ERRORS IN THE DESIGN OF STRUCTURES AND MODERN RECONSTRUCTION

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SYLLABUS

1. Errors in the design of structures and modern reconstruction:

- Introduction,
- History,
- Basic terms,
- Principles of the design and assessment

BASIC TERMS

Many technique address one of the following process:

- Rehabilitation , Repair, Retrofit, Strengthening, Upgrading

Or in short using one of the umbrella terms:

- Conservation / Maintenance / Preservation / Upgrading of the existing structures

Different terminology is used in different countries and in different references to describe the activities aiming at maintaining, restoring, improving, and/or upgrading the structural performance of the existing buildings.

BASIC TERMS

Conservation

(Federation International de Beton FIB) Beside the above mentioned process includes inspection, condition assessment, and regular maintenance activities for structures.

(BD 89/03 UK) is an approach where is something of historical or aesthetic merit to be kept, but there can be change, as long as new insertion are in keeping or enhance that which is existing.

BASIC TERMS

Upgrading

(ISO 13822: Basis for design of structures) modification to an existing structure to improve its structural performance.

- Assessment: set of activities performed in order to verify the reliability of an existing structure for future use.
- Inspection: on-site non-destructive examination to establish the present condition of the structure.
- Maintenance: routine intervention to preserve appropriate structural performance.
- Rehabilitation: work required to repair and possibly upgrade, an existing structure.
- Repair: improve the condition of a structure by restoring or replacing existing components that have been damaged.

BASIC TERMS

Maintenance

(The Manual of Maintenance of Steel Bridge Structures, Japan): Is the generic term for all jobs performed on the structure during its service life, that is, all jobs related to inspection, assessment, repair, reinforcement, replacement, improvement, database generation and input, and feedback operation for building new structures.

(AASHTO Maintenance Manual): Bridge maintenance have been define as work performed to keep the facility in its current condition. However, bridge maintenance has a broader scope because maintenance includes all activity in a facility's life that does not require a redesign and development projects.

BASIC TERMS

Maintenance

(JSCE – Standard specification for concrete structures – Maintenance part)

- (A) Preventive Maintenance: To prevent visible deterioration of the structure during the service life.
- (B) Corrective Maintenance: In which appropriate counter measures are taken after deterioration of the structure appeared.
- (C) Observational Maintenance: Carried out primarily on the basis of visual inspection of the structure without any direct measure and permits deterioration of the structure in a certain extend.

BASIC TERMS

Preservation

(Bridge preservation Association in USA): activities performed on bridge elements or components that aim to prevent, delay, or reduce deterioration. Bridge preservation activities do not entail structural or operational improvement of an existing bridge asset beyond its original design capacity.

BASIC TERMS

Rehabilitation

Is an all-encompassing term that includes concepts of repair, retrofitting, strengthening and weakening that may minimize the vulnerability of the building to earthquake loading.

The terminology used in earthquake engineering for seismic rehabilitation of existing structures is open to misinterpretation.

BASIC TERMS

Rehabilitation

Conventional intervention: includes the established methods of repair, such as concrete encasement, use of bracing, strengthening or weakening of connections. No conventional interventions refers to the use of novel metals, namely aluminum, stainless steel and shape memory alloys and/or special devices, e.g. base isolation and dampers, which significantly enhance the energy dissipation and hence reduce story drifts and shears.

BASIC TERMS

Rehabilitation

Rehabilitation methodology: requires thorough assessment based on detailed as-build data and nonlinear static analysis either static (pushover) or dynamic (time histories)

Rehabilitation objective: is the selection of desired damage level or loss (performance levels) for a specific seismic demands (hazard level). Indeed, the performance levels define the expected behavior of the building in terms of allowable damage state for an identified earthquake ground motion.

BASIC TERMS

Rehabilitation

Repair: the reinstatement of the original characteristics of a damaged section or member

Strengthening: the number of interventions that may improve one or more seismic response parameters (stiffness, strength and ductility) as a function of the desired structural performance level.

Weakening: alternative scheme, reduce the seismic demand in critical regions (connections).

