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Consequences of Small Earthquakes on the Artistic Heritage

Conséquences de faibles séismes sur l'héritage artistique

Auswirkungen schwacher Erdbeben auf das Kunsterbe

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The methodical study of defence from seismic risk of artistic heritage has considerably spreaded in the last years, increasing researchers' interest about problems concerning monumental building.

In spite of this diffused interest there are not scientific and methodical contributes examining the problem of work of art safety. The only research to consider as a specific reference point in this field can be that one performed at Getty Museum of Malibu [1,2]: in Italy, a country full of works of art and with a large part of its territory exposed to seismic risk, there are few researchers interested in the subject [3,6,7].

At last, there are not national or international Codes imposing behaviour to obtain sure results.

As a first step it is obviously very important to classify the wide range of objects according to their form, dimensions and way of exhibition.

The general purpose of this research program .is to give indications suitable for a great part of the situations that can occur in a Museum. This paper, as a first step, examines the single object as a rigid body simply supported on the main structure (leaving out of account the filter' s effect due to the action of structure on the show-case).

Based on the results of precedent studies concerning a generic body and the ones mentioned about the specifity of the objects of art [4,6], this paper reports the results of a set of experiences performed with the aim of establishing the variableness of the effects with the variation of friction conditions between the objects and the fixed floor, the object' s frequency and the increase of dissipated energy when there are oscillations and collisions between the objects and the show-case.

These experimental investigations are completely originals. They have been made using reproductions of vases and small statues supported on a plate oscillating with sinusoidal law.

Experiences have attested the *theorical* results obtained and they march side by side with that ones made in Japan on parallelepipeds.

Different material interposed allowed to obtain the expected results about *sliding and tipping*, as to measure the effective displacements with frequencies and period of simulation near to the real one.

Effective displacements are very important if the object's sliding is established as a desirable situation. In this case it is necessary to evaluate possible relative displacements in order to avoid incidental collisions.

Among different hypotesis made, it is very interesting the combination obtained increasing dimensions of the base by applying a plexiglass pedestal and controlling the friction between object and show case interposing a film of plastic material.

This study has been carried out contacting some Directors of Italian Museums, periodically subjected to sismic events of different intensity. Every one agreed about the necessity of carefully examining these themes and extending them to all the classes of objects, not only the simply supported ones, because there are no indications and the few intervents made depended on the sensibility of experts.

REFERENCES

1. AGBABIAN M.S., MASTRI F.S., NIGBOR R.L., GINEL W.S., Siesmic damge mitigation concepts for art objects in museum. Earthquake Engineering Ninth Word Conference, Tokyo-Kyoto, Aug. 1988, Vol. VII, pp. 235-240

2. AGBABIAN M.S., MASTRI F.S., NIGBOR R.L., Evalution of seismic mitigation measures for objects. Dept. Civil Engrg, Univ. of California, Los Angeles. The Getty Conservation Institute, Marina del Rey, CA. Gen. 1990

3. AUGUSTI G., CIAMPOLI M., AIROLDI L., Mitigation of seismic risk for museum contents: An introductory investigation. Earthquake Angineering Tenth World Conference, Madrid. 1992, pp. 5995-6000.

4. ISHIYAMA Y., Criteria for overturning of rigid bodies for sinusoidal and earthquake excitations. Earthquake Engineering Eighth World Conference, S. Francisco, 1984. Vol. 4, pp. 267.

5. Eurocode N.8, Structures in Seismic Regions - Disign. Part 1: General and Buildings. Commissione della Comunità Europea, Lussemburgo, 1988.

6. AUGUSTI G., SINOPOLI A., Modelling the Dynamics of Large Blocks Structures. Meccanica, Vol. 27, n.3, 1992, pp.195-211.

7. AUGUSTI G., CIAMPOLI M., AIROLDI L., Protezione sismica degli oggetti d'arte: uno studio preliminare. Ingegneria Sismica (in press), 1993.

