ROLE OF CIVIL ENGINEER IN HERITAGE CONSERVATION

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WCCE-ECCE-TCCE JOINT CONFERENCE 2
Antalya, October 31-November 1


The Mausoleum at Halicarnassus (BODRUM)
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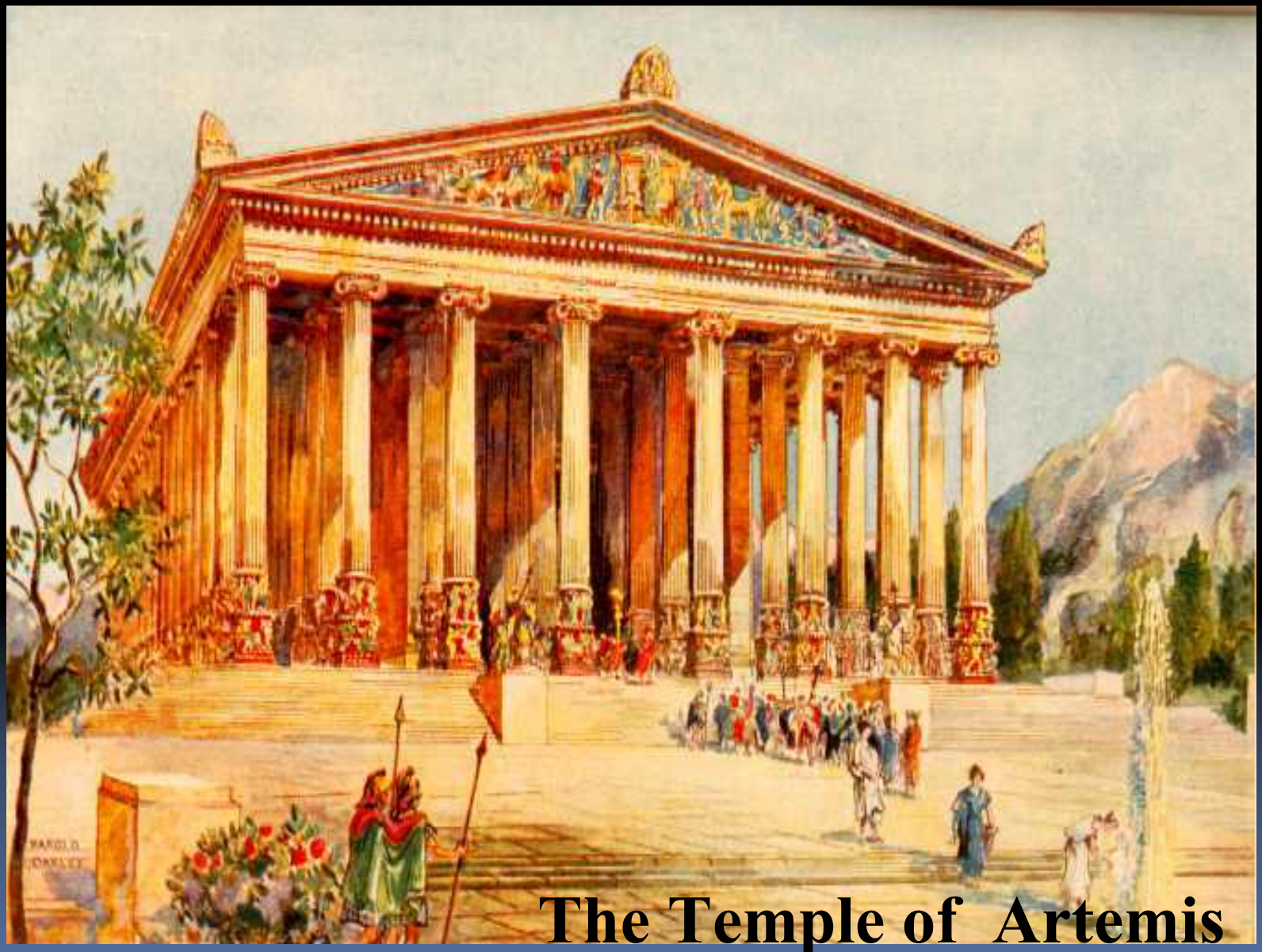
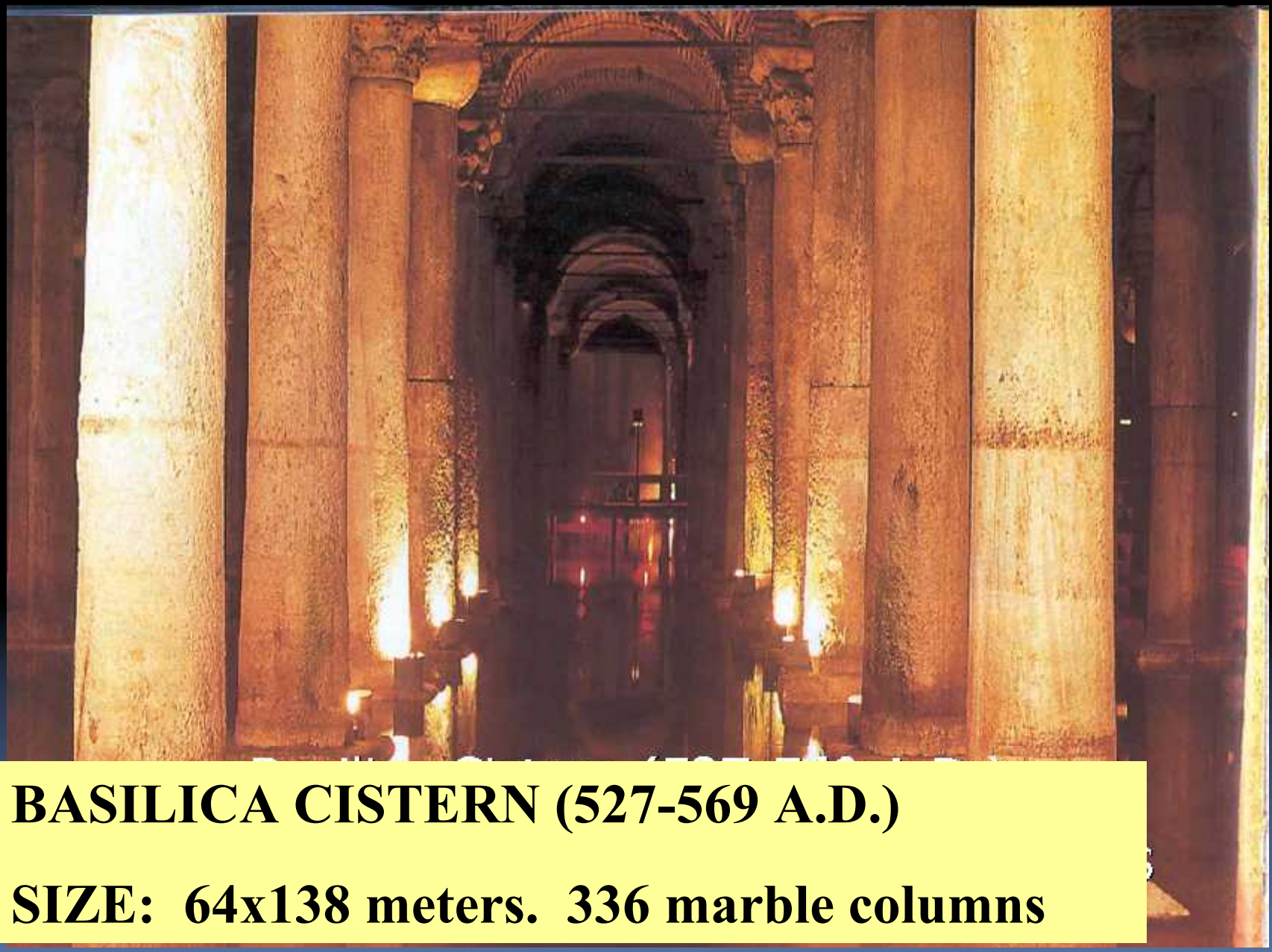


The Temple of Artemis

Bozdogan Aqueduct (370 A.D.)

