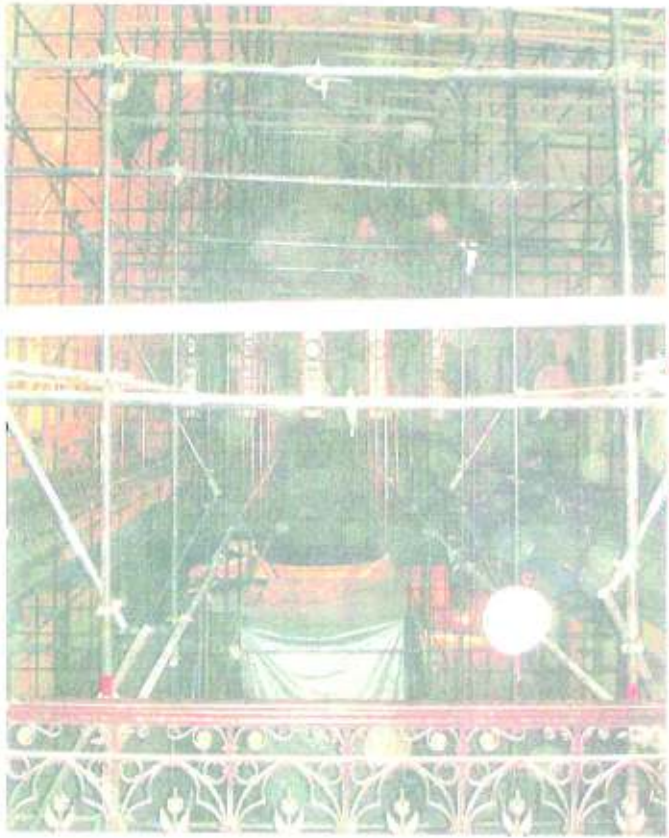




Enabling Works

The Site Work began in earnest on 1st November, with enabling works and mobilization of over a 100 workmen, with a tubular steel scaffolding erected under the monumental vaulted ceiling, workmen busy working on repairs, cleaning years of algae growth from the roof clay tiles or working on lime pointing as conservators spend hours bending over the Victorian stained glass panels, deftly piecing together the myriad coloured pieces like a medieval jigsaw puzzle.





Left: Structural drawings showing the scaffolding arrangement for the tubular steel scaffolding. Above Top: The scaffolding and protective sheeting up along the building face. Above: Protective Plaster of Paris and plastic sheet covering on the Minton Tile floor to protect it from any damage during scaffolding works; Right. A view of the interior hall with the scaffolding erected in the entire space to access the upper vault.

Enabling Works: Project Signs

Enabling Works: Protective Covering

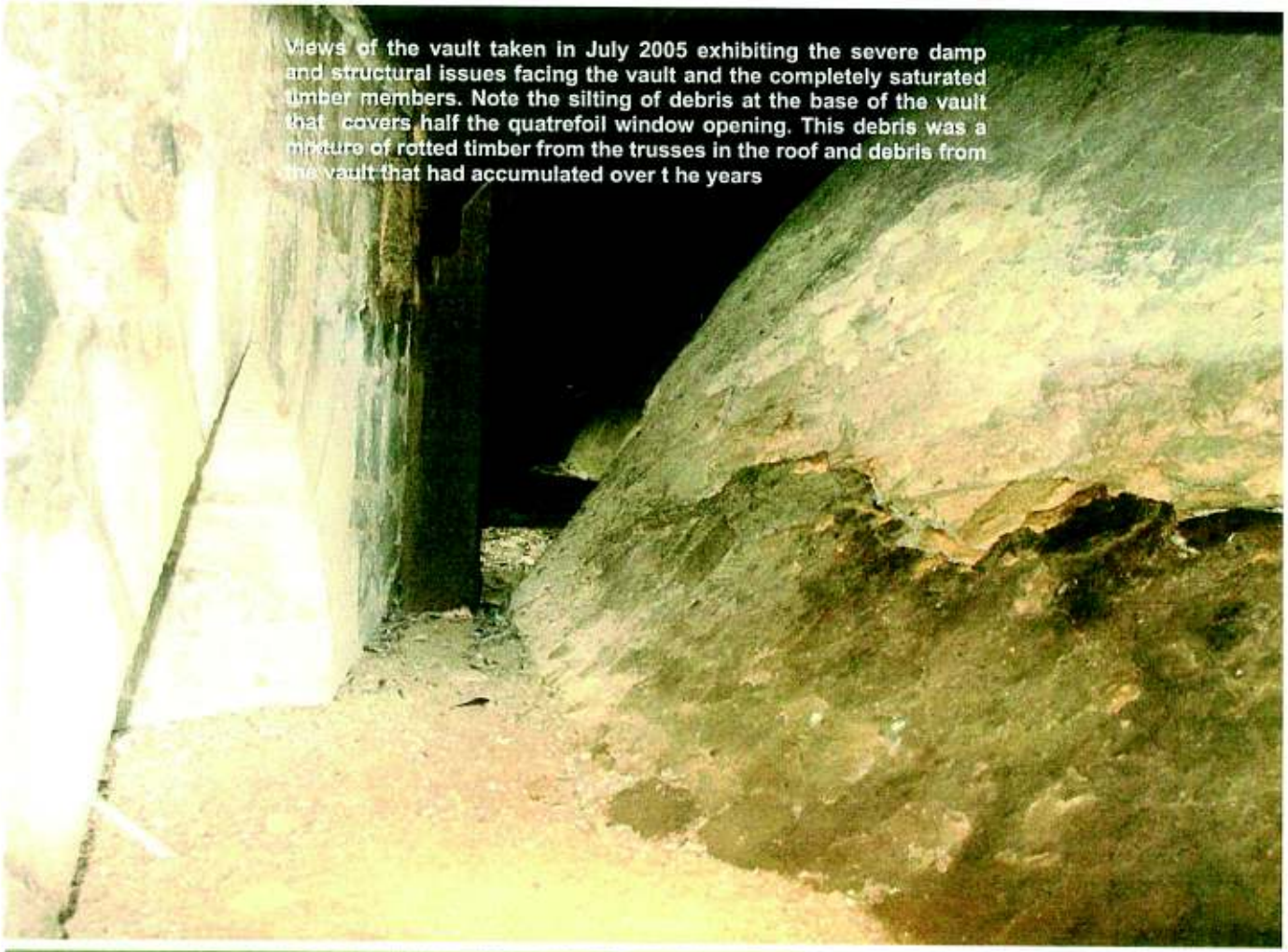
Enabling Works: Opening up Roofs

Enabling Works: Preparing Lime

Restoration of the Convocation Hall: Enabling Works

Upper Roof: Condition Assessment of Stone Vault

The vault was one of the biggest structural challenges in the building as it was constructed with rubble stone and lime concrete. This was subject to a great amount of leakage over the years since the roof above had been leaking. The constant leakage from the roof had leached away at the lime binders holding up the stone vault and water had so saturated the vault that even the acoustic lining below the wall was peeling off as it was heavy with water. Investigations into the lime content and endoscopic examinations had revealed that the lime content had greatly reduced in the vault, threatening its structural stability. The vaulted roof thus required considerable structural investigation and analysis.



Views of the vault taken in July 2005 exhibiting the severe damp and structural issues facing the vault and the completely saturated timber members. Note the silting of debris at the base of the vault that covers half the quatrefoil window opening. This debris was a mixture of rotted timber from the trusses in the roof and debris from the vault that had accumulated over t he years

Upper Roof: Structural Consolidation of Stone Vault

Views 1 to 4: Lime concrete on the surface of t he dome was covered with algae and badly deteriorated. 2: The loose lime concrete being removed. 3: Gravity grouting of lime through tubes inserted in stainless steel nipples to restore the lime content in the dome. 4 & 5: The final coat of lime concreting on the surface of the shell after grouting. This was burnished with natural resins such as *gur* (jaggery), *guggal* (a tree resin) and *methi* (fenugreek) seeds boiled in water over a slow flame for 3 days and mixed in the non hydraulic lime for a waterproof finish. Below: Images of Gur and other additives by weight , boiled over days to mix with lime

Lime was slaked on site to produce non hydraulic lime mortars to match the original used in the building. The upper stone vault was grouted with a fine lime slurry injected through fine nipples under the guidance of the structural rehabilitation specialist Mr. Arup Sarbadhikary, the structural engineer leading the structural repairs. After removing the weak and loose upper coating of lime and subsequently undertaking the grouting, the vault was given a coat of waterproof lime

Upper Roof: Condition Assessment of Roof Structural Members

Images 1 & 2: Timber boarding removed from the upper roof to expose the condition of the structural system; Images 3 to 6: Severe deterioration of the structural framework of the roof trusses with the entire section embedded into masonry completely rotted due to wet rot and fungal infestation. Images 7 & 8: Views showing the completely water logged and soaked timber rafters and boarding with whitish patches indicating fungal infestation. Image 9: Termite run visible in the timber boarding

Upper Roof: Structural Consolidation of Roof Structural Members

Left top: The roof battens were removed to expose the condition of the truss and rafter ends embedded in the masonry. Though the middle sections of the timber framework were alright, the cause of concern were the end sections of both the trusses and the rafters. These were found to be greatly damaged with wet rot having eaten away at the embedded end sections, thereby rendering them structurally unstable.

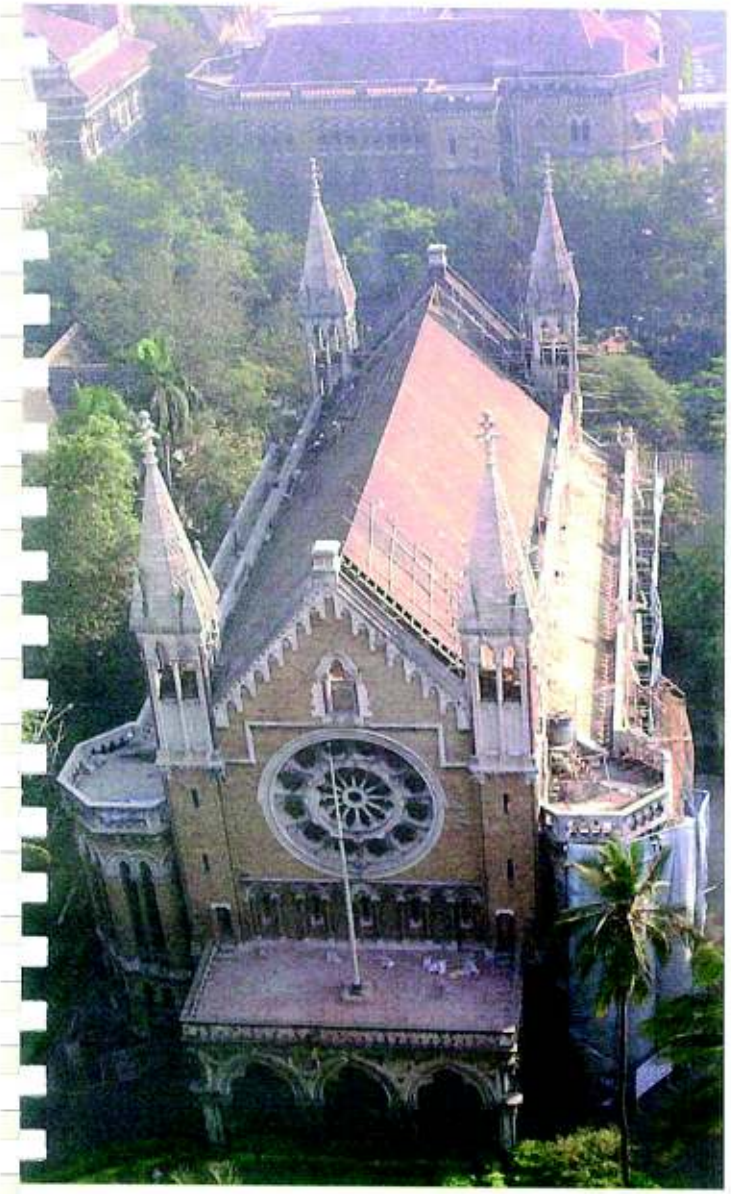
Right & Below: Splice Repair of damaged structural members using seasoned sections of Teak Wood to restore the point of contact between the trusses and the masonry below, ensuring the structural integrity of the roof.

Upper Roof: Timber Planking & Roof Tiling

The upper roof was constructed with a timber framework, of teak wood battens with tongue and groove joints resting on wooden rafters and purlins, supported by teak wood trusses. The damaged teak wood battens were replaced with well seasoned battens and given a sheet covering o f galvanized iron sheeting as a second line of defense. On this sheeting, were fixed timber reapers with non corrosive stainless steel screws and sealed with hot tar. Over these wooden reapers, were fixed the terracotta tiles

Upper Roof: Roof Tiling

Above: Workmen cleaning the terracotta tiles to re use them on the roof after roof repairs. Most of the original terracotta tiles were retained, after carefully cleaning them, thus ensuring authenticity of material. Left: View of the roof showing the terracotta tiles removed to expose the timber battens for repair. Right: View of the upper roof with partial work on resetting the terracotta tiles complete. Below: Treatment of wooden members to prevent infestation.



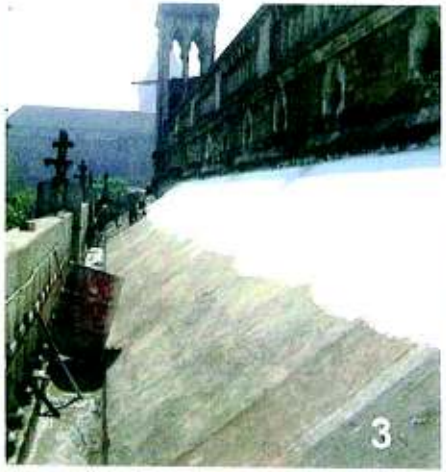
The entire wooden framework of the trusses, rafters and boarding was thoroughly treated for any infestation. The roof tiles were relaid after cleaning them thoroughly, thus retaining maximum old tiles.

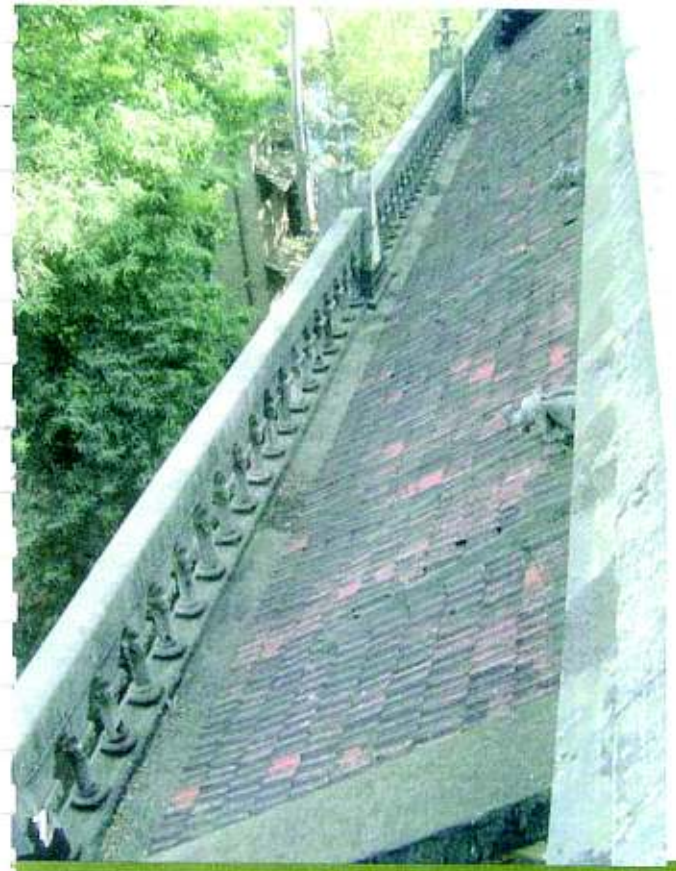
Lower Roof: Condition Assessment

The lower roofs were designed to receive the water from the upper roof through a row of stone gargoyles and finally drain this water out of the building through another row of gargoyles below. Over the years, as debris choked the gargoyles on the upper roof level, water began penetrating through the stone masonry and with each year, instead of undertaking a comprehensive repair of the roof, the local staff just kept adding layers and layers of bitumen, the drainage gutters on the lower roof level too got choked with bitumen, hence making the water drainage system ineffective.

As the lower section of roof was opened out, it revealed a construction of a lime concrete base in which were set timber reapers, over which a tiled roof was laid. As the lime concrete was saturated with moisture, the timber inset in it, rotted and the entire roofing became loose.

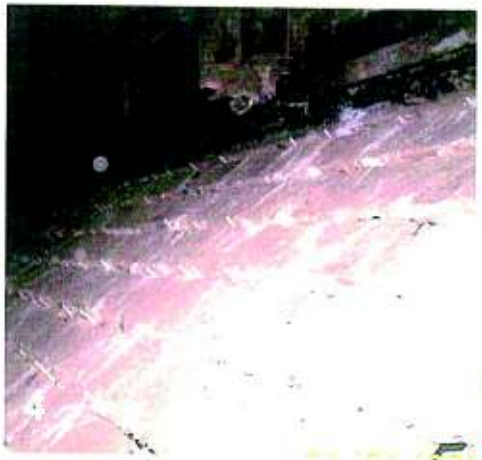
Structural Consolidation of Lower Roofs





Restoration of the Convocation Hall: Lower Roof Repair

Structural Consolidation of Lower Roofs



1: Roof with tar felt before repair works

2: Removal of tar reveals lime concrete

3: Rotted purlins embedded in lime

4: Grouting of lime to consolidate base

5: Provision of smooth finished lime cover over shell

6: Provision of final waterproof layer of lime burnished with additives such as *gur* , *guggal* and *methi* as a waterproofing

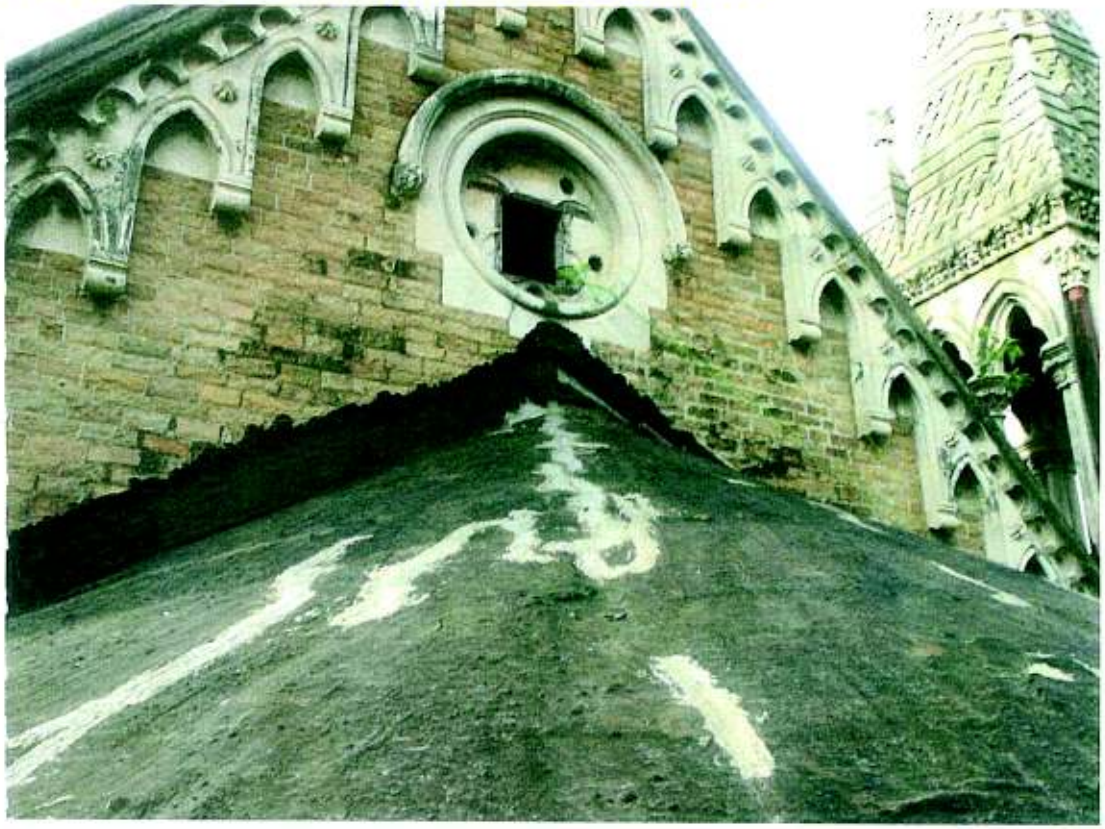
7 & 8 Lead sheeting laid on lime concrete

9 & 10: Roof tiles laid over as final layer with wood reapers

Lower Roofs: Workmen

Restoration of the Convocation Hall: Lower Roof Repair

Apse Roof: Condition Assessment



A major point of leakage was the southern apse roof that had been been reduced to a layer of bitumen tar felt over timber planking, wholly inadequate for the monsoons. This tar felt too had greatly deteriorated, resulting in the apse roof leaking badly during the rain.

Opening up the tar exposed timber rafters in an advanced stage of decay and the stone and lime concrete vault below was distressed

Restoration of the Convocation Hall: Apse Roof Repair

Structural Consolidation of Apse Roof

Restoration of the Convocation Hall: Apse Roof Repair

Structural Consolidation of Apse Roof

Restoration of the Convocation Hall: Apse Roof Repair

Structural Consolidation of Apse Roof

The apse roof posed severe issues of wood rot and decay. While most sections required complete replacement in matching, well seasoned Burma Teak sections, other cases (images above) with limited decay were filled up in situ using a mix of saw dust and epoxy consolidant, thereby restoring the structural strength of the member. In the case of some trusses (images top right) additional steel bracing was inserted to provide additional strength and in some cases of rafters (image bottom right) splice repair of inserting new section of wood to build up the profile, was employed. The entire vault that was greatly deteriorated, was consolidated with lime grout and provided a top cover of burnished lime plaster with traditional waterproofing additives such as *gur, guggal* and *methi.*

Correction of Dislodged Stone Parapets

Stone parapets along the northern façade, especially along the front porch and upper terrace were dislodged at places. This was found to be the result of ficus plants growing into the masonry, with their root systems exerting pressure on the stone crevices, eventually leading to dislodged parapets. The tree growths were pulled out and completely removed from the roots by carefully dismantling the stone balustrade, pouring hot lime and the stone work carefully pieced together, correcting the levels.

Replacement of Severely Damaged Stone work

Restoration of the Convocation Hall: Dutchman Repair

Replacement of Severely Damaged Stone work

The greenish stone resembling Purbeck marble seen in many of England's cathedral visible in the porch was found to be a serpentine from Karnataka. This had severely deteriorated, and had been strapped with metal in the past. The matching stone was found and cut and traditional stone craftsmen from Gujarat were employed to carefully replace the damaged stone pillars with the new stone.

Replacement of Severely Damaged Stone work

Petrographic analysis of stone samples helped ascertain the exact geological make up of the stones that required replacement. Senior professors from the University's Geology Department were consulted and the exact geology and properties of the stones were established.

Whereas the red sandstone was sourced from Dhrangadhra, the white limestone was sourced from Porbunder in Gujarat, thus keeping the source as close as possible to the original quarries.

The greenish stone resembling Purbeck marble in the porch was found to be a serpentine from Karnataka, whereas the grey basalt was sourced from Kurla and Ratnagiri in Maharashtra.

Plinth Protection





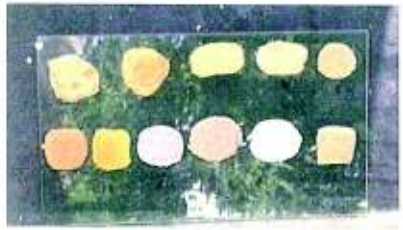

In order to protect the base and plinth from rising damp, a trench was cut along the periphery of the entire building. The wide gaps in the rubble masonry were filled with mortar and grouted to ensure the base from water penetration. The earth was then filled back and site slopes for the entire campus were mapped out to provide a comprehensive scheme for water drainage in the plot.

Pointing in Lime Mortar

Views Above: Raking out of hard epoxy pointing in the staircase areas to repoint in lime mortar with masking tape to ensure thin, flush pointing joints.

Left: Badly deteriorated stone joints along the verandahs were in need of lime pointing

Right: Images showing various samples of lime pointing with additives to obtain a colour matching. Various samples were tried before the perfect match to the stone was obtained.



Specialised Stone Cleaning

Bottom: Images of workmen cleaning limestone details with soft nylon brushes and water. Water Misting techniques were employed for general surface cleaning.

Middle: Before after images of cleaning carved stone faces. Extreme Right: Paper pulp poultices employed in the cleaning of details

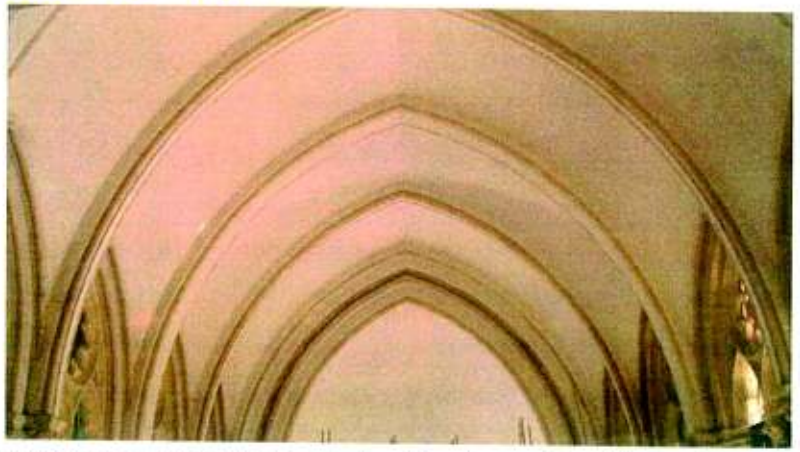
Restoration of the Convocation Hall: Stone Cleaning

Specialised Stone Cleaning: Gargoyles

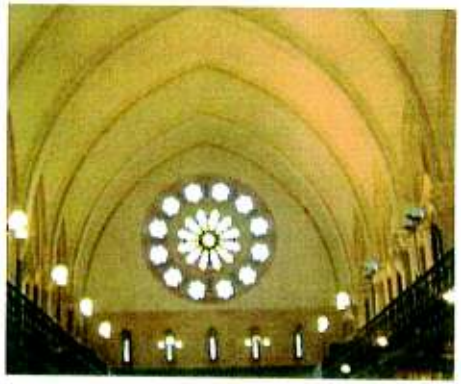
The splendid stone gargoyles, integral to the roof drainage, were choked with thick encrustations of sulphate deposits, forming hard black skins on the surface. These were cleaned by specialized cleaning techniques of poulticing and water misting to restore the aesthetics and efficacy of these water spouts.