Automatic Monitoring of Buildings Deterioration

Surveillance automatique de la détérioration de bâtiments

Automatische Überwachung der Schadensbildung an Bauten

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SUMMARY

The time control of structural failures should be accomplished by monitoring systems which can provide data in real time. Using such a system we are able to follow the evolution of structural cracking , thermohygrometric conditions, structural yielding and other sources of material and structural deterioration occuring within a time domain.
The data acquisition unit connected to the measuring transducers is based on an intelligent system endowed with a programmable microprocessor which received analogic signals transformes into digital values. This unit, using a modem, submits the data by phone to a central control point where the received data are read and processed by a personal computer. The central control point can be located in a designer office or any other place where monitoring data are required. This acquisition data system is fully automatic permitting remote control of data readings. The system, once installed, permits monitoring continuously in time without staff assistance at the control point both for receiving and processing of data.
Autors examine the real possibility of monitoring today and present the last significant applications they made in Italy.

1. INTRODUCTION

Step 1. Find the Deterioration

In practise, this apparently obvious and simple statement may present a very subtle problem when defects are not visible. For example, timbers and timber pilling can be damaged by insects or other organisms, virtually to the point of collapse, without exhibiting any external evidence; corrosion of steel can be difficult to detect because it occurs, principally, in the most inaccessible parts of the structure.

Step 2. Determining the Cause

This is, by far, the most difficult and important step. There are no rules or procedures for determining the cause or causes of deterioration, each case is an individual problem. However the analysis of cracks, the appearance of the surface of concrete, the inspection of timber and steel structures, furnishes an idea for further investigations. It is important to study the structure in bad weather as well as in good. Also it is important to investigate the problem sufficiently deeply to discover any hidden or latent defect.

Step 3. Evaluating the Strength

Usually, the building being investigated is in active use, and it is necessary to determine, as quickly as possible, if it is safe to continue to use it, or if the facility should be restricted to some less severe usage.