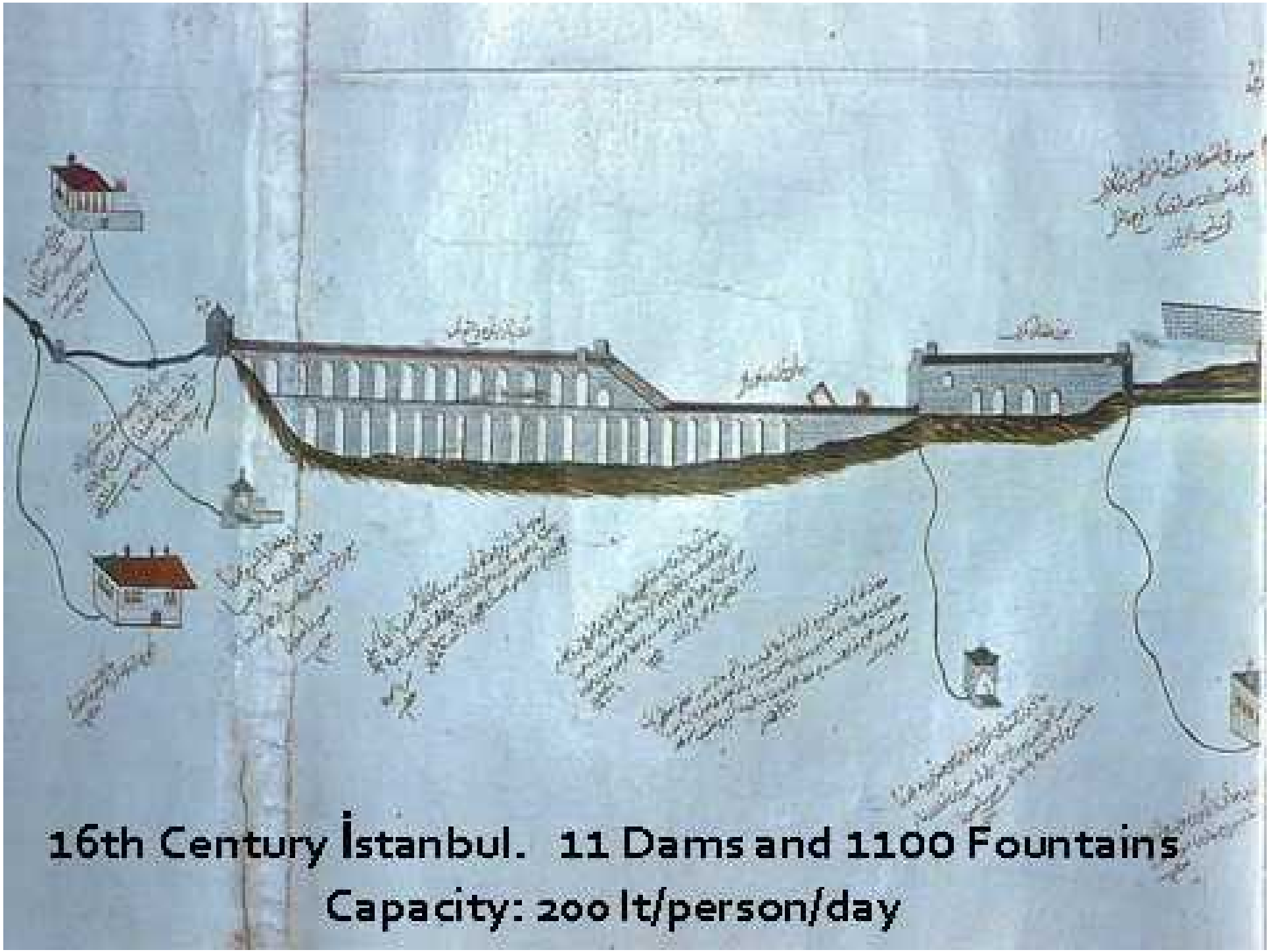
Waterline = 240 km

From Stranca Mountains to İstanbul



BASILICA CISTERN (527-569 A.D.)

SIZE: 64x138 meters. 336 marble columns



16th Century İstanbul. 11 Dams and 1100 Fountains

Capacity: 200 lt/person/day


ROMAN BRIDGE, ADANA, TURKEY
(117-138 A.D.), LENGTH = 320 m.


•St Sophia, İstanbul


Selimiye Mosque Edirne
16th Century

CIVIL ENGINEERING PRIOR TO 18 th CENTURY:

ARCHITECTURAL AND CIVIL ENGINEERING WORKS WERE DONE BY THE SAME CRAFTSMEN.

I WOULD CALL THEM :

“MASTERS” OR “MASTER BUILDERS”

MAIN TOOLS USED BY EARLY BUILDERS:

-PAST EXPERIENCE

-THEIR OWN EXPERIENCE

-ENGINEERING INTUITION

INDUSTRIAL REVOLUTION:

-FORMAL CIVIL ENGINEERING EDUCATION

-SPECIFICATIONS

FIRST ENGINEERING SCHOOL FRANCE , 1752 ??

FIRST ENGINEERING SCHOOL IN TURKEY, 1773

TO ILLUSTRATE THE IMPORTANCE OF **EXPERIENCE AND INTUITION,**

THE GREAT MOSQUE SULEYMANIYE (16 th century) WILL BE TAKEN AS AN EXAMPLE.


SÜLEYMANİYE
MOSQUE
16 th CENTURY

LEGENT !?

THE CHIEF ROYAL ARCHITECT SINAN, PILED UP THE MATERIAL ON THE SITE AND THEN DISAPPEARED FOR TWO YEARS !

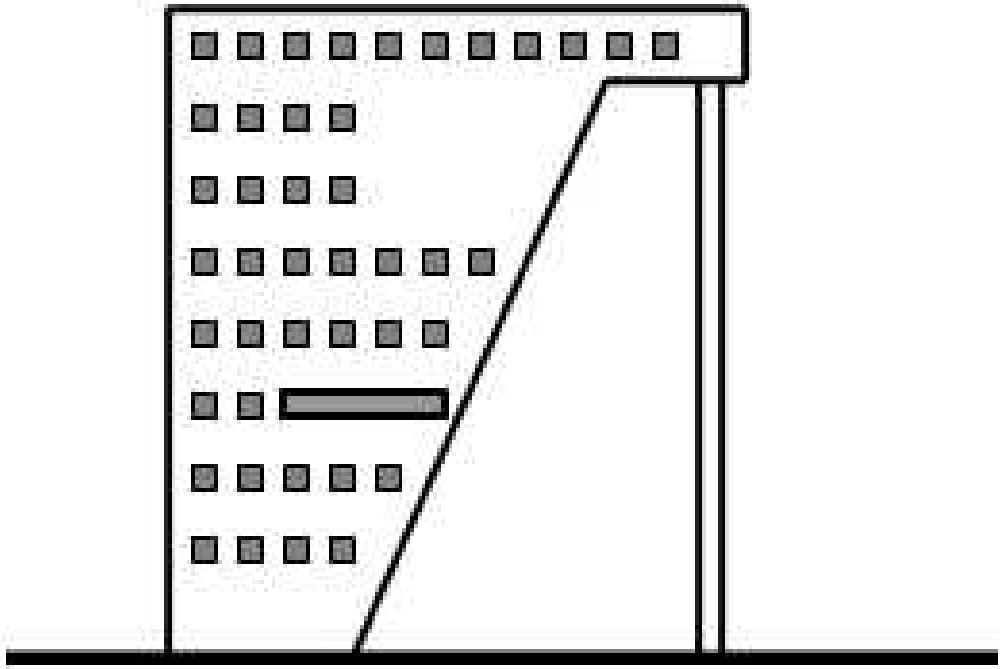
WAS SINAN AWARE OF THE CONSOLIDATION THEORY ?!

TODAY WE HAVE VERY SOPHISTICATED ANALYTICAL TOOLS AND HIGHLY DEVELOPED COMPUTERS AND SOFTWARES

HOWEVER IN CIVIL ENGINEERING PROJECTS, INTUITION, EXPERIENCE AND JUDGEMENT ARE STILL VERY IMPORTANT !

Building designed by architect “X”

YEAR: 2011 LOCATION: High seismic risk area




4000 YEARS AGO EGYPTIANS DID BETTER BY
PUTTING THE PYRAMID ON ITS BASE !

CIVIL ENGINEERING IS QUITE DIFFERENT FROM SOME OTHER BRANCHES OF ENGINEERING SUCH AS ELECTRONIC ENGINEERING, CHEMICAL ENGINEERING ETC.

IN DESIGNING OR IN EVALUATING A STRUCTURE, CIVIL ENGINEER IS FACED WITH MANY UNKNOWNS.

TO SOLVE THE PROBLEMS, HE OR SHE HAS TO MAKE MANY ASSUMPTIONS.

