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# Galata Tower Restoration Project

Le projet de restauration de la tour de Galata

Die Restaurierung des Galata-Turms

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## SUMMARY
Engineering problems encountered in the adaptation of historical constructions for new needs are generally more challenging than the problems faced in new constructions. In the article, problems whose solutions require a considerable amount of engineering intuition and judgement are discussed, and the 1500 year old historical Galata Tower's restoration project is presented.

## RESUME
Les problèmes rencontrés dans l'adaptation de constructions historiques à de nouvelles fonctions, sont différents de ceux d'une nouvelle construction. L'article décrit ces problèmes nécessitant un large synthèse des connaissances du génie civil, et présente le projet de restauration de la tour de Galata, une construction de quinze siècles.

## ZUSAMMENFASSUNG
Die technischen Probleme, die bei der Umarbeitung von historischen Bauten auftauchen, sind anders als die der Neubauten. In diesem Artikel werden die Probleme, für deren Lösung sehr grosse technische Kenntnisse und Synthesen erforderlich sind, erörtert und der Entwurf zur Konsolidation und Restaurierung des Galata Turms, der etwa 1500 Jahre alt ist, erläutert.

## 1. INTRODUCTION

In conserving historical buildings for new uses, there are two approaches :

I. Authentic conservation (using similar materials and technology)
   a) for same functions, b) for similar functions ,

II. Conservation for new functions (using new materials, and technologies).

Problems faced in adaptation for new needs can be discussed in 3 stages.

## 2. PROBLEMS RELATED TO DECISIONS

The owner has determined the new functions. He has asked the engineer to realize these functions. Can the structure stand the loads imposed by the new functions? How will the equilibrium of the structure be affected by the new measures? A positive decision cannot be reached without answering these questions. Time has depreciated the structure and all the damages cannot be readily detected. Therefore, the structure must be surveyed with special care. Also, the technology of the period it was built and the restorations it has undergone in its life-span must be meticulously evaluated.

If a structure has been able to stand for centuries, it deserves a certain amount of (careful) trust. Also, historical buildings contain a reserve structural strength due to their being dimensioned by intuition-experience based empirical construction methods. This reserve capacity may be determined by modern analysis techniques. Generally, such a reserve load bearing capacity enables additional loads to be imposed on the structure.

## 3. PROBLEMS RELATED TO THE BASIC STRENGTHENING PROPOSALS AND PRINCIPLES

After the engineer has given a positive answer to whether the structure can be loaded for new needs, he has to determine the basic proposals and principles on how the strengthening and adaptation measures be shaped. The engineer has 4 types of responsibilities at this point.

Historical : The structure's shape has evolved throughout the history. People would want to see the structure as they are used to, or as they are ready to accept. Thus, the proposals should fit with the historical evolution of the structure.

Social : The society would like to convey a message of its culture to the future generations. The structural intervention has to be a reflection of today's civilization.

Structural : The structure has stood up for a long time. The renovation has to guarantee a still longer life than without it.

Personel : The historical structure is in a way changing its character during the adaptation. The engineer who can identify his position thoroughout the history must be able to convey a message to the structure from himself.

## 4. PROBLEMS RELATED TO DESIGN DETAILS AND CALCULATIONS

In general, strengthening and repair projects show an organic development and sometimes the designwork may only be completed when the construction work is over. As the construction proceeds new conditions may come up and new ideas may develop. The details can sometimes be changed several times. Nevertheless, the basic proposals and principles determined in the beginning of the project must not be changed. If such a change is required, it may be more suitable to stop the project and ask another engineer to examine the situation. The statical calculations of strengthening projects are only useful to select the right direction. Usually, it is difficult to explain the created constructive measures and details by statical calculations. These are only the materialized illustrations of engineering feelings.

## 5. GALATA TOWER RESTORATION PROJECT

The 15 century-old historical Galata Tower's restoration, adaptation, and strengthening project which has been realized by the authors is a typical example of a conservation for new functions. The designwork has been completed in 1964-1965, and the tower has been put to service in 1967.