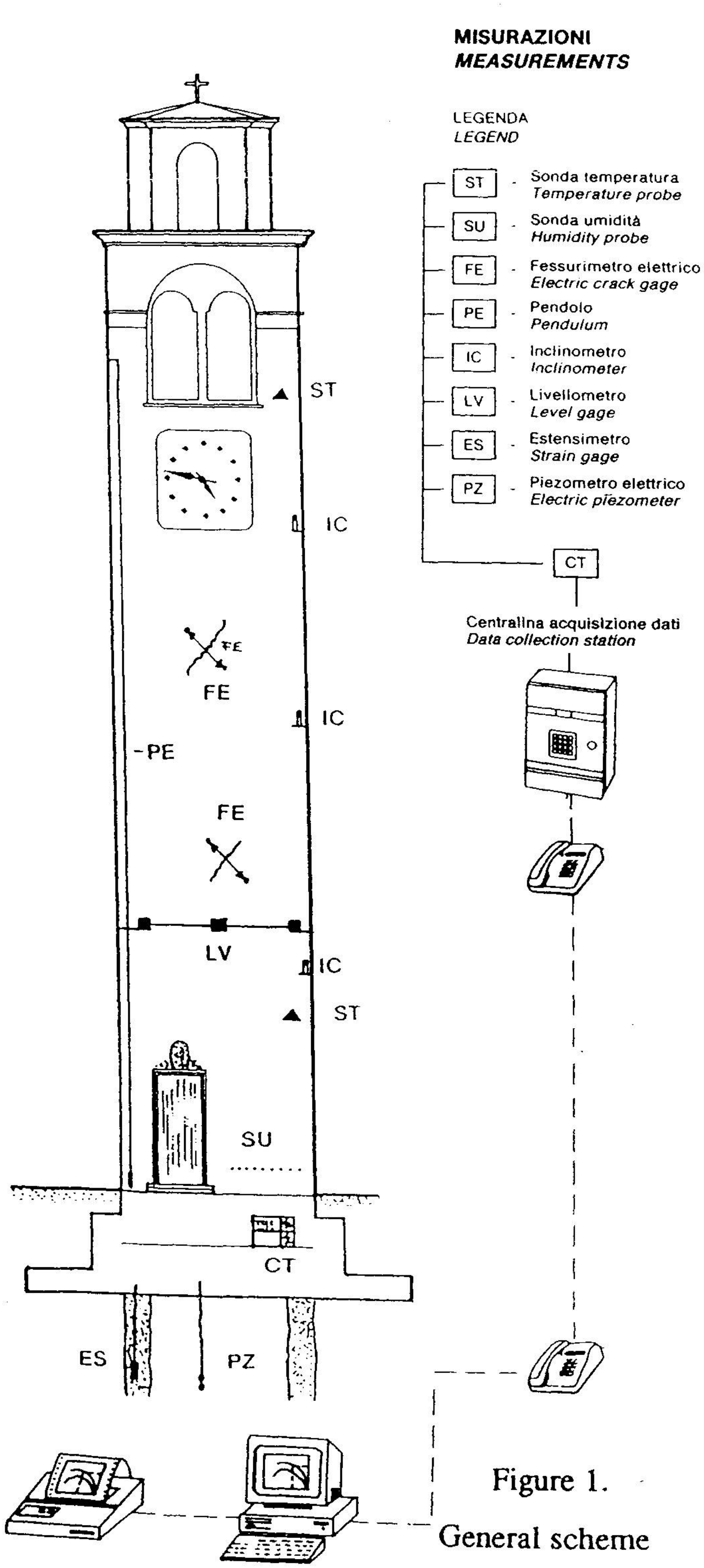

Figure 1.
General scheme

All the difficulties encountered in the steps for detection and diagnostic can obtain a powerful aid by monitoring the main parameters of the structure with non destructive techniques.

The modern technique and technology of measurements made the controls and monitoring easy. Electrical transducers transform every important parameter in numeric digital signal, data-loggers can retain for further manipulation, computers and suitable software elaborate data in real time, modems diffuse every information or data requested all over the world.

This acquisition data system is fully automatic permitting remote control of data readings.

The system, once installed, permits monitoring continuously in time without staff assistance at the control point both for receiving and processing of data.

Although this system and the corresponding software are very sophisticated they are permanently upgraded and further developed.

In the example (Figure 1) we examine the actual possibilities to control a church tower. Transducers continuously measure the variations of: width of cracks, temperature, moisture content, global and partial verticality, stresses, strains, relative displacements. All the transducers are connected to a central controller that by modem release actual values of measured parameters.

This arrangement of instrumentation allows to evaluate the evolving of deterioration in the time and also to study the importance of the cyclic variation of temperature and moisture content of the walls and foundations.

The last application we made in Italy concern the evolution of cracks in the upper part of Castel S. Angelo in Rome, Chiesa S. Paragorio in Noli and Chiesa S. Lorenzo Maggiore in Naples.

Strength Assessment of a Brick Masonry Building of 1895

Détermination de la résistance d'un bâtiment en maçonnerie de 1895

Widerstandsbestimmung eines Backsteingebäudes von 1895

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1. Introduction

Recent severe damage to old brick masonry buildings in Japan as a result of even moderate earthquakes has emphasized the need to retrofit such buildings to enhance their seismic performance. This paper describes a collaborative project to investigate the seismic performance and appropriate retrofit measures for a famous 3–story brick masonry building, 130m long, 45m wide and 15m high and containing many interior walls. The building was completed in 1895 and is the only remaining masonry structure in a Tokyo business district where it is part of a government office complex.

This paper consists of two parts. Part 1 provides detailed information on the strength of the brick walls. Part 2 examines the seismic performance of the building by using earthquake response spectrum methods and the strength results.