Restoration of the Convocation Hall: Dutchman Repair

Acoustic Treatment & Removal of Asbestos Fibre

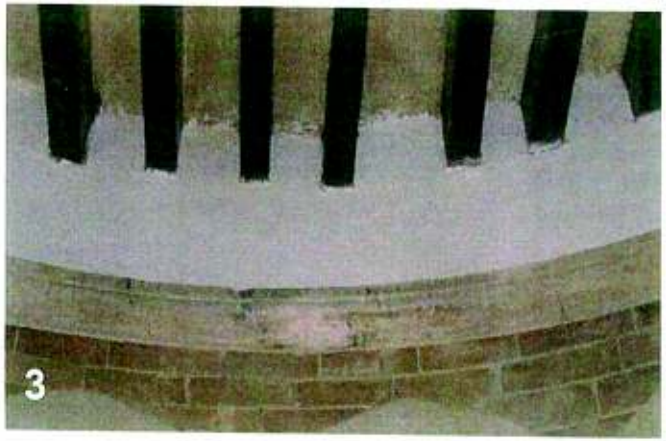


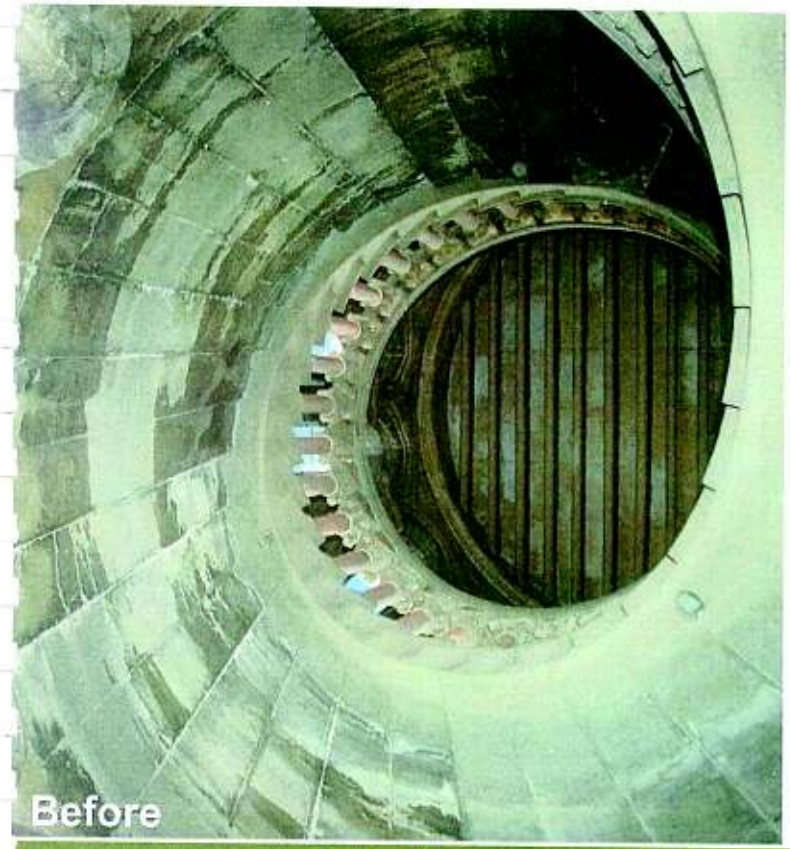
The entire underside of the vault and all the inner surfaces of the walls had been covered with asbestos fibre in an attempt in the 1940s to address the issue of sound reverbration in the building. This was not only peeling off in patches due to the dampness in the building, but was a health hazard. With acoustics playing an important role in the functioning of a public hall in use, a specialist firm of Jhaveri & Jhaveri, acoustical engineers became an integral part of the team to study the present acoustical performance of the building and design a system that would give appropriate acoustical levels for public events. The hazardous asbestos fibre introduced in the 1940s as an acoustical treatment was not only peeling of with water leakage (image top left) but was also a serious health hazard for a public building. This lining covered the entire vault and lower level spandrels (image bottom left) and was removed with gas masks and protective gear.



A new acoustic treatment consisting of a patented cellulose based fibre barely 6 – 8mm thick was finally selected as the acoustic treatment, spraying it on to the underside of the vault (top right) and the upper section of the north gable end, carefully matched to the colour of stone

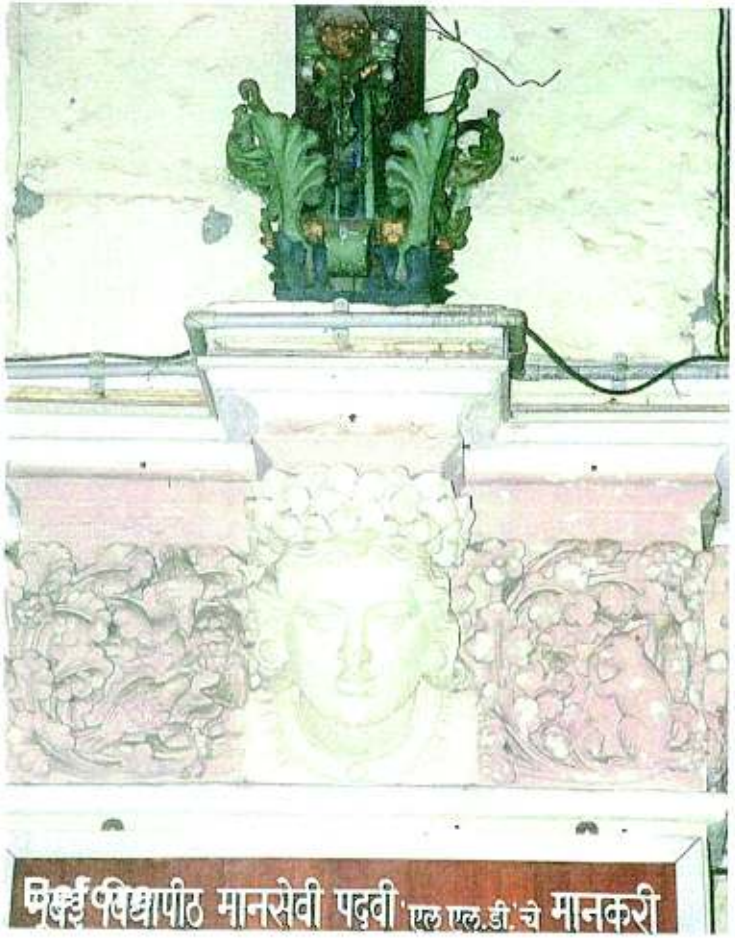
Restoration of Staircases



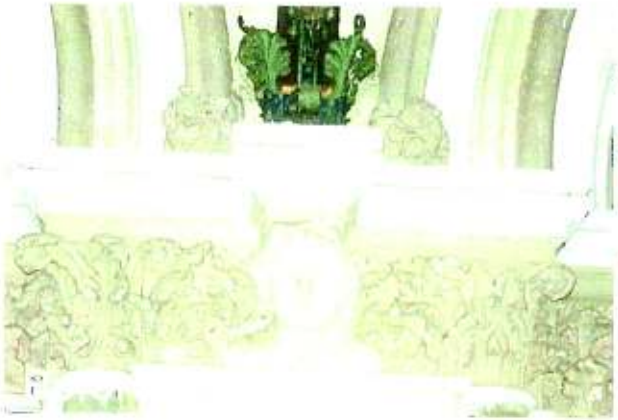


Restoration of the Convocation Hall: Staircases

Restoration of Interior Statuary

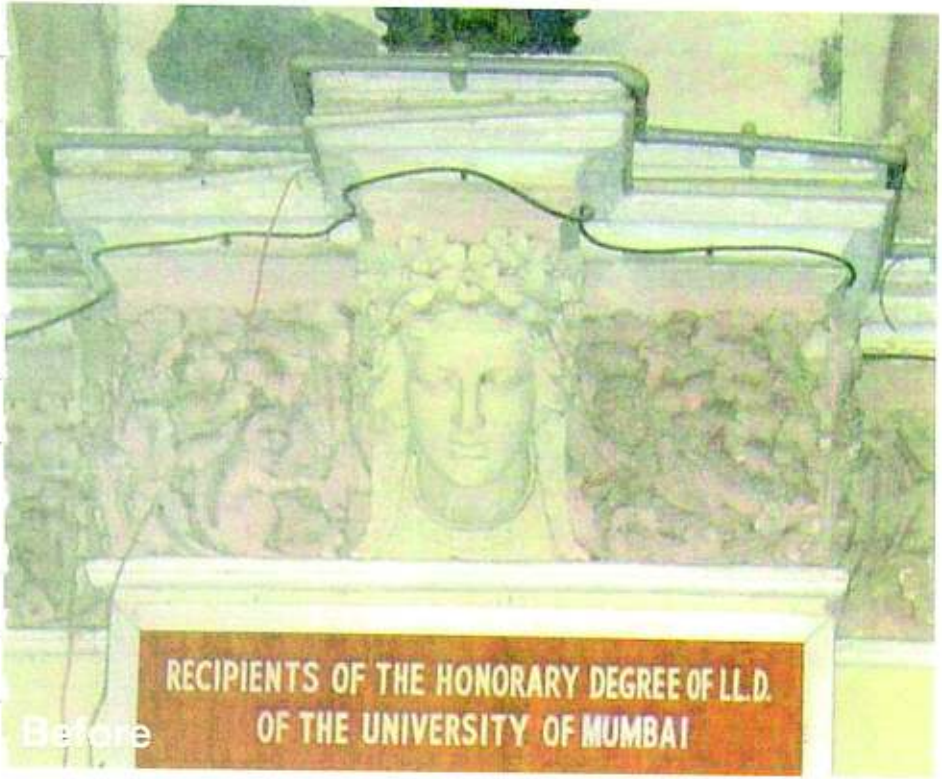


The entire interior statuary was covered by thick layers of paint. This was most unsightly and obliterated the original texture of the lime stone carvings. Paint layers were carefully removed from the stone by employing non abrasive paper poultices, water washing with nylon brushes and application of mild surfactants. The ugly electrical conduits running across the carved faces were re located to expose the beautiful stone carvings.



Restoration of the Convocation Hall: Interior Statuary

Restoration of Interior Statuary



Restoration of the Convocation Hall: Interior Statuary

Restoration of Interior Statuary

While the paint was being removed, in the case of 2 male heads, the base was found to be made of cast cement, with a steel armature. This was quite a surprise to the team as all the other figures were crafted out of limestone. This would have been a past intervention, possibly as a stone figure head was damaged. It was decided to retain this as a layering of past intervention and the head was given a surface covering of lime plastic repair to match it with the surrounding stone.

Restoration of Interior Statuary

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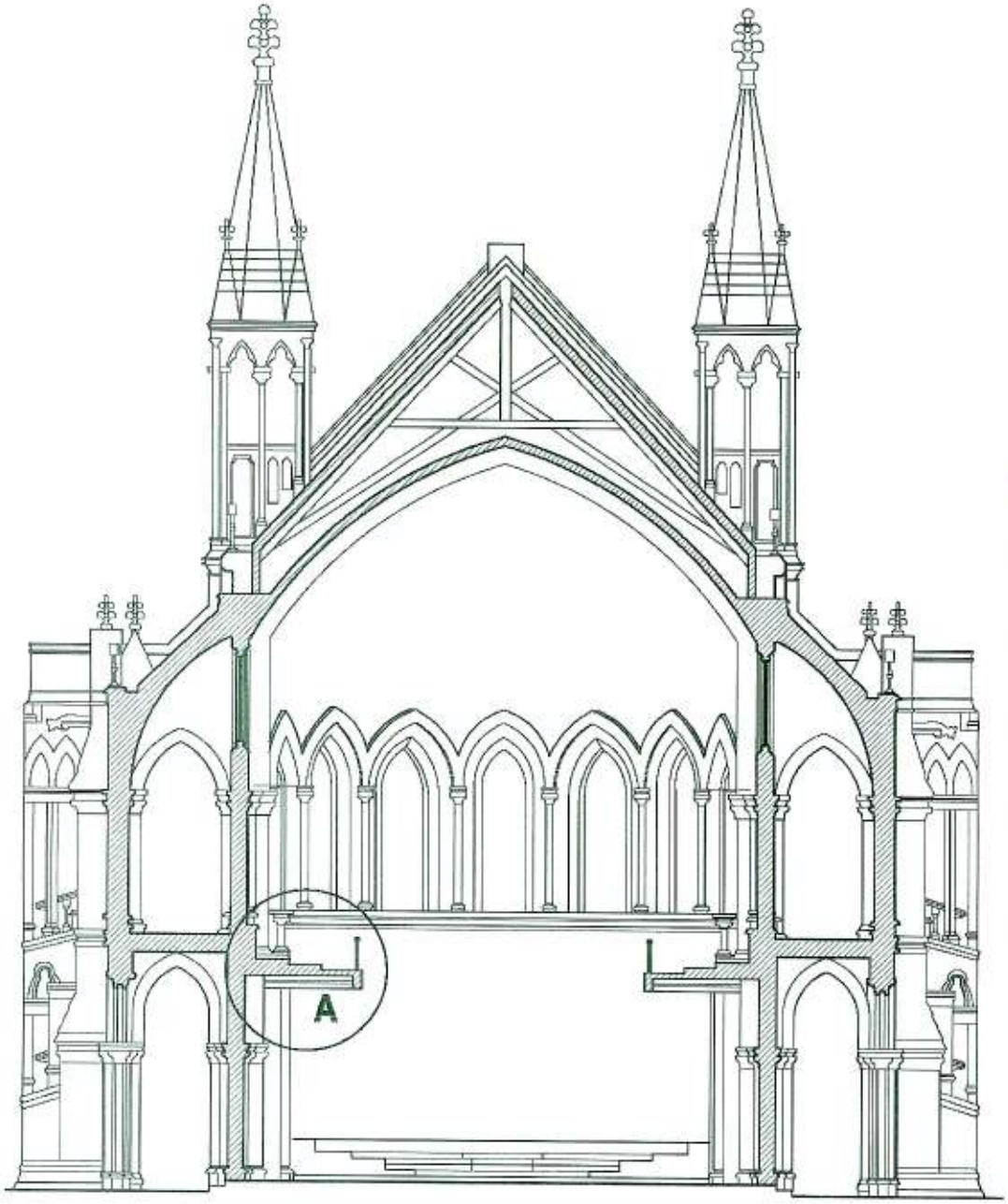
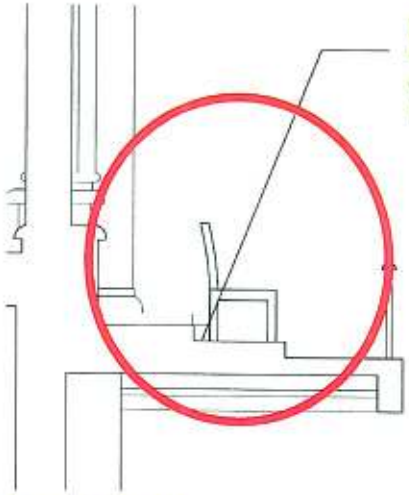
Restoration of the Convocation Hall: Interior Statuary





Electrical cables running along the length of the riser on the upper mezzanine and dropped at each decorative bracket to feed a row of lights

Detail at A

The electrical wiring that ran in an ad hoc manner, defacing stone cornices and abruptly cutting across stone details has now been concealed, re-routing it under the timber boarding of the upper balconies to ensure that the architectural details are not obstructed

A major challenge facing the architects, was the need for integrating issues such as modernization and upgradation of the electrical systems in the building. The architects took on consultants and set up a team of engineers led by Mr. Vikas Joshi and an international firm specializing in lighting design, Available Lights N.Y. for designing a specialized lighting system for the interiors and exteriors, carefully calibrating lighting systems to appropriate designs and lux levels suited for such a historic structure.

The wiring that had in the past been a chaotic mess of unsightly conduits and wiring defacing architectural details was re-routed along the upper balcony at the mezzanine level. The main cables ran up directly to this level and were routed horizontally along the length of the upper balconies, to discreetly run under the linear seating of timber benches, running along the face of the timber step at this mezzanine level. From here, it was discreetly dropped to the lower level at each decorative bracket, to feed a row of lights fitted under the wooden beam

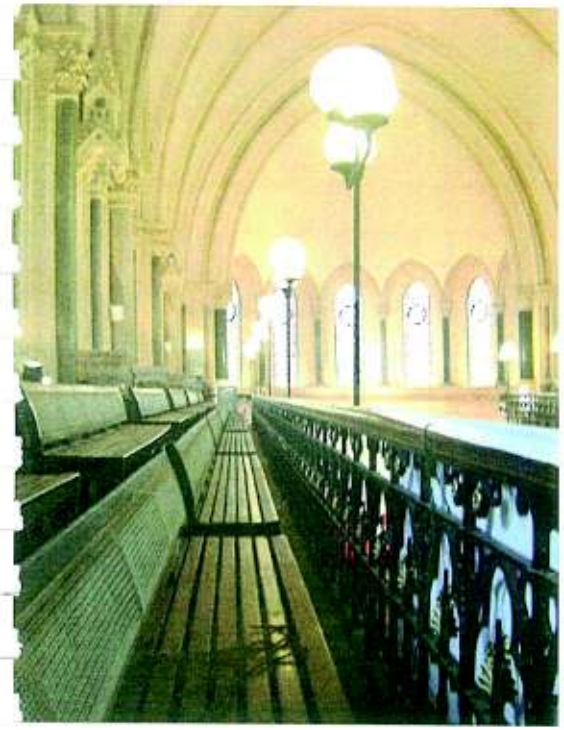

Before


After

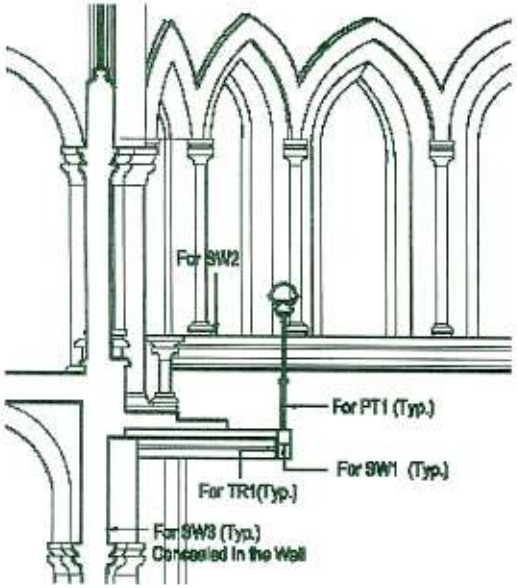
Upgradation of Electrical Services & Wire Management

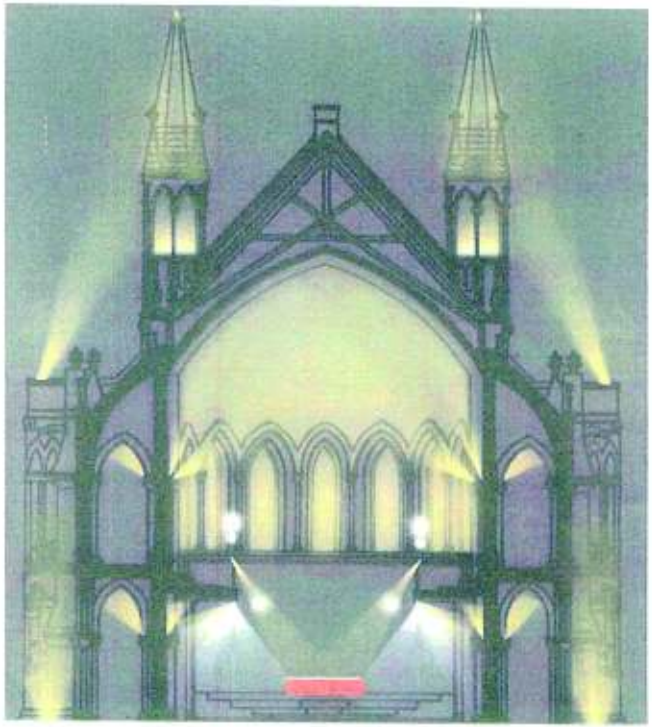
The interiors of the spectacular hall had undergone a series of insensitive alterations ranging from insensitively placed tube lights, switches and electrical conduits that criss crossed over architectural details, greatly detracted from the architectural ambience of the once grand interior.

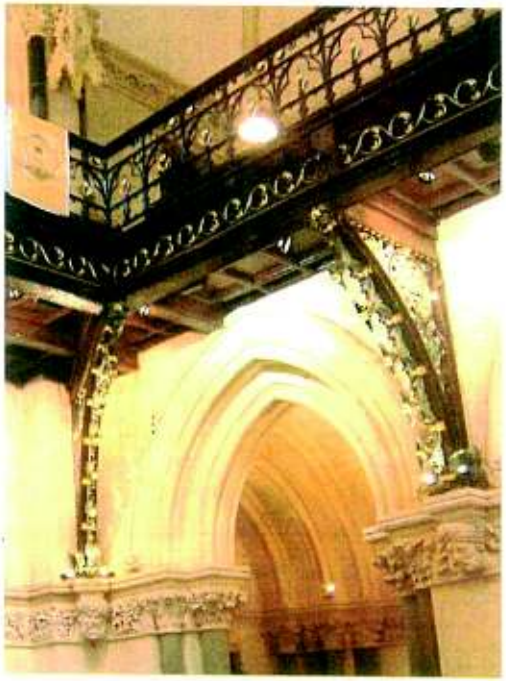
Lighting Design



The original lighting for the hall had Victorian lamps as seen in the upper balconies. These were surviving in some cases, while in others, the glass domes were broken. The only other surviving light fixture of the original Victorian design was a brass disc fitting with six decorated glass fruits suspended from it. Over the years however, a range of ugly fluorescent tubelight fittings were suspended from the balcony, an eyesore. A design firm specializing in lighting design, was involved in designing a specialized lighting system for the interiors and exteriors, carefully calibrating lighting systems to appropriate designs and lux levels suited for such a historic structure. The electrical wiring that ran in an ad hoc manner, defacing stone cornices and abruptly cutting across stone details has now been concealed, re-routing it under the timber boarding of the upper balconies to ensure that the architectural details are not obstructed.

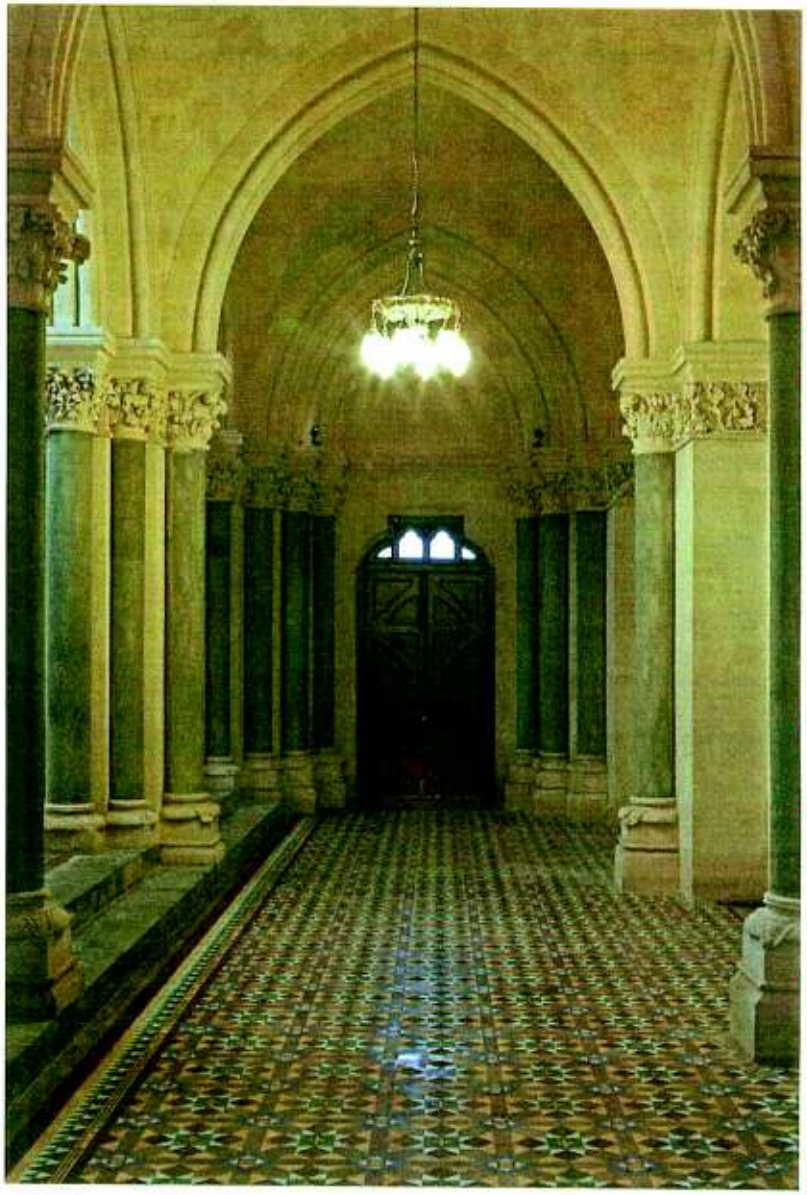






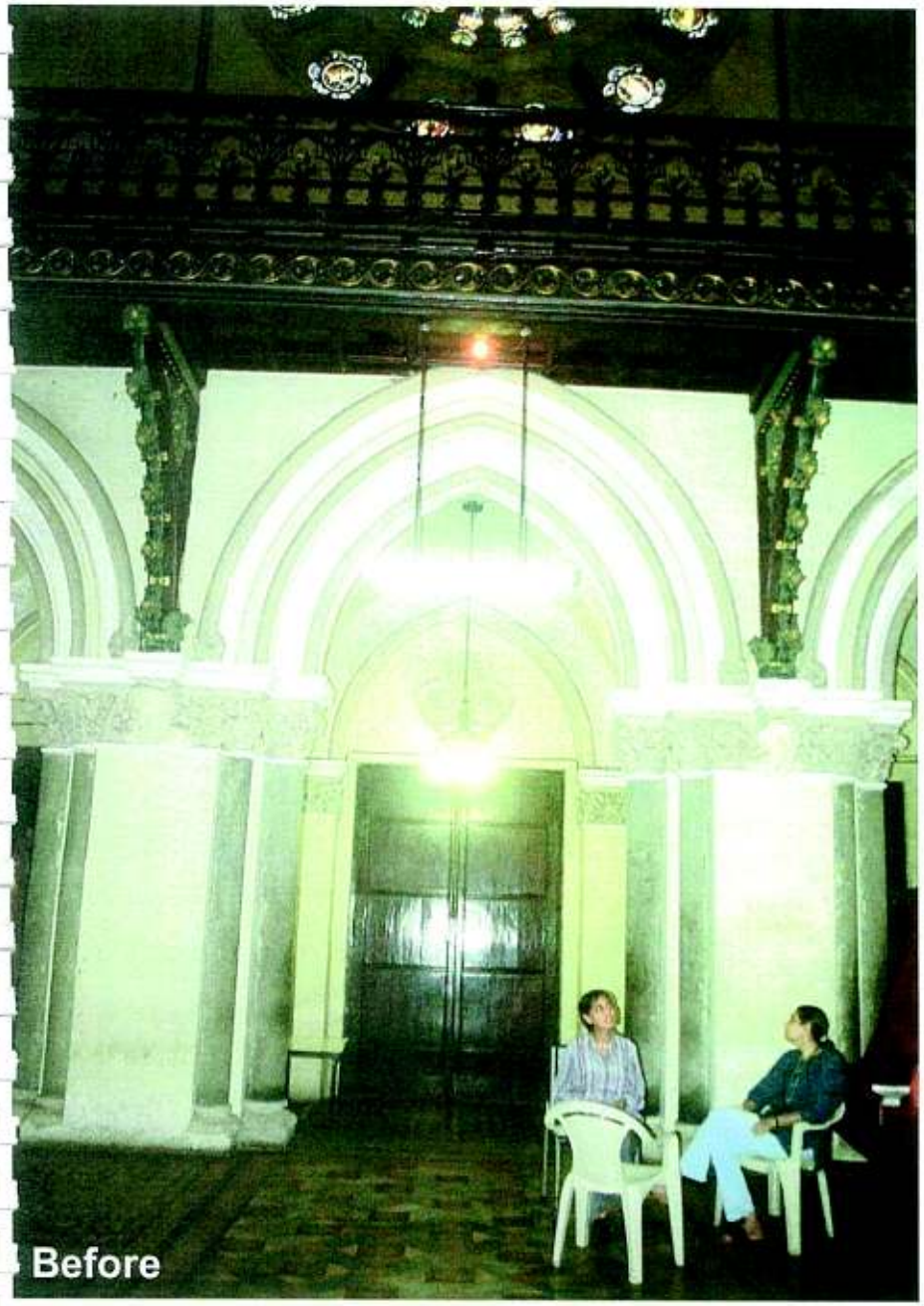
Lighting Design: Reviving Original Fittings