### 5.1. Brief Historical Summary of Galata Tower

It is not cleary known when the Galata Tower, situated on one of the most strategic locations in Istanbul, was built. According to historical records, Galata Tower has been constructed by the Eastern Roman Empire around 500 A.C. However, it is known that the Genoese after settling in Galata has partially torn down the tower and rebuilt it within the dimensions of its present structural walls. Some of the views and the changes the tower went through in history are shown in table 1.

### 5.2. The New Functions of the Tower and its Condition in 1965

The Municipality of Istanbul, the Owner, has decided to use the empty and abondoned tower as a tourism coplex. The new functions given to the tower are shown in Table 3. A careful survey study was conducted on the tower in 1965. Based on the observations, surveys, and analyses, the following decisions were reached.

- o The cracks on the main structural walls are in-active, they can be repaired and will not be affected by additional loadings.
- o The structural walls and foundations have reserve capacity for a 20% load increase.
- o Increasing the tower's height and weight will increase its dynamic stability and will not affect its overturning safety.
- o The measures to be taken can increase the expected life of the structure.

### 5.3. Main Proposals and Principles of the Restoration

- o For realizing the new functions, the existing wooden floors must be torn down and reinforced concrete floors at the same elevations must be built.
- o The 1832 silhouette of the tower must be obtained with a conic reinforced concrete roof.
- o The structural walls of the tower should not be externally intervened.
- o The first 4 floors to be rebiult must be able to convey their loads to the ground inside the tower independent of the tower's structure.
- o Upon the niche on the 20.80m elevation, the loads of three floors (including the two floors over that level) can be beared.
- o The stone walls over the 40.04m elevation must be surveyed, then torn down to be restored after the conic roof is built.
- o The conic roof must bear its load on the tower's structural walls at the 40.04m elevation.
- o At the 20.80, 32.60, 40.04m elevations precautions must be taken to secure the floors to the structural walls.
- o The internal equilibrium of the foundation walls must be minimally effected.

The design proposals listed above have been preserved to the end,and the renovation has been accordingly realized. The critical details and strengthening principles are shown in Table 2. Table 3 illustrates the view after the restoration is completed.