BASIC TERMS

Renovation

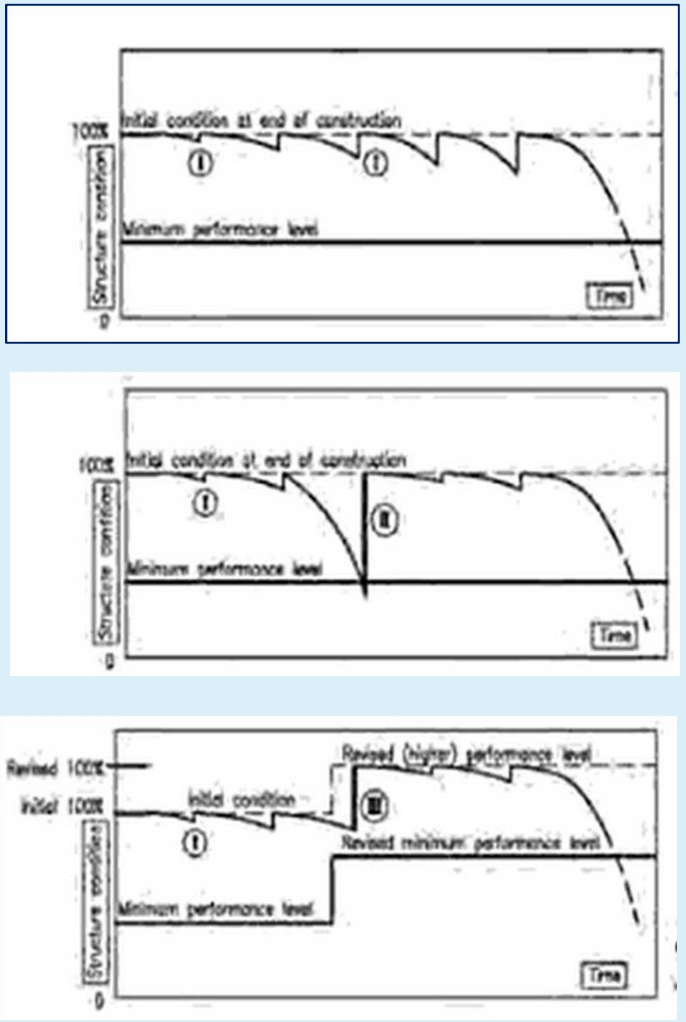
Generic term define by various “R words” that sound similar but refer to slightly different concepts: rehabilitation, remodeling, renovation, repair, restoration, retrofit.

Retrofit

Is use in some countries mainly for seismic upgrading. In other countries is use as an umbrella term for all repair and strengthening activities.

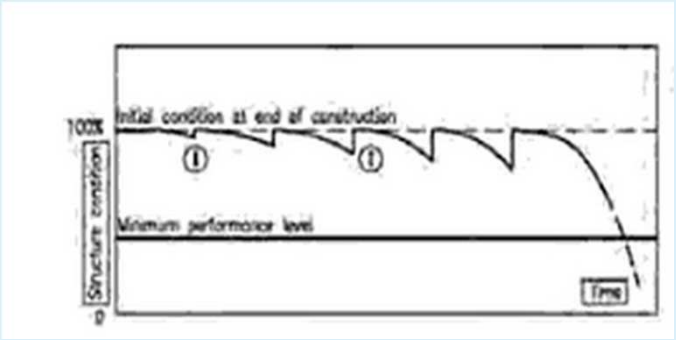
SCHEMATIC PRESENTATION

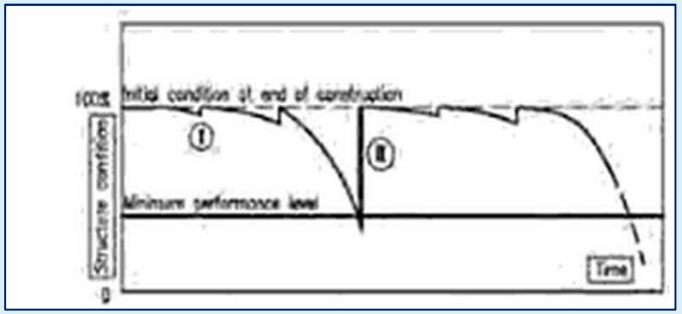
At the time of the inspection, the structure fulfilled performance requirements but is predicted to not do so on the future due to a decline in performance due to load action and environmental action over time; performance improvements are conducted to prevent this in advance. Includes also routine maintenance activities such as painting of steel structures.