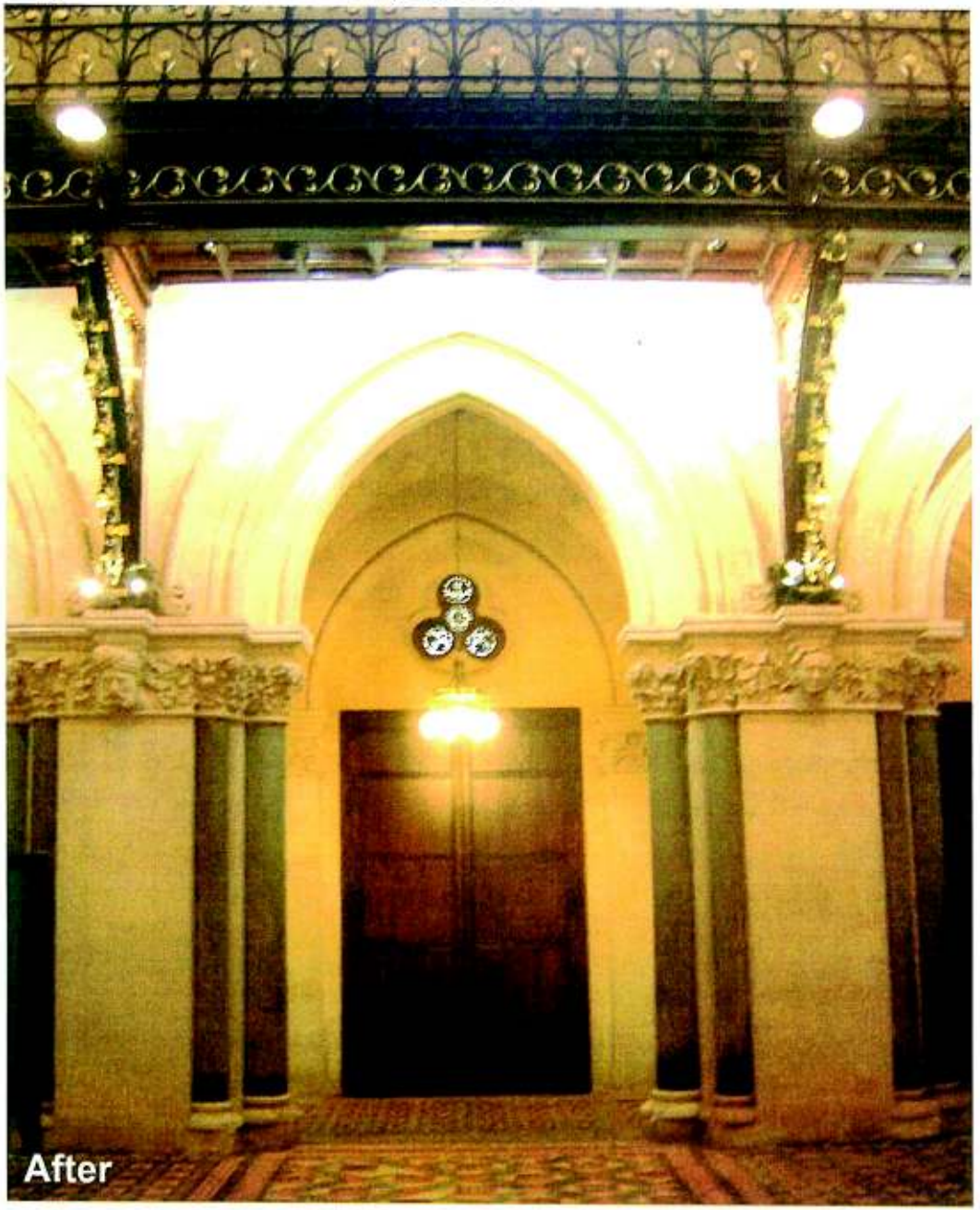
Apart from the vertical trident upstands placed along the upper viewing balcony, the other surviving light fixture of the original Victorian design was a brass disc fitting with six decorated glass fruits suspended from it. Of these, three of the glass fixtures had been broken with three surviving. The design was replicated in brass and blown glass and replicated for the three groin vaults on the porte cochere.

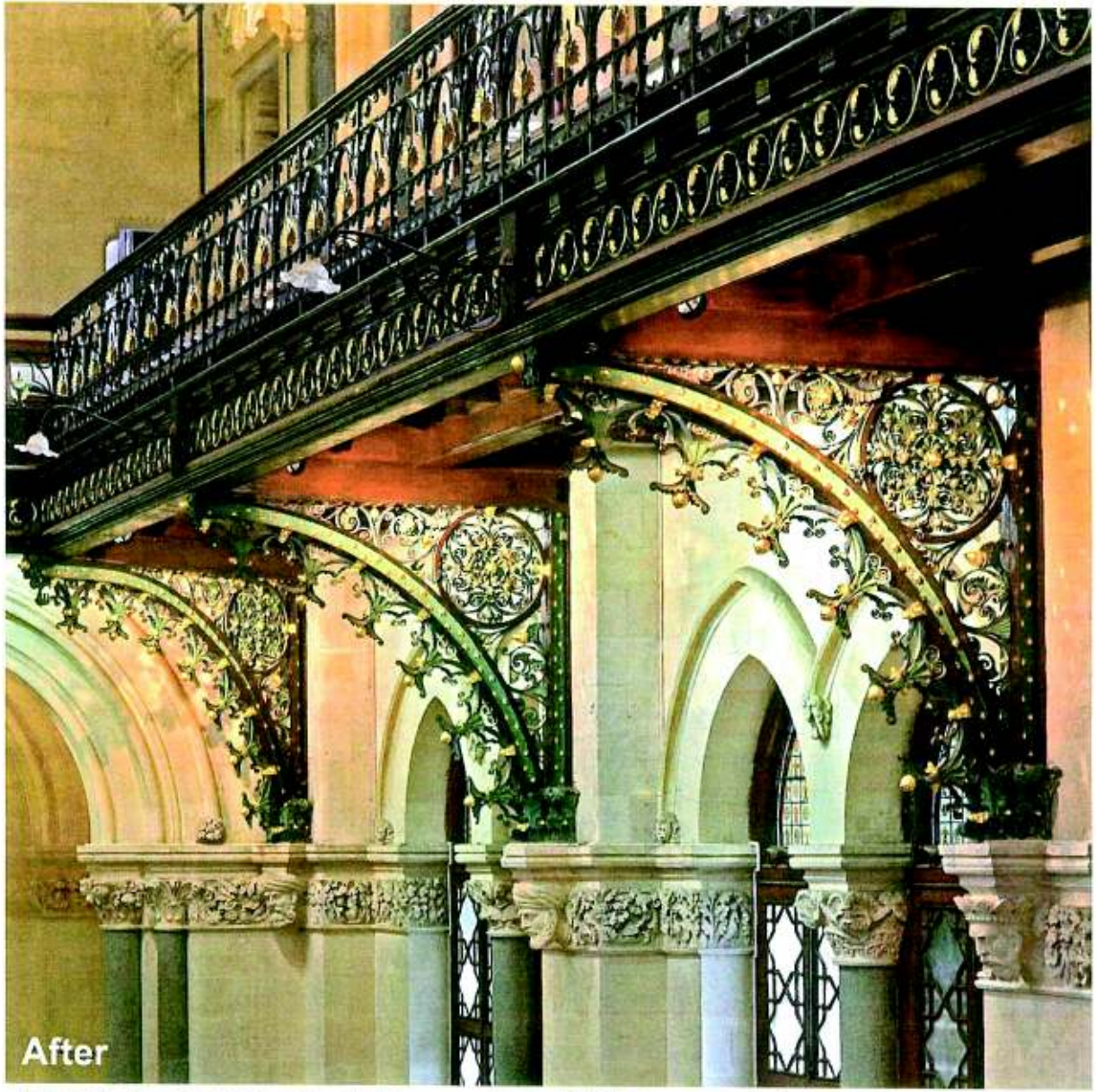


Restoration of the Convocation Hall: Lighting Design

Fluorescent tube lights replaced by well designed lighting systems that create a warm glow in the interior and are visually unobtrusive



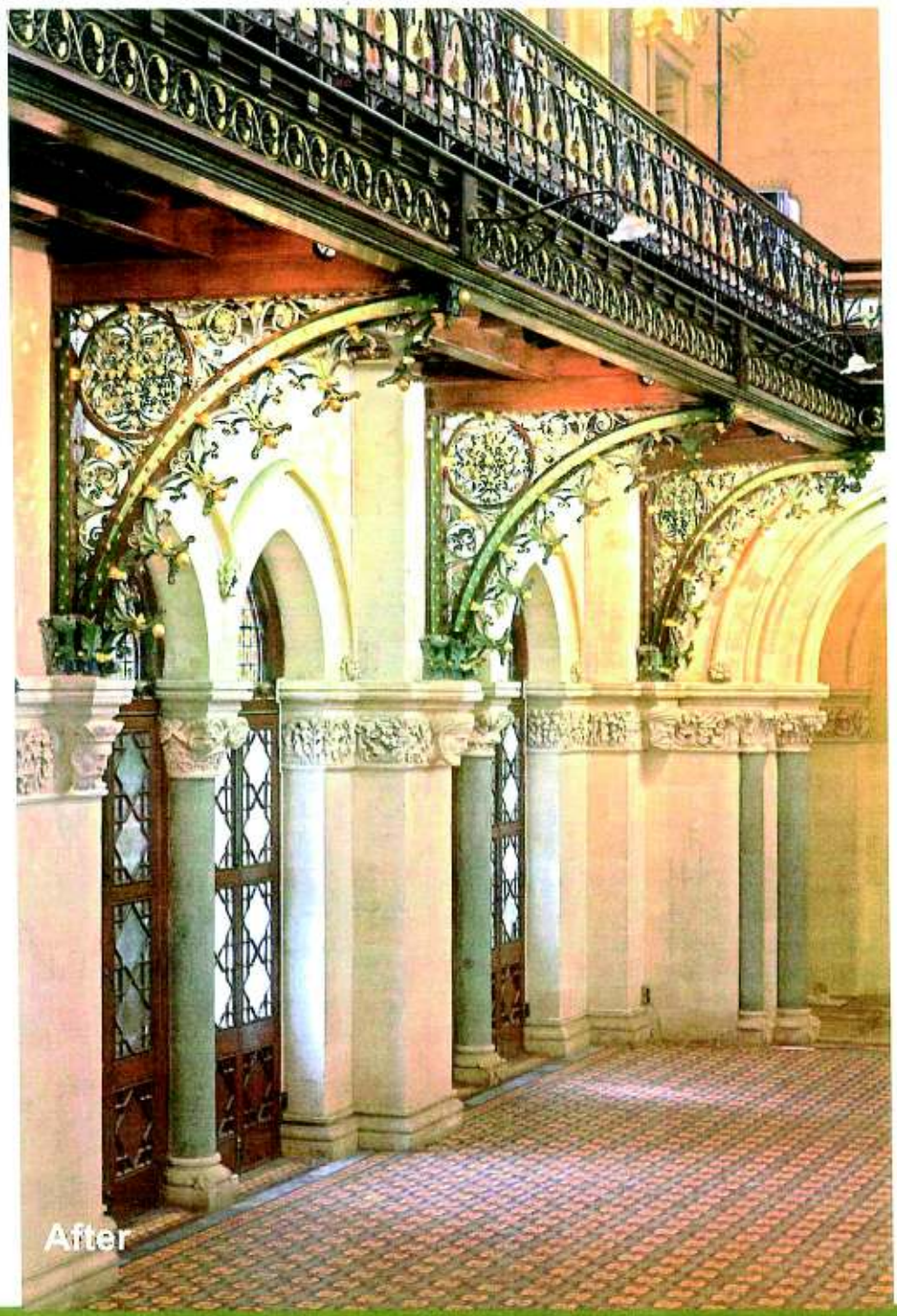




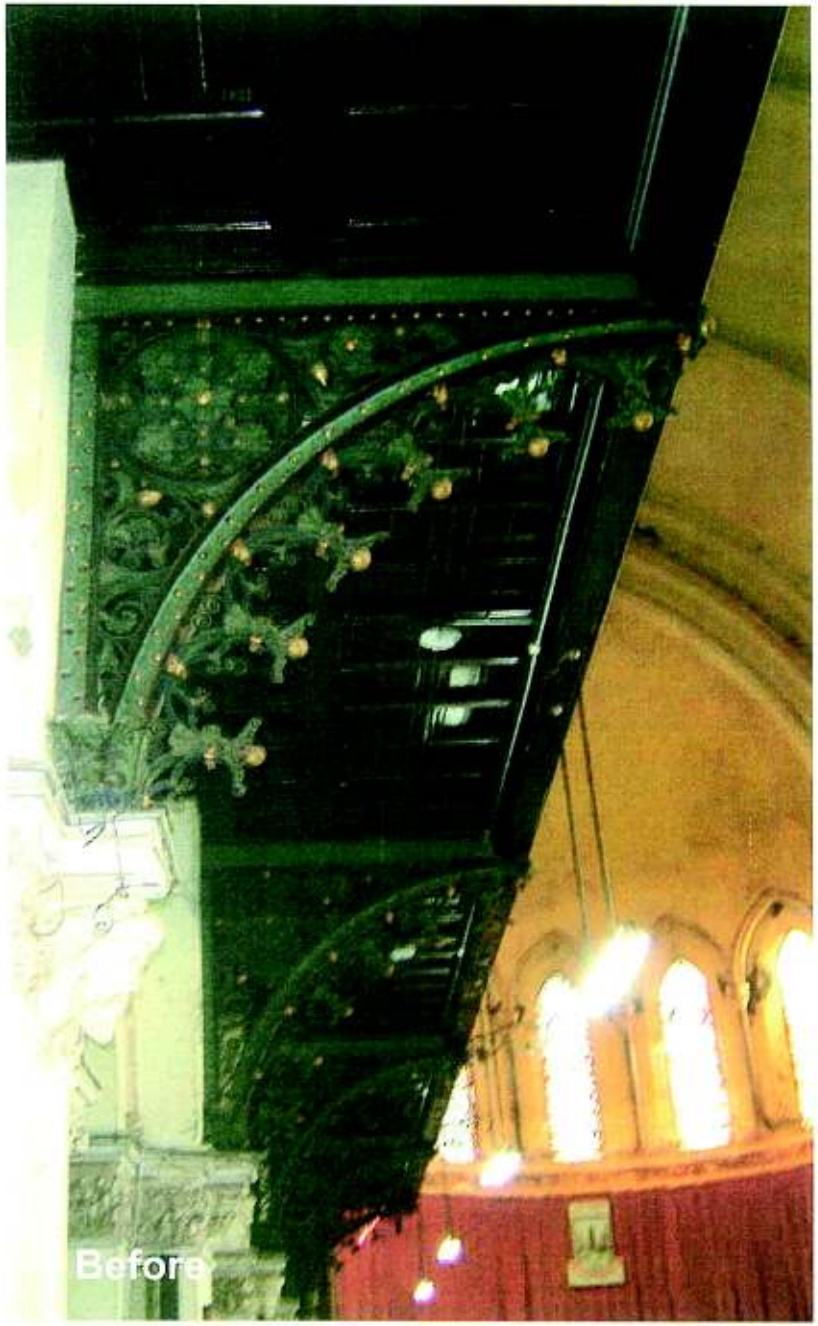
Top Left: A row of ugly suspended fluorescent tube light fixtures cut off the line of sight to the brackets and stained glass beyond. Also visible, were electrical pvc conduits running along the length of the building, cutting across carvings and arbitrarily placed light bulbs .Above: These have been removed and discreetly placed lights under the beam soffit of the balcony focus on the architectural details, bathing them in a warm glow.

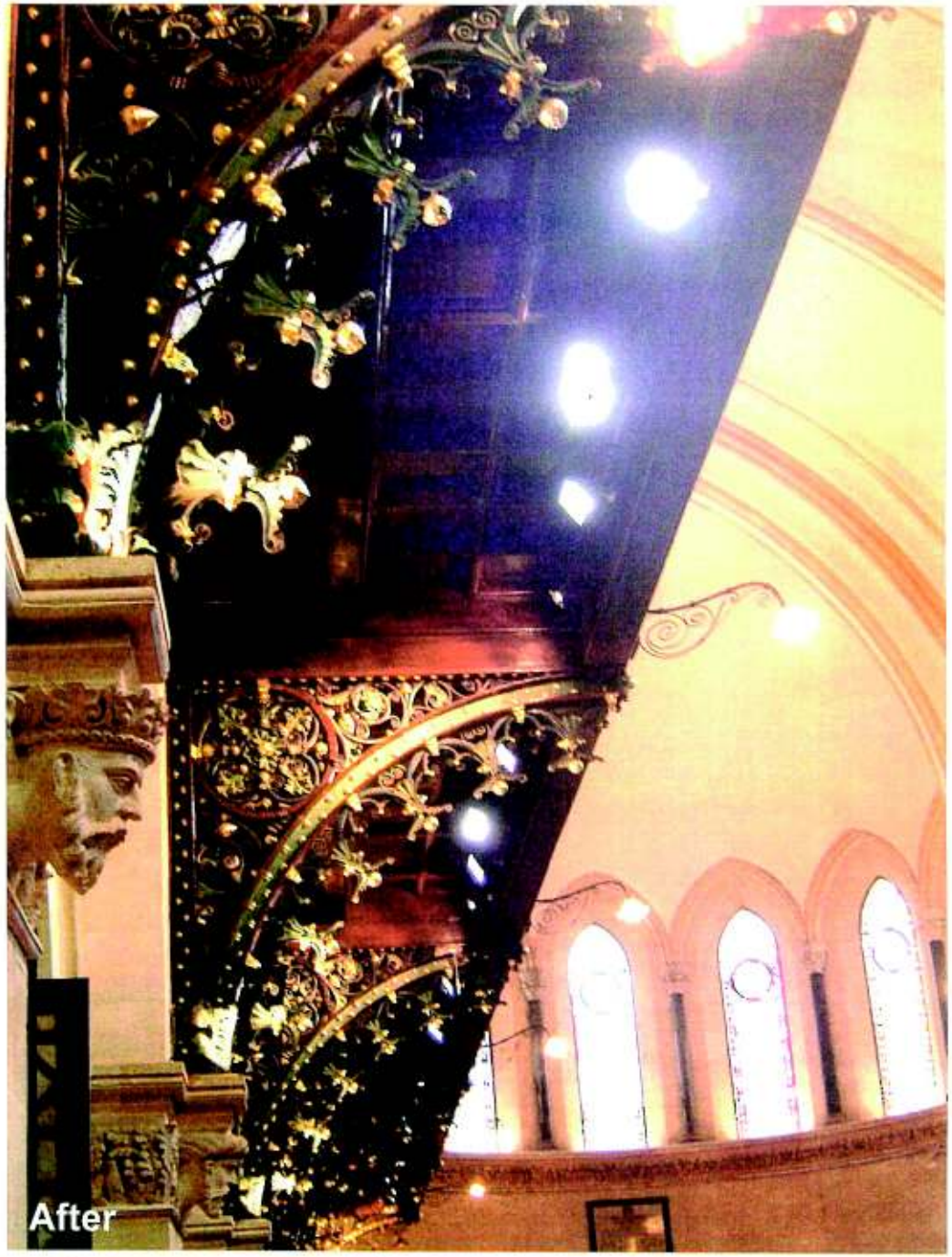
Lighting Design

The lighting scheme seen in 2005 was that of fluorescent tube lights suspended from the ceiling. These were removed and lights were discreetly fixed under the soffit of the balcony beam to conceal them. Sharp white lights of the tubelights was replaced with warmer tones of lights focusing on architectural details such as brackets and carvings.



Gold Leaf Gilding & Restoration of Iron Work





Gold Leaf Gilding

A group of master craftsmen in gold leaf gilding work, under the supervision of National Award Winning Craftsman Shri. Ghanshyam Nimbarak worked on the gold leaf gilding of the decorative railings and brackets for 6 weeks on site.

The gilding work was a painstaking process, entailing a thorough cleaning of the surface, followed by application of *alsi* oil and a special kind of clay obtained from Rajasthan. To this sticky base, the 24 carat gold leaf was applied by hand, burnishing it and pressing it down to the base. This was followed by another application of gold leaf in a similar manner and followed up until the surface was fully covered in gold leaf. Each floret was carefully wrapped in bubble wrap to avoid any accumulation of dust or damage during the site work and finally opened up to reveal a brilliant, rich gold work.

Gold Leaf Gilding

Not just the iron work brackets and railings, but even the wood work freize of curvilinear floral motifs was similarly worked upon in gold leaf gilding.

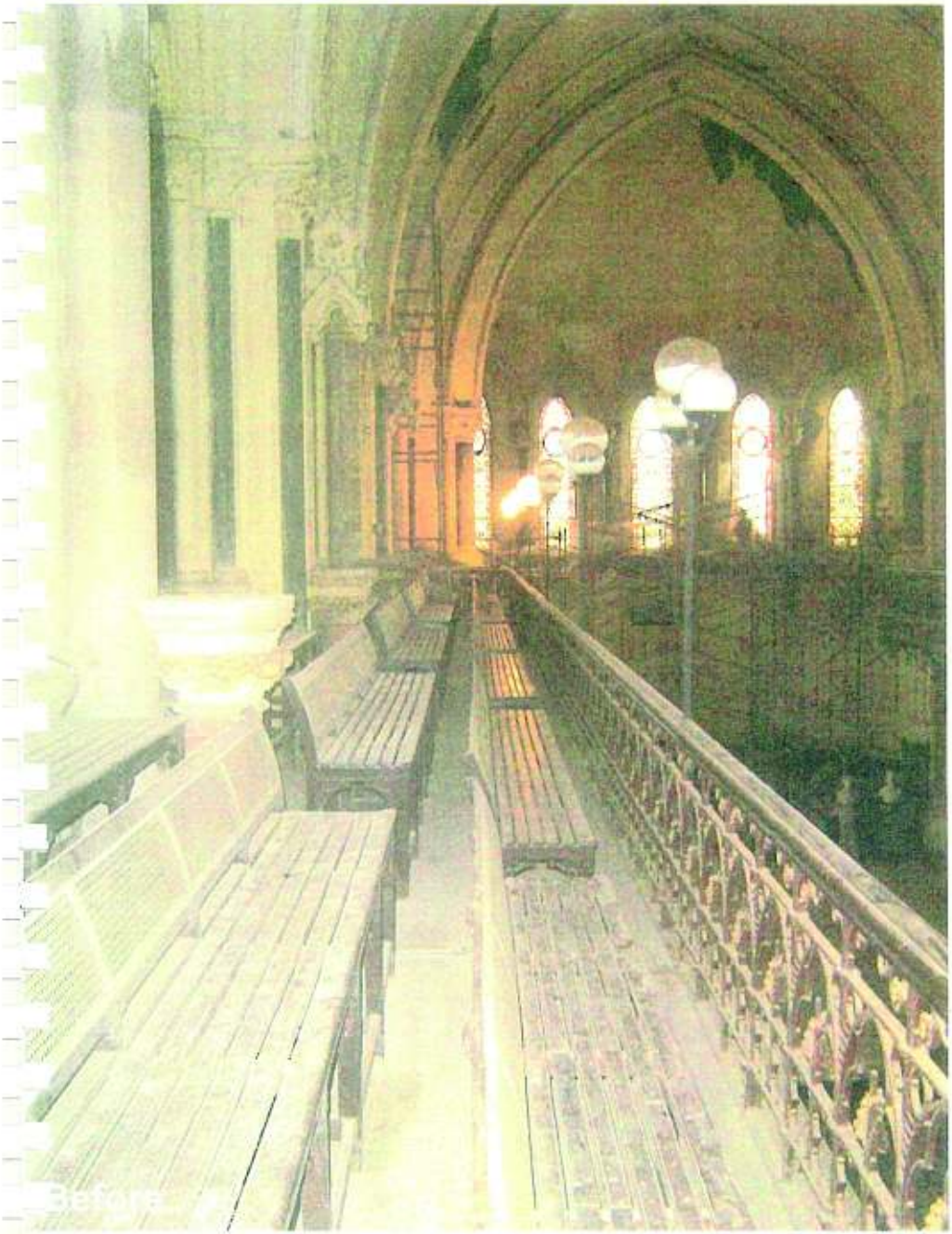
A group of 8 Rajasthani craftsmen worked on the project, applying layers of finely hand pressed pure 24 karat gold leaf.