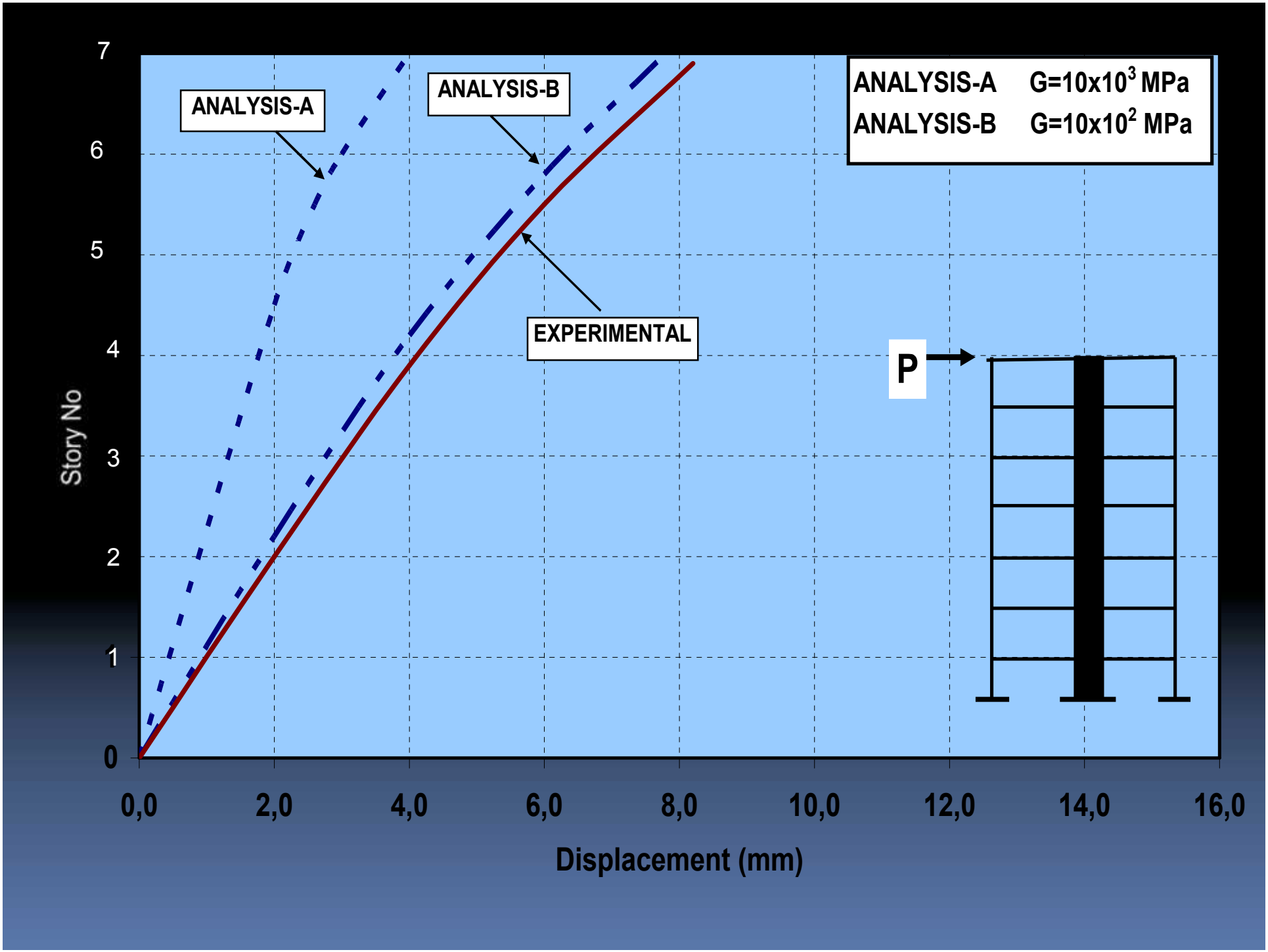
THEREFORE THERE IS NO "EXACT SOLUTION" IN CIVIL ENGINEERING !

SOMEONE HAS SAID THAT THE THEORY OF STRUCTURAL DESIGN IS BUILT BY ATTRIBUTING IMPOSSIBLE PROPERTIES TO NON-EXISTENT MATERIALS !!!

Hardy Cross

IN HISTORICAL MASONRY AND TIMBER STRUCTURES THERE ARE MORE UNKNOWNS AS COMPARED TO MODERN STEEL OR REINFORCED CONCRETE STRUCTURES !

ASSUMPTIONS MADE IN ANALYSES SHOULD BE REALISTIC AND REASONABLE !


ANALYSIS-A
ANALYSIS-B
EXPERIMENTAL
ANALYSIS-A G=10x10^3 MPa
ANALYSIS-B G=10x10^2 MPa
P
Story No
0
1
2
3
4
5
6
7
0,0
2,0
4,0
6,0
8,0
10,0
12,0
14,0
16,0
Displacement (mm)

AN OLD MOSQUE WAS INSTRUMENTED AND TESTED USING FORCED VIBRATION TECHNIQUE.

AN ANALYSIS OF THE MOSQUE WAS MADE USING FINITE ELEMENT TECHNIQUE

ANALYSIS RESULTS AGREED WELL WITH THE MEASURED VALUES.

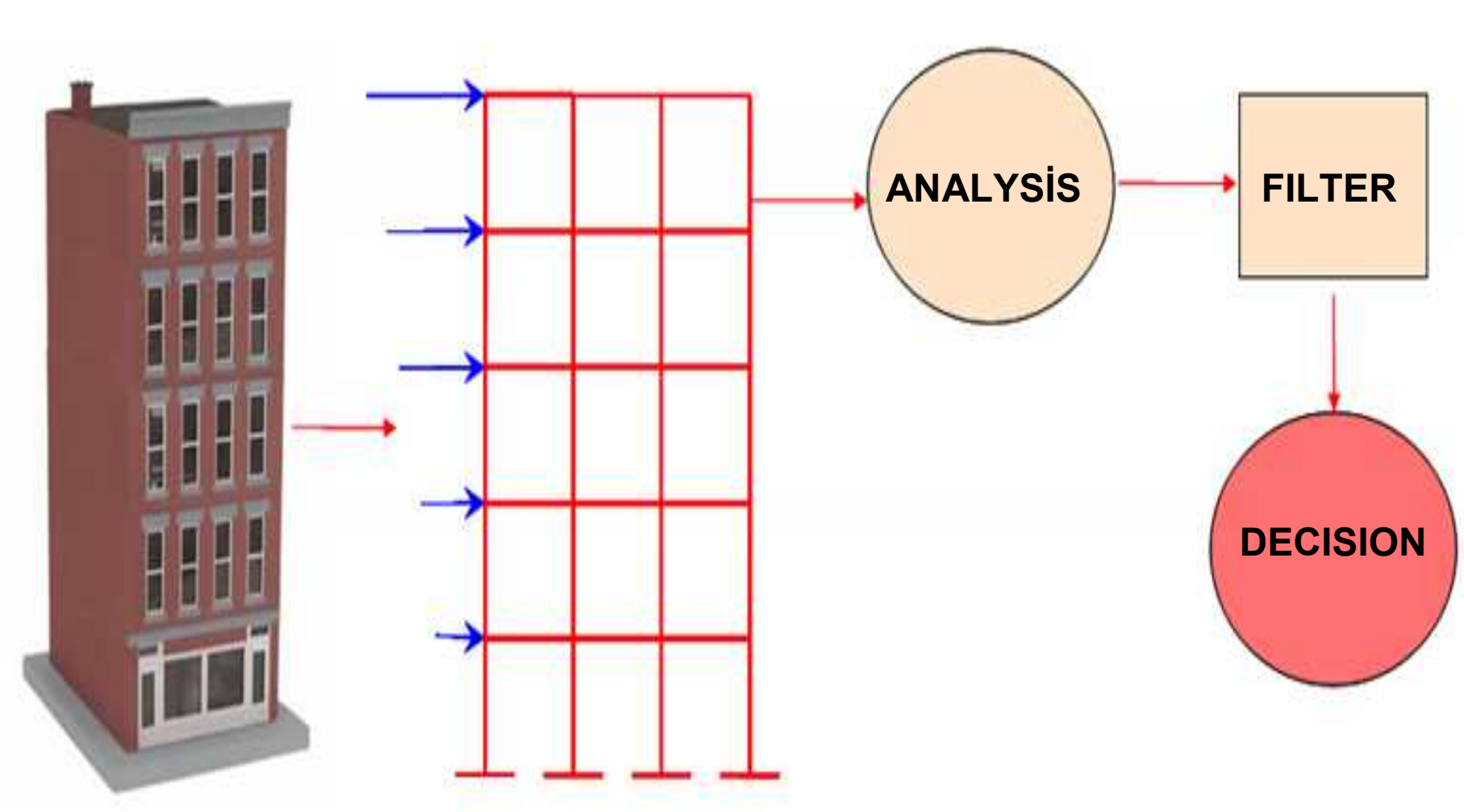
HOWEVER IN ANALYSIS, MODULUS OF ELASTICITY OF MASONRY WAS TAKEN AS

E = 60 000 MPa

THIS IS TWICE THAT OF CONCRETE !!!

IF YOU HAVE MEASURED VALUES, YOU CAN MAKE YOUR ANALYSIS AGREE WITH THESE VALUES BY CHANGING THE MATERIAL PROPERTIES, CONSTANTS, BOUNDARY CONDITIONS ETC. !!

TURKISH STUDENTS CALL THIS, “SOAPING !”



Building Model

Sultan Selim II (son of Suleiman the Magnificant)

2. Selim'in Mimarbaşı Sinan'a Yazdığı Yazı

HASSA MİMARLARIN BAŞI SİNAN'A HÜKÜM Kİ, RUMELİ'DEN VE SAİR YERLERDEN GELİP NECCARİYE VE BİNA İLMİNDEN HABERİ OLMAYIP MÜŞARUNİLEYHİN MARİFETİ OLMADAN ELLERİNE ARŞUN ALUP MİMARLIK EDİP NA-EHİL OLMAĞLA BİNA EYLEDİKLERİ EVLERİN EKSERİYE OCAKLARI TUTUŞUP İHRAK OLDUĞUNDAN BİLDİRDİĞİN ECİLDEN BUYURDUM Kİ,

VUSUL BULDUKTA BU BABDA MUKAYYED OLUP ONUN GİBİ BİNA DİLGERLİK İLMİNDEN HABERİ OLMAMAYIP ELLERİNE ARŞUN ALUP VECH-İ MEŞRUH ÜZRE MİMARLIK EKLEYENLERİ MEN EDİP SENİN MARİFETİN OLMADAN OL VECHİYLE NA-EHİL KİMSELERE MİMARLIK ETDİRMEYESİN.

