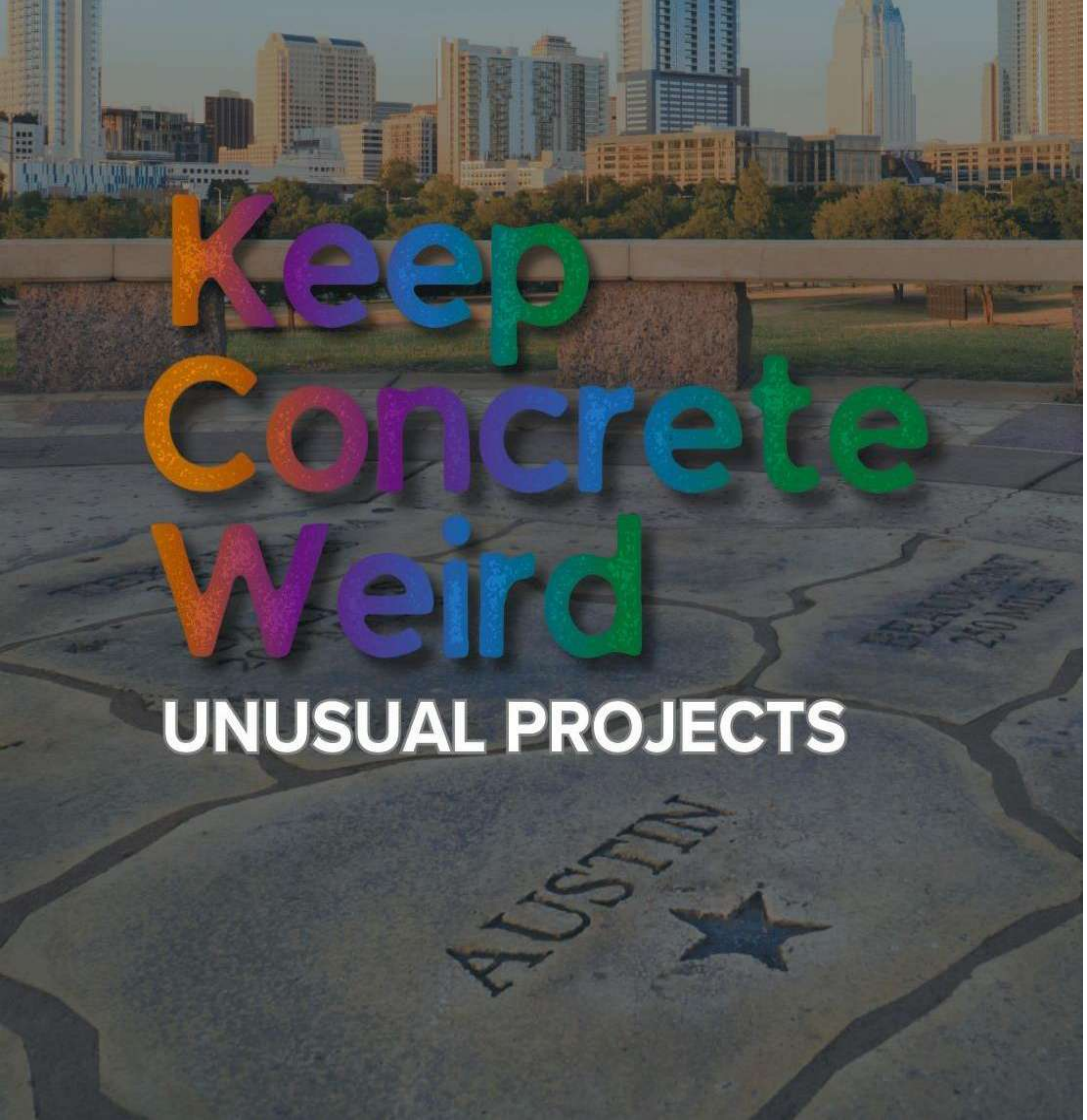

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2025 SPRING CONVENTION

AUSTIN, TEXAS • APRIL 13 – 16, 2025

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REHABILITATION OF HERITAGE BUILDINGS