Repairs to the Viewing Gallery

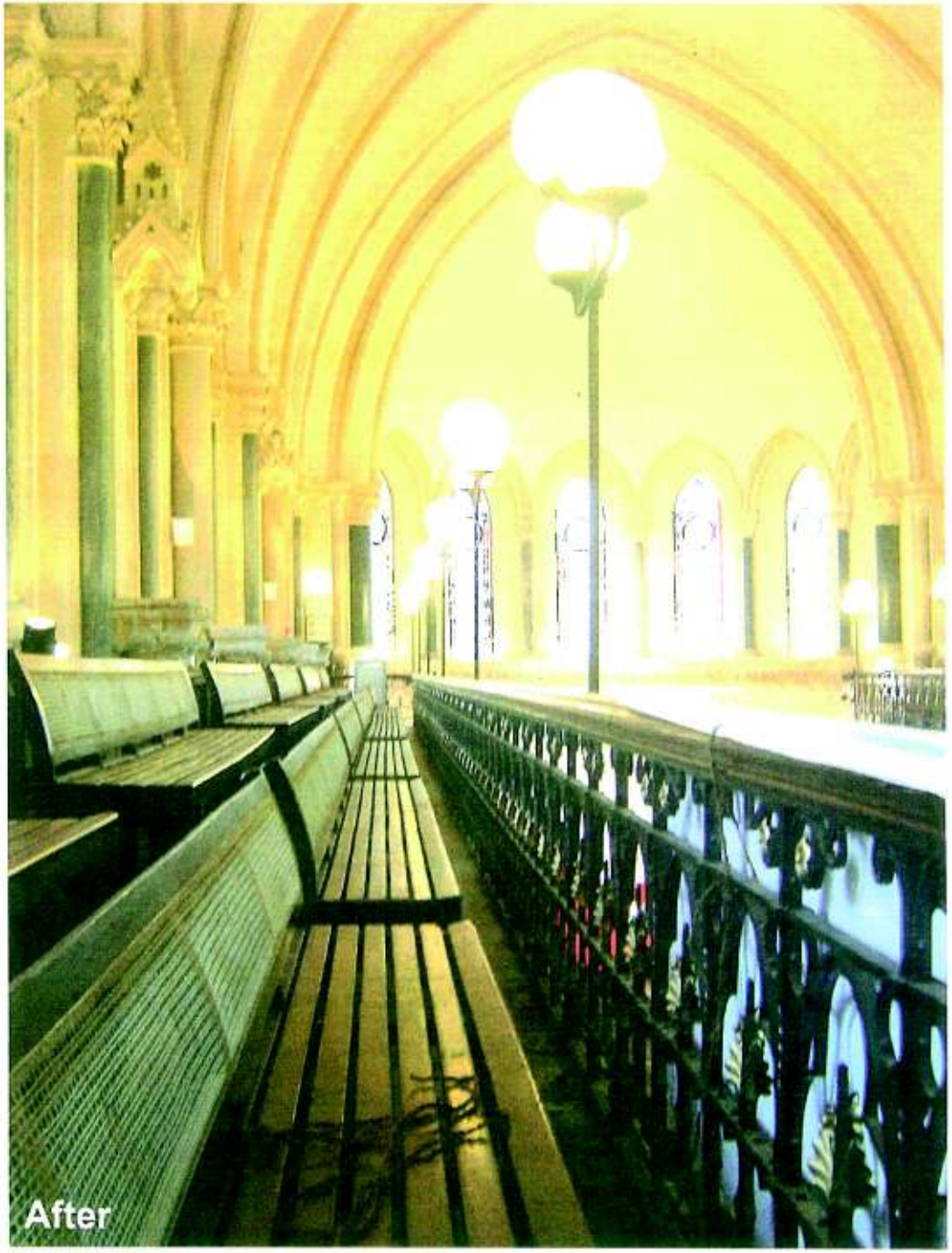
The upper viewing gallery was designed to seat 400 people for the Convocation and Senate Hall functions. However, completely cantilevered from the three ends, the structural stability of this balcony was to be ascertained. Timber planks were opened up and wet rot was suitably addressed. The steps running along this gallery were also used to route electrical conduits (images to right) to run through the entire length of the building without being visible from the hall at the ground level.

Restoration of the Convocation Hall: Viewing Gallery

Repairs to the Viewing Gallery



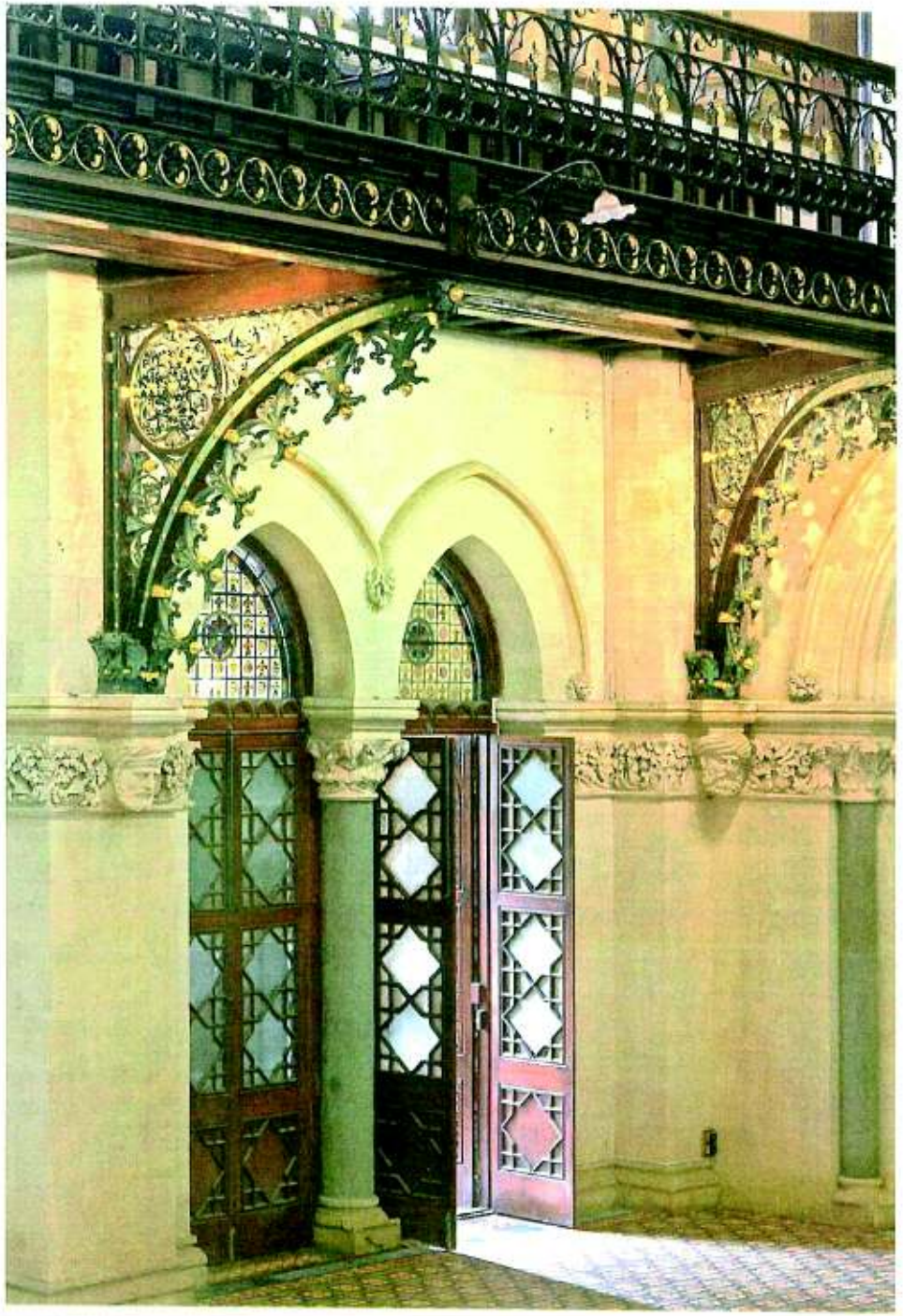
Before



After

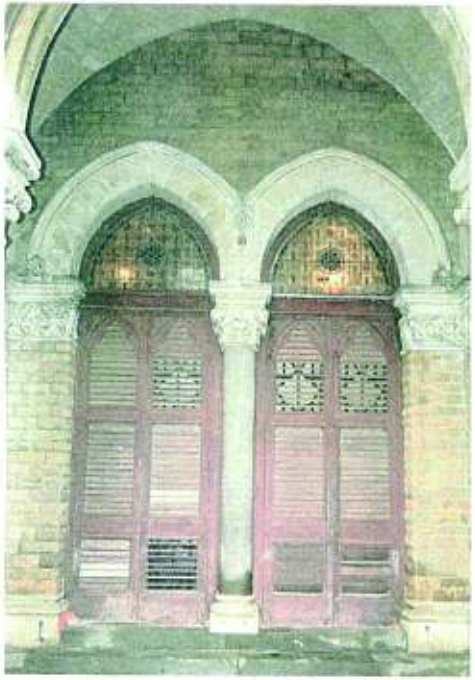
Restoration of the Convocation Hall: Viewing Gallery

Door & Window Restoration



Restoration of the Convocation Hall: Window Restoration

Door & Window Restoration

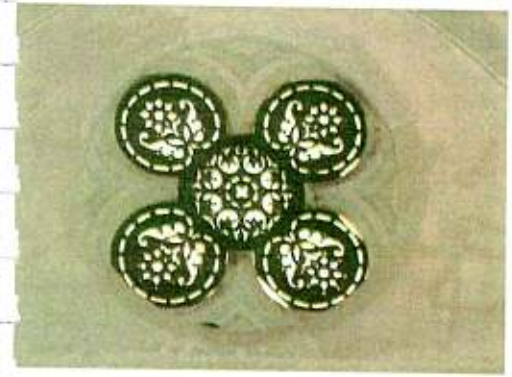


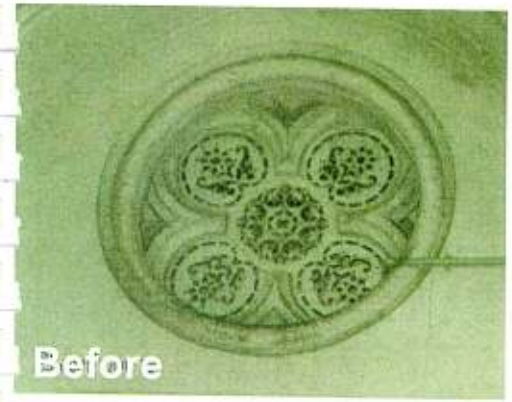
Restoration of the Convocation Hall: Window Restoration

Fretwork Restoration

Above: Fretwork panel inserted in the quatrefoil windows of the upper roof to allow for ventilation of the roof that was earlier damp and un ventilated.

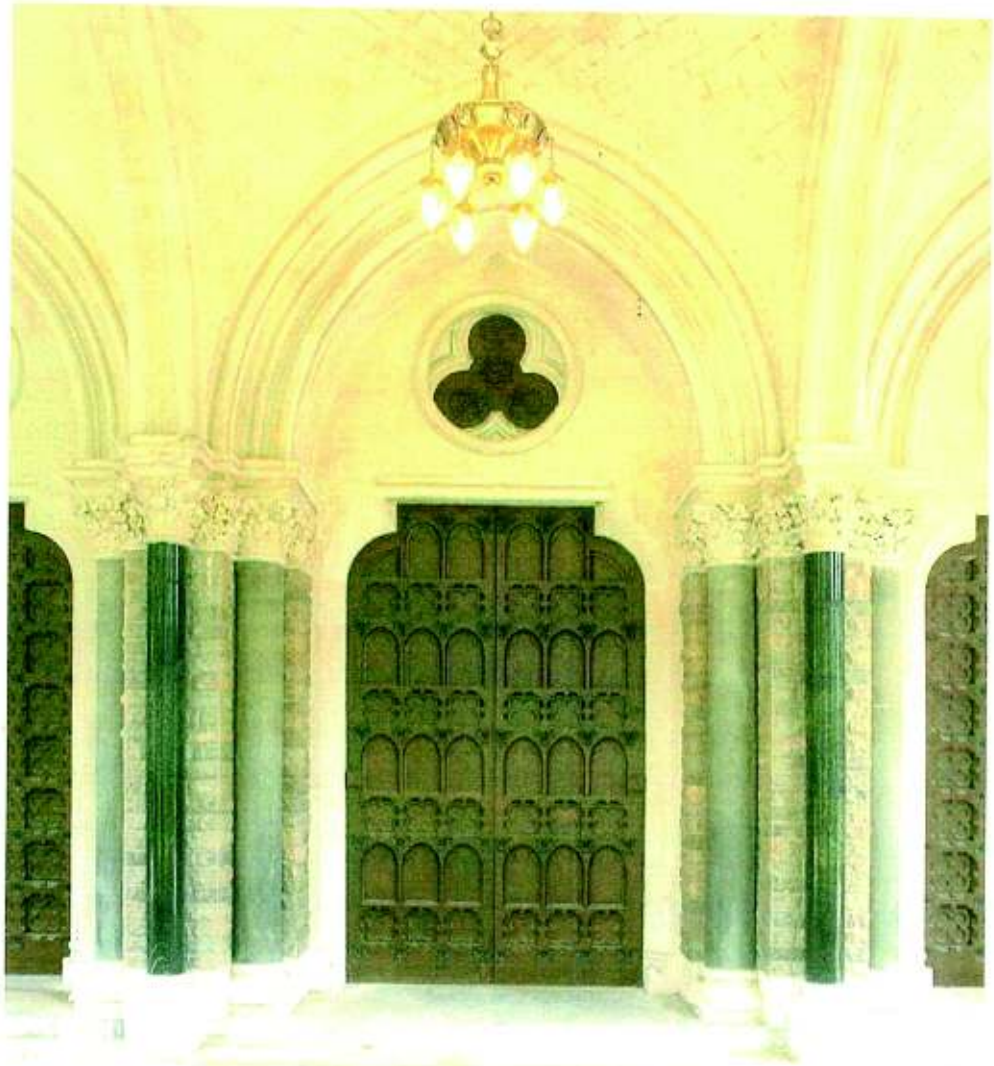
Below Left: Images showing a fretwork fanlight in the porch door restored after removing layers of oil paint.





Far Left: Images of the fretwork panel slit windows on the north face below the wheel window. These were broken and boarded up with plywood, later restored with teak wood fretwork.

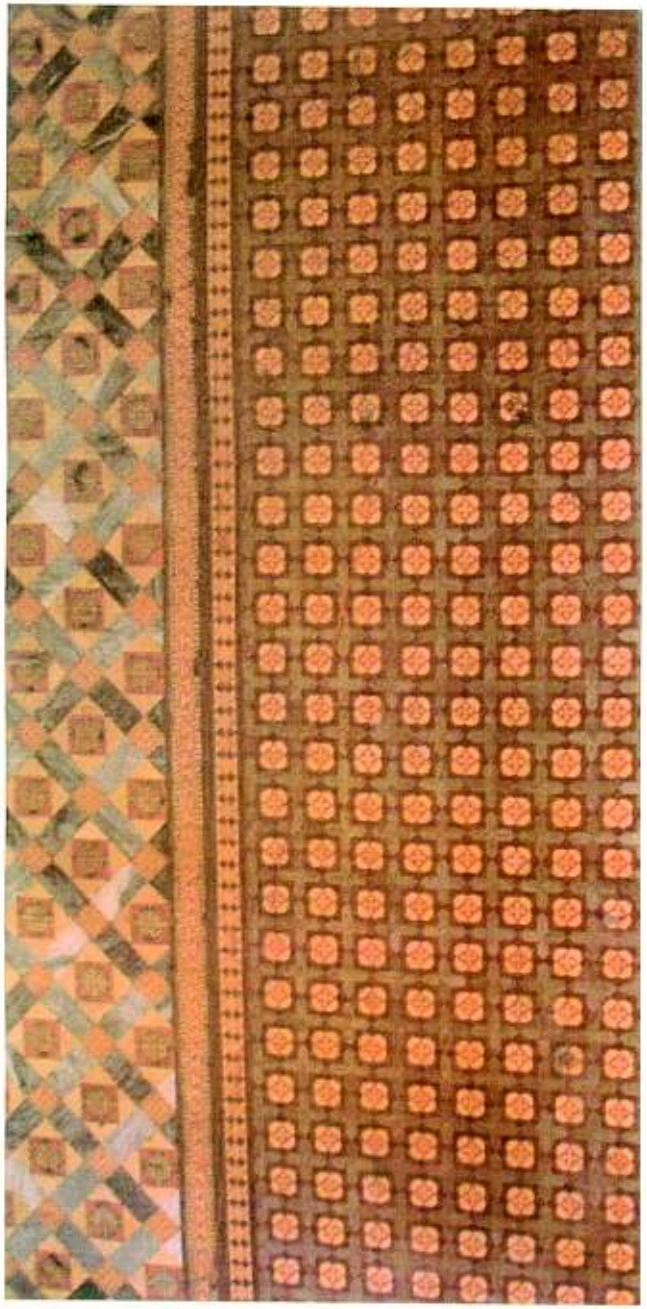
Below: Before and after images of the central entrance door on the north porch that had a trefoil fanlightboarded up with plywood. The other was covered with layers of oil paint. The plywood panels were removed and a missing pentafoil pattern refixed in teak fretwork by replicating the surviving piece on the other door.



Restoration of Minton Tiles

The entire hall, its staircases and verandah were fitted with encaustic Victorian tiles from Minton & Co. At the height of fashion for Victorian buildings of the era, these encaustic and geometric clay tiles were shipped in from Stoke on Trent in England. Inlaid within these at some patterns (top right) was marble. The tiles were found in a range of patters in shades of ochre, terracotta, blue, beige, brown, green and grey. At many places, the tiles were damaged or missing, filled in with cement repair. In other sections, bulging of tiles required to be reset, carefully removing each tile from the bedding and cleaning them , after which they were resent in a lime mortar bedding and wax polished.

Restoration of Minton Tiles



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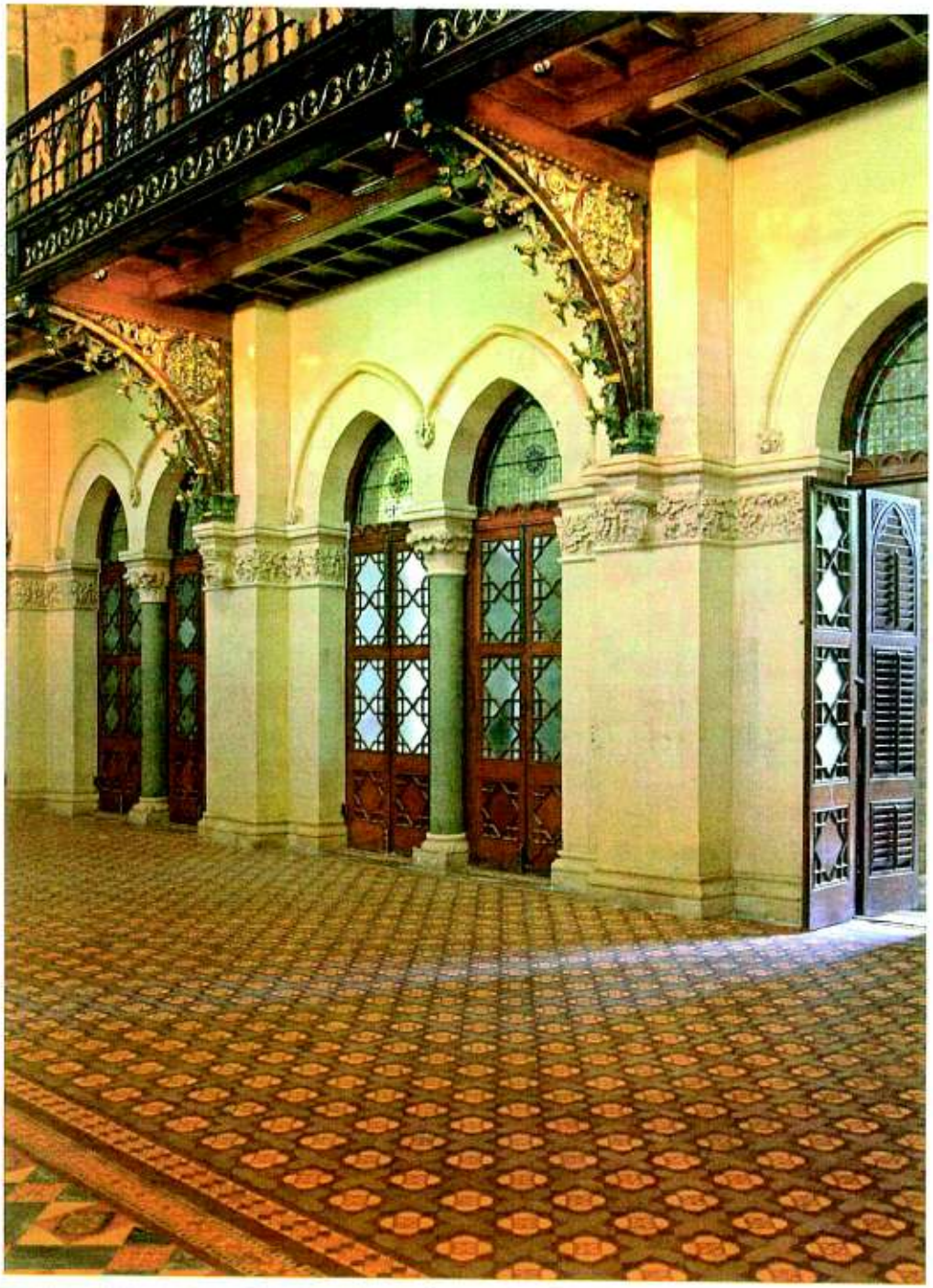
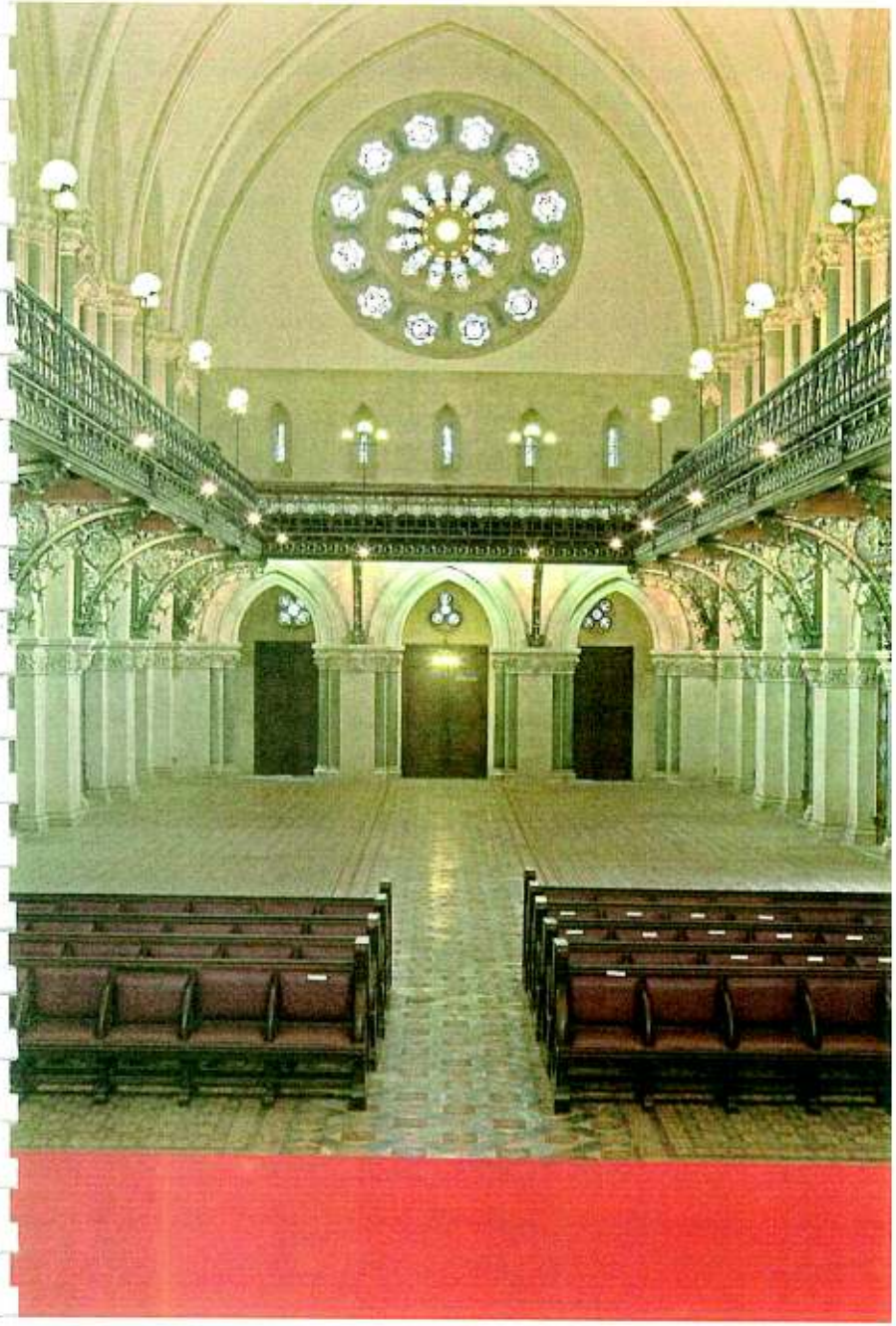


Restoration of the Convocation Hall: Minton Tiles

Furniture Restoration

The Convocation Hall was originally fitted with Burma Teak wood furniture of the Gothic Revival design. The upper galleries had rows of benches with wicker weave backs and the lower hall was furnished with heavy pew like seating of a Gothic Revival design. When the project began, the condition of the upper balcony benches was greatly deteriorated but the lower hall original seating was entire missing. This had been replaced with aluminum chairs and plastic chairs, wholly unsuitable to a grand Victorian space.



The architects found some wooden benches in a rather damaged condition scattered over the offices of the Registrar, and also in the Kalina campus in the suburbs. These were exactly the size of the seating bay in the ground level as defined by the Minton tiles and were of the Gothic revival design, in heavy sections of carved Burma Teak wood and with trefoil carvings. These were collected from all the various campuses and restored.

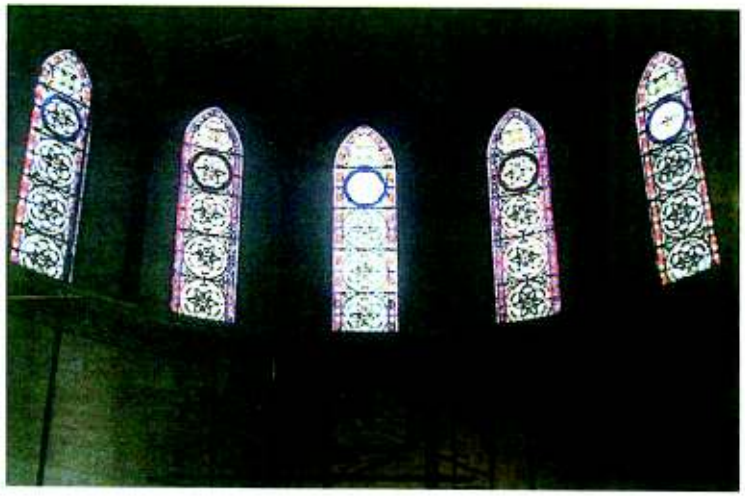
Description of the Stained Glass

The archetypically neo-Gothic buildings of the Bombay University – The Rajabai Tower Library and the Convocation Hall – are resplendent with stained glass. The stained glass in the Convocation Hall of University of Mumbai (earlier known as the **Bombay University Senate Hall**) came from the London studios of Heaton, Butler & Bayne one of the leading studios of the period, in 1873. The Windows are classified into typologies by the team's stained glass expert, Ms. Swati Chandgadkar.

1. The Lancet Lights in the South Apse - **Type I:**

The tall lancet Lights are arranged in seven vertical rows along the Apse and are composed in repetitive geometric-foliate design. The heavy grisaille work together with the ruby-red and blue borders cleverly filters the harsh light from the east side.

Original details: Each lancet-light consists of five independently arranged panels, each of which is located inside a steel (Mild Steel) framework and held internally by horizontal tie-bars that are welded into the steel frame. The second panel consists of a circular panel within a pivot, flanked by smaller triangular ones. The steel frame was fitted into a rebated timber framework which in turn was fitted into the stone rebates of the window. All the lancet-lights were fixed originally from the outside and had a wire-mesh (in MS) for protection.The Lancet Lights were **numbered** 1 to 7 moving left to right, and individual panels within the lancet were numbered 'a' to 'g' moving top downward. Number of independent panels in Type I: 49. Total Area of the South Apse Lancets: 300 sqft.