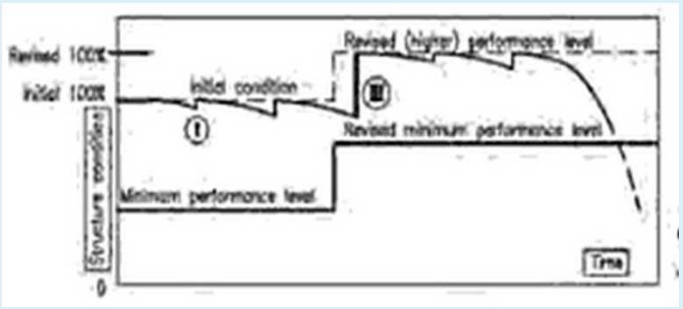


SCHEMATIC PRESENTATION

The performance requirements are the same as those of the structure when was first build, bur because the performance of the structure has decline due to load action and environmental action over time, the structure did not fulfill performance requirement at the time of the inspection; through retrofitting, the performance that would satisfy performance requirements is added.

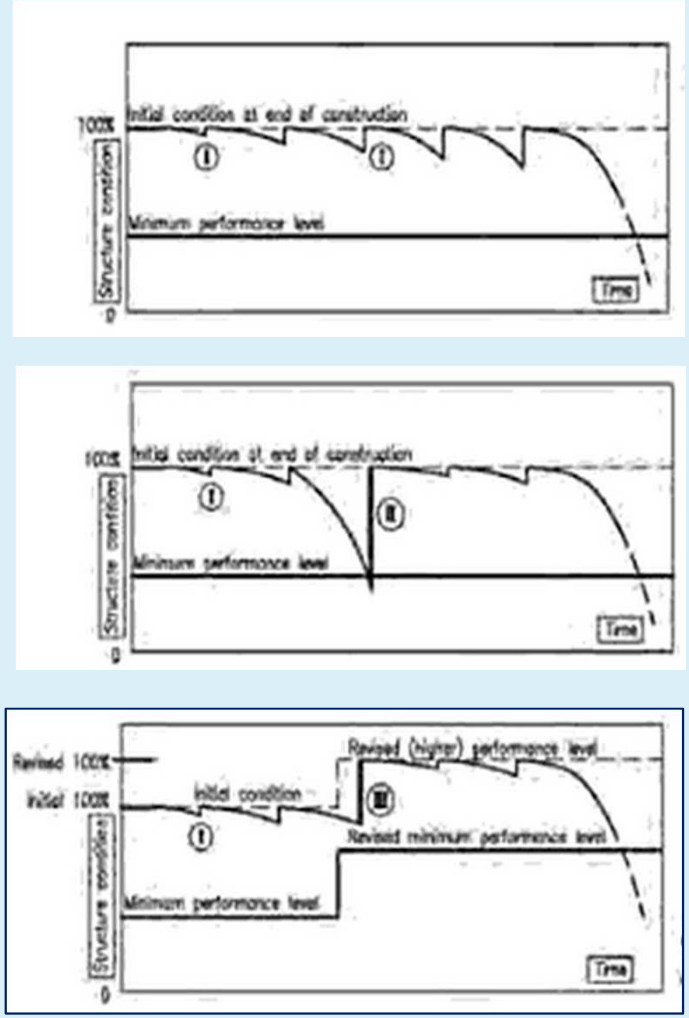






SCHEMATIC PRESENTATION

The design load has been changed or the structure otherwise requires a higher level of performance than when initially constructed, and therefore it does not fulfill performance requirements; through retrofitting, the performance that would satisfy performance requirements is added.



BASIC TERMS

Maintenance (Policy, Strategy, Optimization, Cost),
Management systems (Bridges, Buildings, Facilities),
Operation – the policies and planning of the activities in the post-construction on phase, aiming at maintaining and/or improving structural performance

BASIC TERMS

Inspection, Monitoring, testing and Load Tests, Non-destructive Testing – the observations and investigations carried out on the structure

BASIC TERMS

Assessment, Evaluation, Extending Service Life, Load Capacity, Performance, Robustness, Safety, other relevant keywords also include Analysis, Appraisal, Durability, Investigation, Rating – condition assessment and evaluation of structural performance

BASIC TERMS

Corrosion, Cracking, Damage, Deterioration, Fatigue, Fracture, Scour, Vibration, Weathering – the deterioration in materials and/or in structures, which may results in a reduction of structural performance.

BASIC TERMS

Prevention, Protection. Additional relevant words include: coating, impregnation, painting, remove debris from joints, resurfacing, sealing (cracks deck surface) – preventive maintenance

BASIC TERMS

Preservation, Refurbishment, Rehabilitation, Remedial, Renew, Repair, Replacement of components, Restoration, Retrofit, Stiffening, Strengthening, Upgrading, Widening. Relevant keyword also include: Conservation, Addition (of structural members), Increase Load Capacity, Modification, Reinforcement, and Renovation – changes in the dimensions of the structural members (large structural intervention) to restore and/or upgrade the structural performance.