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CONTENTS

INTRODUCTION

- Al Balad is an exceptional urban and historical fabric which is an essential part of Jeddah's identity. Jeddah is the second city of Saudi Arabia located on the Red Sea. It is the main seaport of contemporary Saudi. Jeddah is part of the Hejaz region composed by the strip of land between the Red Sea and the mountains, which are also part of the region

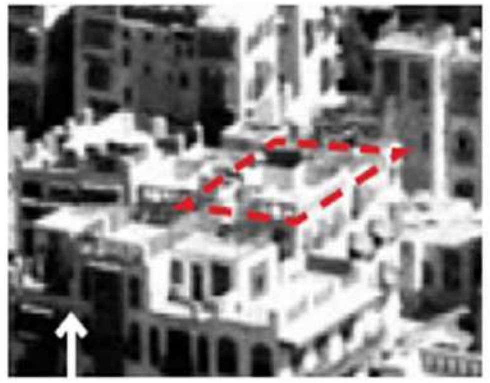
- Jeddah is characterized by a distinctive architectural tradition composed of tower houses built in the late 20th century by the city's mercantile elites. Jeddah's proximity to the red sea combines the local extraction of the renowned coral stone with contemporary influences and crafts from the trade routes. The combination brought forth a very unique and characterizing type of architecture and construction methods

INTRODUCTION

CASE STUDY (BAIT AL-SIRAFI BUILDING)

- The building is located at Haret Al Sham, west - south of Al Baiaa Square at Jeddah city
- It consists of four stories, with total built up area of 1367 m2. The building system consists of coral stones for walls and structural wooden beams for slabs
- The building was constructed as a residential building. Based on the architectural design and historical conclusions, the building was inhabited by two different families

بيت الصيرفي



Live Content Slide

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Poll: Using natural raw materials found in the surrounding environment instead of materials such as concrete or steel may be more economically and environmentally friendly for building residential buildings.

BUILDING SYSTEM

Foundations :

Coral (Manqabi) stone

Bearing walls:

Coral stone + wooden beams (Takalel)

Slabs:

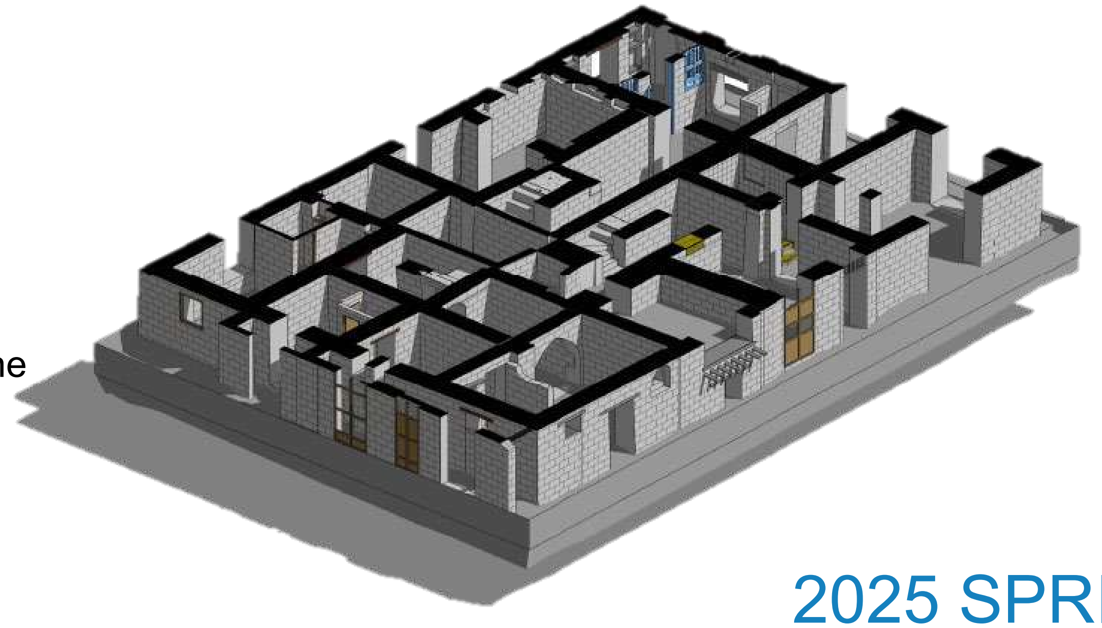
Structural wooden beams + cladding + top reinforced concrete slabs