2. Wheel Window on the North Façade - **Type II:**

Commonly known as the Rose window, the Wheel Window spans twenty four and a half feet in diameter. The composition is characteristic of Rose Windows, depicting the *Sun* as the centre of the Universe and the *Zodiacal Signs* round it in circular panels along with the *Seasons* portrayed in the spinning movement of a *Rainbow*. The design, painting and execution are of a high order and the colours are well-suited for its location on the west side. The spokes of the stone tracery together with the independent panels enhance the effect created by the Wheel shape of the Window.

Original details: The Window has a central panel, an arrangement of panels in the Outer Ring and the Inner Ring. The outer ring panels were located inside steel frames that were fixed into masonry, while the inner ring panels were fixed directly into masonry. All the panels were fixed originally from the outside and had a wire-mesh each (in MS) for protection.

The **numbering** was done thus: 1. Central Panel: No 1 A single painted panel depicting "The Sun" was numbered 1.2. Inner Ring: The twelve 'spokes' depicting the Seasons were numbered beginning with No 2 top-right, at one o'clock position and moving clockwise to No 2, No 3 till No 13. 3. Outer Ring: The twelve "six-petalled" panels depicting the Zodiac signs were numbered begnning with No 14 top-right, at one o'clock position and moving clockwise to No 15, No 16 till No 25. Number of independent panels: 25.Total Area of the Wheel Window: 455 sqft.

Description of the Stained Glass

3. The Heraldic Stained Glass - Type III: The length of the East and West walls is filled with twelve traceries, six on each side. Each tracery holds heraldic glass in **Octafoils** and **Head-to-Lights** that has images of the *Rose*, the *Shamrock* and the *Thistle* in quarry-glazing and the *Crown* in the centre.

The Heraldic glass with its iconography on the Coat-of Arms and Crest is by far the best stained glass in the University buildings and one of the best in the country. The Windows are "true to the science and art of Heraldry in (their) use of the symbols and colours to distinguish eminent people, institutions and even countries. The East Wall consists of: 1, The Arms of Sir Cowasjee Jehangir Readymoney; 2, , University Bombay; and the opposite side – 1, Arms of Lord Elphinstone; 2, Arms of Sir George Russell; 3, Arms of Sir Henry Bartle Frere; 4, Arms of Sir Robert Seymour Vesey Fitz-Gerald (past Chancellor); 5, Arms of Sir Philip Wodehouse (present Chancellor); 6, Arms of the University of Bombay. "Round each shield is introduced the order of knighthood to which the owner belongs, and beneath is a motto on scroll: each circular piece is also surrounded by eight outer foils in which in which are placed the charges of the several shields."[i]

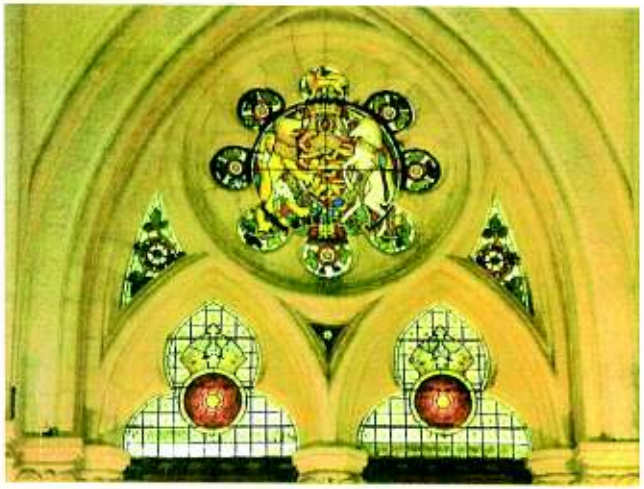
Each Coat-of-Arms personifies the owner through specific imagery. For example, the Coat-of-Arms of Lord Elphinstone, the first Chancellor of the University has "*boar-heads*" from the family Crest, an "open book" to represents *Learning* and the *Golden Lion* with an astern Crown to represent the union of India and England. The heraldic stained glass ranges from highly ornate (flora, fauna, animals, figures) to elegantly simple as in the case of the armorial shield of Sir Cowasjee Jehangir. This panel is composed with eight stars, delicate water-lilies, a golden ray and the motto: *"My Life Is His Who Gave It"*.

Original details: Each bay has a tracery that consists of an Octafoil, three triangular panels or "Eyes" and a pair of trefoils. 1. The central panel in each Octafoil was held internally by a circular steel frame and saddle-bars welded into the frames.

2. The eight independent panels or "foils" surrounding the circular panel were pointed directly and based along the rim of the central circular ring. Of the eight, four panels on the upper (on the left & right sides) section were fitted into pivots in cast-iron. There were no supporting bars or clips to hold the eight panels. 3. The pair of trefoils below the Octafoils were pointed directly into stone masonry and were held internally by three horizontal saddle-bars. 4. The small triangular panels or "Eyes" were pointed inside the grooves of the stone masonry and held internally by a horizontal saddle-bar each.

The **numbering** of the traceries was from 1 to 12, beginning east and moving clockwise to west. Hence, NOs 1to 6 were located along the East wall and NOS 7 to 12 along the West Wall. Within each tracery, the trefoils were 'A'/left and 'B'/right, the Eyes were 'C'/left, 'D'/middle and E'/right.

The Octafoil panels were numbered 'a' moving in a clockwise direction up to 'h', and the central panel was numbered 'F'. The stained glass within each bay was protected from the outside by wire-mesh in MS fixed inside the stone rebates. Number of independent panels: 168. Area: 1,304 sqft.



4. The "Head-to-Lights" / Tympanums (1873) - Type IV: The tympanums are located between Bays on the ground floor. Each bay has a pair of tympanums above the door, summing up an arrangement of twelve pairs along the length of the east and west walls each. The tympanums are designed in a simple quarry-glazing style and each quarry has an elegantly painted "fleur-de-lys" in silver-stain.

Original details: The tympanums were fixed inside timber frames which in turn were fitted into masonry. Each tympanum was held internally by one horizontal saddle-bar (in mild steel) and by timber 'beadings' from the outside. Each panel was protected from the outside by a wire-mesh (in mild steel).

The **numbering** of the tympanums was from 1 to 24, moving east to west in a clockwise direction. Hence, NOS 1 to 6 were located along the East wall and NOS 7 to 12 along the West Wall. Within each Bay, the tympanums were numbered 'A'/left and 'B'/right.

Number of independent panels: 24.

Total Area: 460 sqft.

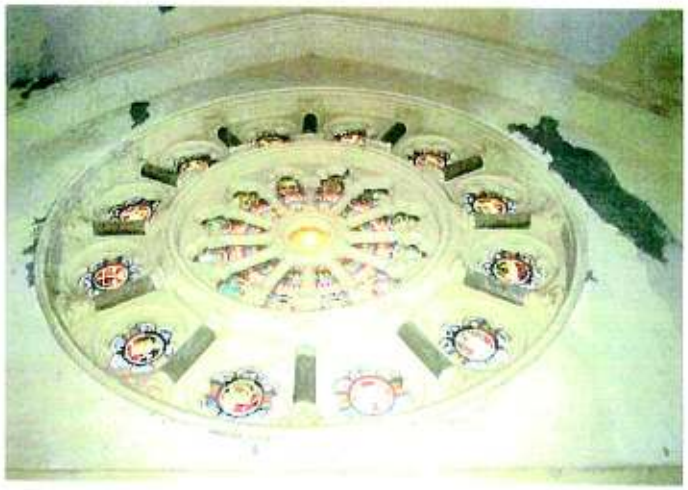
Condition of Stained Glass

Type I / The lancet Lights: The general condition of all the seven lancets was found to be fragile. This was expected considering the south-west orientation of the lights and the onslaught of the rain and the wind currents in the monsoon months. Many panels had come loose of their steel framework and daylight was clearly seen between the 'T' sections and the panels. All seven Lights showed marginal to severe buckling in the lower two panels. There was bitumen on the glass and foliage trapped between glass and wire-guard. In the Head panel of Light NO 6, one of the four foils was missing, while the fourth panel ('d') had 100% paint-loss. Copper-ties of all the pivoted panels had come loose. Most of the mastic-putty had fallen out.

Type II / The Wheel Window: The Wheel window was found to be in stable condition, except for single cracks and slight stress in some panels. The damage to the panels was essentially due to broken masonry into which they were located.

Type III / Tracery Lights: The east side panels were in a better condition than their counterparts on the west side and their proximity to the sea. However, two traceries at the south end of the east wall (NOS 5 and 3) were previously damaged owing to heavy water leakage through the roof. Three foils and two large areas (in NOS 1, 5 and 6) were found to be completely missing, while many cracks were seen in the foils in NOS 7, 10, 11 and 12. The pivoted foils showed stress, glass loss and heavy rust build-up, as the pivots had completely corroded and imposed upon the panels. The trefoils only showed glass and paint loss, but no buckling due to the three tie-bars re-enforcing the panels. Only the 'Eyes' were in good condition as they were small and held well with a tie-bar each.

Type IV / Tympanums: The general condition of tympanums along the East wall was found in comparison with the West wall ones. Acute buckling was seen in NOS 2-B, 8-B, 9-A, 10-B, 11-B, 12-A. The upper section of NO 7-B had come loose and fallen over. Panel NO 11-A was completely missing.



Approach towards the Restoration of Stained Glass

The four basic Conservation principles adopted in case of historic stained glass were diligently observed in the restoration process, and every attempt was made to keep as much of the original material – glass, lead, metal and surrounding masonry – as possible.

1. **Minimum Intervention:** The conservators kept in mind that a dramatic transformation of the existing glass was not the objective and undertook a minimalist approach.

2. **Documentation:** The conservators made extensive records of the original fabric status of the windows in two ways, a) through photographs of the stained glass panels *before* removal of the windows, *during* the bench-repair and re-fixing, b) trough rubbings or impressions of the lead-matrix on tracing papers, of every independent panel that was removed for repair/restoration. The second type records the steps taken in the repair process and is therefore a significant reference for future conservators.

3. **Reversibility of Technique**: The conservators were told to undertake repair techniques that were reversible. By this, certain harmful processes carried out in the past (previous interventions) were eliminated. It ensured reversal of errors in the future as well.

4. **Viewing the Stained Glass in its entirety**: The conservators understood and were sensitive toward materials surrounding the stained glass windows like original fixing methods together with timber framework, steel armatures, lime-mortar, stone rebates, iron dowels. All repair approaches were discussed with the Architect, consultant and the civil contractor when these composite materials had to be addressed vis-à-vis stained glass.

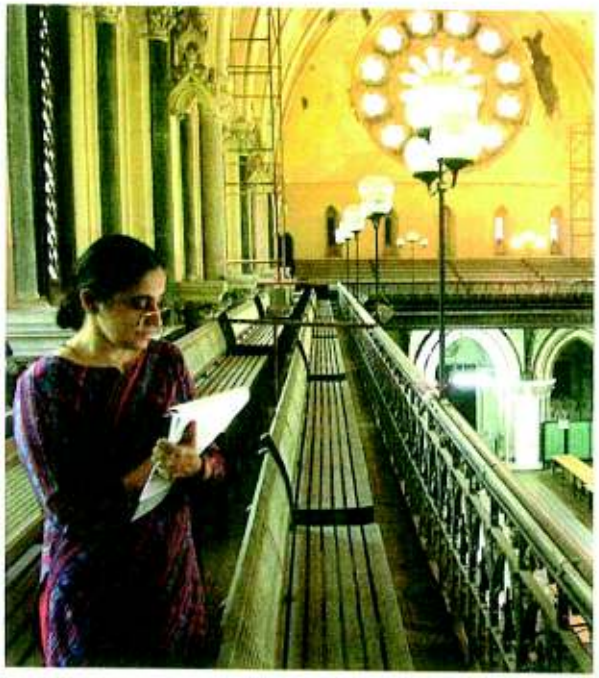
As mentioned above, in view of the limited time allotted by the University to complete a project of this length and breadth, the stained glass restoration work was divided between the two selected conservators based on their respective bids and the strength of their teams. Ms Parveen Mistry's firm was in charge of the Lancet Lights / Type I and the Traceries in the Upper Gallery / Type III. Mr Rohinton Arethna's firm handled the Wheel Window / Type II and the Tympanums / Type IV.

The conservators moved into the University campus and set up their studio in the allocated workshop behind the Convocation Hall on February 4, 2006. Their actual work gained momentum a week when they commenced the removal of their respective windows on february10, 2006.

It is important to state that though a minimal restoration approach was to be taken, all the independent panels had to be removed from Types I, III and IV. This was because the surrounding framework into which these panels were located had been inspected earlier and found to be in need of extensive repairs. In the case of the Lancet Lights (Type I), the steel (MS) armature was in poor condition and had resulted in heavy buckling of the panels. With the Traceries (Type III), the stone cusps were damaged and needed plastic repairs, and the circular steel rings that held the Octafoils had to be re-placed on account of corrosion. As for the Tympanums (Type IV), the fixing methodology had to be improved upon as the outer rebates that held the panels were too narrow, while only one tie-bar each held re-enforced the panels internally. In fact, the "accordion-effect" was already seen in all the 24 panels, with at least two horizontal rows of quarries collapsing. In the Wheel Window only the damaged panels were removed while in-situ repairs were undertaken in the rest.

The stained glass consultant Ms. Swati Chandgadkar emphasised on careful removal of the panels after observing the original fixing methodology, non-abrasive forms of cleaning, the consolidation and stabilisation of its components and their protection against further damage. A regimen of studio work was decided upon for the entire stained glass: a) digital recording and rubbings of the panels to record surface dirt, glass condition, structural stability of the leads and unstable or lost paint, b) determining the repair-approaches to each panel based on its condition and recording the 'line-of-treatment' on the rubbings and in notes after discussion with the consultant, c) making one team member responsible for the treatment of a given panel who would execute tasks from cleaning and stop-repairs to replacing broken/missing glass and re-leading, d) cementing and finishing the repaired panels a team of workers.

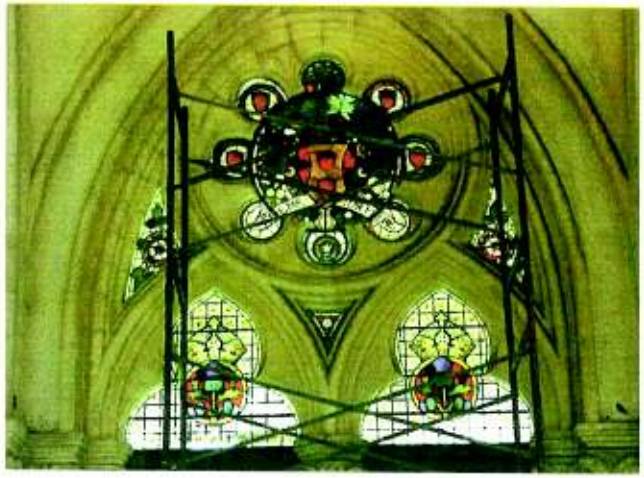
Stained Glass Conservator Swati Chandgadkar inspecting the stained glass work and recording her inputs before the work began

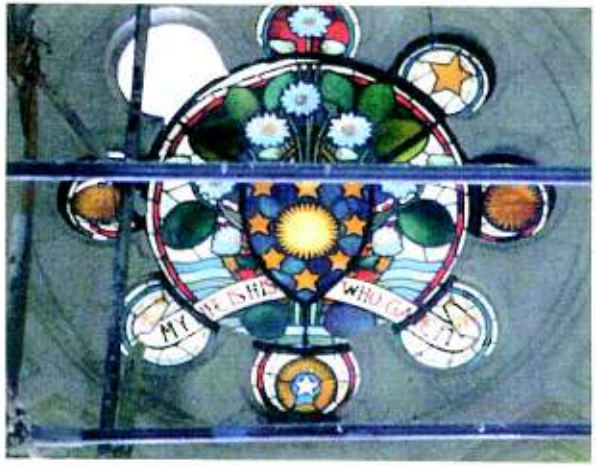


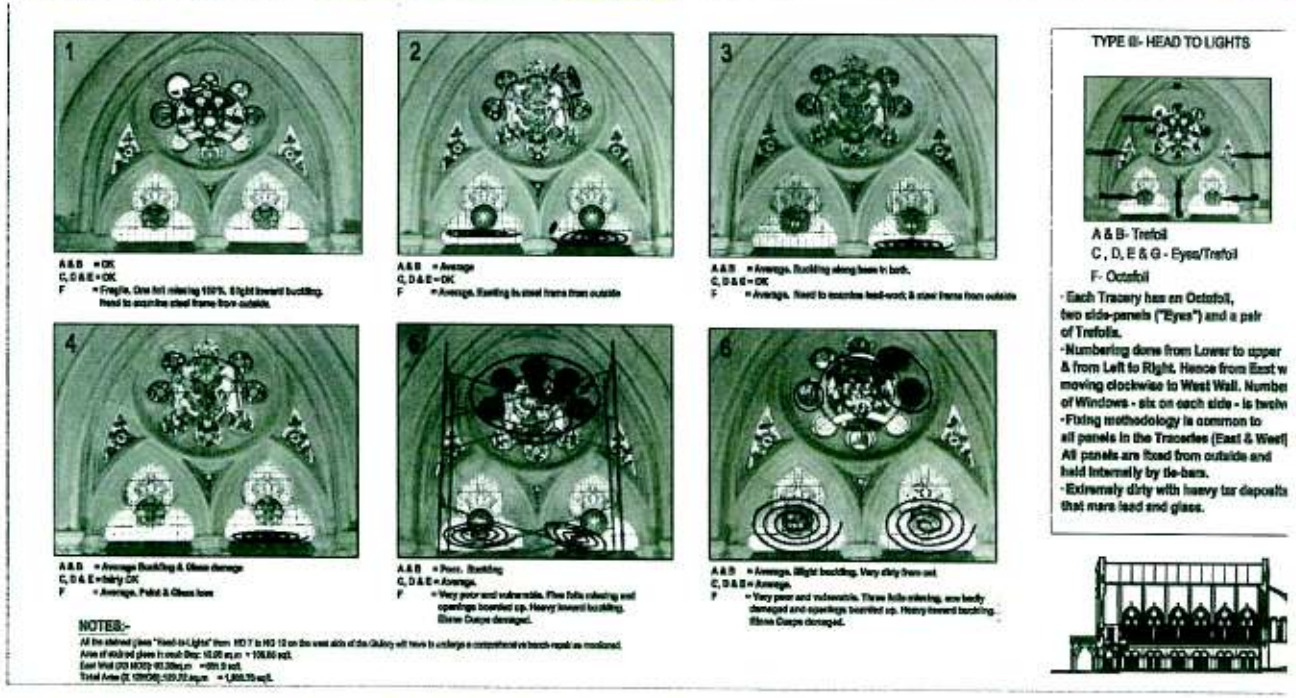
Approach towards the Restoration of Stained Glass

The Specialist Consultant for stained glass restoration was Swati Chandgardkar, a well known conservator with a lot of experience in the restoration of historic stained glass. After undertaking a thorough inspection of the stained glass, the Consultant drew up a detailed pre-qualification Document to select stained glass conservators from across the country for the restoration work of one of the finest stained glass collections in India. The document took care to sift conservators with technical know-how from glaziers or "glass-handlers", as it emphasised not just on the company pedigree of the applicant/conservator in general and the projects undertaken in particular, but also tested their application skills in the specific context of restoration. It included a brief note to be written by the applicant on the Convocation Hall stained glass and the approaches he or she would adopt toward its restoration. As stained glass restoration is still in its nascent stage in India, it was important to determine the selection on knowledge and skills of the conservator rather than his/her company profile and strength of his/her team. This also inadvertently separated the 'Contractor' (under whose jurisdiction all the civil works are done) from the 'Conservator'.

Second, the Tender Document in three volumes: Volume I on General Instructions and Notice to the Tenderees, Volume II on the Scope, Nature and Approaches to Restoration of Stained Glass and Volume III on Schedules of Items and Bill of Quantities. An in-depth mapping of the fabric status of the stained glass was made, complemented by detailed drawings and dimensions given by the lead architects. Stained glass restoration includes several stages that are inter-dependent and cannot be undertaken in isolation. Hence, the Rate-analysis for stained glass restoration had to be quantified based on a holistic approach to the work that included materials involved – lead, glass, iron-works, timber, mortar – and the integrated and highly specialised "skills" (as against "labour") to address these materials.







Top: Scaffolding was erected to closely study the extent of damage to the stained glass panels. These were carefully boarded up with protective plywood panels when the restoration work began. Later, as the stained glass work progressed, these were taken down for bench repair.
Above: View of a typical Tender Drawing prepared for stained glass, illustrating the kind of defects to be addressed

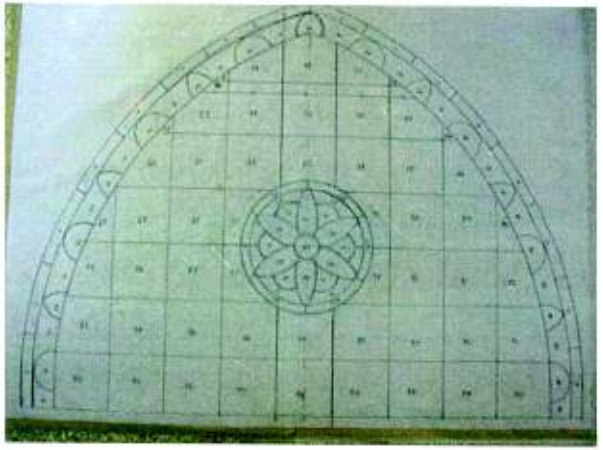
Stained Glass Restoration

Numbering of the panels: The *Corpus Vitrearum* system of numbering was adopted. Though all the panels were fixed from the outside, all numbering was from the inside; the Lancets were in Arabic numerals, from left to right, the Wheel Window was divided into radial sections in capital letters, the traceries and the tympanums were in capital letters.

Removal of the panels: A certain methodology was followed here. In case of panels located into stone rebates, they were first freed of the mortar before untying the copper-ties from inside. In case of panels fitted into steel armatures, one panel was removed at a time beginning with removal of the metal wedges, then untying of the copper-ties and finally releasing of the panel from the mastic-putty from the outside. In case of panels joined with interlocking, *division* leads, care was taken to start removal from the top moving downward and by loosening the copper-ties to flex the panel.

Cleaning of the panels: Mechanical methods of cleaning were used instead of chemical methods. In case of calcium or lime deposits on the glass and stubborn surface dirt, soft-bristled brushes were used with "Teepol" (a non-alkaline) liquid soap. This was done only when the paint was found to be stable. The more tenacious dirt on paint areas (if stable) was cleaned with glass fibre brushes. In case of unstable paint, only dry form of cleaning was done using dry, soft cloth or cotton swabs. The cleaning process also revealed the exact status of the paint and improved the translucency of the glass colours.

Types of repair: The panels were inspected closely by the conservators to determine the type of repair. In most cases, all single, neat cracks in the glass within a stable and firm matrix around it were either "strap-headed" or sealed with an epoxy resin in-situ. As required. Glass with multiple cracks was removed from the leads and mended using either the copper-foil method (as "mending leads" were not available), where the glass edges were grozed, or by edge-bonding with silicone where the cracks were neat. The edge-bonded piece was then re-assembled into the panel with a 2mm



glass back-platted introduced inside the same leads. As for the lead matrix, care was taken not to dismantle it unless it showed over 50% lead-fatigue or lead-joint fractures. Only the damaged leads were replaced by new ones. In exceptional cases where the panels were found in a buckled state compounded by the above damage was complete re-leading undertaken.

As for painted glass, the approach was damage–specific, as re-painting is an irreversible intervention and therefore unacceptable as it destroys the historic value of the glass. This argument is more rigid in the case of medieval glass. Here, the following was done:

a) In case of more than 75% paint-loss, the glass was replaced and re-painted using the existing as reference guide. Care was taken to match glass and paint oxides with the original.

b) In case of less than 75% paint-loss, the "leave-as-found" principle was adopted, especially if they were in a fairly stable panel.

c) In case of missing glass, the area was recovered by glass newly cut and painted using the surrounding as reference guide.

Cementing of the panels: Every single panel, whether in-situ and on the bench, was cemented on both sides to render them water-proof. In case of in-situ cementing, the cement-putty was introduced into the leads with fingers instead of brushes. This had to be carefully without applying pressure on the glass.

Re-fixing of the panels: All the panels were re-fixed by using the same methodology as in the original. All the damaged MS saddle-bars were replaced by new ones in SS. The external framework meant to fit the stained glass was repaired or replaced with new as required.

Top: Rubbing of the stained glass panels before intervention helps accurately record the panel. After this, a tracing of the exact dimensions is drain up with each section numbered.
Middle: Reconstructing missing paint
Bottom: Changing external leads

Stained Glass Restoration: Lancet Lights on Apse End

1. The Lancet Lights / Type I: Here, the stained glass was located entirely into MS frames and pivots, and the damage was mainly due to rusting of these frames, especially the 'T' sections. Also, paint loss was considerable in many panels.

A decision to retain the original iron fabric was taken, mainly because the 'L' sections were not available in the local markets. Complete new vertical sections (fabricated by joining two plates of the desired width) or partial replacement of old sections by new ones would only weaken the structure of the frames. Hence, repair and intensive anti-corrosion treatment of the original was desired over new frames and pivots. Only the horizontal 'T' sections found to be in poor state were replaced completely. Though pivots in SS were available, using two incompatible materials welded into each other was not advisable.

As for the lost paintwork, it was originally due to heavy use of borax (a common approach in the 19th century when glass was mass-produced) to quicken the firing. The paint had completely disappeared in many quarries especially (note: No. 6b), but the original glass was intact. Only a faint trace of the original line-work could be seen. A decision was taken by Ms Parveen Mistry to use the original glass and reconstruct the lost paintwork on it *instead of cutting new glass to match*. This was acceptable, because an exact match of the original glass could not be procured, and the original pigments had disappeared.

Small lengths of leads were 'nibbled at' by squirrels from the outer side of the panels.. However, this unusual activity had not weakened the leads, rather had only marred them visibly. Hence, these leads had to be replaced by new ones only partially rather than the entire length as is the practice.



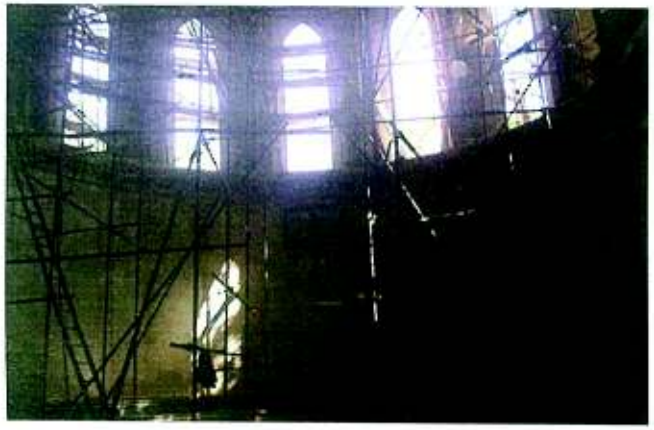



Above From Left: Panel with lead came eaten by squirrel; During Bench Repair; Panel After repair of lead came



Above From Left: Panel before Restoration; During Bench Repair; Panel After Restoration

Stained Glass Restoration: Lancet Lights on Apse End



Top Left: The seven lancet lights in the south apse end were badly damaged due to the heavy leakage along this section of the roof. Above: The scaffolding was erected and the lights carefully removed to enable bench repair.