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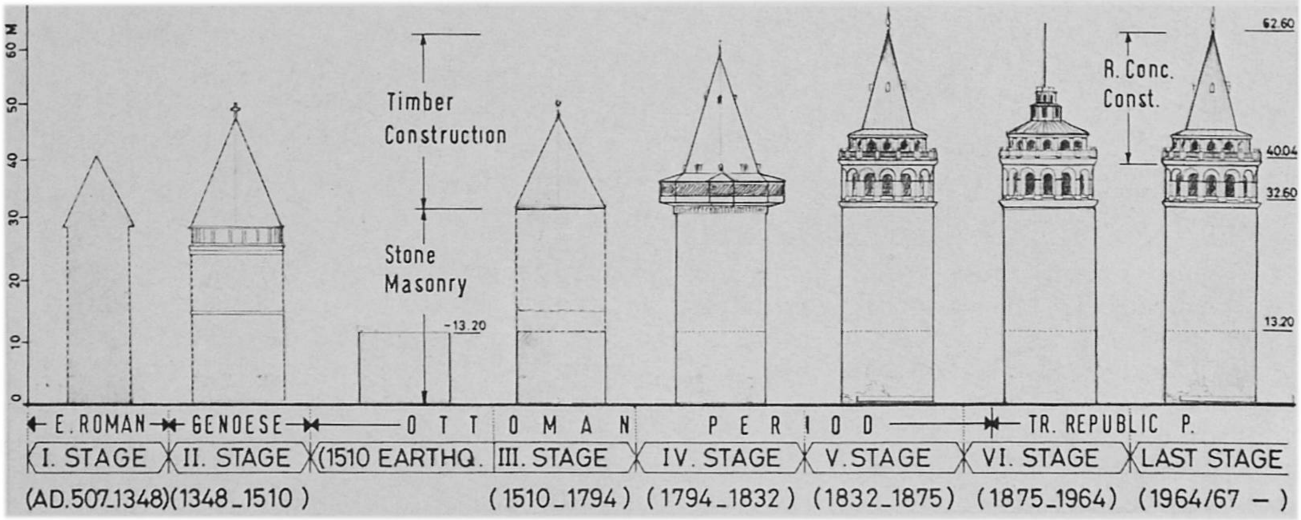