BUILDING SYSTEM

Third floor + roof
Area = 219.66 m2

Second floor + Mezzanine
Area = 342.62 m2

First floor + Mezzanine
Area = 425.97 m2



Ground floor + Mezzanine
Area = 379.14 m2

3D LASER SCANNING

North & East elevations

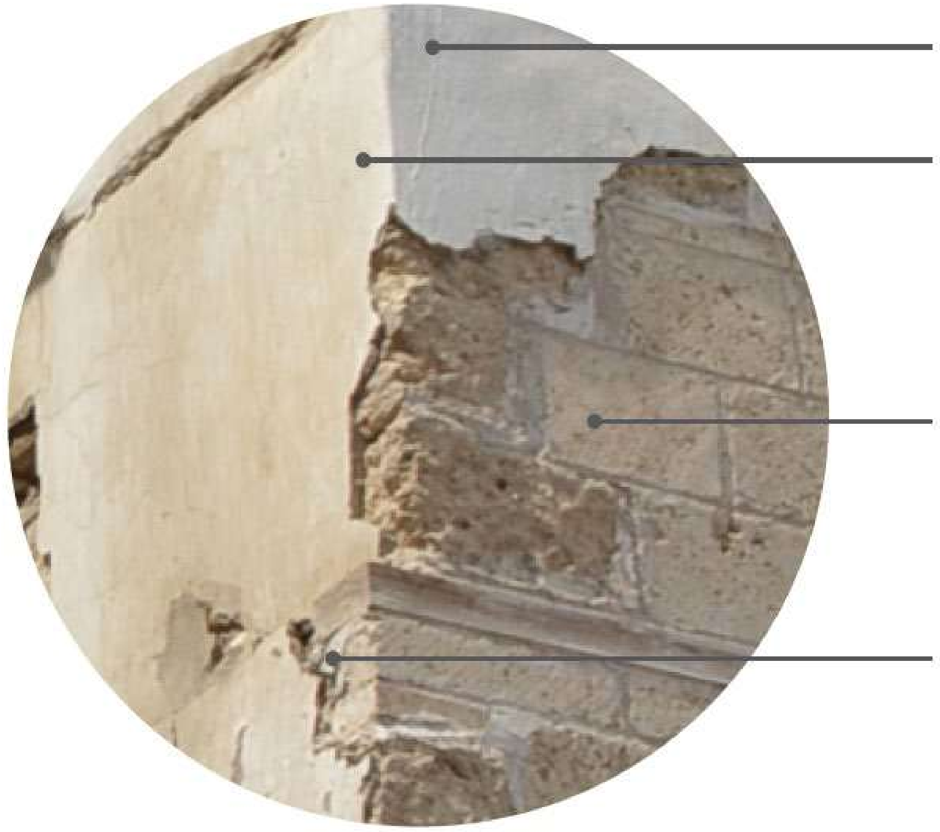
North & West elevations

South & East elevations

South & West elevations

BUILDING MATERIALS

CORAL STONE



MORTAR

STRUCTURAL ELEMENT
(BEAMS, JOISTS)

GUIDELINES & STANDARDS

- Survey & Inspection
- Structural behavior assessment
- Evaluation
- Rehabilitation recommendations

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RECOMMENDATIONS FOR THE ANALYSIS, CONSERVATION AND STRUCTURAL RESTORATION OF ARCHITECTURAL HERITAGE

GUIDELINES

1 **GENERAL CRITERIA**

A combination of both scientific and cultural knowledge and experience is indispensable for the study of all architectural heritage. Only in this context can the guidelines help to the better conservation, strengthening and the restoration of buildings. The purpose of all studies, research and interventions is to safeguard the cultural and historical value of the building as a whole and structural engineering is the scientific support necessary to obtain this result.

Conserving architectural heritage usually requires a multidisciplinary approach involving a variety of professionals and organisations. These guidelines have been prepared to assist this work and facilitate communication between those involved.

Any planning for structural conservation requires both qualitative data, based on the direct observation of material decay and structural damage, historical research etc., and quantitative data based on specific tests and mathematical models of the kind used in modern engineering. This combination of approaches makes it very difficult to establish rules and codes. While the lack of clear guidelines can easily lead to ambiguities and arbitrary decisions, codes prepared for the design of modern structures are often inappropriately applied to historic structures. For example, the enforcement of seismic and geotechnical codes, can lead to drastic and often unnecessary measures that fail to take account of real structural behaviour.