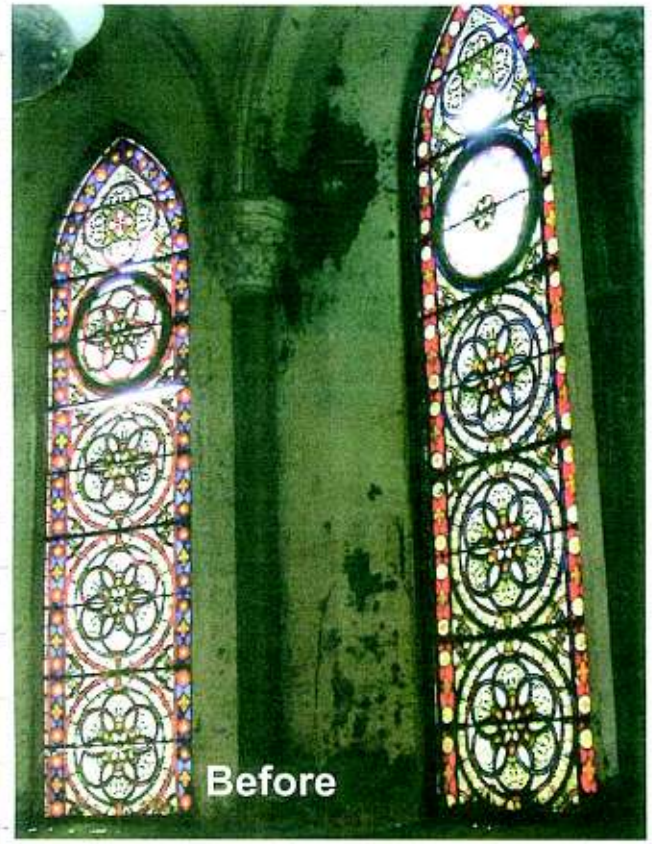
Right Top Row: Before and after Lancet 1

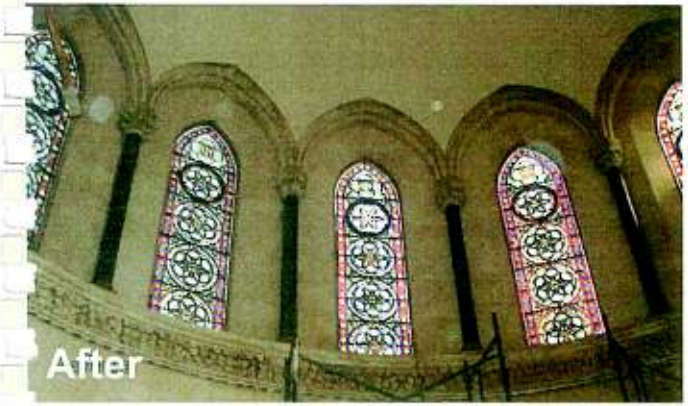
Right Middle Row: Paint loss was carefully restored

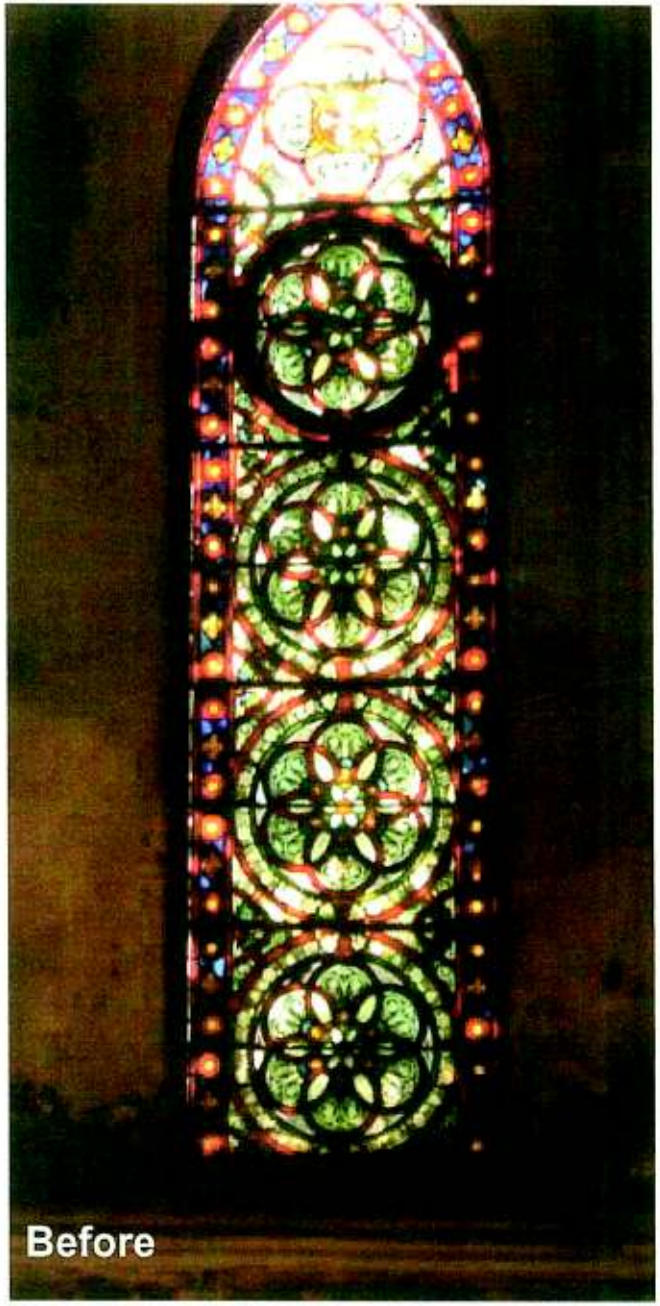
Right Bottom Row: Before and After images of a panel

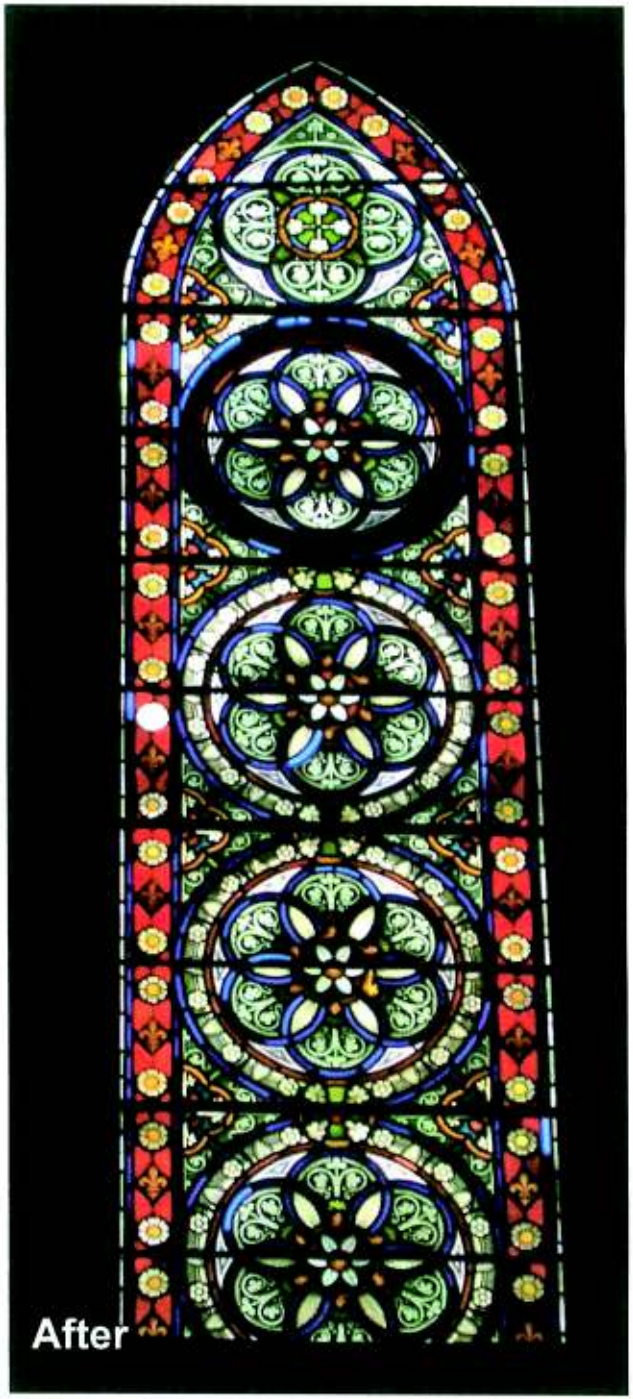
Restoration of the Convocation Hall: Stained Glass

Stained Glass Restoration: Lancet Lights on Apse End









Restoration of the Convocation Hall: Stained Glass

Stained Glass Restoration: Wheel Window on North End

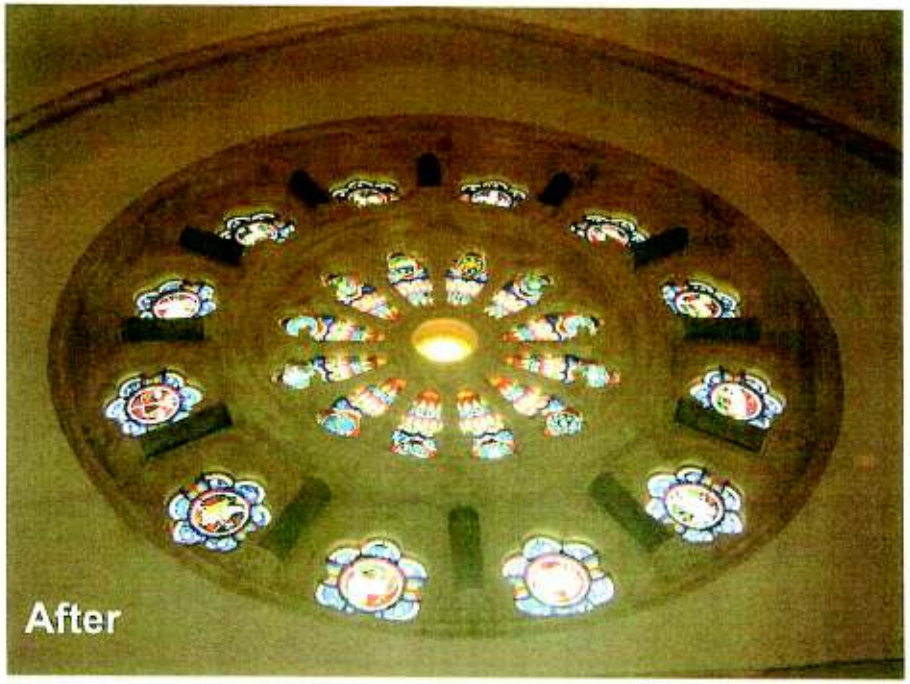
2. The Wheel Window / Type II: Here, twelve panels (50% of the window) were found to be buckled and damaged removed. However, as the surrounding material (stone and ferramenta) were found to be good condition, it was decided to repair the panels in-situ. This included stop-repairs to the cracks, re-enforcement of weak lead-joints and re-cementing of the panels on both sides. De-stressing in some panels was also conducted in-situ by loosening the copper-ties and lime-mortar. These time- consuming and complex activities were carried on by Mr Arethna and his team on the scaffolding in the most painstaking manner. Only panels that had paint and glass loss were removed for bench-repair.

Top: The wheel window seen from the interior before restoration.

Right: The wheel window after restoration

Left Top: View of the exterior face of the wheel window.

Left Bottom: Damaged condition of the wire mesh on the exterior surface



3. The Tracery Lights / Type III: Here, maximum damage was to the glass in the surrounding foils that were on pivots. The heavy rust build-up had caused these small panels to loosen from their frames.

The pivots were in cast-iron and were badly corroded. They were originally held into the stone cusps with the help of (MS) dowels. It was decided to replace the damaged and rusted pivots with new ones in MS rather than repair them being in cast-iron. The new pivots were heavier than the original and hence, in addition their original fixing, they were also welded into the circular ring along their base. In case of the rings that held the circular panels, the damaged ones were completely replaced with new ones.

Far Left: The exquisite details of paint on the tracery lights, by far the most superior work of painting

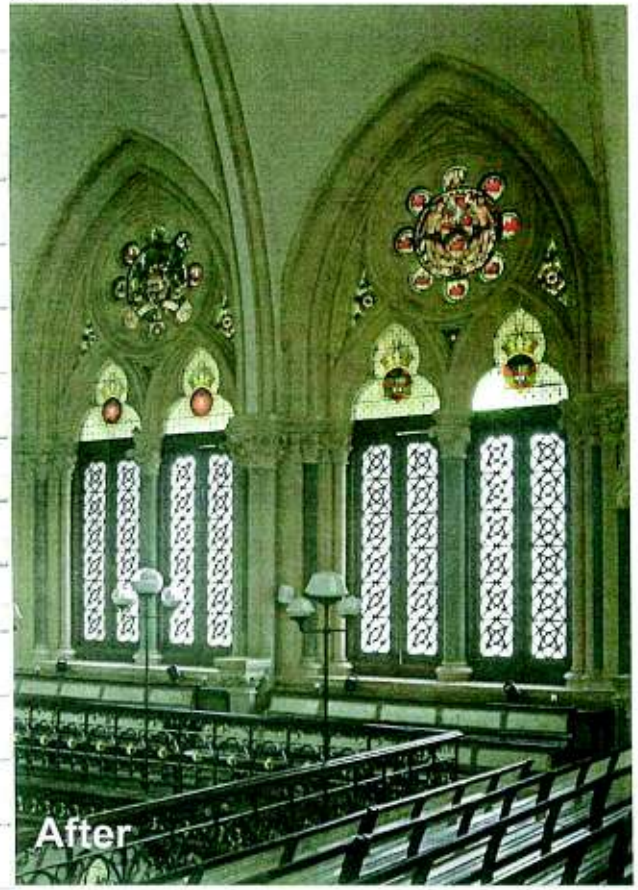
Top Left and Middle: Newly painted sections

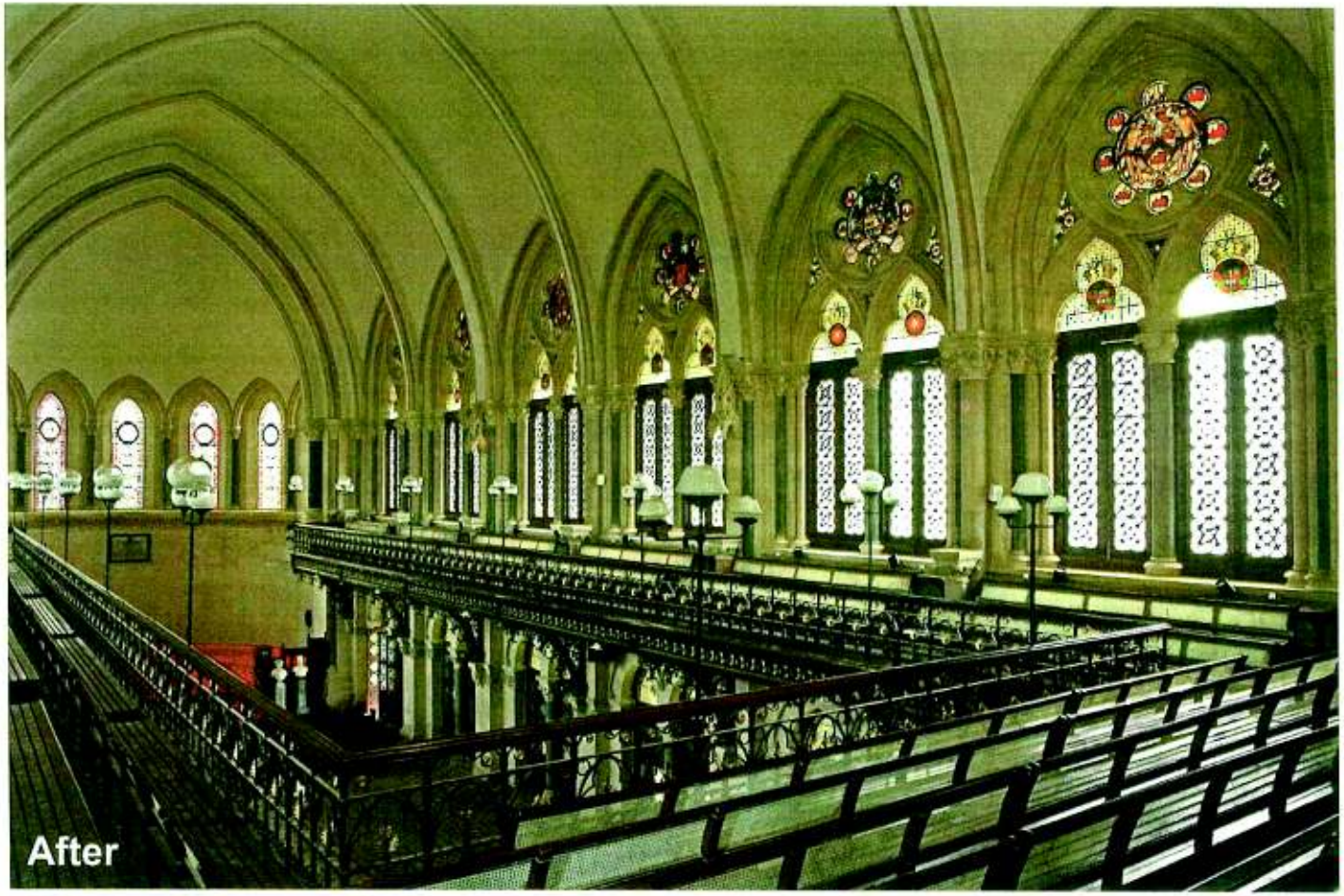
Left: View of a reconstituted piece with painted panel inserted.

Above: Reconstruction of lost paint

Stained Glass Restoration: Tracery Lights on East & West

Much of the design in these Octafoils was foliated and represented in an olive-green shade of glass. This shade and texture of glass was common in the 19th century but is quite uncommon today. Also, the location of these windows did not permit sharp, natural light favourable to stained glass to pass. Hence, Ms Mistry decided to edge-bond or strap-lead even multiple cracks instead of re-placing them with new glass as this form of intervention was not perceivable due to the poor light. This way the original glass was retained as much as possible. To combat the unavailability of the olive green pieces, blue glass was used and silver-stained to gain the olive tone.





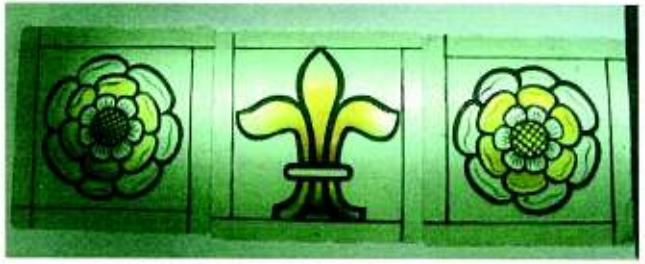
Stained Glass Restoration: Tympanums on East & West

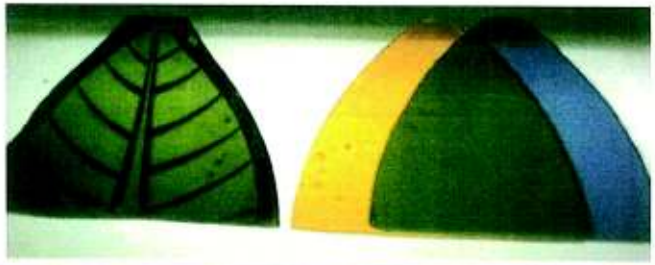
4. The Tympanums / Type IV: Here, three new interventions were undertaken by Mr Arethna.

An 'accordion effect' was seen in the quarry-glazed tympanums, and one panel (7B) had completely bent over its saddle-bar This is common in grid patterns when lead fatigue sets in owing to age and weathering augmented by appropriate re-enforcement like saddle-bars. Hence, one extra saddle-bar (SS, 12mm in gauge) was added to the tympanums along the upper horizontal section and the existing original one (fitted in the centre) was re-located along the lower base of the panel. This gave added support to the panels. The new bars matched the original in gauge and material.

Many quarries showed partially or fully lost paintwork, though the silver-stain was found to be in impeccable condition. As re-painting is an irreversible process, it was decided to retain these quarries with silver-stain in tact and to restore the lost paint by painting on new matching glass. The lost paintwork was reconstructed 'face-to-face' on a 2mm back-plate and inserted into the leads with the original piece as one unit. The periphery of the two quarries was sealed with silicone to prevent condensation or cement seepage.

The original timber 'beadings' that held the panels in their rebates were moulded to fit the curvature of the tympanums. During removal, many were found to be "jointed" to achieve this curve. As many were warped and had got further damaged when the panels were removed, it was decided to replace all the timber beadings with new ones in Burma Teak. Two things were achieved with this intervention: one, the partial pieces of beadings were replaced with full mouldings with no joints, and two, the original narrow rebates (¼") were made deeper (½") and thus, improved upon.





Top Row: The Conservator preparing rebates for re fixing; Right: Glass cut and painted for new panel

Middle Row: A missing section reconstituted

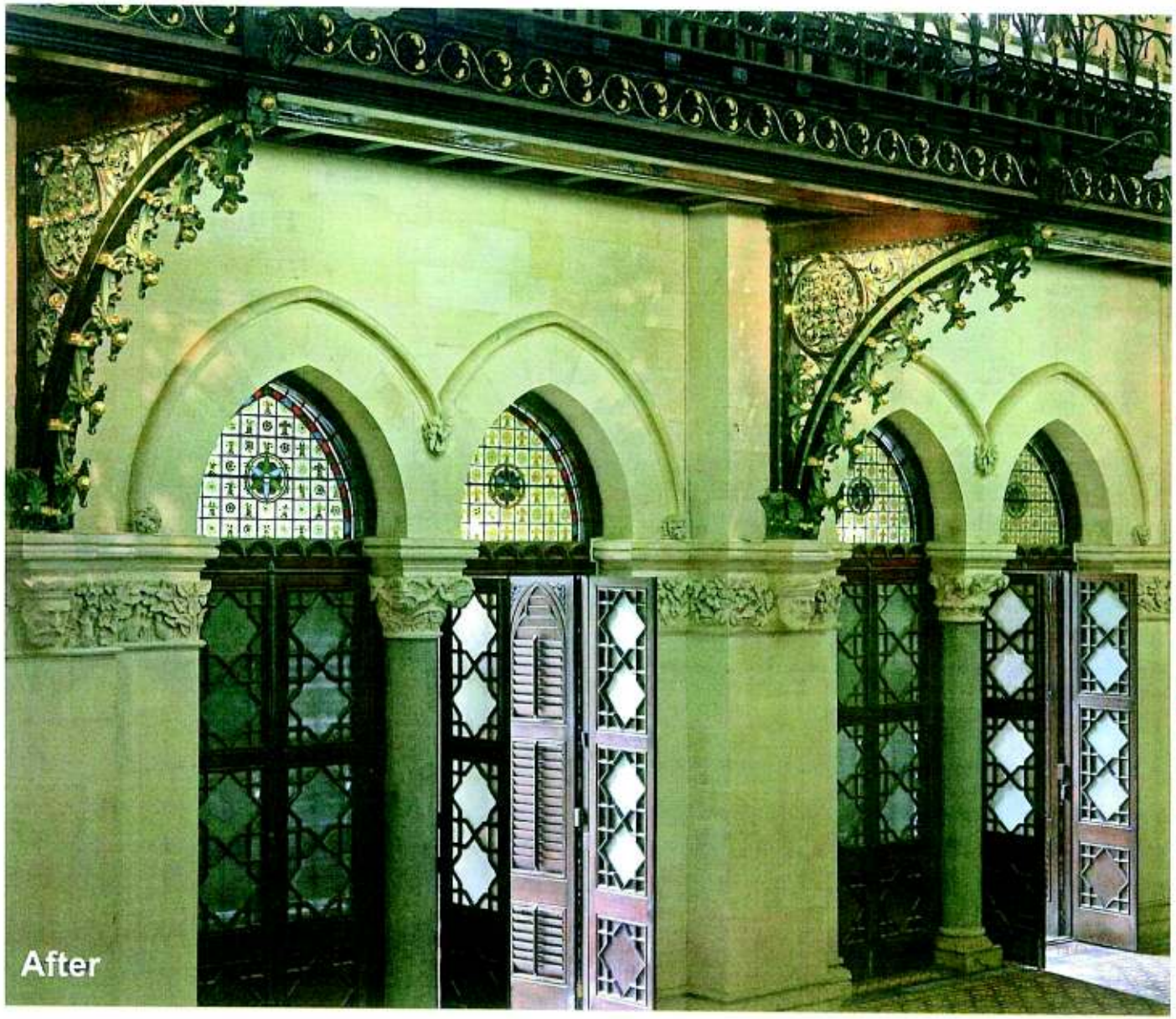
Bottom Row: Pieces silver stained and matching glass by back platting.