AVOIDANCE AND DETECTION OF DEVIATIONS AND FAULTS

Deviations and faults of structures

Consequence of certain types of faults

Assurance of satisfactory safety by limiting the deviations and defects

Detections of the defects

Analysis of the faults in order to establish a remediation strategy

General methods for reduce the faults effects

Remedy of the structural defects

EXAMPLES REMEDIATION STRUCTURAL FAULTS

Remedy of structural defects a complex problem

Design mistakes

Workshop and manufacturing errors

Execution and erection failure

Maintenance and service errors

Damages independent of construction state

Earthquake damages

Complex causes of defects appearance

INTRODUCTION

Nowadays the increasing of the quality and safety of structures have become the most important task.

In civil engineering sense, the quality means:

- A structure should meet all the requirements for which it was designed.

Quality and safety of a structure cannot be expressed in an absolute way, a probabilistic approach is need (a minim risk is accepted).

Due to the execution and erection reasons also a range of admissible deviations should be accepted.

DEVIATIONS

Admissible deviations

Deviation:

- the act of deviating.
- departure from a standard or norm.
- the difference between one of a set of values and some fixed value, usually the mean of the set.

Technical deviations may have major consequences, may influence the overall conception, detailed design calculations, quality of the prescribed materials, elements manufacturing procedures and structure erection techniques.

DEVIATIONS

Admissible and Inadmissible

Values for deviation are prescribed in specific norms, technical condition for manufacturing, erection and assembly of structures.

Express as a difference between an nominal value and the real resulted value.

Can be:

- geometric: dimensions, shape,
- material: mechanical or other properties.

An perfect ideal structure cannot be achieved.

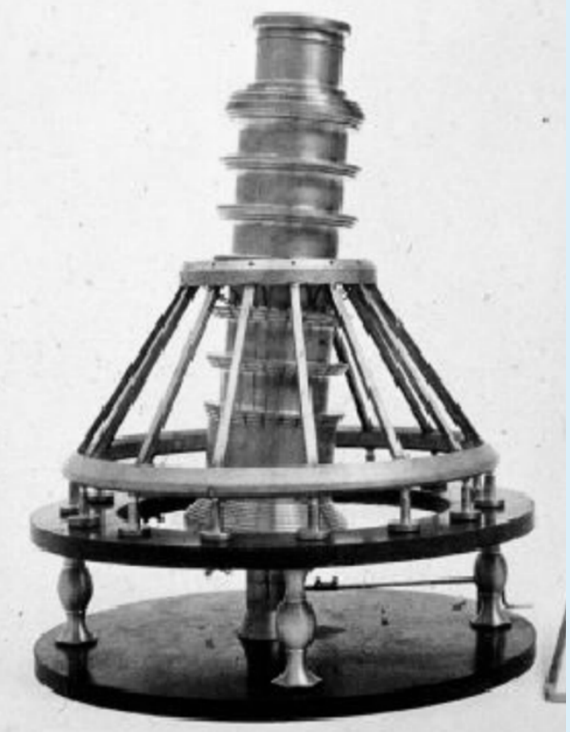
INADMISSIBLE DEVIATIONS

Avoiding

- Self-control
- Quality control from the authorized persons (design verifiers, quality inspectors, etc.) and supervisory, and control bodies.

Usually, after the identification of an deviation in one of the construction phase, before the completion of the structure, the deviation may be easy remedied or eliminated, prior causing irremediably damages to the structures.

DEVIATIONS



FAULTS

In civil engineering a fault represent an defect or imperfection to a structural element, part of or entire structure that threaten the structural safety and may cause the partial or total collapse.

Generally, are caused by inadmissible deviation.

Deviation in geometry, material quality, loading condition accounted in design, in normal use of domestic installations, equipment, etc.

Inappropriate maintenance on regular basis, at specified time intervals favors the appearance of small defects that will increase in time.

FAULTS

Depending on their magnitude:

- Without or with insignificant influence on quality and safety of the structural system but cause inconvenience in use of structures.
- Which cause damage of the secondary elements that can be easy remediated.
- Which may cause damage at structural elements belonging to the bearing structure that affect the safety and can be repaired only with high costs.
- Which may deteriorate the structure causing failure of many elements or extend parts of structure, case in which the repairing in not an option from the economical point of view.