The subjective aspects involved in the study and safety assessment of an historic building, the uncertainties in the data assumed and the difficulties of a precise evaluation of the phenomena, may lead to conclusions of uncertain reliability. It is important, therefore, to show clearly all these aspects, in particular the care taken in the development of the study and the reliability of the results, in an EXPLANATORY REPORT. This report requires a careful and critical analysis of the safety of the structure in order to justify any intervention measures and will facilitate the final judgement on the safety of the structure and the decisions to be taken.

The evaluation of a building frequently requires a holistic approach considering the building as a whole rather than just the assessment of individual elements.

2 **ACQUISITION OF DATA: INFORMATION AND INVESTIGATION**

2.1 **Generally**

The investigation of the structure requires an interdisciplinary approach that goes beyond simple technical considerations because historical research can discover phenomena involving structural behaviour while historical questions may be answered by considering structural behaviour. Therefore it is important that an investigating team be formed that incorporates a range of skills appropriate to the characteristics of the building and which is directed by someone with adequate experience.

Knowledge of the structure requires information on its conception, on its constructional techniques, on the processes of decay and damage, on changes that have been made and finally on its present state. This knowledge can usually be reached by the following steps:
- definition, description and understanding of the building's historic and cultural significance;
- a description of the original building materials and construction techniques;
- historical research covering the entire life of the structure including both changes to its form and any previous structural interventions;
- description of the structure in its present state including identification of damage, decay and possible progressive phenomena, using appropriate types of test;
- description of the actions involved, structural behaviour and types of materials;

A 'pre-survey' of both the site and the building should guide these studies.

Because these can all be carried out at different levels of detail it is important to establish a cost effective plan of activities proportional to the structure's complexity and which also takes into account the real benefit to be obtained from the knowledge gained. In some cases it is convenient

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BUILDING STATUS(before rehabilitation)

- Ground water table exists at 1.20 m below ground level
- Decay of many coral stone bearing walls
- Third floor and roof walls were built with irregular shape coral stones
- NHL plaster at most of coral stone walls was found in deteriorated condition
- Structural wooden beams at walls (Takalel) deterioration condition vary from medium (need restoration) to severe (need replacement)
- Structural slabs wooden beams deterioration condition vary from medium to severe
- Architectural wooden elements condition vary between missing elements, medium damage elements (need restoration), and severe damage elements (need replacement)

REHABILITATION WORKS

Work steps

- Site housekeeping and pest control
- Documentation and coding
- Temporary supporting installation
- Tests
- Critical cracks stitching at walls
- Replacement of deteriorated walls coral stones, from ground floor to roof
- Restoration / Replacement of structural wooden elements at slabs from roof to ground floor
- Resisting building slope by using reinforcement bars and galvanized steel plates at concrete slabs
- Insulation of roof slab
- Strengthening of foundations
- Plastering with NHL material (Natural Hydraulic Lime)
- Restoration / Replacement of architectural wooden elements
- Restoration of gypsum decorative elements