2. Test program

To evaluate the seismic resistance of the masonry, flexural, shear and compressive monotonic loading tests were conducted on the walls. The walls were constructed of bricks 240*115*65 mm with 10 mm thick bed joints. And tests, as follows, were conducted

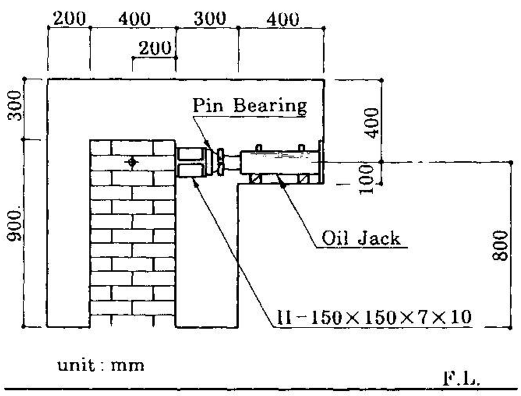

Fig.1 In–plane flexural test

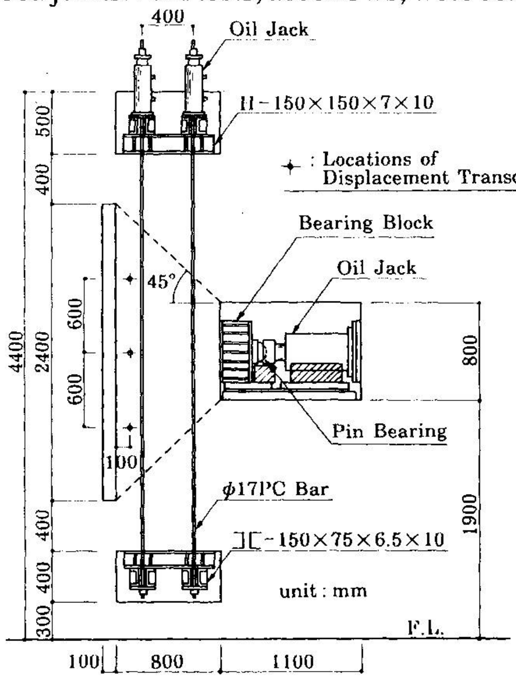

Fig.2 In–plane shear test

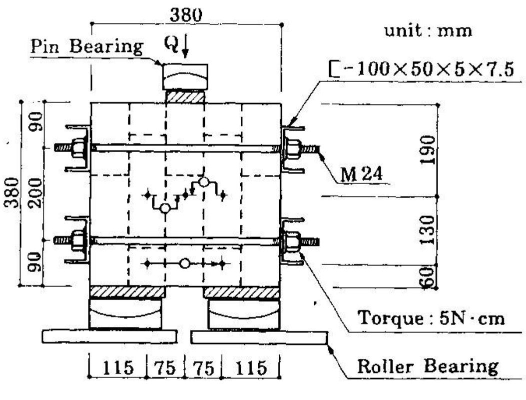

Fig.3 Double shear test

on the actual brick walls and on 380 mm cubic specimens cut from the walls:

a. In–plane flexureal and shear tests of the walls (Fig. 1 and 2) ;
b. Double shear tests on cubes loaded parallel to the horizontal joints (Fig. 3) ;
c. Compressive tests on cubes loaded perpendicular to the horizontal joints ; and
d. Compressive, splitting and modulus of rupture tests on individual bricks

3. Test results

The setup for the two in–plane shear tests is shown in Fig. 2. The loading jack was inserted in a 800*1100 mm hole cut in the wall and the area between that jack and a 2400*100 mm slot also cut in the wall was preloaded to a mean vertical stress of 0.4 Mpa. Horizontal load, Q , versus horizontal center displacement, δ , relationships obtained from this test are shown in Fig. 4. The slope of the curves, which represents the stiffness of the walls, gradually decreased as the loading increased. The load carrying capacities degraded asymptotically once severe diagonal shear cracks initiated along the joints. For specimen B–1 the maximum load was 230 KN at a horizontal displacement of 9.9 mm.

In the double shear tests, displacements were measured parallel(slip) and perpendicular (separation) to the horizontal joints. Fig. 5 are the resultant load – displacement relationships for specimen C–1. Slips and separations were not observed until immediately after the maximum load of 98 KN was reached. Then large plastic displacements occurred without significant reduction in load carrying capacity. The other three specimens exhibited similar behavior but their capacities and stiffnesses were slightly smaller than for C–1. The mean shear strength at the joints derived from this test was 0.28 Mpa.