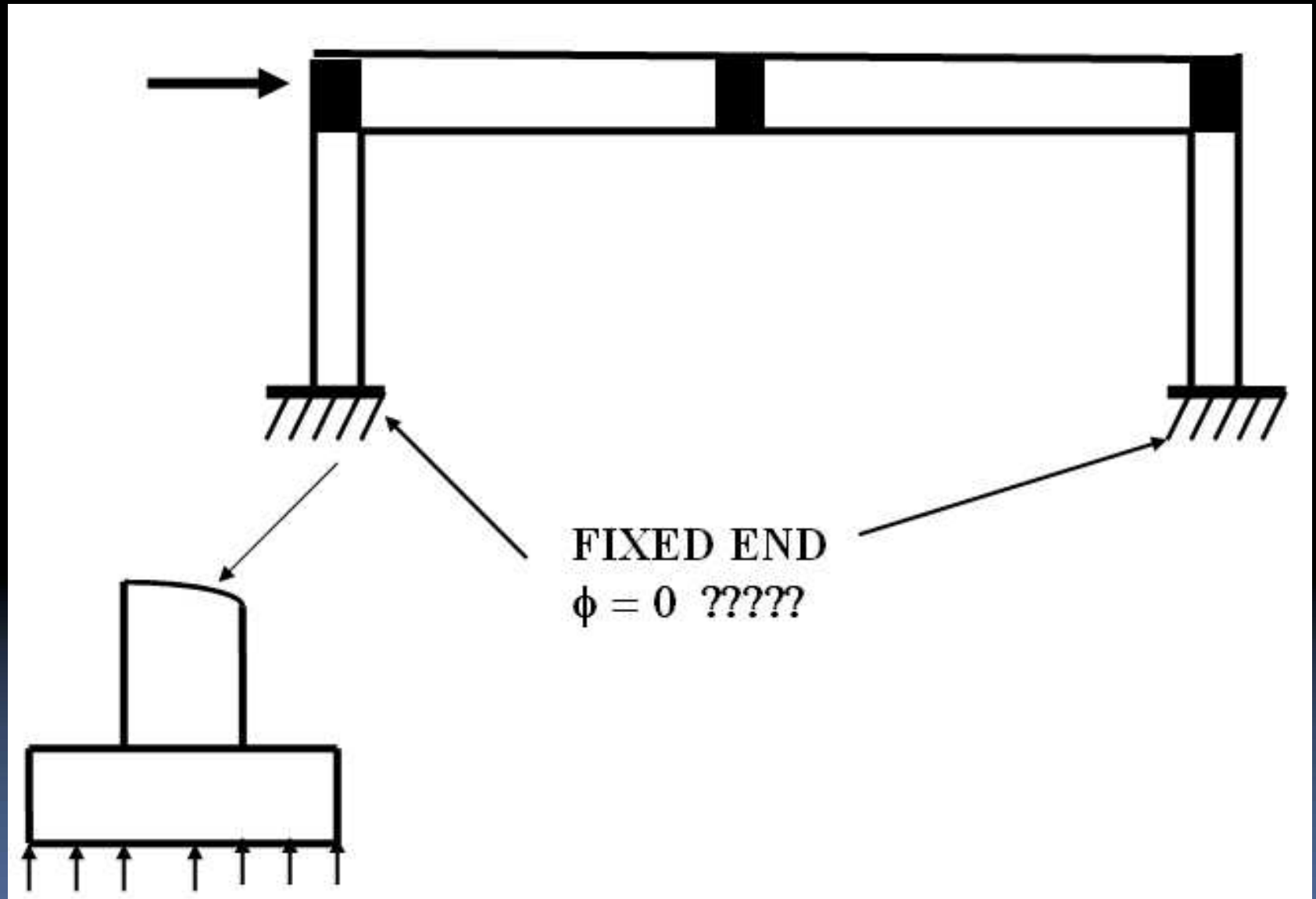
DECREE WRITTEN BY SULTAN SELİM II TO THE CHIEF ROYAL ARCHITECT SİNAN (16th century):

I WAS INFORMED THAT MEN FROM COUNTRY SIDE COME TO İSTANBUL, WHO CLAIM TO BE CRAFTSMEN, BUILD BUILDINGS FOR MY PEOPLE. THESE MEN ARE NOT FAMILIAR WITH THE BUILDING ART. THE BUILDINGS BUILT BY THESE UNQUALIFIED MEN ARE NOT SAFE.

I ORDER YOU TO FORBID THESE MEN TO BUILT IN ISTANBUL.

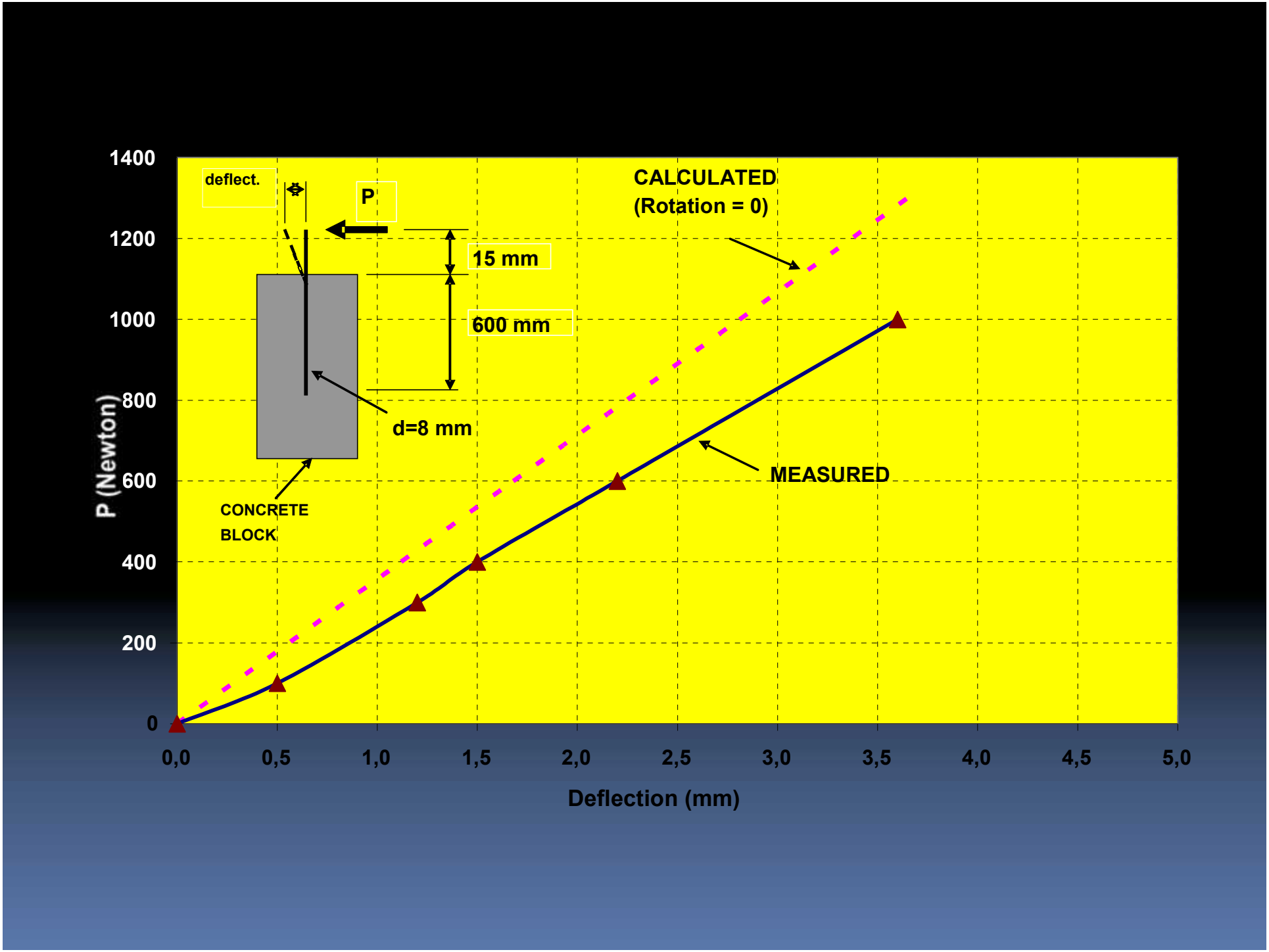
SULTAN SELİM HAN (son of Suleiman the Magnificent) , 1571

MY FIRST EXPERIENCE
DISAPPOINTMENT !
FIRST LESSON !


FIXED END
ϕ = 0 ????