REHABILITATION WORKS

Housekeeping and pest control

- Removal of all wastes
- Pest control

REHABILITATION WORKS

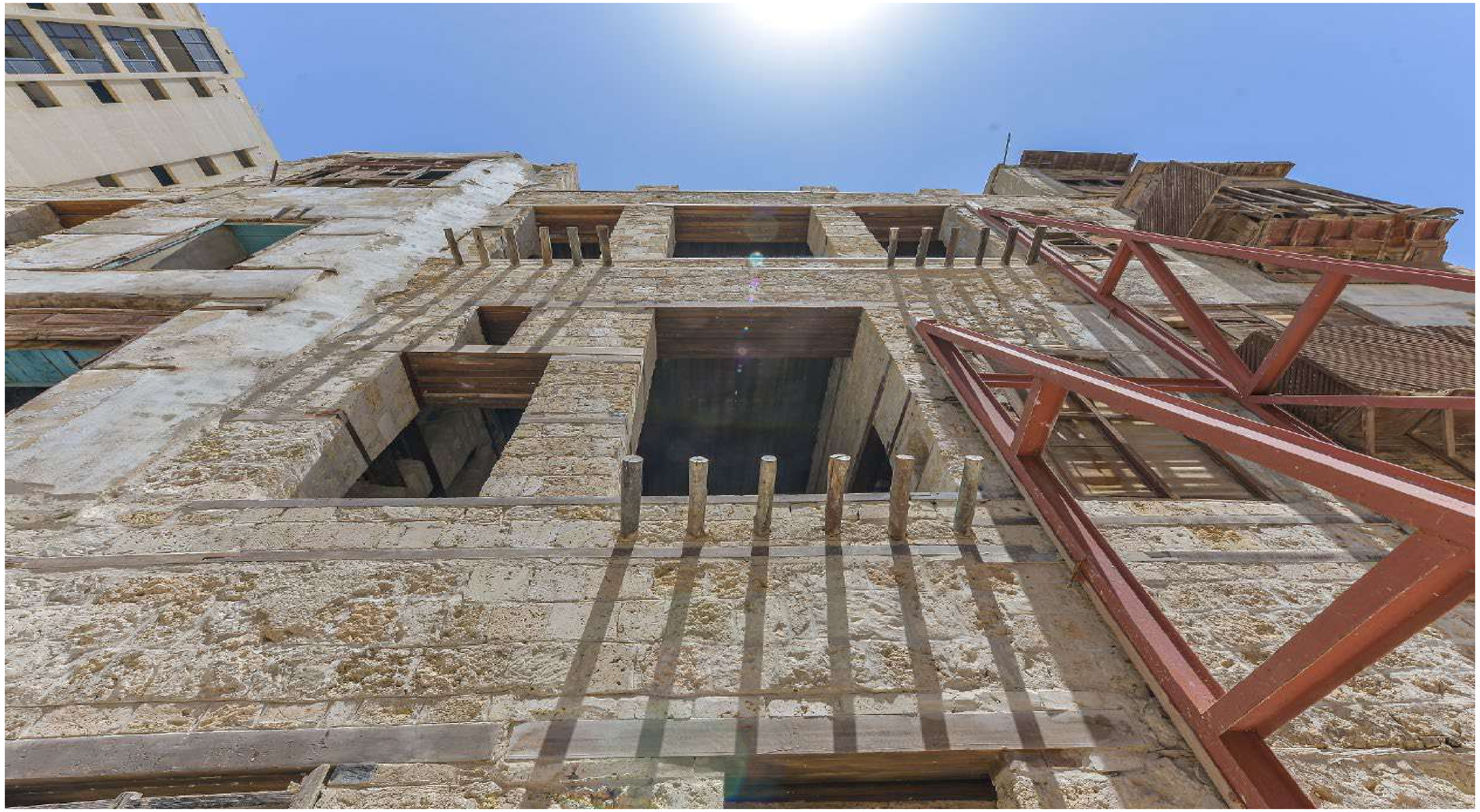
Documentation and coding

- Numbering each room / void
- Photograph each room / void
- Preparation of documentation report

REHABILITATION WORKS

Temporary supporting installation

- External supporting with steel sections
- Internal supporting with Propping



REHABILITATION WORKS

Tests

- Soil investigation
- Masonry test
- Structural wood test
- Architectural wood test

REHABILITATION WORKS

Tests

Minimum acceptable range of material properties to be used in restoration

Stone		
Property	min	max
Absorption (%)	N/A	20
Specific Gravity (bulk oven dry (-))	1.40	1.98
Compressive Strength (Mpa)	5.08	N/A

Wooden Beams			
Property	Wood type	min	max
Dry Density (kg/m^3)	Juniperus (Arar)	900	1200
	Mahogany	500	1100
Compressive Strength (Mpa) Parallel to Fiber	Juniperus (Arar)	40	N/A
	Mahogany	40	N/A
Compressive Strength (Mpa) Across the Fiber	Juniperus (Arar)	20	N/A
	Mahogany	20	N/A
Flexural Strength - Modulus of Rupture (Mpa)	Juniperus (Arar)	79	N/A
	Mahogany	79	N/A

	Windows					
			Parallel to Fiber		Accross to Fiber	
	Natural Density (kg/m3)	Flexural Strength - Modulus of Rupture (Mpa)	Compressive Strength (Mpa)	Young's Modulus (Mpa)	Compressive Strength (Mpa)	Young's Modulus (Mpa)
Not Less than	350	5.5	3.6	95	2.2	8.9
Accepted Average	530	30.8	13.0	633	4.1	89.0