Shown in Fig. 6 is a comparison of the stress–strain relationships from the compressive tests. The vertical strains at the peak load for each specimen differ due to differences in the maximum strengths of the fragile joint mortar. The initial stiffness for the walls, defined as the secant modules at one third of the maximum strength, averaged 2800 Mpa .

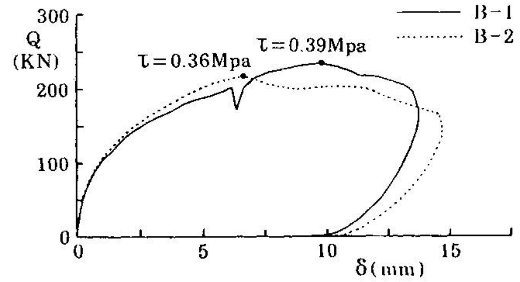

Fig.4 Load – displacement relationships for In–plane shear test

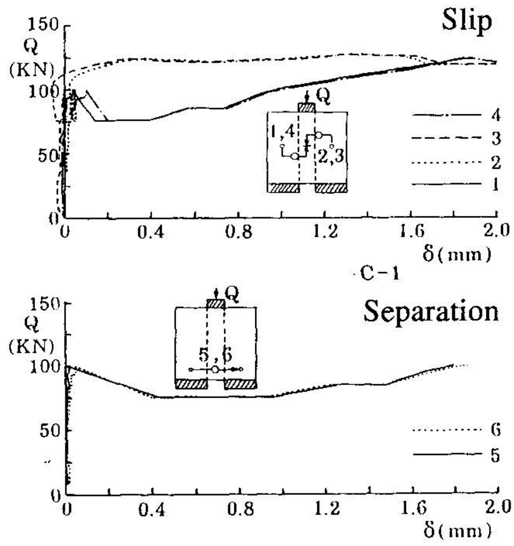

Fig.5 Load – displacement relationships at the joints

4. Summary and conclusions

The test results showed that the strength of the joint mortar had a significant effect on the behavior of the brick walls. That strength was reduced by long term deterioration effects. The following conclusions were drawn as to mechanical properties of the brick walls:

1. Flexural strength σt=0.15 Mpa ;
2. Shear strength τu=0.38 Mpa ;
3. Compressive strength σu=6.4 Mpa ; and
4. Modulus of elasticity Ew=2800 Mpa