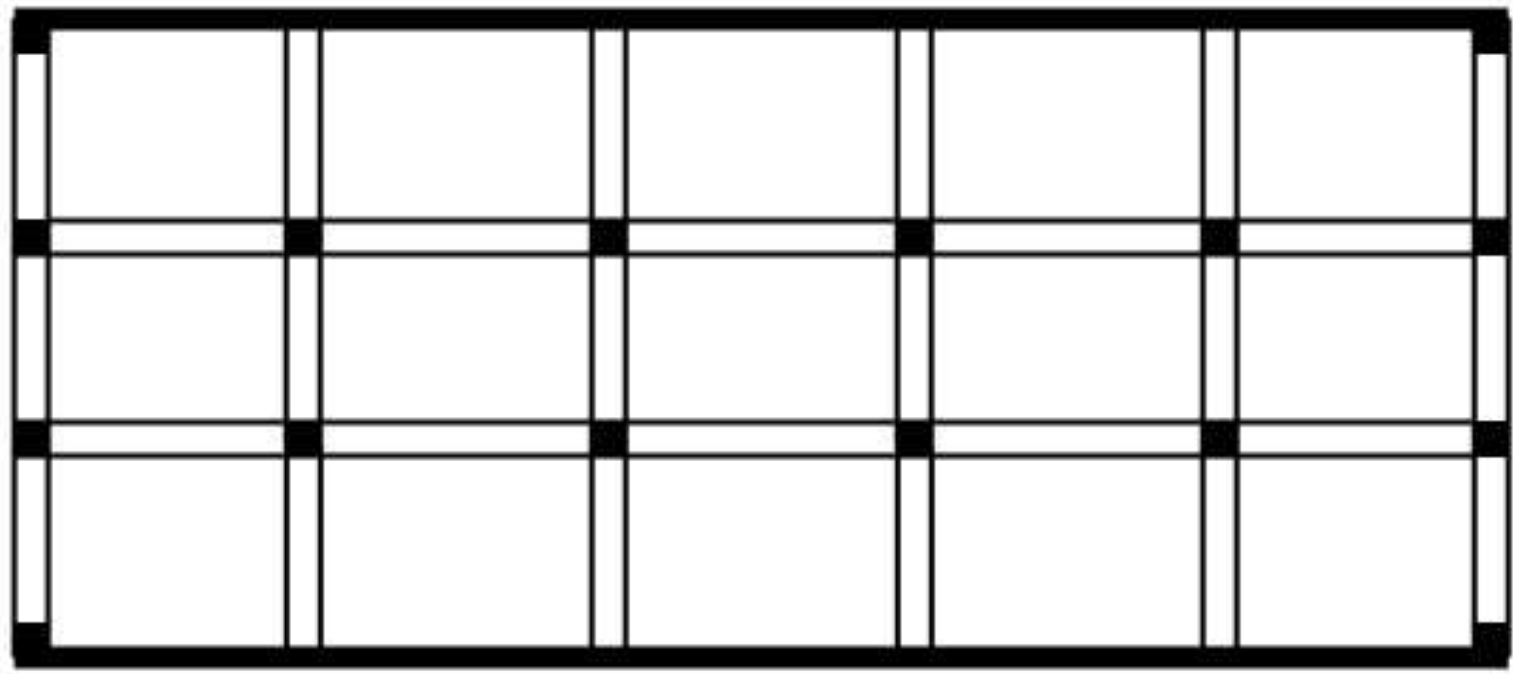
FIXED END ????

ROTATION = ZERO ????


deflect.
P
15 mm
600 mm
d=8 mm
CONCRETE
BLOCK
CALCULATED
(Rotation = 0)
MEASURED
P (Newton)
1400
1200
1000
800
600
400
200
0
0,0
0,5
1,0
1,5
2,0
2,5
3,0
3,5
4,0
4,5
5,0
Deflection (mm)

COMPUTER PROGRAMS FOR ANALYSES

???

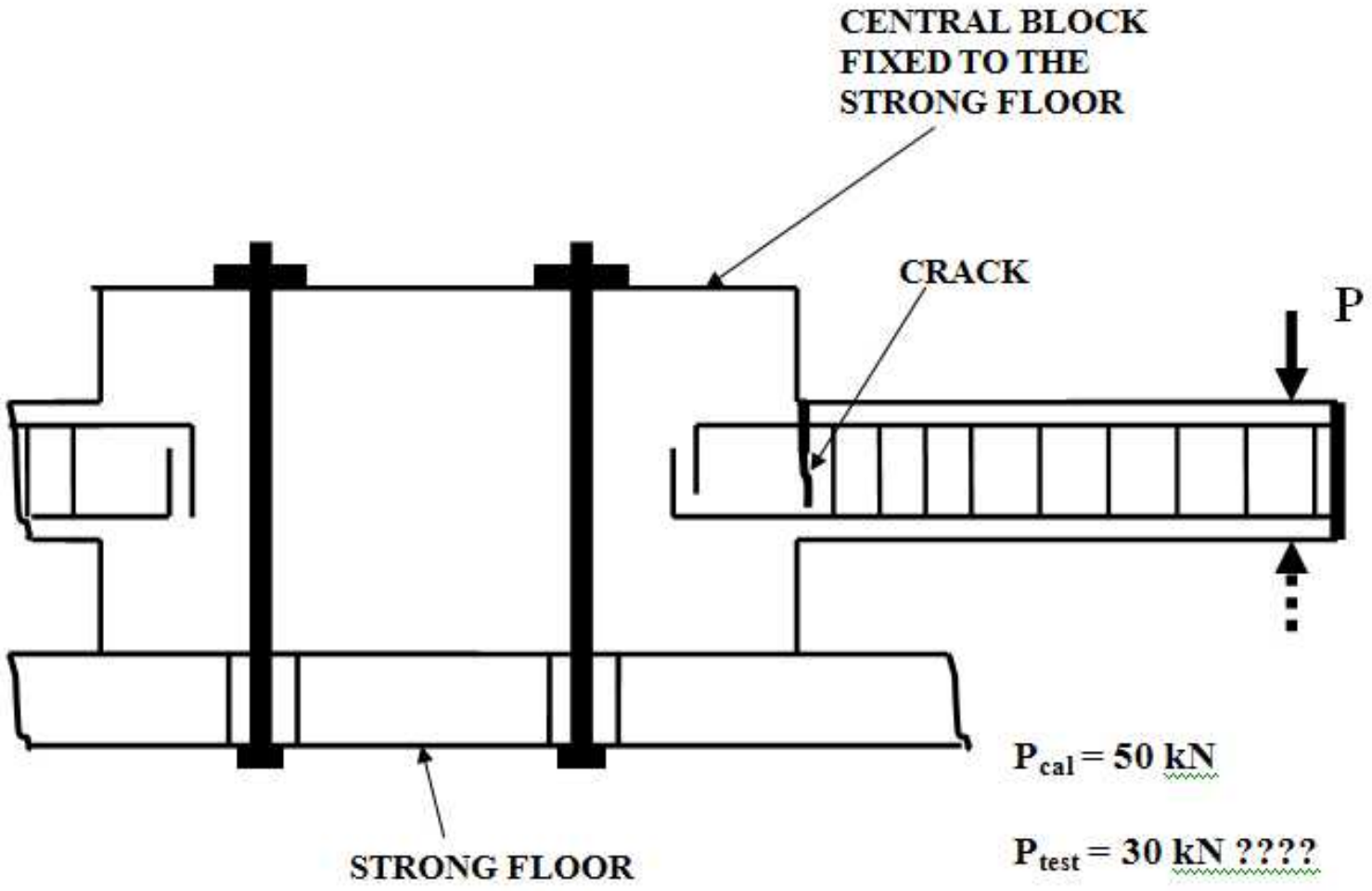


FLOOR PLAN

HISTORY OF SCIENCE IS FULL OF BEAUTIFUL THEORIES, BUTCHERED BY SMALL UGLY FACTS !