	Roshans					
			Parallel to Fiber		Accross to Fiber	
	Natural Density (kg/m3)	Flexural Strength - Modulus of Rupture (Mpa)	Compressive Strength (Mpa)	Young's Modulus (Mpa)	Compressive Strength (Mpa)	Young's Modulus (Mpa)
Not Less than	385	20	3.3	103	2.9	95
Accepted Average	697	35.5	14.3	808	4.8	354

REHABILITATION WORKS

Critical cracks stitching at walls

- Inspection of all the building cracks
- Stitching the critical cracks
- Installation of gypsum stickers at cracks locations
- Installation of cracks meters (rulers) at cracks locations

REHABILITATION WORKS

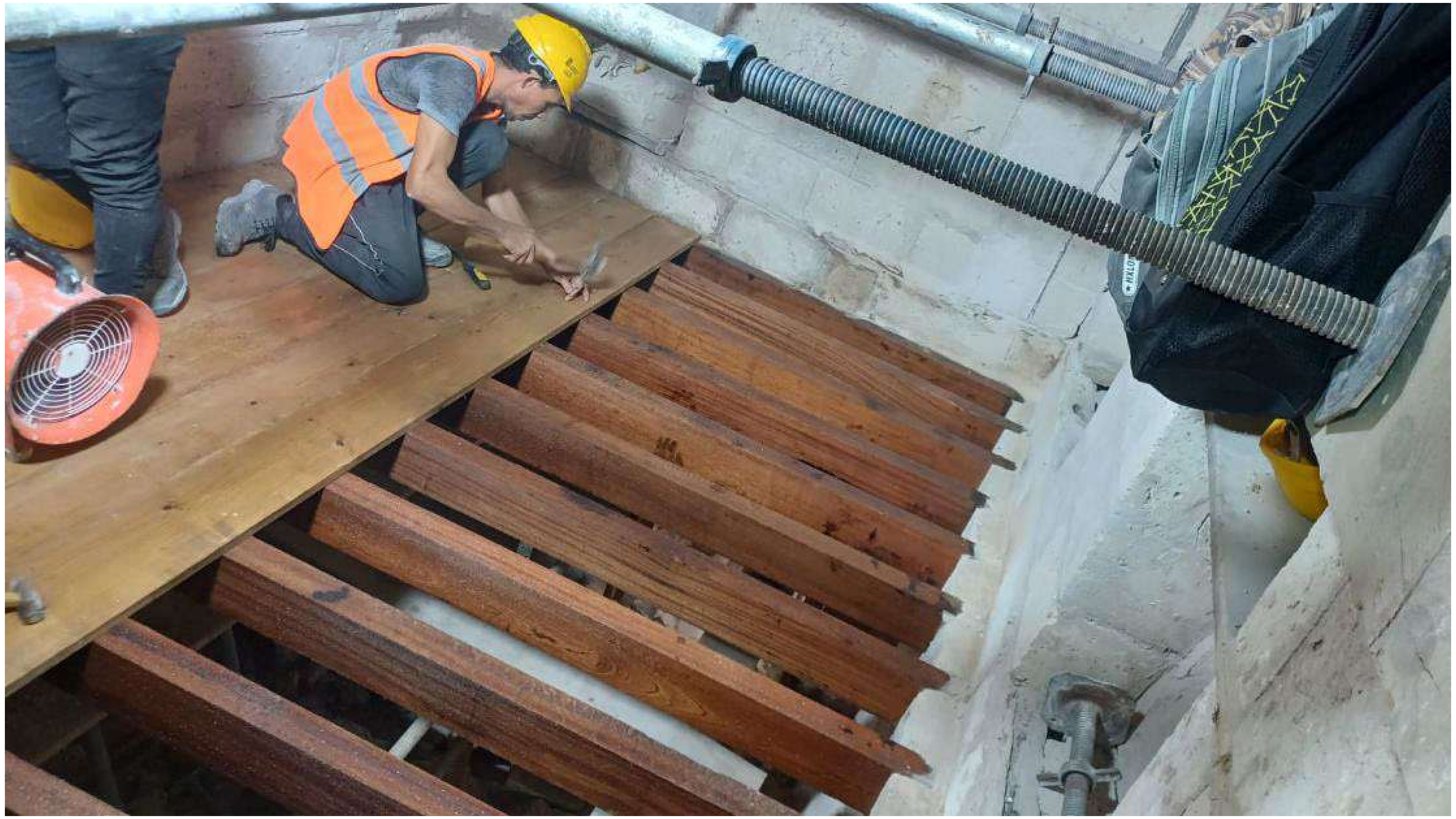
Replacement of deteriorated walls coral stones, from ground floor to roof