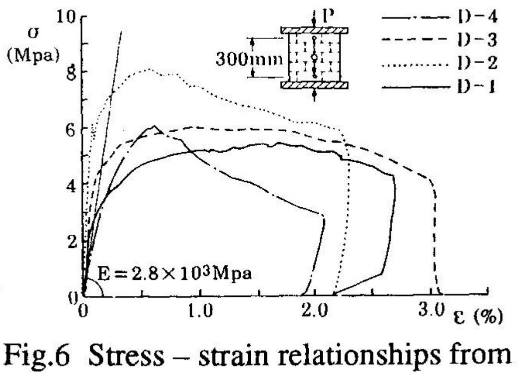

Fig.6 Stress – strain relationships from compressive tests

Survey of Statical Conditions of Churches in Rome

Etat des conditions statiques d'églises de Rome

Statischer Zustand römischer Kirchen

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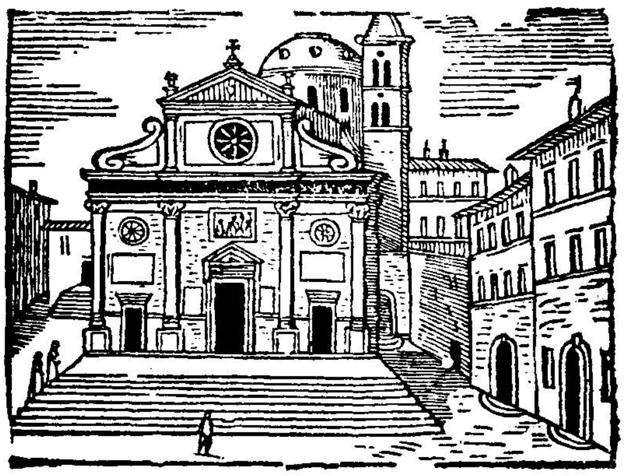
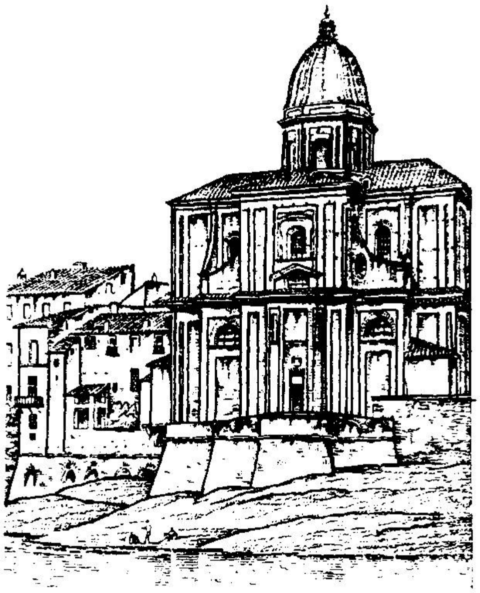
Historic public buildings have often undergone limited spot repairs, following the emergencies rising time by time. Such maintenance is in the end poor and expensive.
Ancient architectures were often built over the remains of former buildings, or taking advantage of existing structures; seldom at once or according to one design, but rather in multiple phases, due to changes in available cash, sponsors and taste. Their overall statical conditions are not well known, in lack of information about construction materials, soil and foundations, modifications and repairs made in the past, state of conservation and even drawings showing the exact geometry of the structure. Thus, investigations are needed in order to understand and to assess these essential aspects of th life of the buildings.
The objective of the authorities concerned with monumental buildings is now to set organic plans of preservation, foreseing the needs of the building in a global view and assigning the priorities, in order to pursue a logical and economic sequence of maintenance and upgrading, despite fragmented funding.
In this context, the writers have been commisioned by the Ministry of Public Works to undertake surveys and investigations on the statical conditions of three main basilicae in the heart of Rome: St. Augustine's, St. John of the Florentines' and the Gesù.



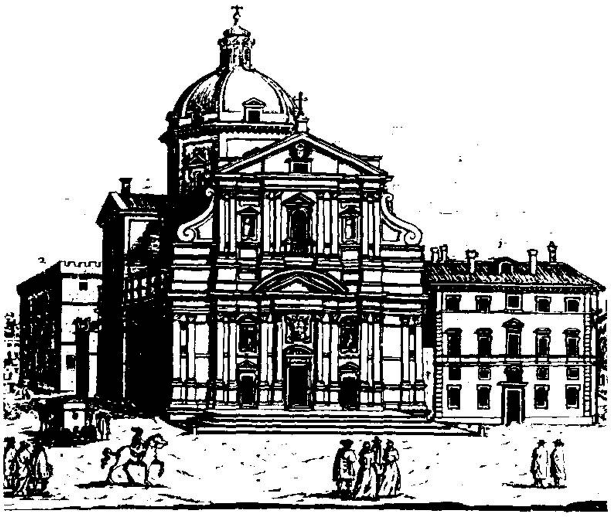
St Augustine's has been called the "living room" of Rome. This church lies between the Tiber and the stadium of Domiziano (piazza Navona) and was built by the Augustinian hermit order who, in the 13th century, acquired some land with a small church, S. Trifone, and started the construction of a greater one, for completing it only in 1483. The new church incorporated the older walls in its transept, but it is not yet clear where and to what extent.
In 18th century, the structure was in bad shape, with severe cracks in the central part, including the drum sustaining the dome. Then, L.Vanvitelli completely renovated it, consolidating all foundations, dismantling the whole dome and replacing the old bell-tower (both still appearing in the engraving).
In the middle of 19th century, the internal ornament work was renewed and brought to the present look.