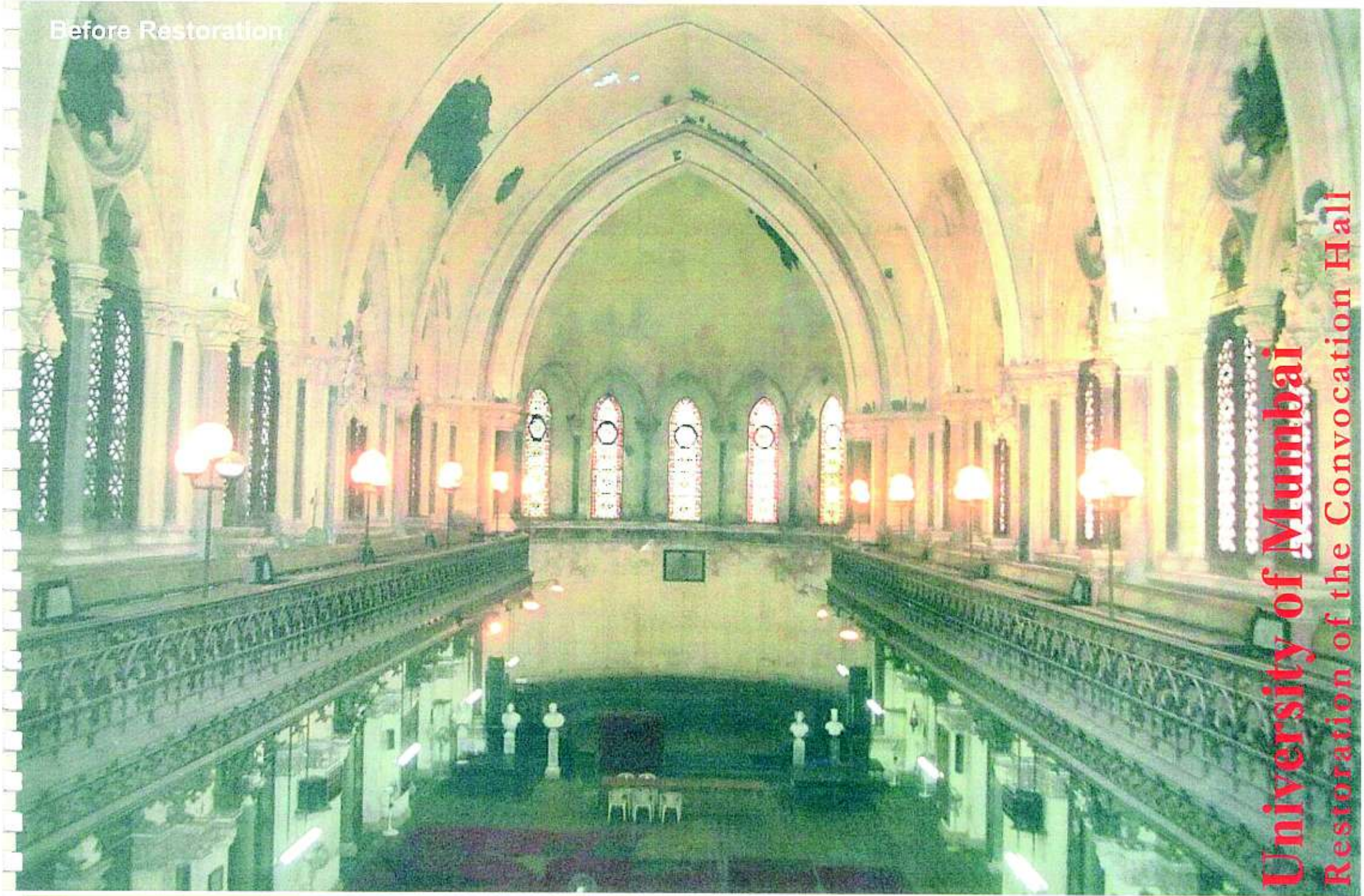
Stained Glass Restoration: Tympanums on East & West

One missing tympanum (11A) was completely reconstructed. A new cartoon was made by Mr Arethna using the adjacent panel (11B) as reference and the same painting and staining style, and imagery was adopted. Attention was given to match the original glass, the lead profile and the leading technique. All departures from the basic principles of conservation were well argued by the conservators; and all interventions were made with the approval of the Architect and the stained glass Consultant, and were recorded.

Below: The tympanums were badly damaged with some sections buckling and others completely missing

The entire stained glass restoration work which commenced on February 4, 2006 was completed in four months. Mr Rohinton Arethna completed his work on June 10, 2006, and Ms Parveen Mistry completed her work on June 25, 2006.





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Restoration of the Convocation Hall

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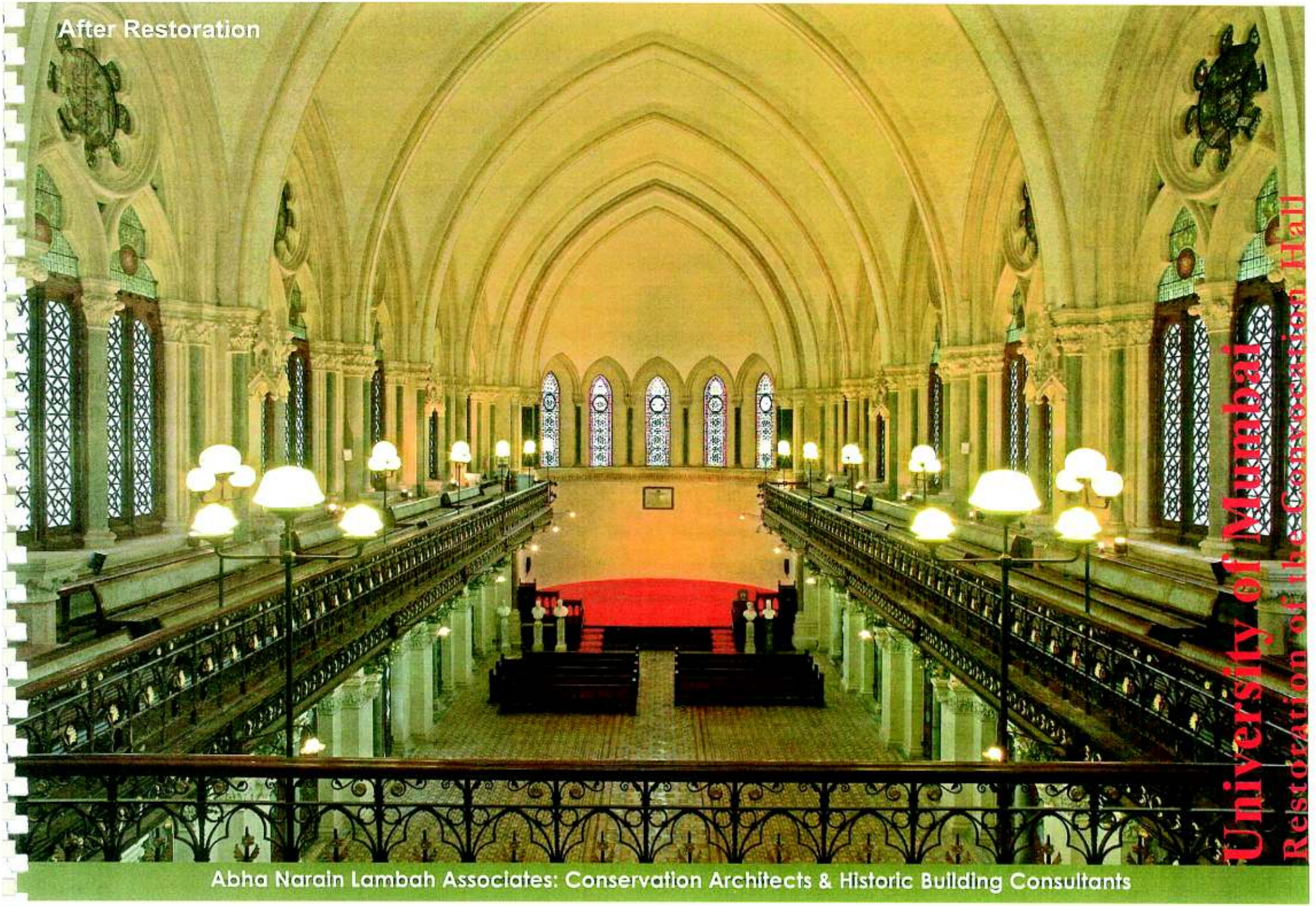
After Restoration
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Restoration of the Convocation Hall
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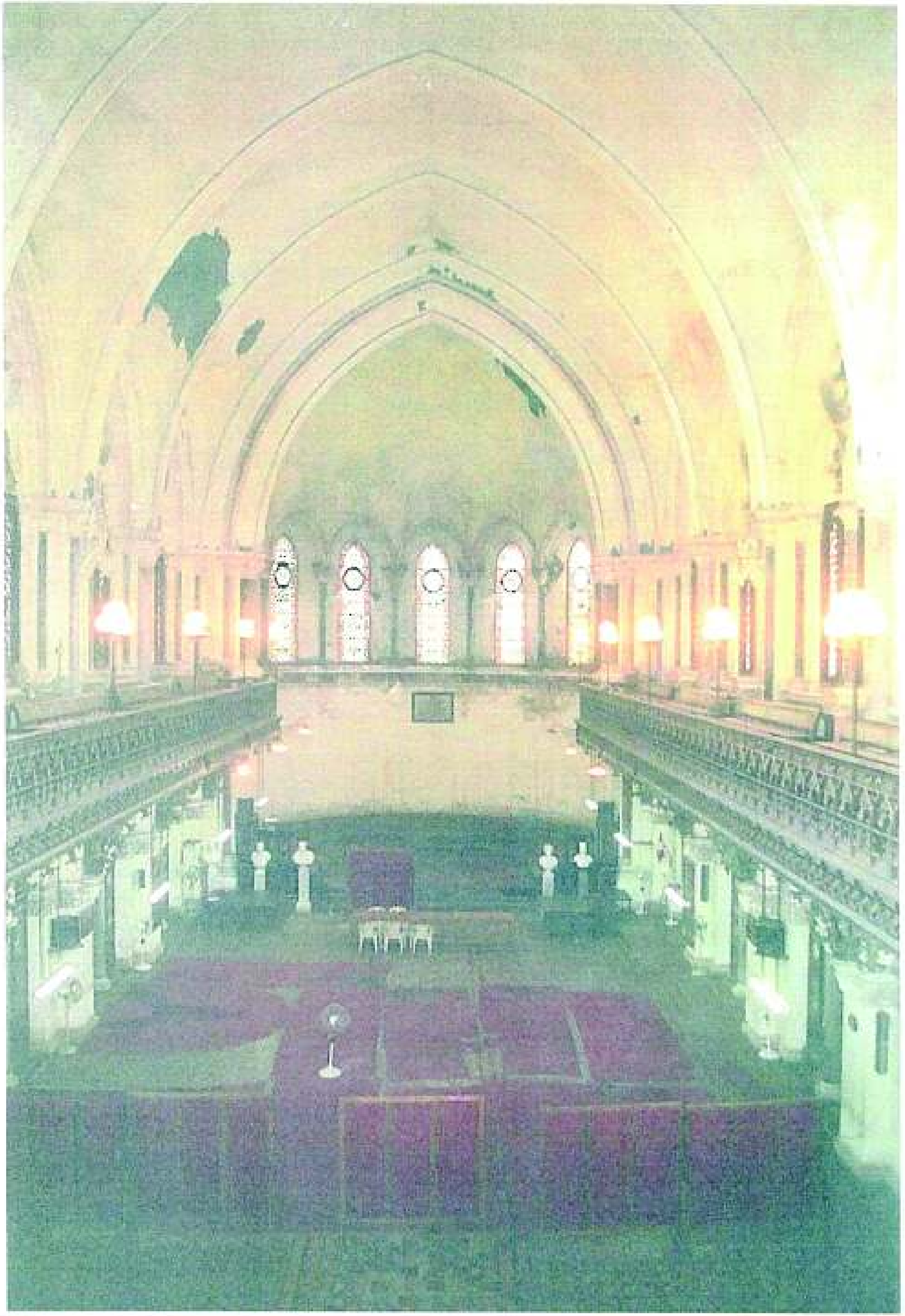
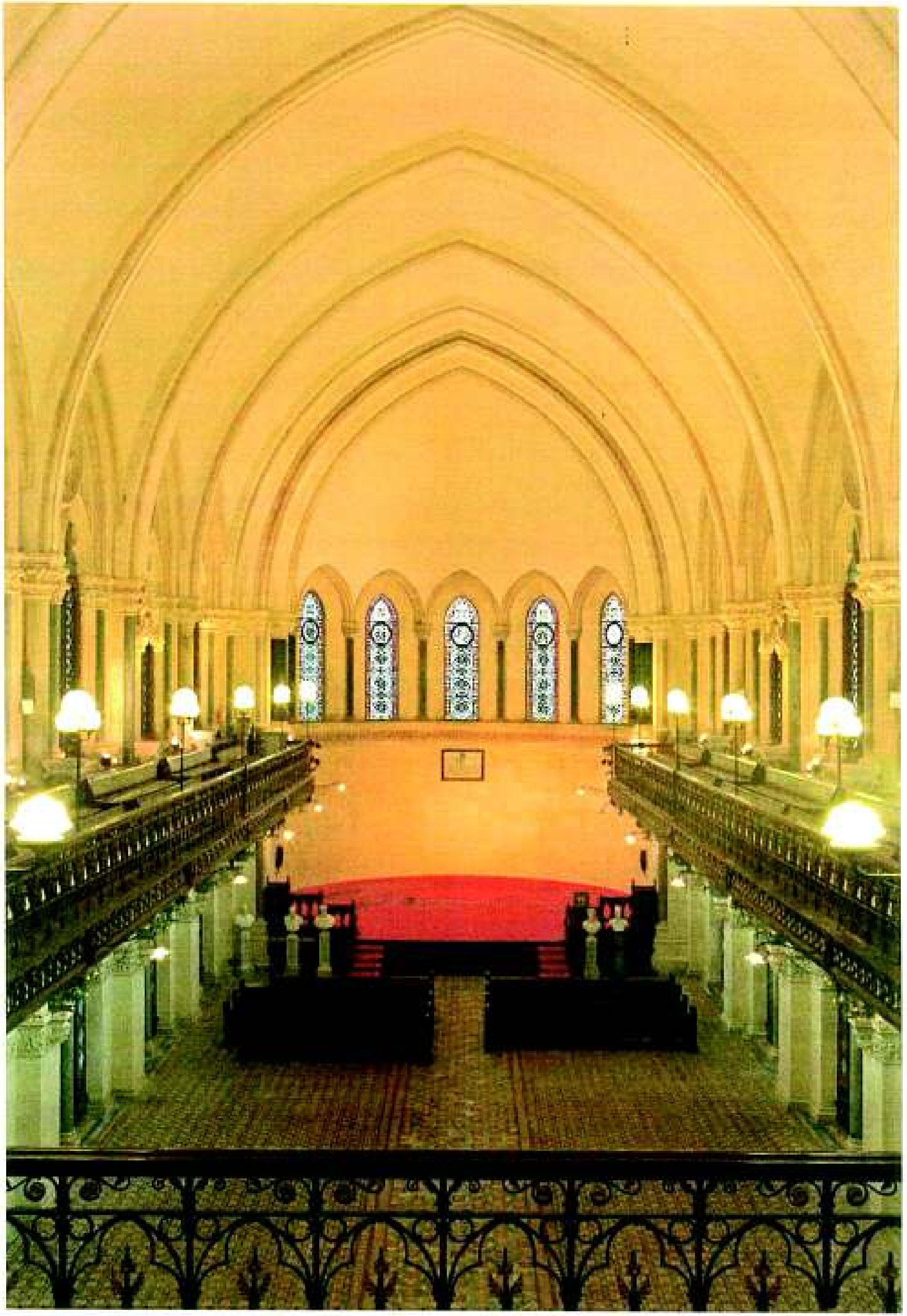
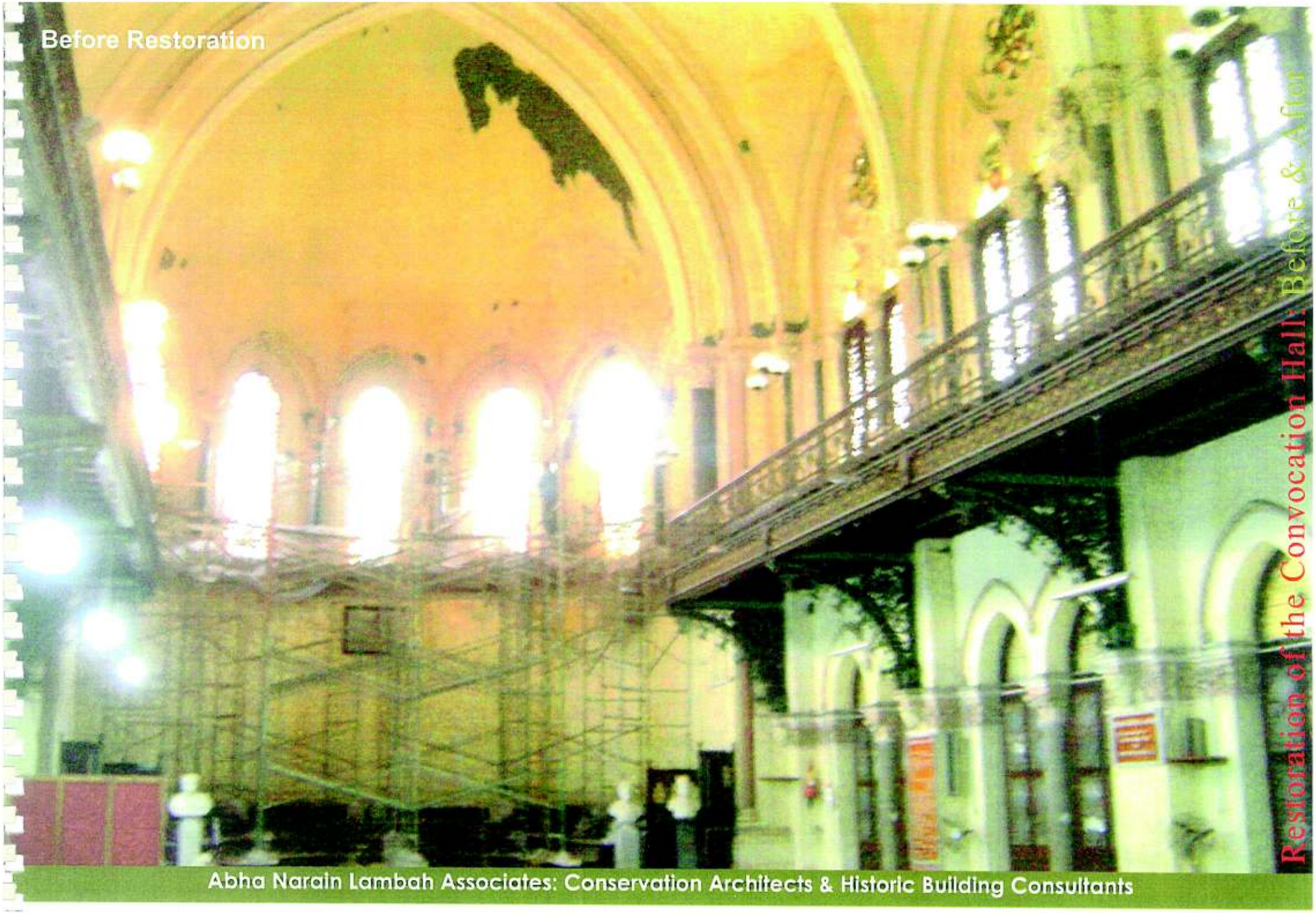
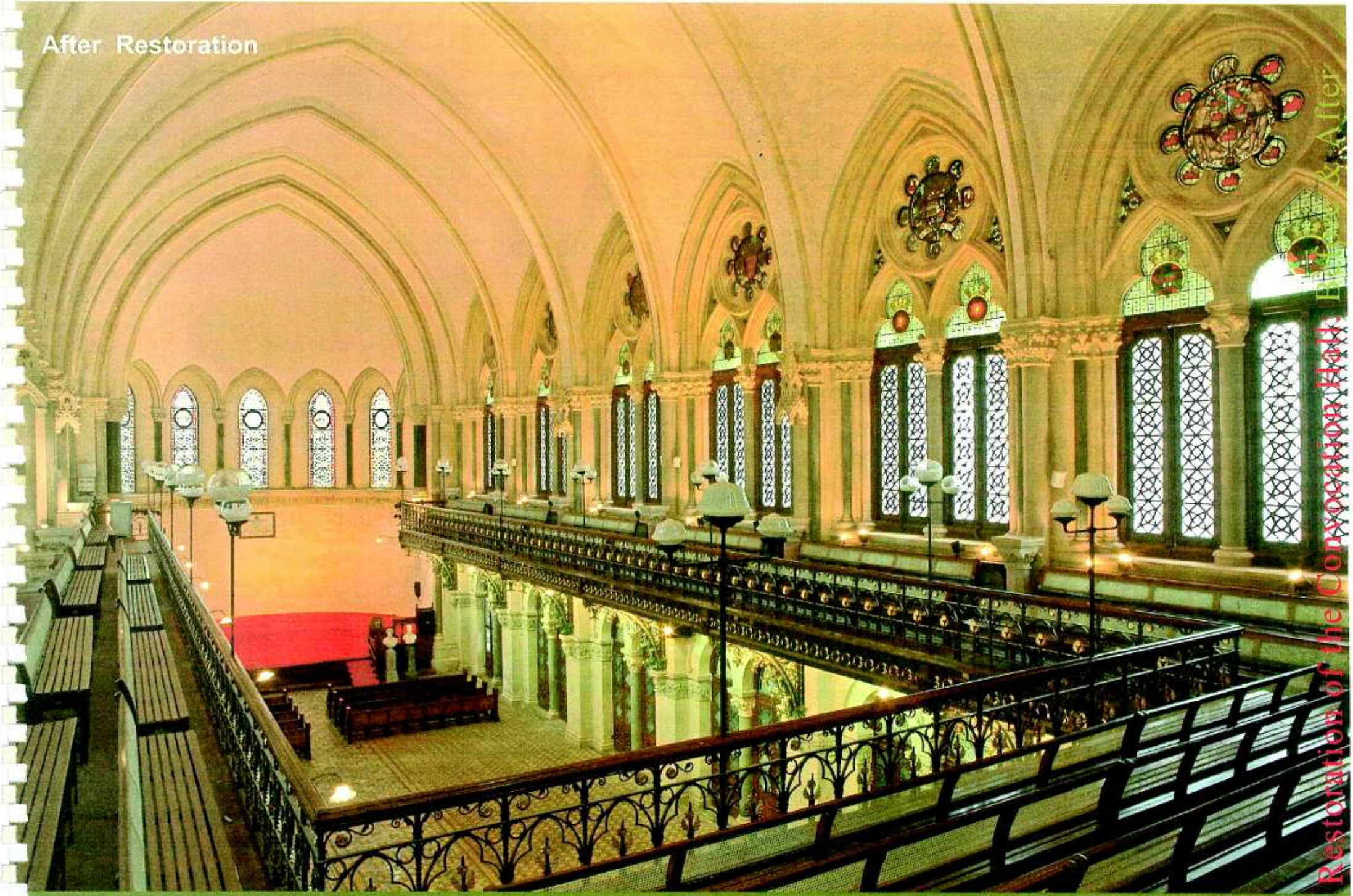




Restoration of the Convocation Hall: Before & After


Before Restoration
Restoration of the Convocation Hall: Before & After
Abha Narain Lambah Associates: Conservation Architects & Historic Building Consultants


After Restoration
Restoration of the Convocation Hall: Before & After
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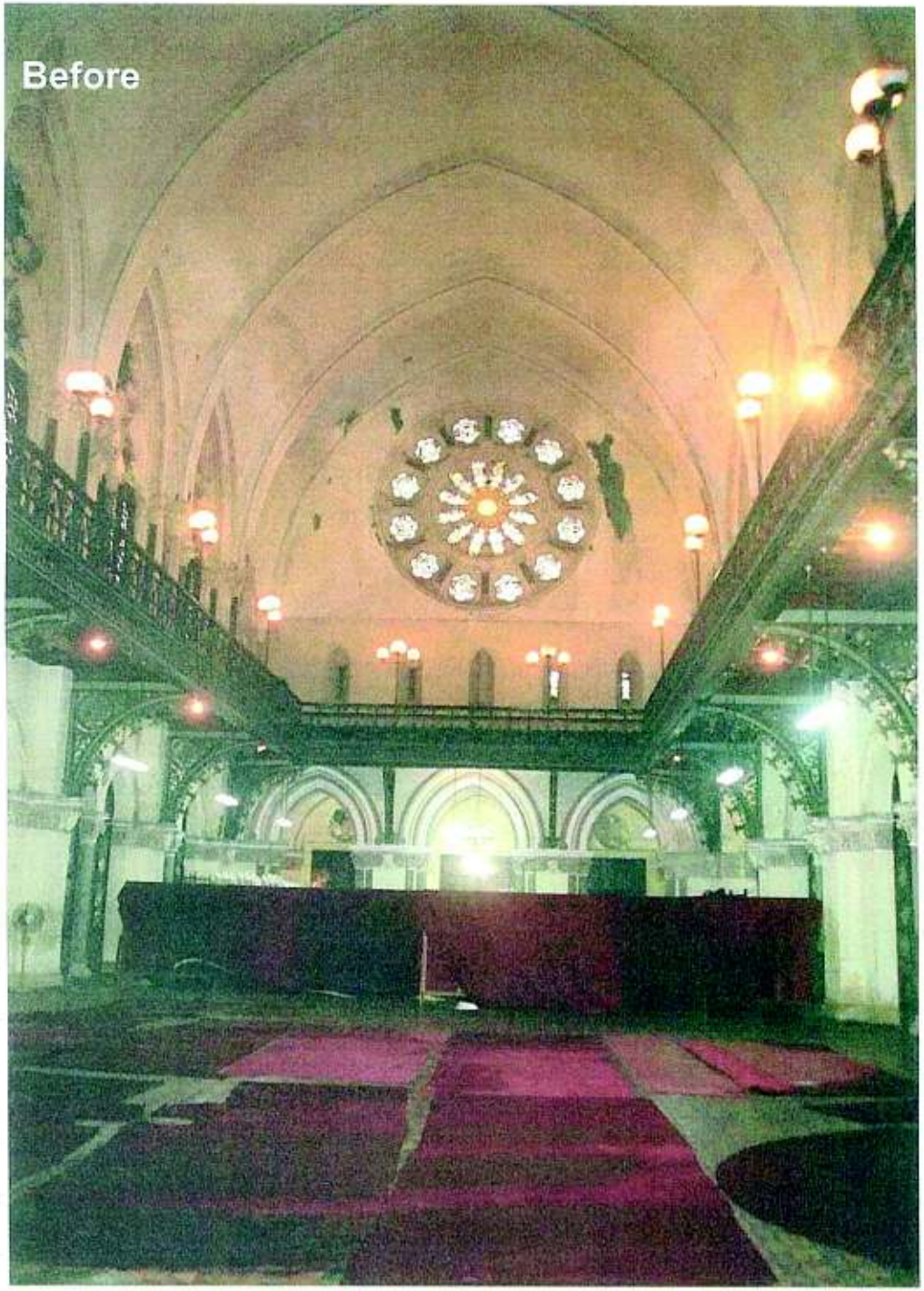