- Restoration of partially damaged coral stones
- Replacement of totally damaged coral stones
- Building new coral stone walls (where required)
- Removal of existing coral stone walls (where required)
- Restoration / Replacement of wooden Takalel

REHABILITATION WORKS

Restoration / Replacement of structural wooden elements at slabs from roof to ground floor

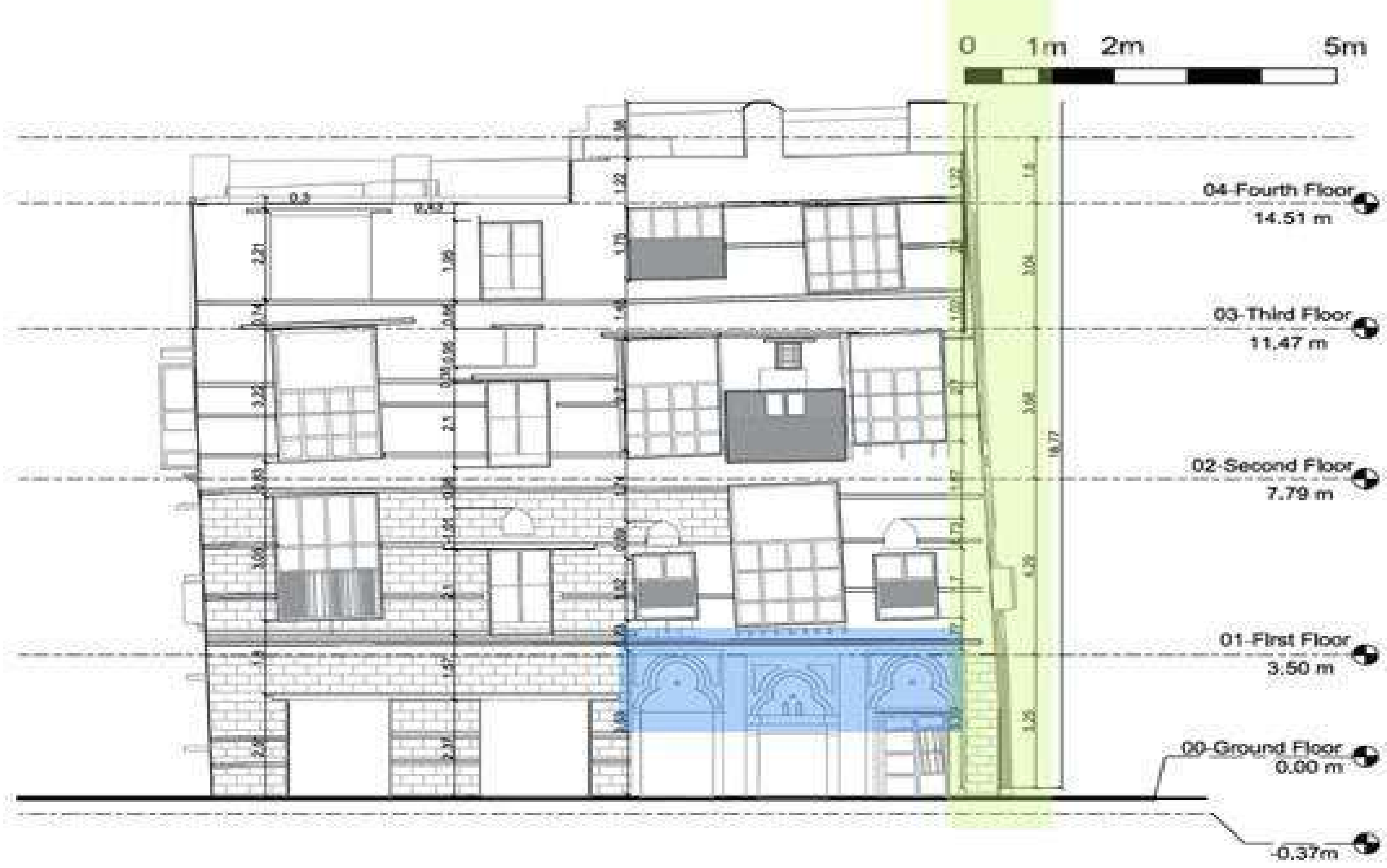
- Demolition and removal of existing RC slabs above wooden beams
- Restoration of semi damaged wooden beams
- Replacement of damaged wooden beams with new ones of same shape and section
- Installation of cladding