St John of the Florentines' was built by the state of Florence in the beginnings of the 16th Century and completed in the following, involving several of the most important architects of the time. It lies on the Tiber left bank, opposite the Vatican. A large foundation plate was built into the river bed, then without embankments (see the engraving), giving the church a lenght appropriate to its importance.



Subsequent architects chose different layouts among centric and longitudinal plans, while construction was going on. Finally, the longitudinal scheme prevailed with A. da Sangallo. Some older structures were incorporated such as those of a chapel; but they are not on the same plate as the church and may suffer differential settlements, also due to the high changes in water level of the nearby river.
Later, the church underwent strenghtenings several times.

The Gesù (the Holy Name of Jesus'), Mother-Church of the Society of Jesus, is perhaps the most important Renaissance church in Rome. A small chapel, S. Maria della Strada, assigned to theSociety on the site, was soon demolished, yielding place to the new majestic architecture. Several designs were examined, including Michelangelo's, implying various positions, before the actual one by G. Della Porta was agreed upon, its façade rising in front of the *Papal Street* and chancel in the place of the former chapel.



Documents describe difficulties and cost of founding *in the water*.
The dome is low, not to impose upon the view of the façade; it had masonry ribs also on the inner face, that were demolished in the 17th century for frescoing the ceiling (a report says that the masonry of the vault was *good and strong*, needing no ribs!).
"Instructions" in 27 items, written by the Jesuites, codified the construction works and are testimony to the state of the art at the time.

The survey has begun with historic research on structural data, geometric measurements and visual inspections. No evidence appears on overall statical weaknesses, but typical degradations are present in all buildings, namely, roof timber aging and leakings, detachings of lead plates from domes, humidity from soil, settlement cracks in masonry. Particularly difficult is checking the foundations. In fact, inside the churches the underground space is filled with historic graves and, outside, streets and buildings hinder inspections. The survey will proceed by sampling the structural materials and monitoring the deformations, where needed. Finally, a maintenance plan will be established.

Testing the Steeple of the Peter and Paul Cathedral in Saint Petersburg

Contrôle du clocher de la cathédrale de St. Pierre et Paul à Saint Petersbourg

Kontrolle des Glockenturms der St-Peter und Paul-Kathedrale in St. Petersburg

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The steel steeple with a cross of 60 m in height (from el. + 60.0 to el. 120.0) was erected in 1857 in place of a wooden one destroyed by fire. When examining the cathedral structures in 1991, cracks were found in the masonry at an el of 40.0 m in a place where the steeple anchoring beams had been built in.

The dynamic loading tests of the steeple structures were performed for experimental determination of the following:

— natural frequency of the first mode of oscillation and its comparison with the design mode;
— decrement of oscillation for calculation of dynamic forces;
— values of the revealed crack;
— an oscillograph and a cinecamera started working simultane-ously with the radio command.