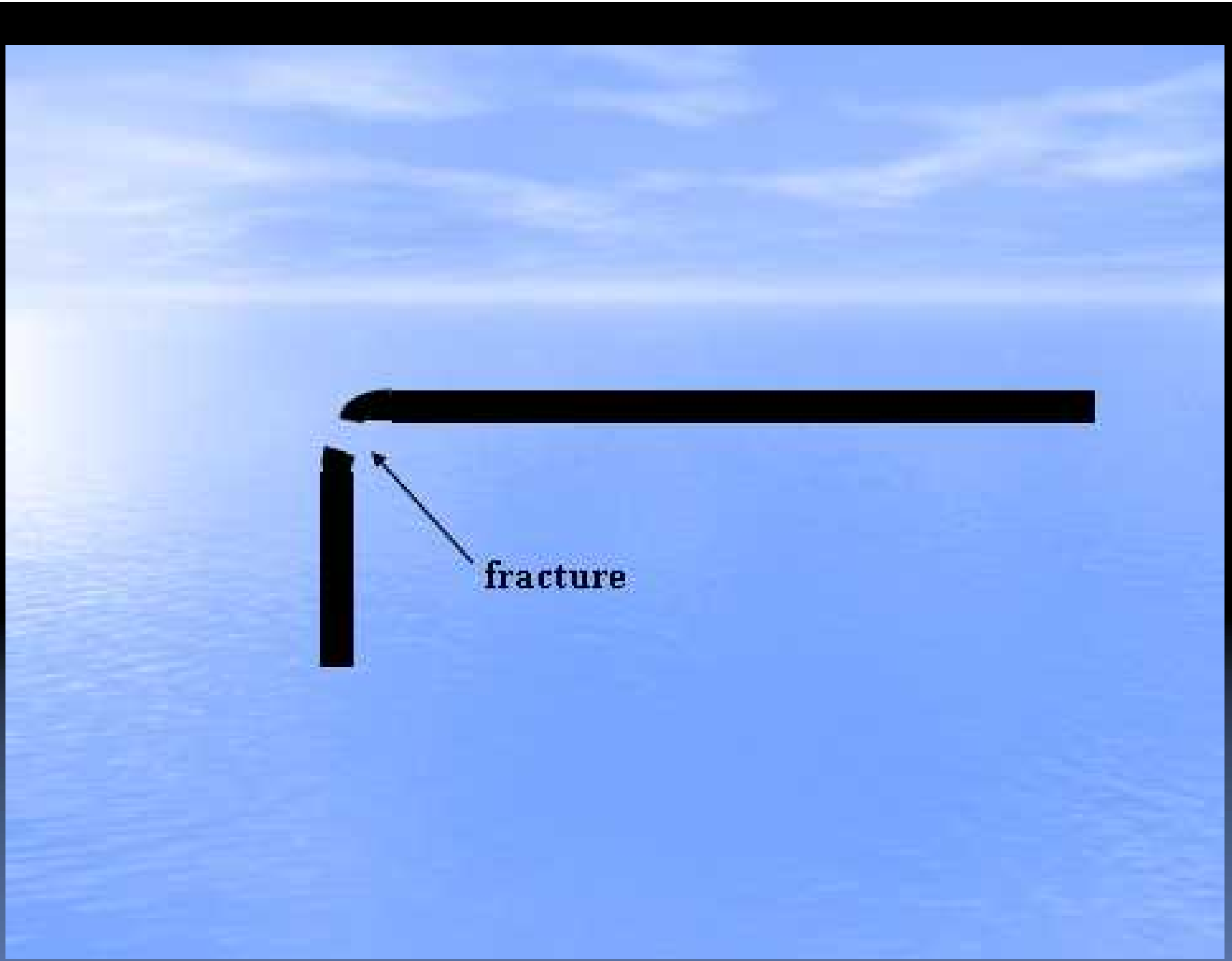
Sir S. Thomas

NOTE:
REINFORCEMENT OF THE CENTRAL BLOCK IS NOT SHOWN

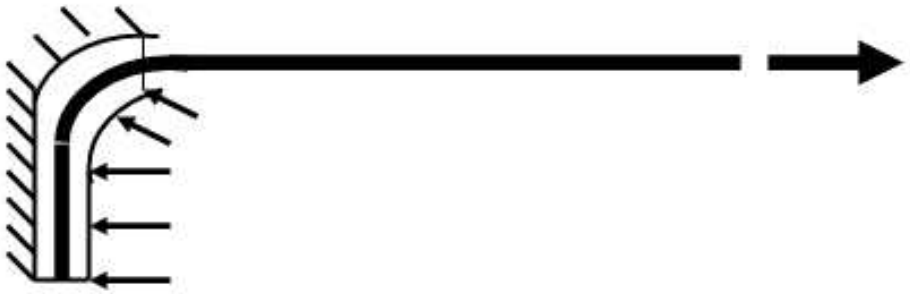


P_{cal} = 50 kN

P_{test} = 30 kN ????


fracture

METU TESTS ON BENT BARS:



P = 1.0

P = 0.4 - 0.7

THE GREAT TRUTHS OF ENGINEERING ARE SIMPLE...
AN ENDLESSLY COMPLEX PRESENTATION OF AN ENGINEERING FACT INDICATES COMPLICATION IN THE BRAIN OF THE PROPOUNDER RATHER THAN COMPLEXITY OF NATURE.

Hardy Cross

IF THE MODEL AND METHOD USED IN ANALYSES ARE SIMPLE THE ENGINEER CAN UNDERSTAND THE BEHAVIUOR BETTER.