REHABILITATION WORKS

Resisting building slope by using reinforcement bars and galvanized steel plates at concrete slabs

- Building slope status
- Survey monitoring of the slope



REHABILITATION WORKS

Resisting building slope by using reinforcement bars and galvanized steel plates at concrete slabs

- Installation of additional reinforcement steel bars at slabs, that are welded with the slab reinforcement steel bars, and extending in the coral stone walls to outside
- Installation of galvanized steel plates (10 cm width, 1 cm thickness) connecting the reinforcement steel bars from outside, to stabilize the building slope at all floors

REHABILITATION WORKS

Insulation of roof slab

- Waterproofing insulation
- Heat insulation
- Screed casting

REHABILITATION WORKS

Strengthening of foundations

- Excavation
- Dewatering
- Replacement of deteriorated coral stones
- Casting plain concrete
- Strengthening (increasing the existing foundations width), as per structural study recommendations
- Termite control
- Backfilling
- Casting RC slab on grade

REHABILITATION WORKS

Plastering with NHL material (Natural Hydraulic Lime)

- 1st and 2nd layers, before foundations strengthening
- 3rd layer (finishing), after foundations strengthening and installation of architectural wooden elements

REHABILITATION WORKS

Restoration / Replacement of architectural wooden elements

- Restoration of partially deteriorated elements
- Replacement (fabrication) of missing or fully deteriorated elements

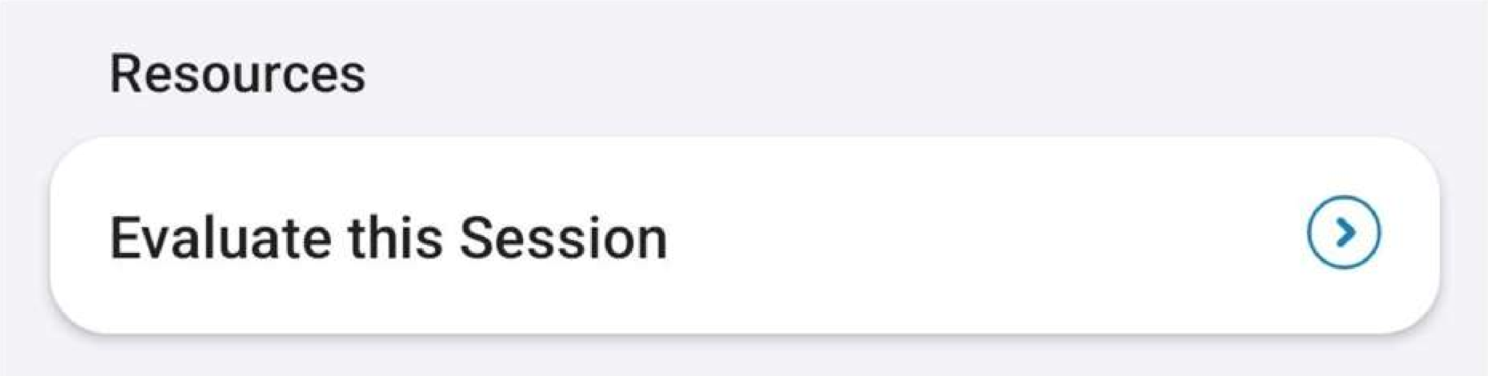
REHABILITATION WORKS

Restoration of gypsum decorative elements

- Restoration of partially deteriorated elements
- Casting similar molds for fully deteriorated elements

REHABILITATION WORKS

SESSION EVALUATION



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ANY QUESTIONS?