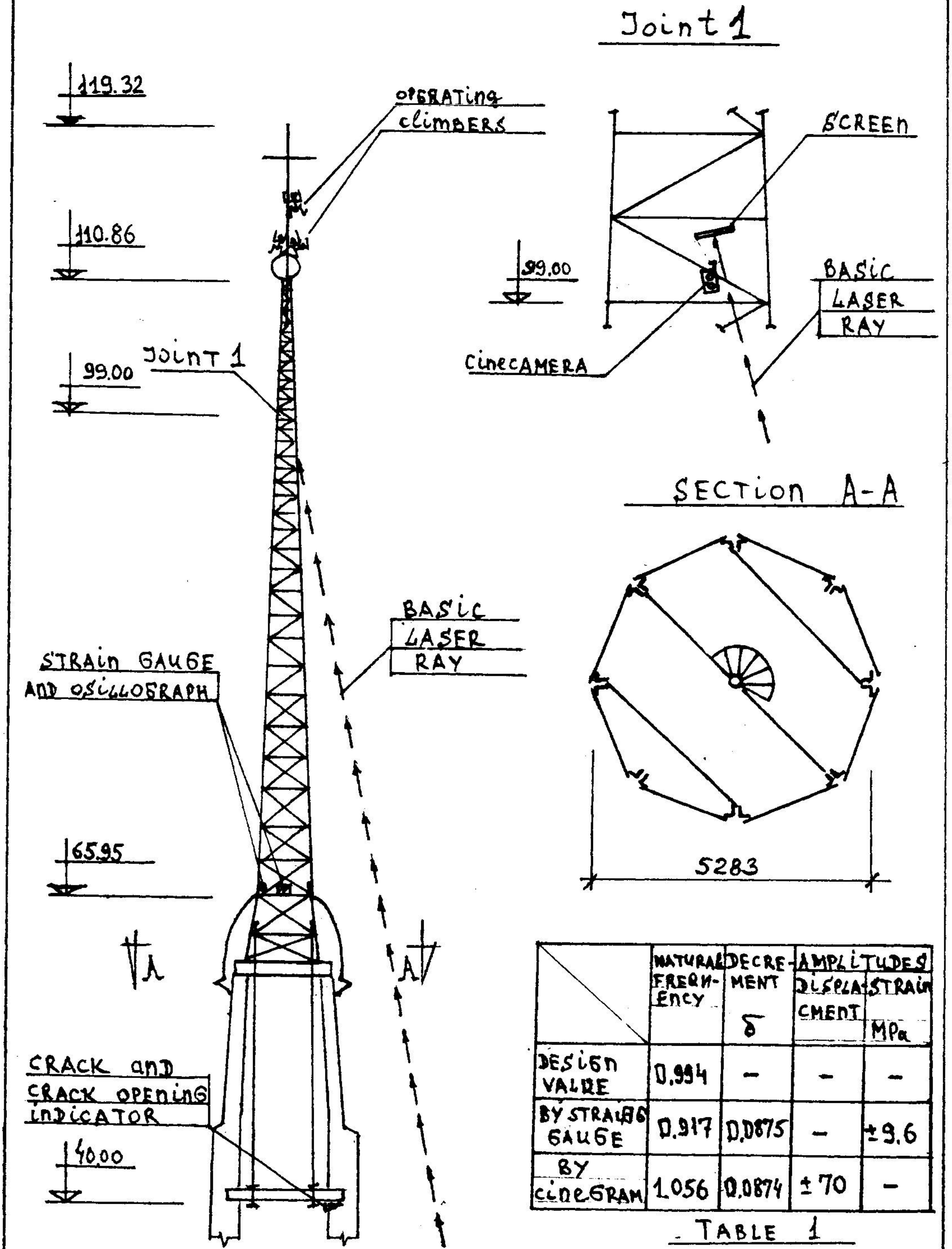
The tests were performed eight times.

The valute $\delta = 0.0875$ with an amplutide of strain $\pm$ 9,6 MPa is explained by the fact that the copper sheets of the steeple displace in oscillation which be clearly seen and dissipation of the oscillation energy accelerated due to dry friction.

In the cracked area at an elevation of 40.0 m, vertical displacement was recorded of the steel supporting beam relative to the brick masonry with an amplitude of $\pm$ 0.01 mm at a maximum amplitude of the steeple 70 mm at an el. of + 115.0.

The diagram of the tests is shown in Fig. 1. The results are presented in Table 1.

The tests showed coincidence of the design and the field strain characteristics of the steeple structures. The verification calculations, the results of examination and the field tests made it possible to give a comples assessment of the condition of one of the main historical structures of Saint Petersburg.



	NATURAL FREQUENCY	DECREMENT δ	AMPLITUDES DISPLACEMENT	STRAIN MPa
DESIGN VALUE	0.994	–	–	–
BY STRAIN GAUGE	0.917	0.0875	–	±9.6
BY CINEGRAM	1.056	0.0874	±70	–

TABLE 1

Fig.1 STEEPLE TEST DIAGRAM