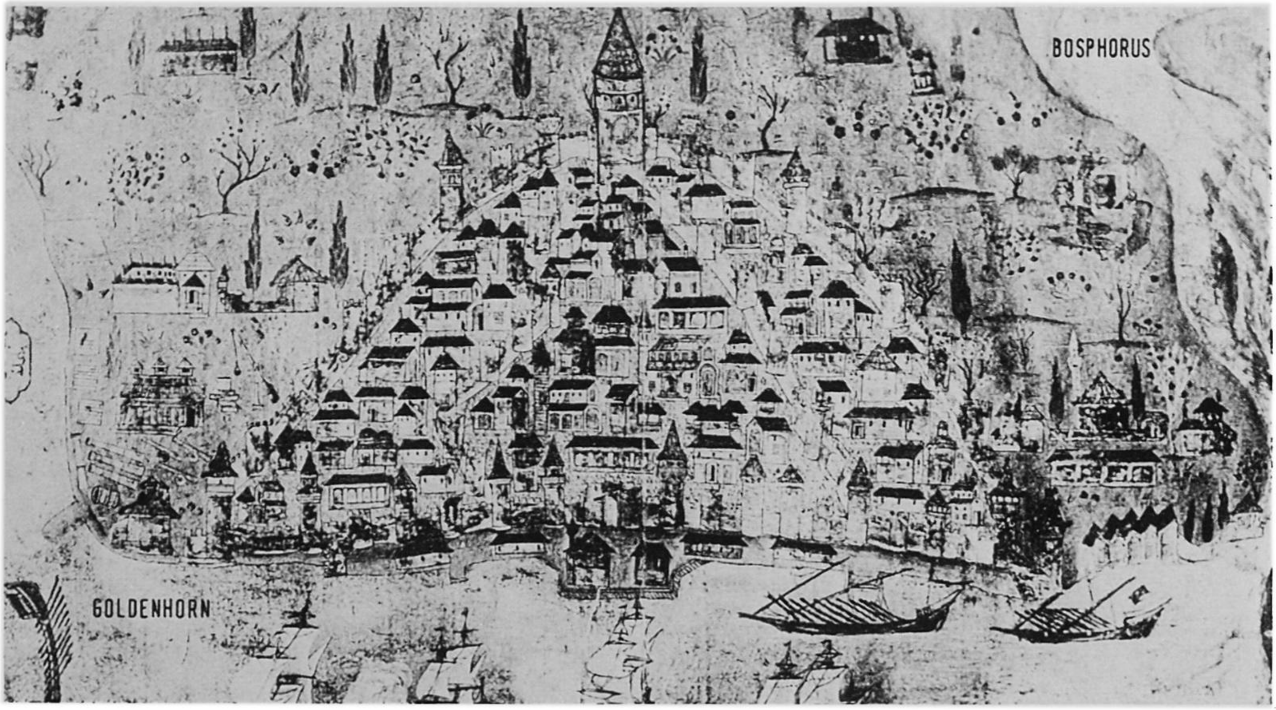
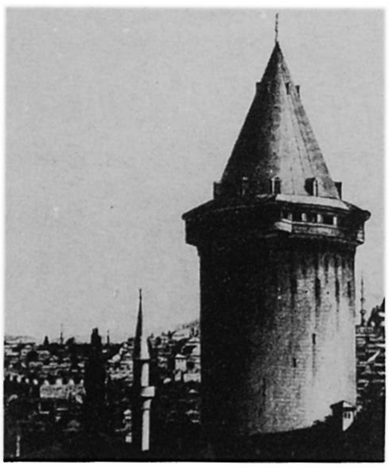
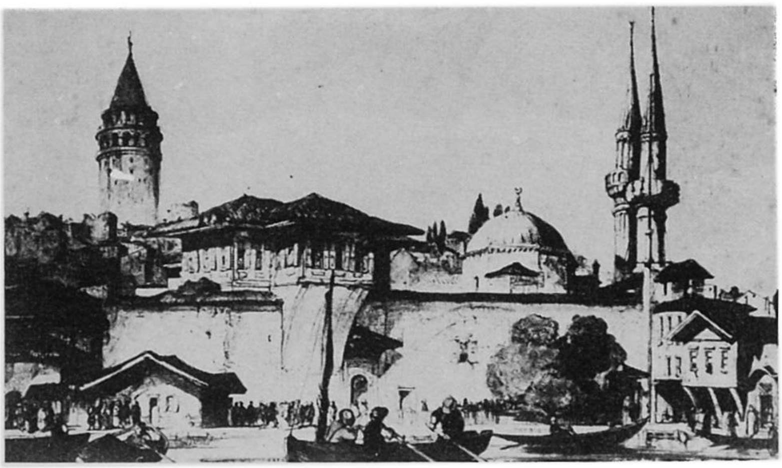