OBSERVATION: DAMAGE

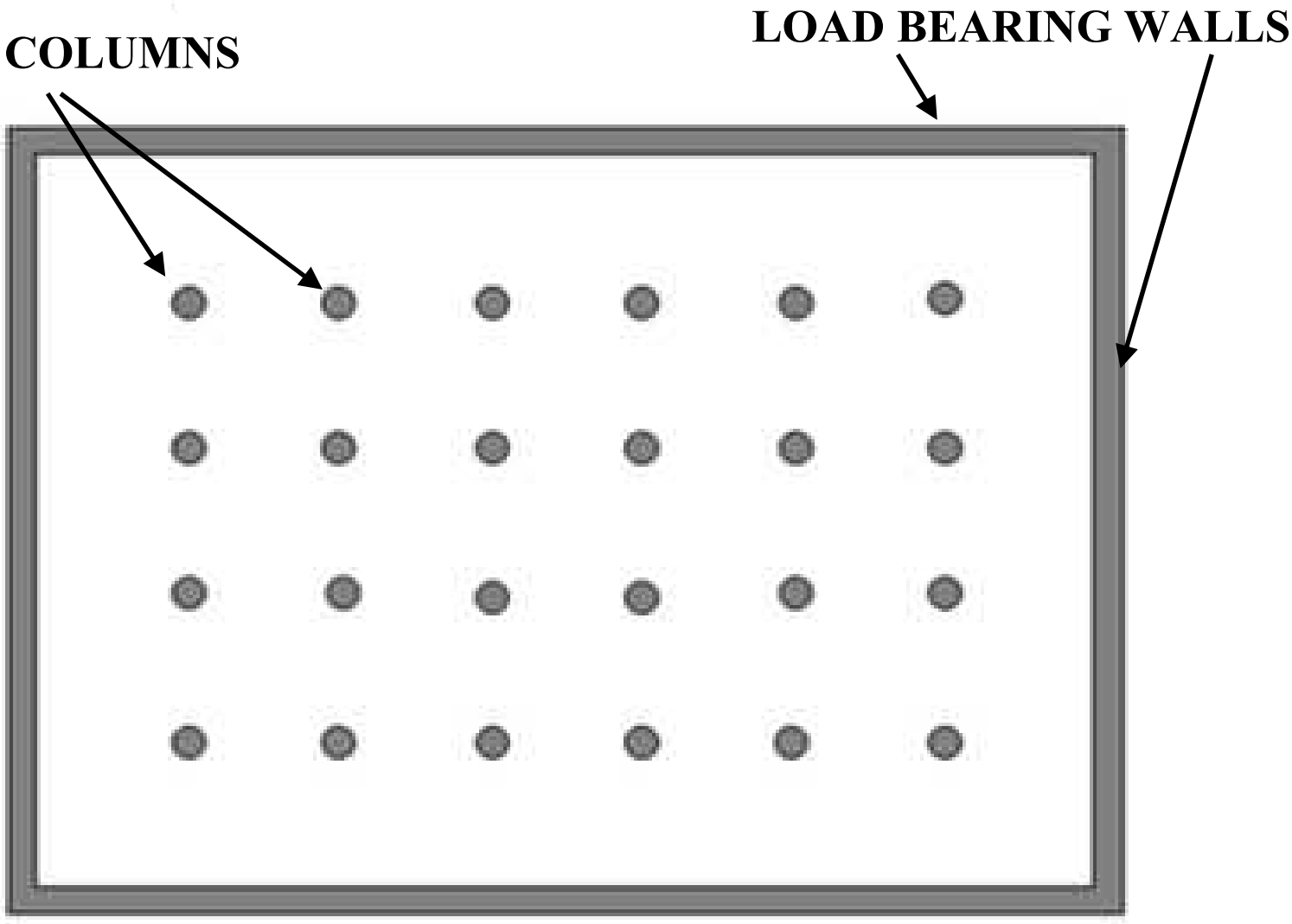
WRONG DIAGNOSIS

WRONG INTERVENTION

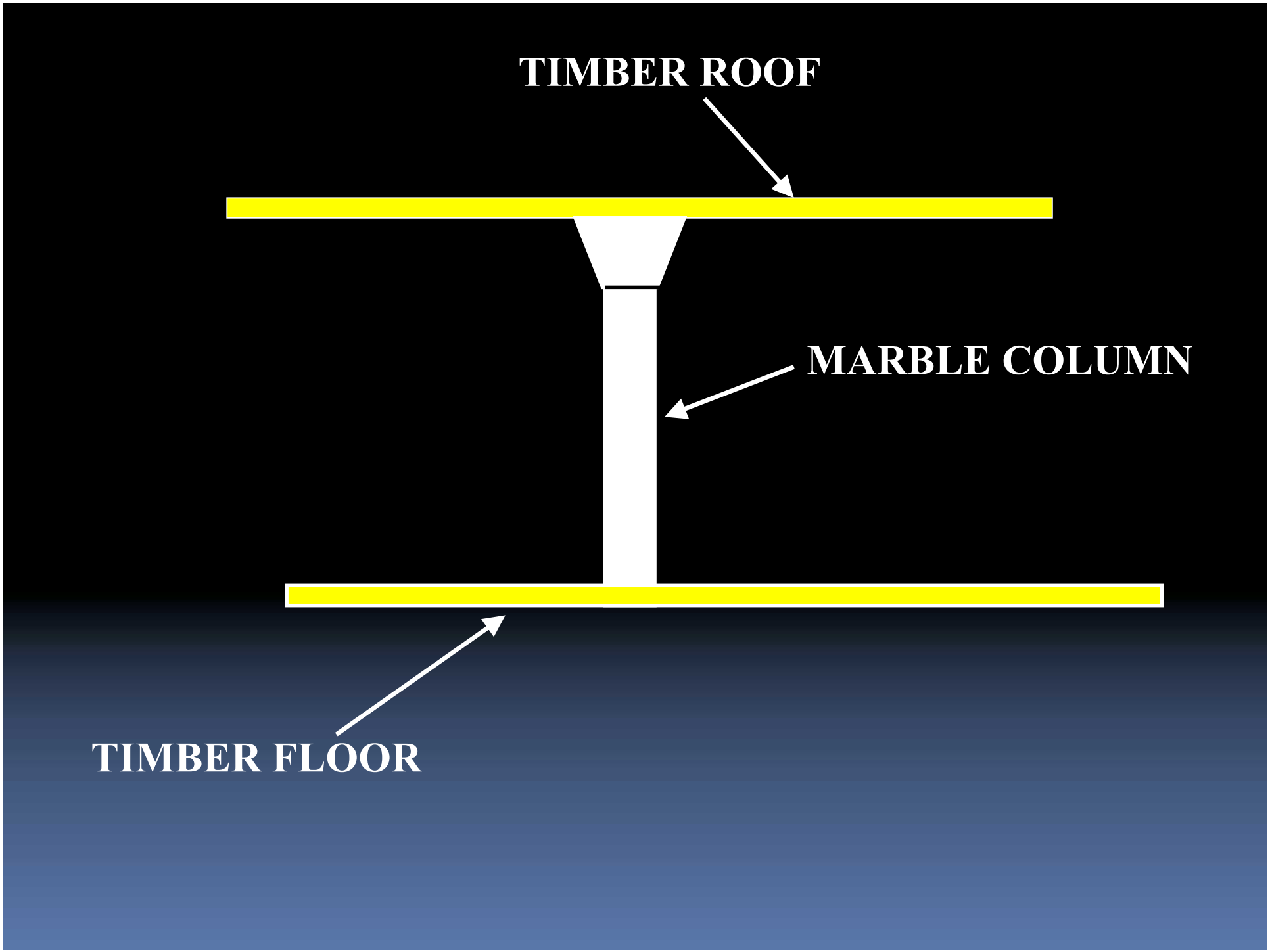
DISASTER

AN OLD MOSQUE IN ANATOLIA.

STRUCTURAL SYSTEM:
TIMBER ROOF CARRIED BY MARBLE COLUMNS



SIMPLIFIED FLOOR PLAN

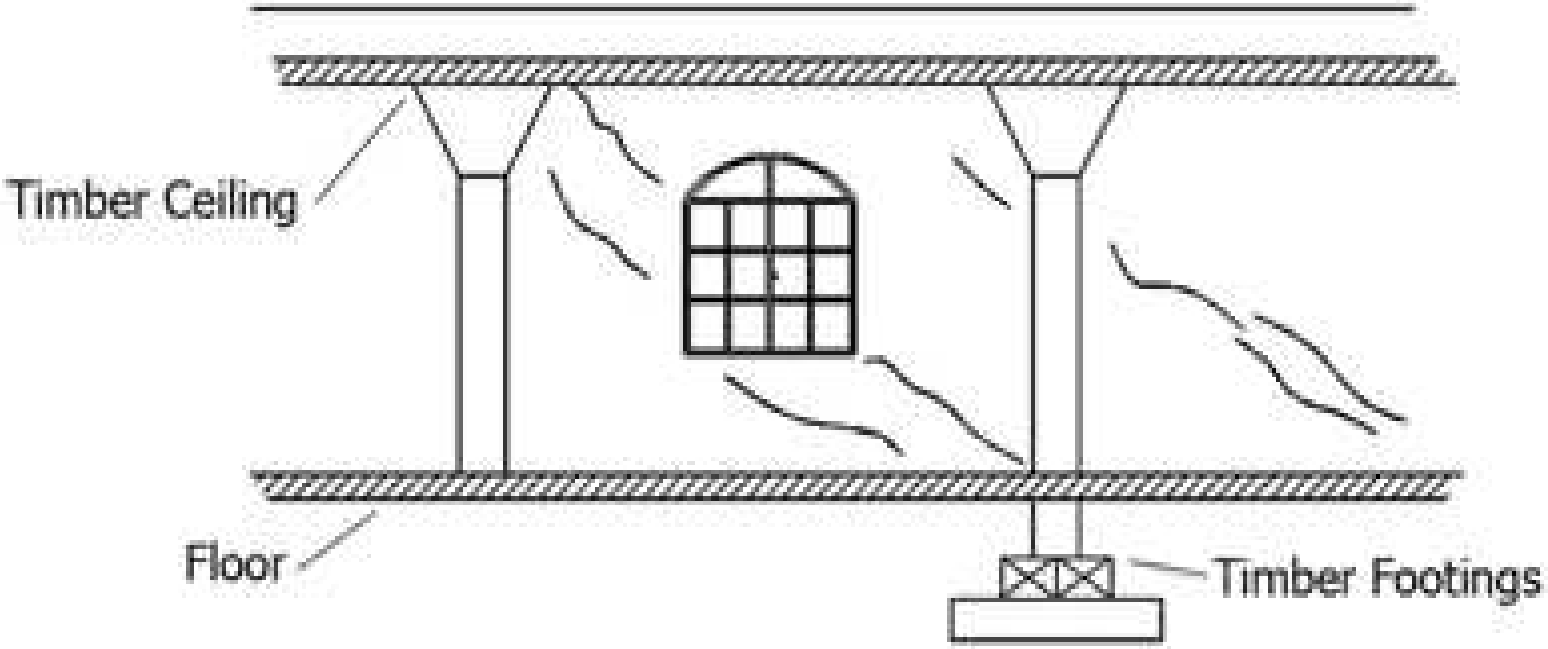

TIMBER ROOF
MARBLE COLUMN
TIMBER FLOOR

PROBLEM:

DUE TO PENETRATION OF WATER TO THE FOUNDATION,

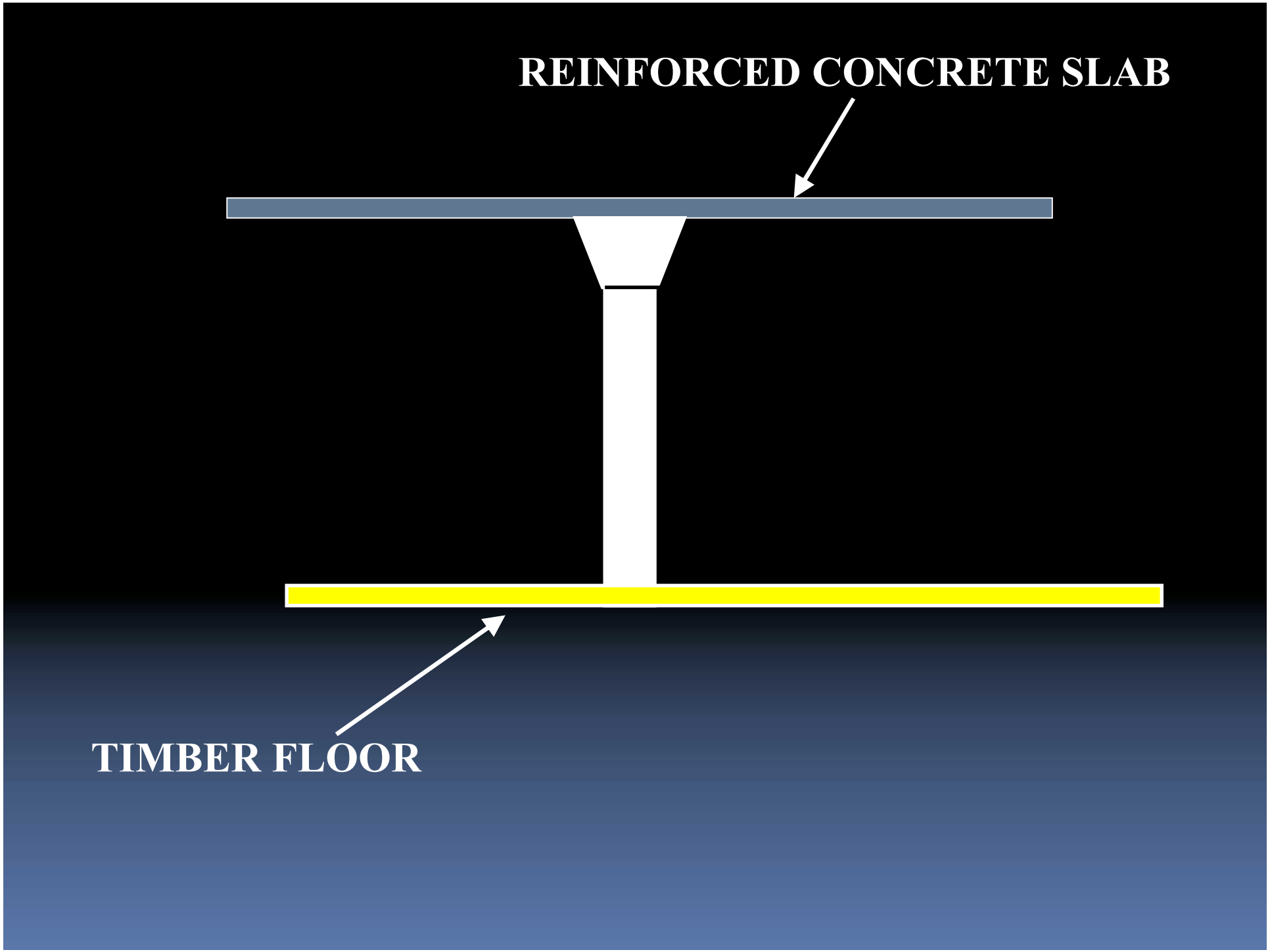
DIFFERENTIAL SETTLEMENT.