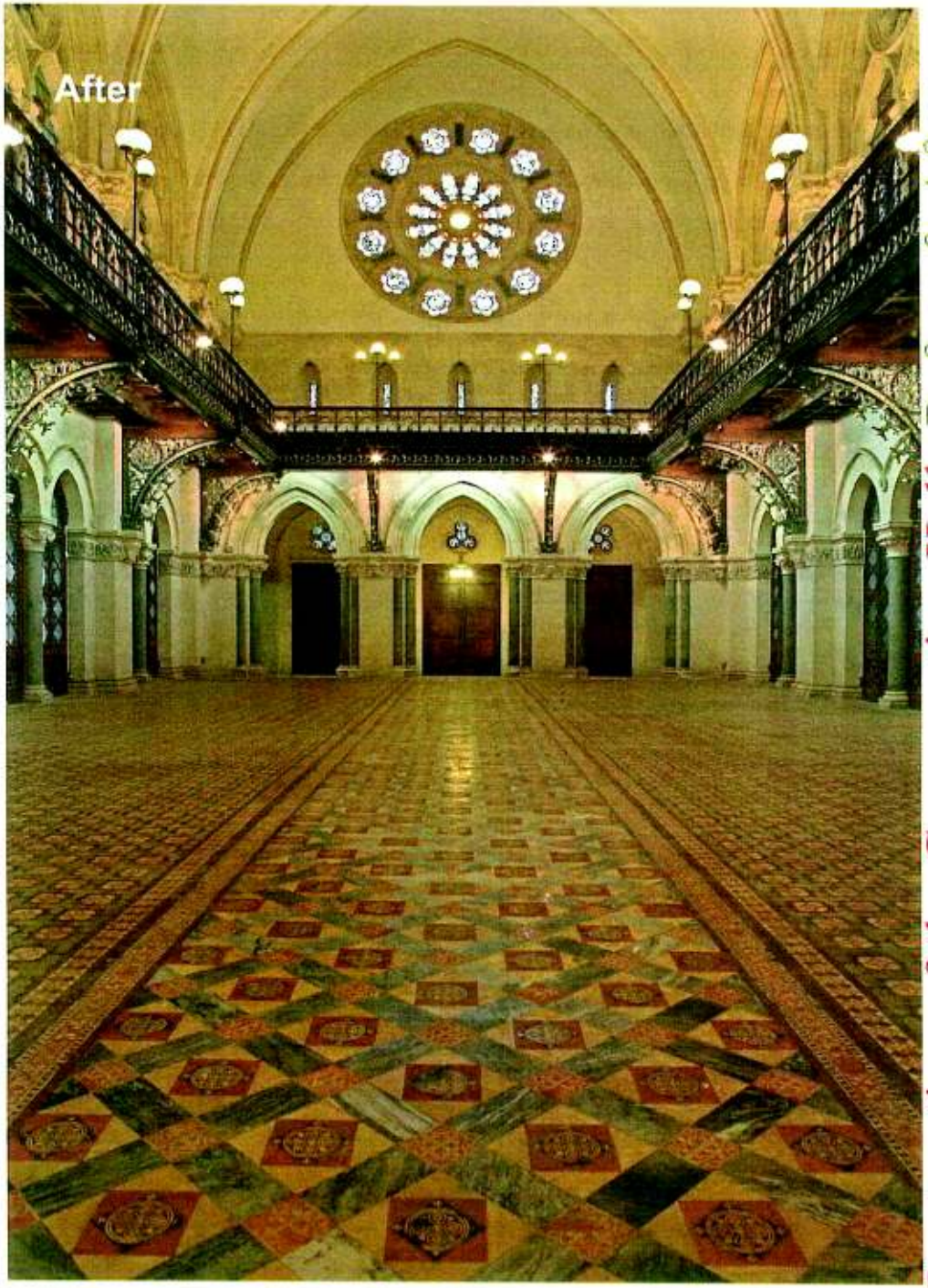

Restoration of the Convocation Hall: Before & After

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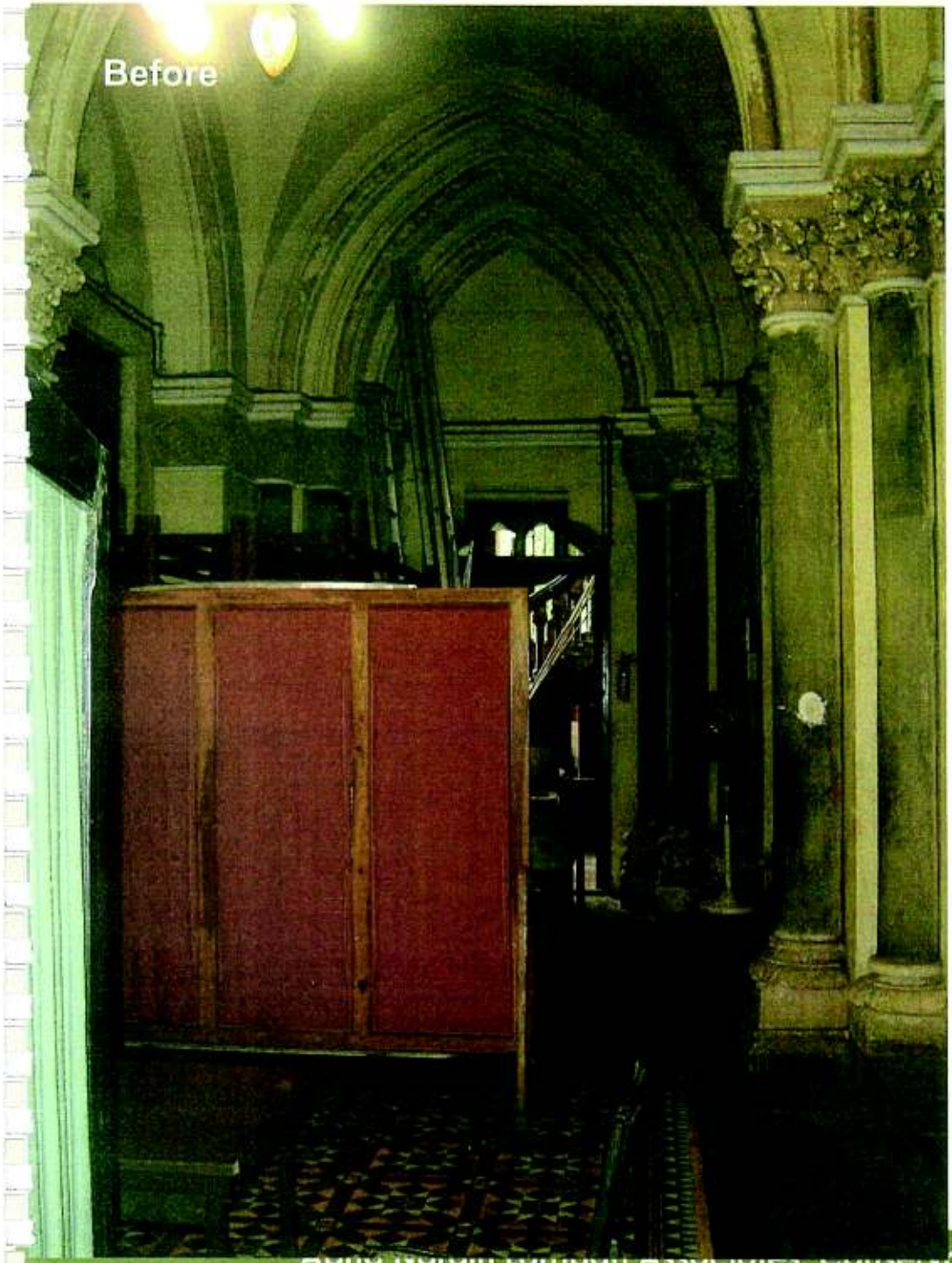
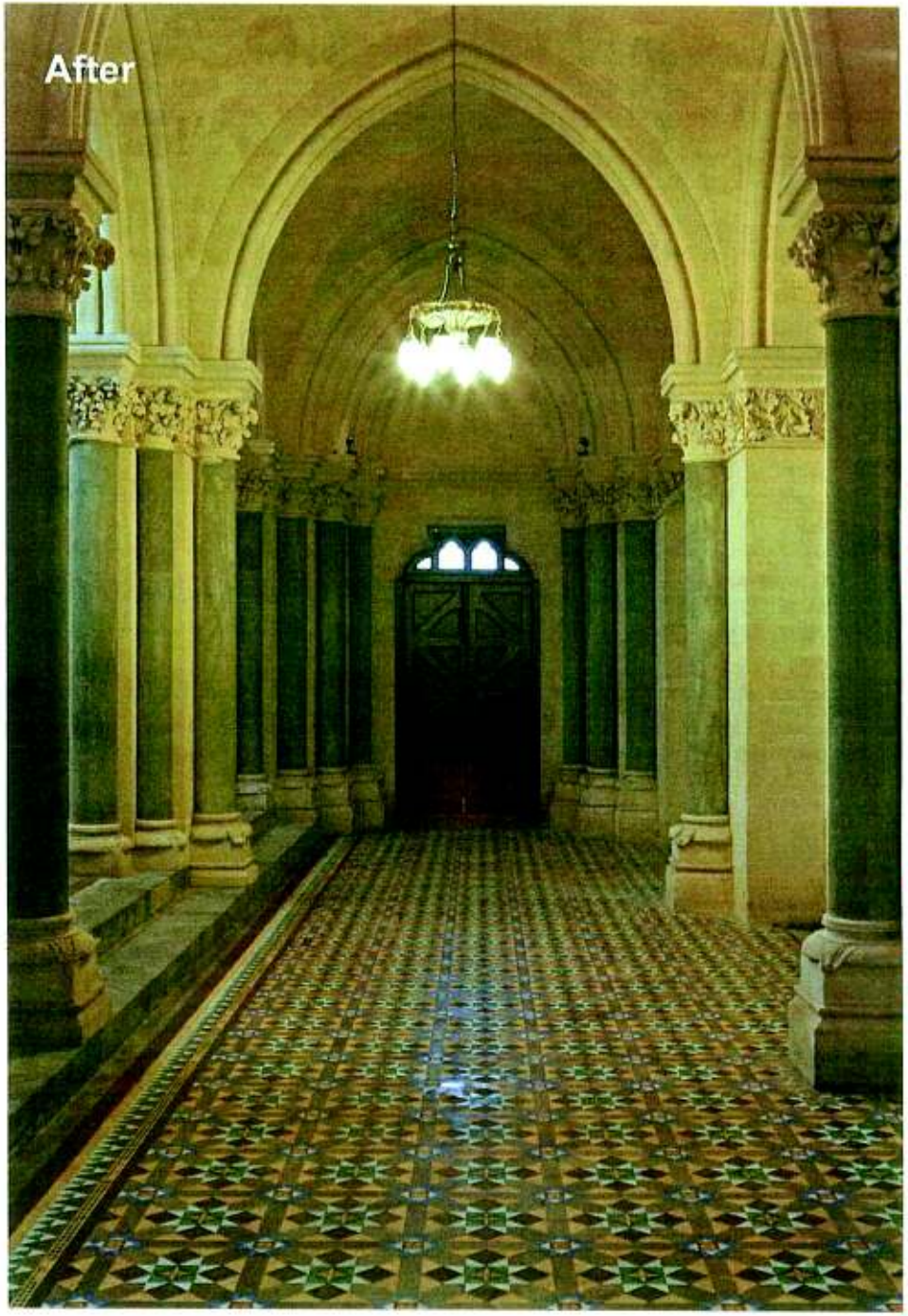
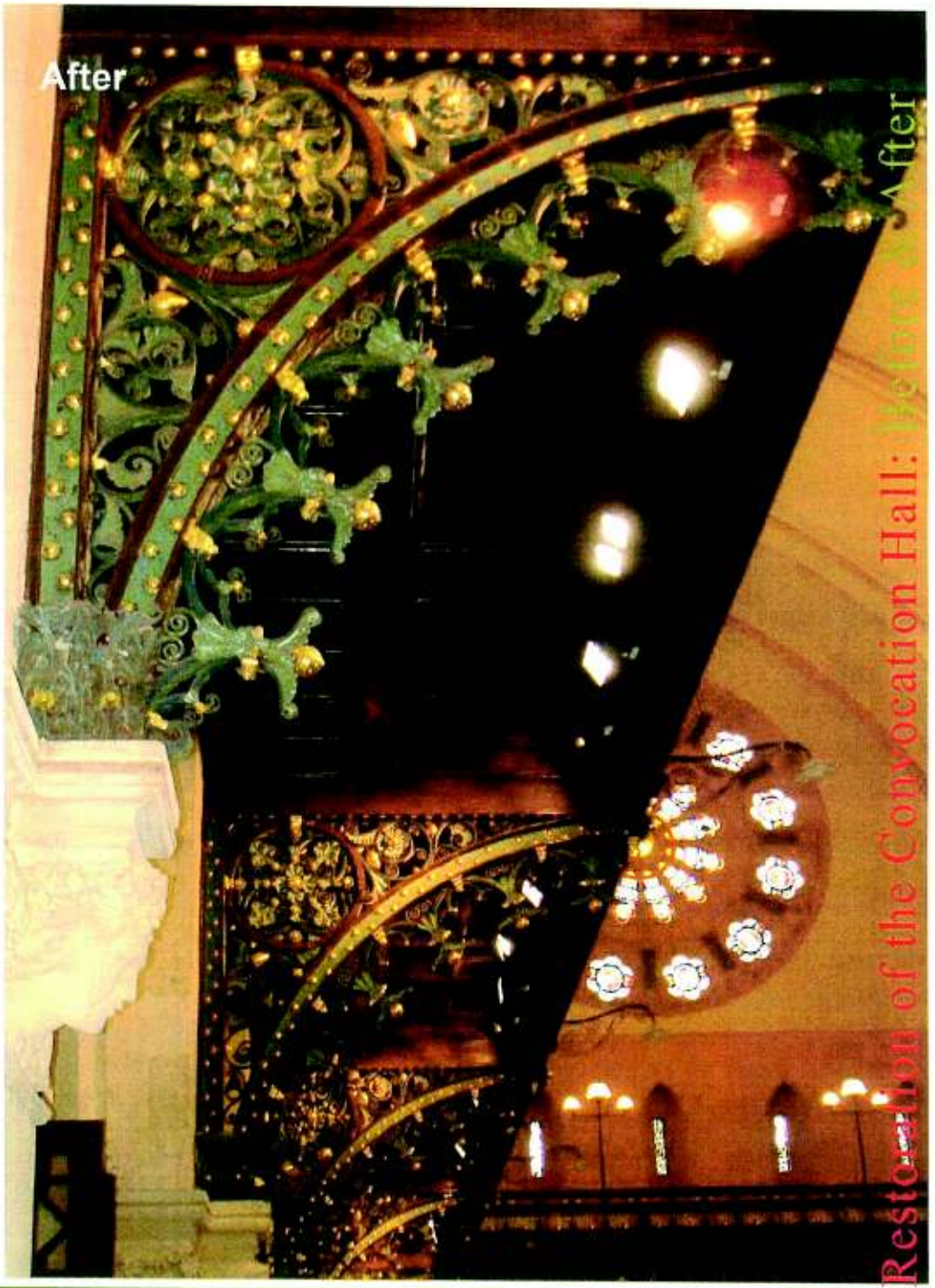




Restoration of the Convocation Hall: Before & After



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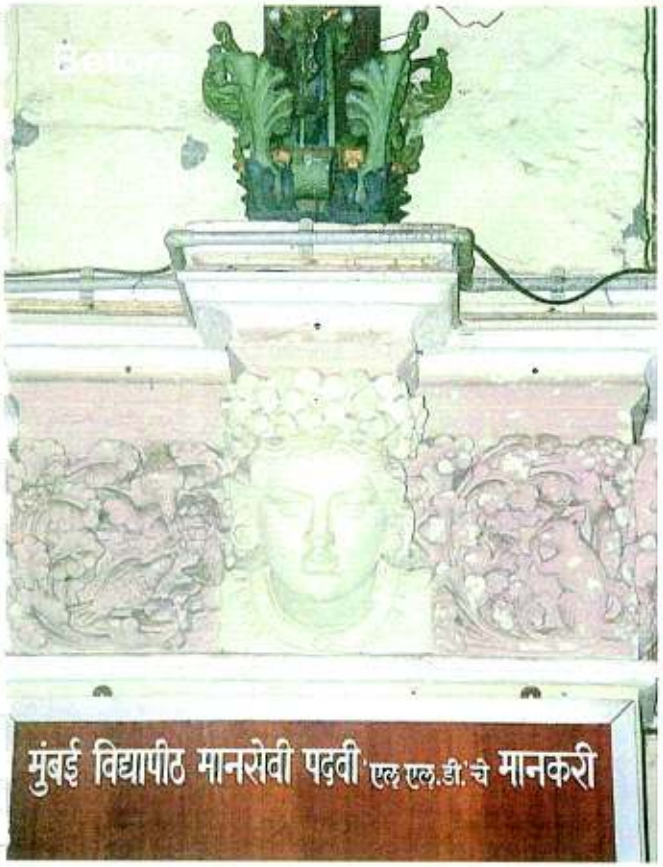

Restoration of the Convocation Hall: Before & After

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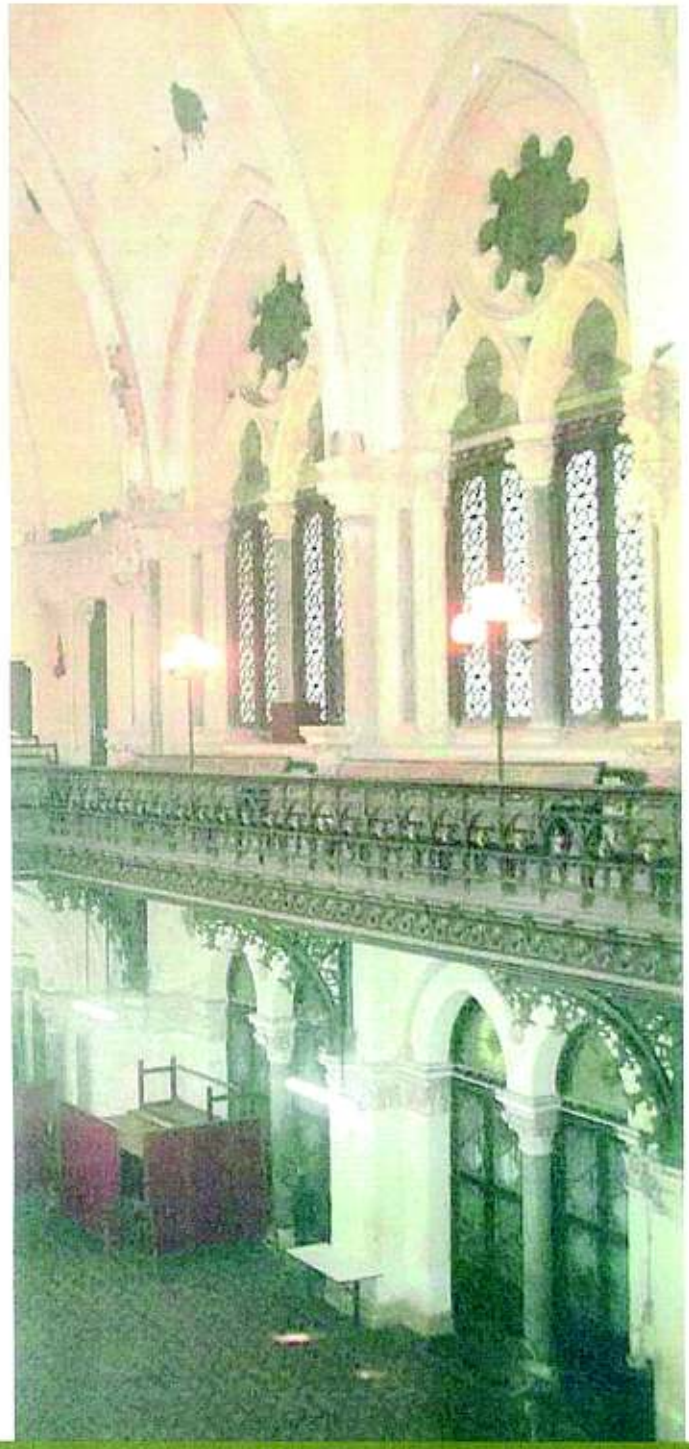

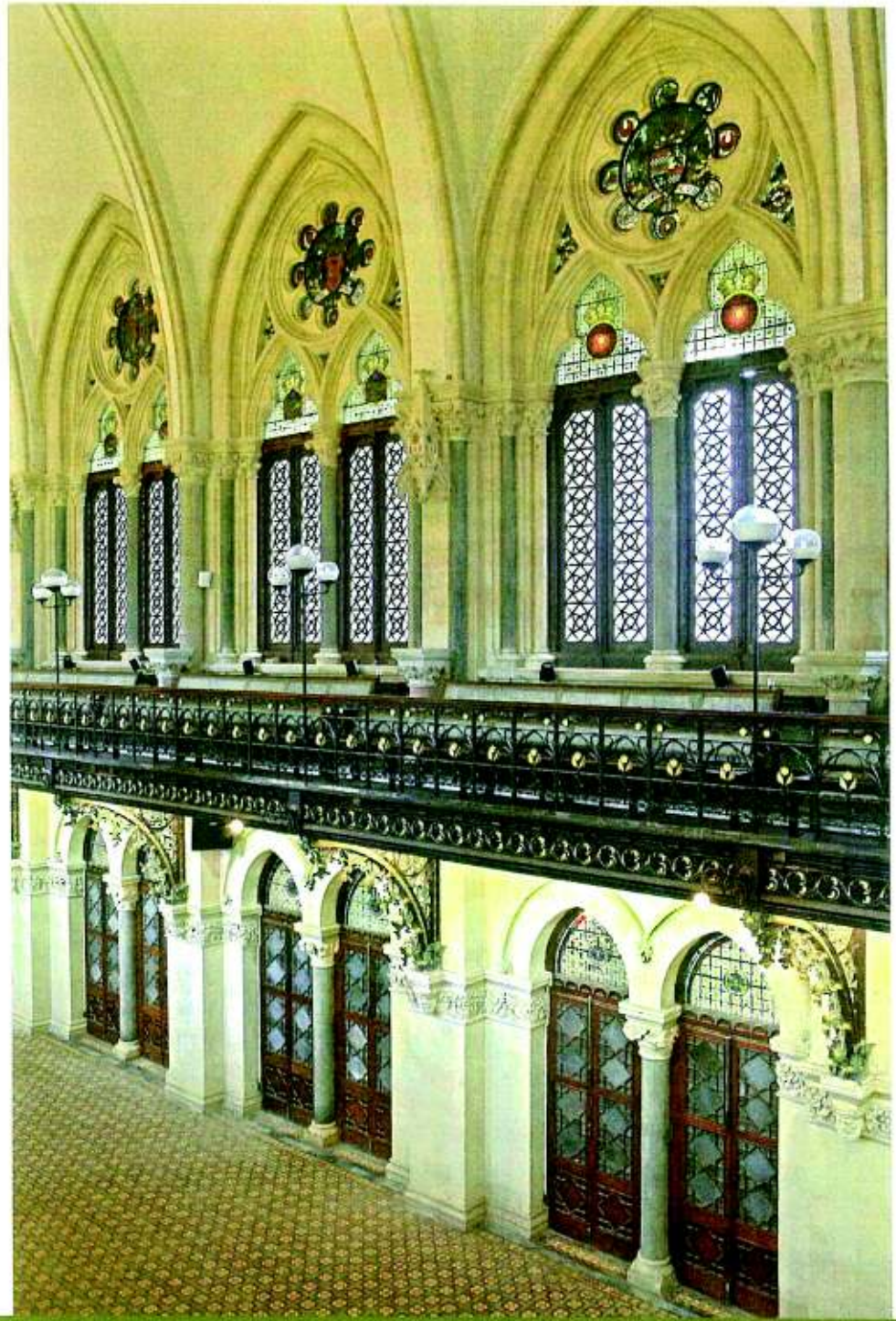

Restoration of the Convocation Hall: Before & After

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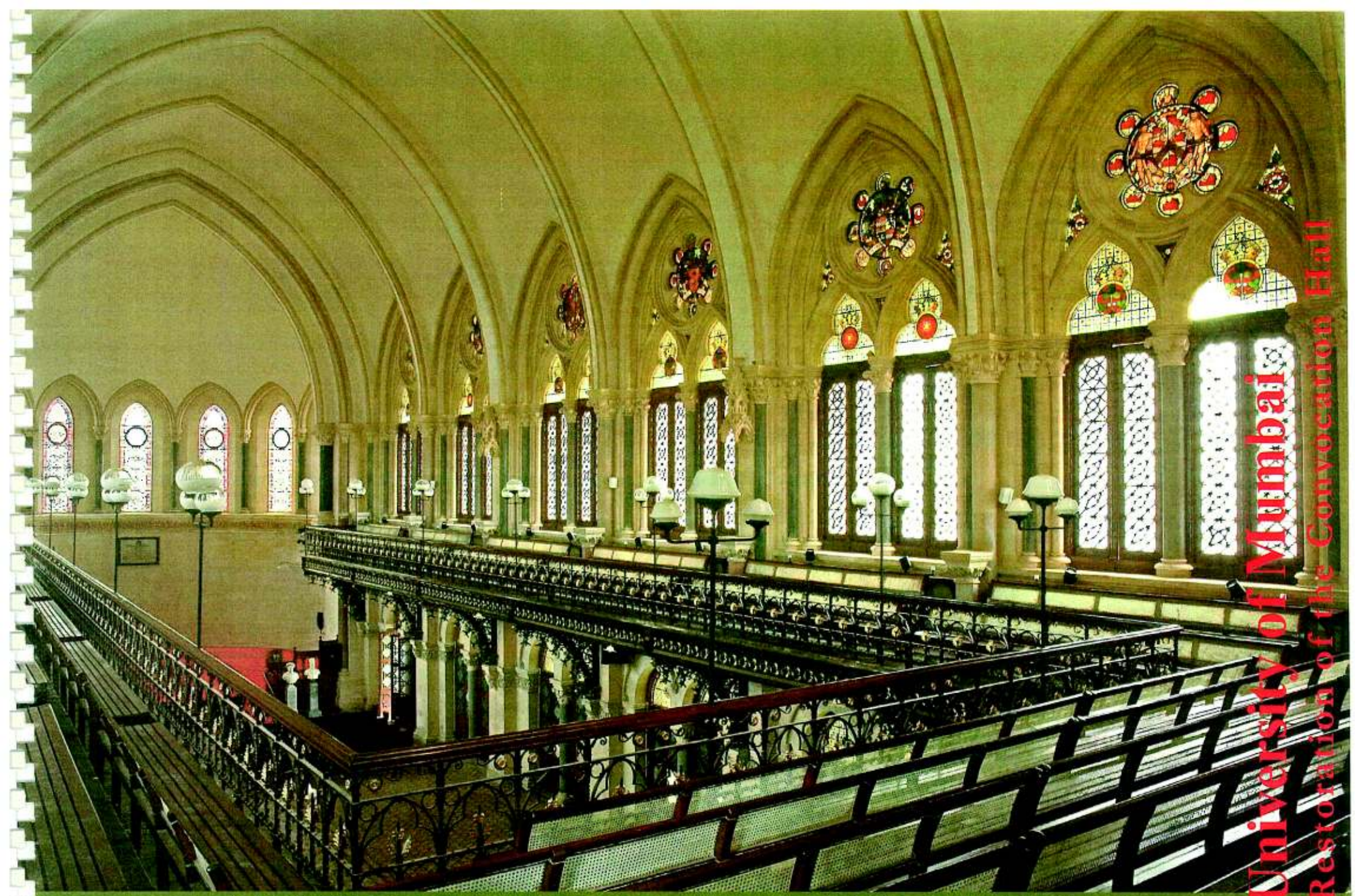
Restoration of the Convocation Hall



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Restoration of the Convocation Hall

Abha Narain Lambah Associates: Conservation Architects & Historic Building Consultants

Project Team

Principal Conservation Architects
Abha Narain Lambah Associates

Project Architects
Abha Narain Lambah
Shalini Mahajan
Aishwarya Tipnis
Krishna Iyer
Mekhla Chauhan

Structural Consultant
Arup Sarbadhikary

Electrical & Services Consultants
Vikas Joshi Associates

Lighting Consultants
Available Lights N.Y.

Stained Glass Consultants
Swati Chandgadkar

Acoustic Consultants
Jhaveri & Jhaveri

Contractors

Civil Contractors
Savani Heritage

Stained Glass Conservators
Rohinton Arethna
Parveen Mistry

Gilding Master Craftsman
Ghanshyam Nimbarak

University Engineer

University Engineer
Mr. Bharat Ishi

Mr. Masurekar
Mr. Rajadhyaksha

Clerk of Works
Mobin Chishty

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