THE STAGES OF EVOLUTION OF THE TOWER'S SHAPE



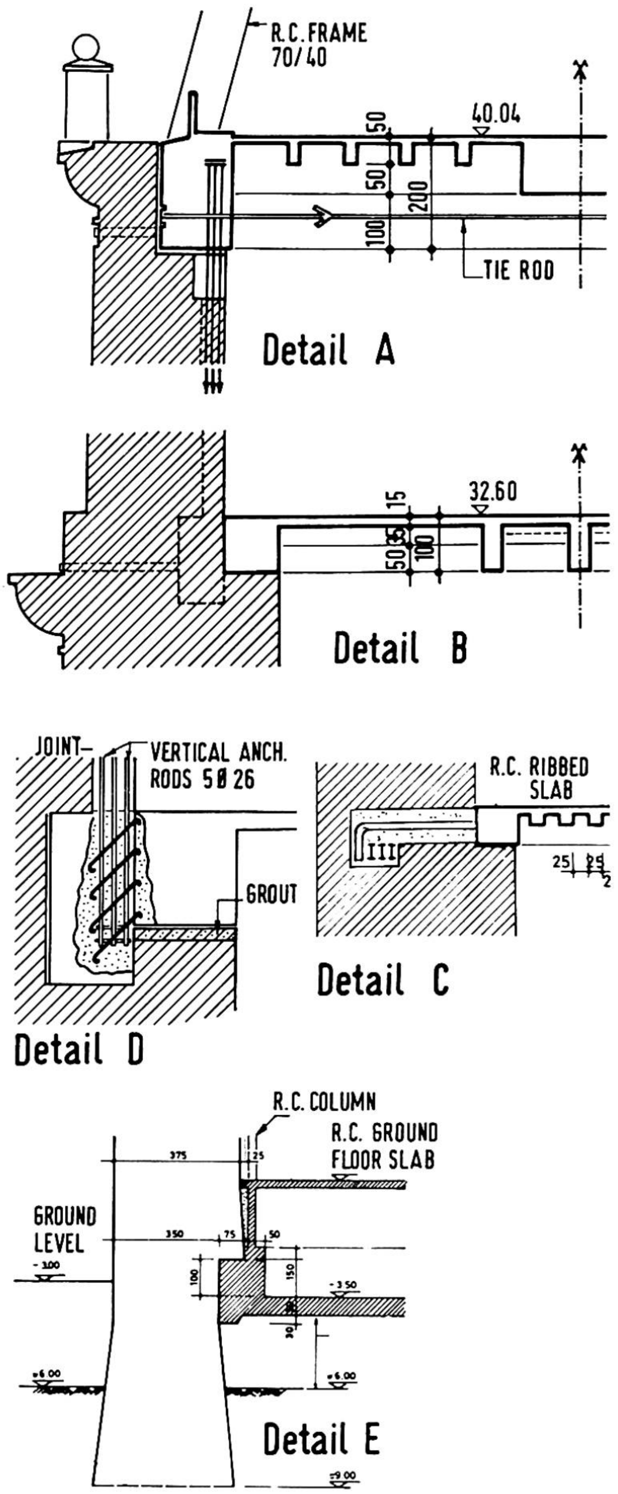

AN EXTRACT FROM THE ENGRAVING OF M. NASUHI EF. IN 1535 SHOWING GALATA AND ITS TOWER

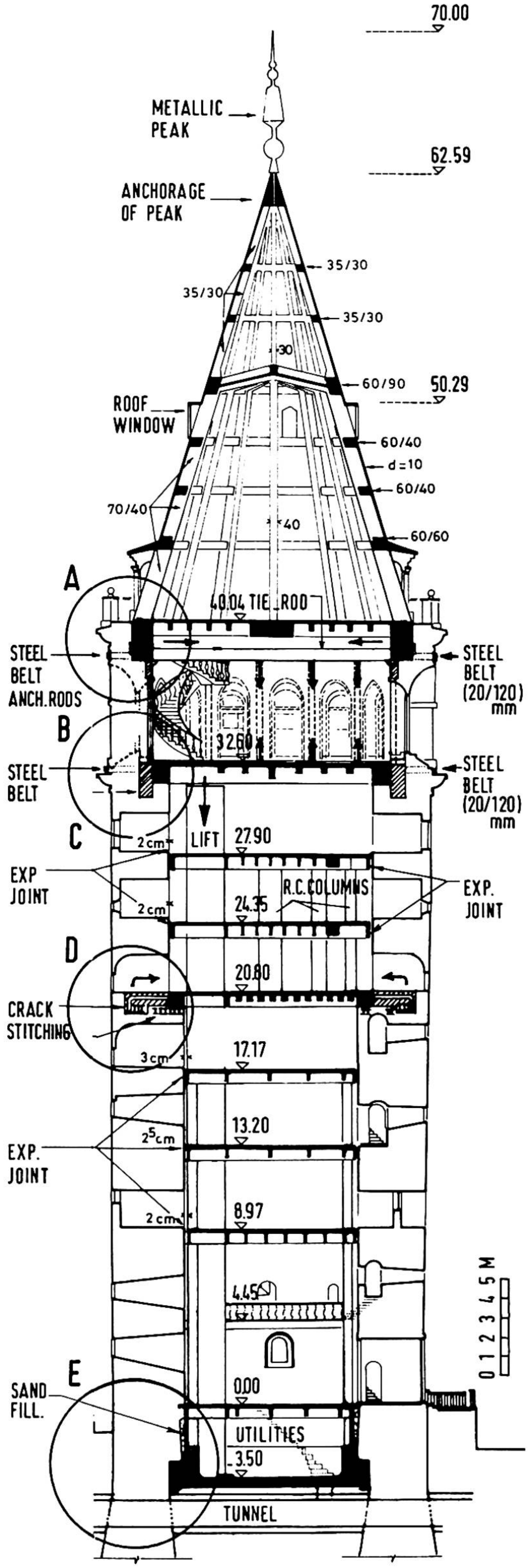




HISTORICAL VIEWS OF THE TOWER DRAWN BY A. IGNAZ MELLING IN 1800 (IV. STAGE_LEFT) AND J. F. LEWIS IN 1836 (V. STAGE_RIGHT)