DIFFERENTIAL SETTLEMENT CAUSED CRACKING OF EXTERIOR LOAD BEARING WALLS.


Timber Ceiling
Floor
Timber Footings

INTERVENTION:

TIMBER ROOF WAS REPLACED BY A REINFORCED CONCRETE SLAB.

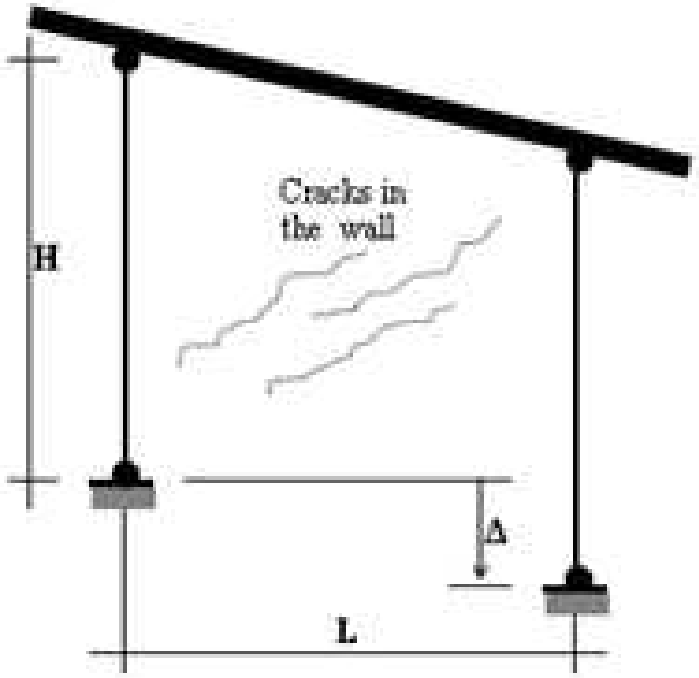

REINFORCED CONCRETE SLAB
TIMBER FLOOR

RESULT OF INTERVENTION:

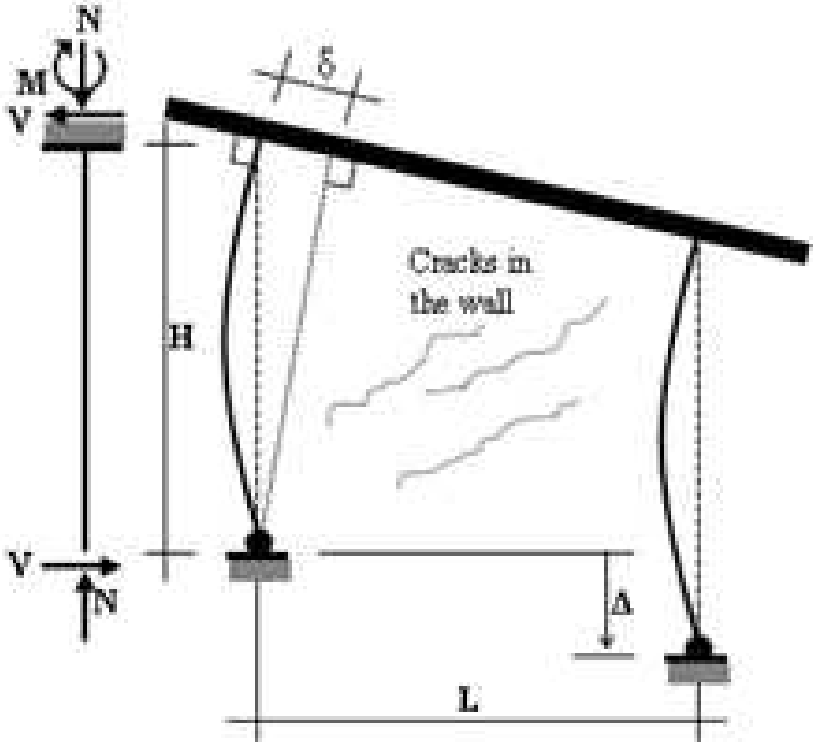
Before intervention, pin connected columns. No shear, no moment in columns due to settlement.

After intervention, partial fixity on the top. Shear and moment are introduced to columns.

Simplifid Differential Settlement Model



Both ends pinned

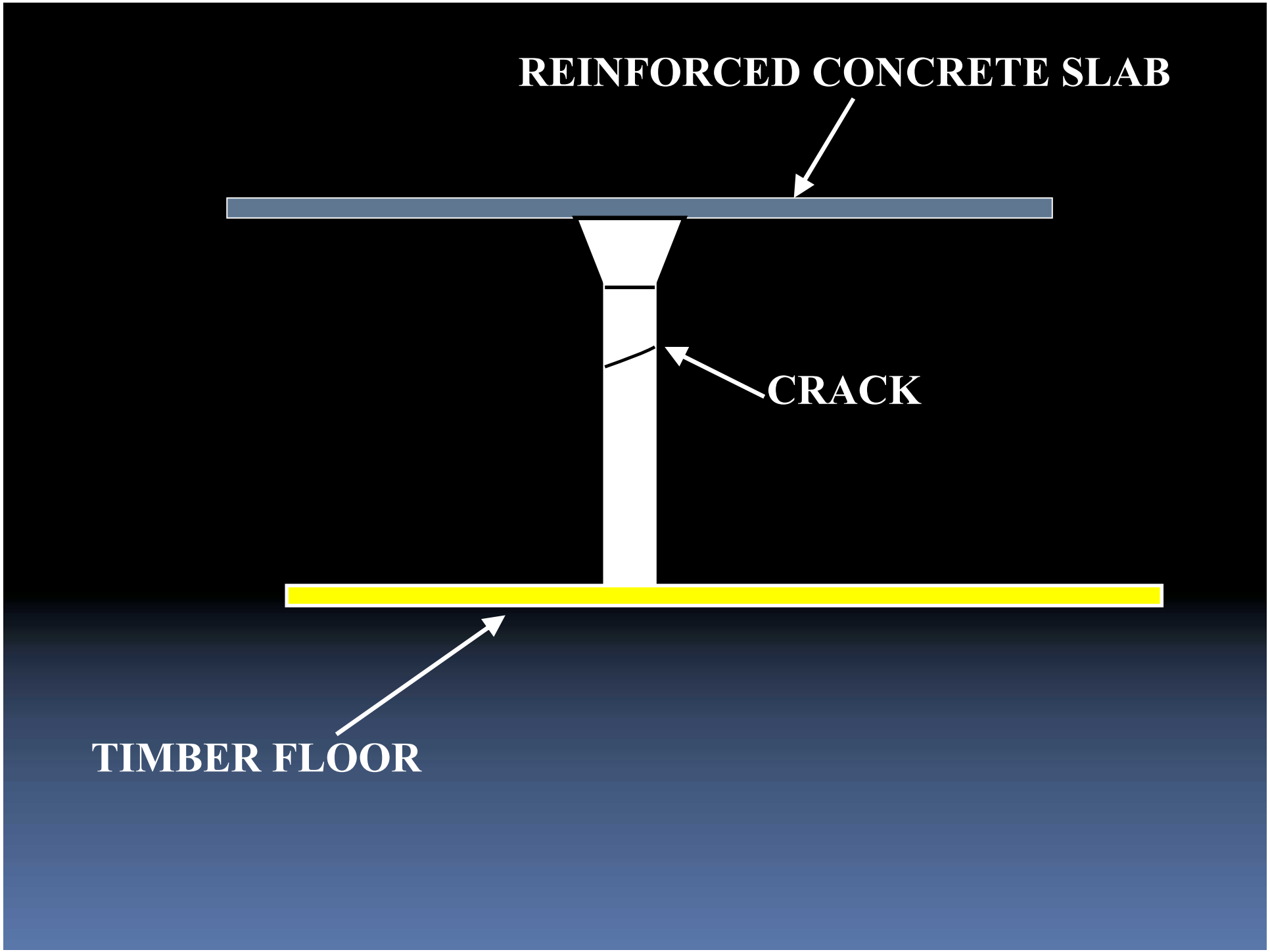


One end pinned
one end fixed

RESULTS OF SIMPLE ANALYSIS:

DUE TO THE BENDING MOMENT INTRODUCED, TENSILE STRESSES EXCEEDED THE TENSILE STRENGTH OF MARBLE.

MARBLE COLUMNS CRACKED !!!


REINFORCED CONCRETE SLAB
CRACK
TIMBER FLOOR

“WHAT’S DONE CANNOT BE UNDONE”

W. Shakespeare (Macbeth)

HERITAGE DESTROYED
CAN NOT BE REPLACED !