# TABLE 1_ GALATA TOWER IN THE HISTORICAL PERSPECTIVE



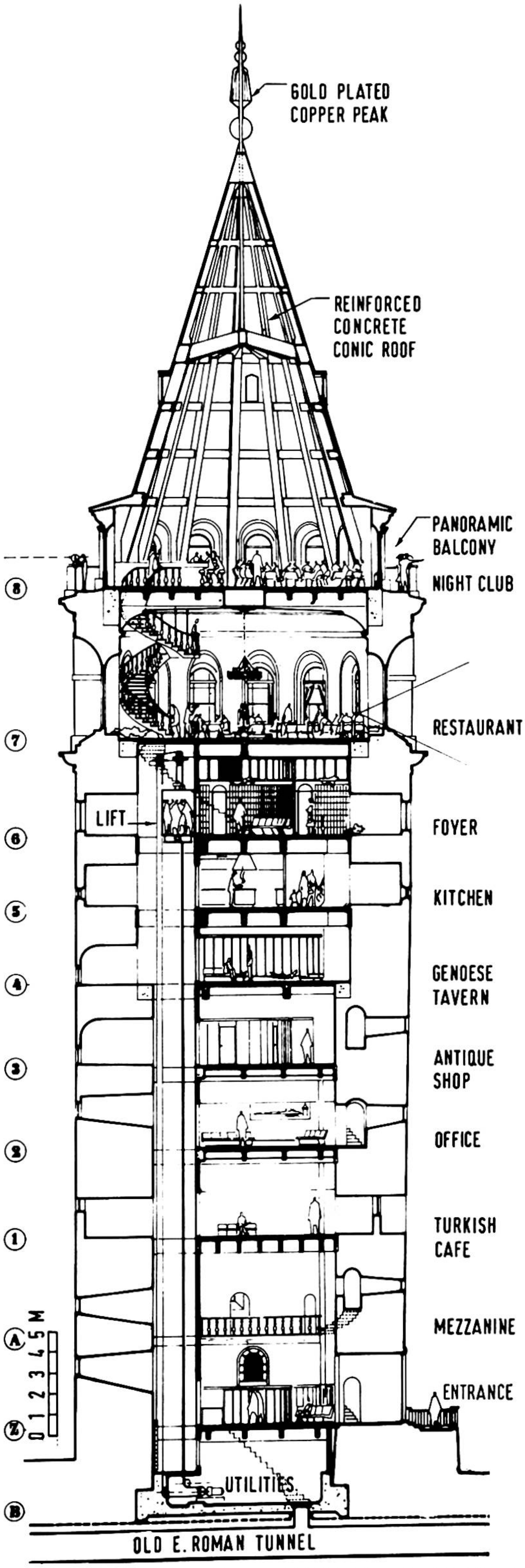



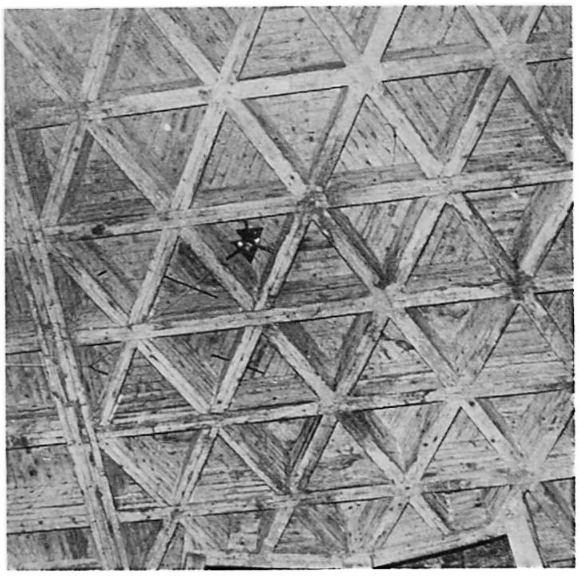

BRIEF INFORMATION

Owner : Municipality of Istanbul
Design_Consultant : Yapı Merkezi _ Istanbul
Contractor : Yapıtaş Ltd _ Istanbul

| | Before Resto. | After Resto. | |
|---|---|---|---|
| Σ Weight of building | $1.00 \times 10^5$ | $1.12 \times 10^5$ | kN |
| $\sigma_{so}$ Max. soil stress | 0.48 | 0.54 | MPa |
| $\sigma_w$ Max. wall stress (vert. load) | 0.79 | 0.89 | MPa |
| $\sigma_w$ Max. wall stress (with horiz. load) | – | 1.47 | MPa |
| $T_o$ Fundamental period | ~0.25 | ~0.45 | sec |
| δ Max displacement at top | – | 5.5 | mm |

TABLE 2 _ TYPICAL STRENGTHENING AND RESTORATION DETAILS



ENTRANCE HALL R.C. CEILING

ARCHITECTURAL VERTICAL SECTION (LEFT)
EXTERIOR VIEW OF TOWER (ABOVE)

TABLE 3 _ GALATA TOWER AFTER RESTORATION