IMPORTANCE OF KNOWING THE CAUSES AND EFFECTS OF FAULTS

Helps not to repeat the mistakes.

Cause are many and varied.

Acts as an snowball causing other and other faults.

To identify faults some times are required detailed inspections, use of suitable instruments and apparatus, laboratory tests and professional expertise and experience.

A simple and effective removal procedure of a fault should act at the cause of the fault, otherwise complicated and expensive measures will be needed in the future.

STANDARDS EVOLUTION

Lack or insufficient legislation.

At the beginning norm prescriptions were provided by tradition and similar experience.

Code of Hammurabi provide severe punishment for constructors mistakes, but only according to the effects of mistakes, doing nothing to prevent them.

Quality laws in construction industries are very important. For issue the erection certificate approval, the legal authorities should ask for - more than simple architectural drawings – detailed design drawings and calculation, technical specification drafted by competent persons.

STANDARDS EVOLUTION

Lack or insufficient technical prescription.

Mandatory provisions with specific rules for design, execution and maintenance of different materials structures, specifying the loading conditions and rules for dimensioning, check are relative recent in the construction history.

These have appear around the second half of the XVIII century and until first decades of XIX century modifies often due to the accelerated speed of technical and experimental findings in the field, and unfortunately, due to the experience gained after numerous accidents.

STANDARDS EVOLUTION

Only for public buildings have been compulsory to respect some rules.

Major private association have their own technical rules respected by their specialists.

Even so many major and important construction works have been realized.

Today, in all European Countries is a clear legislation in the field of quality and safety of civil engineering works, are detailed and comprehensive technical prescription and specialized faculties.

FAULTS DUE TO DESIGN AND EXECUTION OF THE STRUCTURES

The main aim of the design project is to establish all the details needed for realization of a structure:

- Buildings
- Roads and platforms
- Water supply and drainage
- Warehouses etc.

After approval of the design project all the phases of the construction should be in accordance with his prescription.

FAULTS DUE TO LACK OF KNOWLEDGE

Underestimating the loading conditions:

- Wind;
- Earthquake;
- Other.

Lack of structural behavior understanding.

Absence of analysis tools.

FAULTS DUE TO DESIGN

To eliminate and reduce the errors in the design phase:

- a good collaboration between all the involved specialties and beneficiary of the work is needed.
- check of all the calculations and drawings by an authorized person who didn’t take part in the design team.

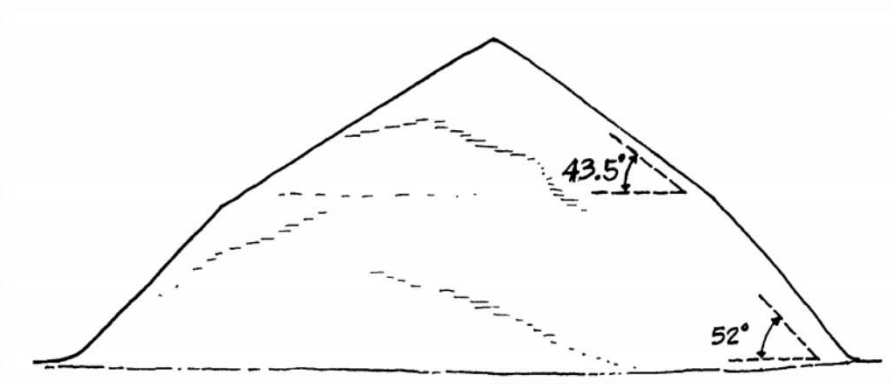
The designer must assure the technical consultancy during the entire phase of erection, to avoid misinterpretation of the project or inappropriate modifications.

FAULTS DUE TO DESIGN

The first structural failure:

Tower of Babel

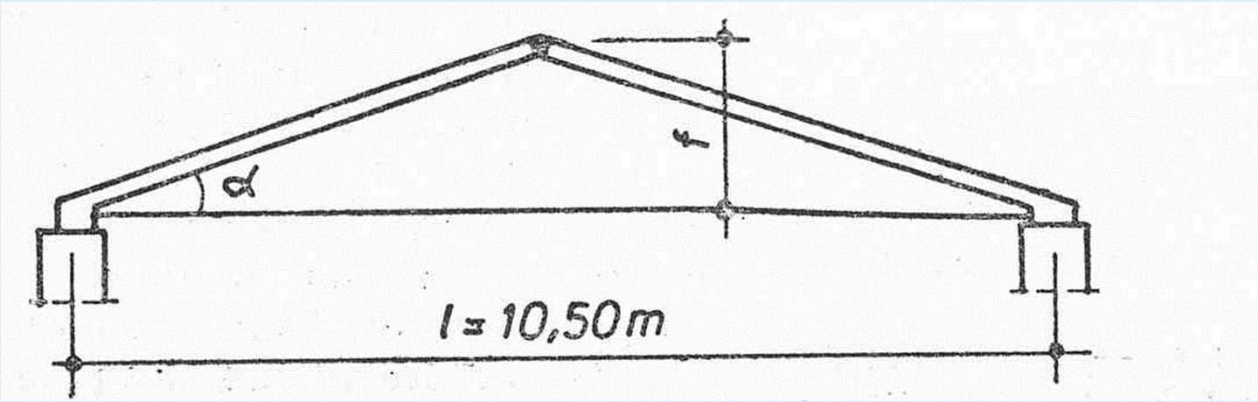
Pyramid of Medium / Pyramid at Dahshur



FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Wrong structural conception of the overall system, which will involve unreasonable interventions at bearing system, detail conception, and other.
- Choosing a structural system highly sensitive at different execution deviation or small changes of the design input parameters.



FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Misinterpretation or omission of some code provision.

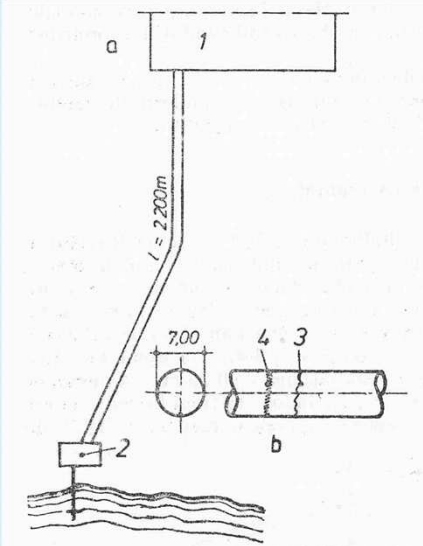


Fig. I.6. Fisurarea a două conducte de apă :
a — plan ; *b* — conductă ; *1* — uzină ; *2* — stație de pompare ; *3* — fisură ; *4* — sudură.

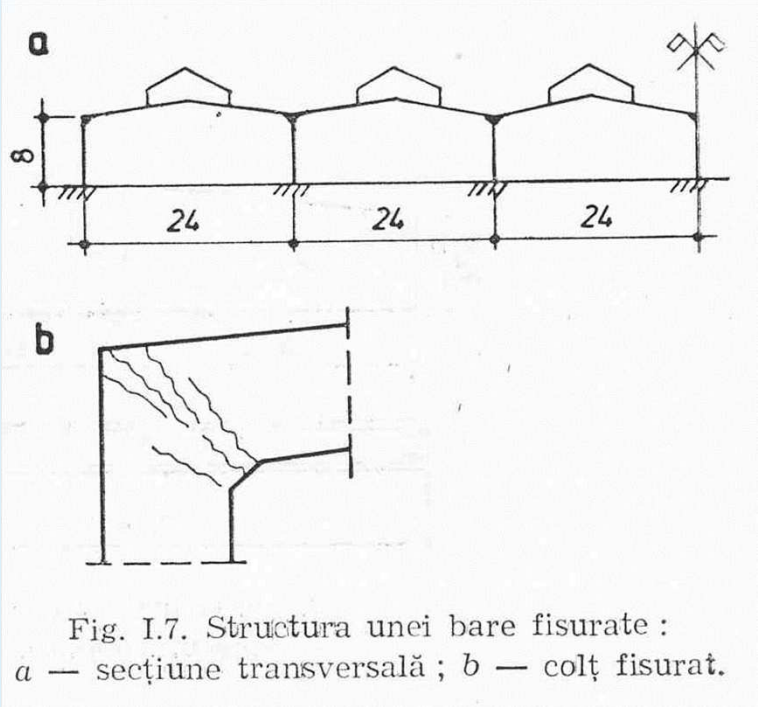


Fig. I.7. Structura unei bare fisurate :
a — secțiune transversală ; *b* — colț fisurat.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Consideration of a inconsistent static scheme with the structural detailing resulting different internal efforts other than the computed ones

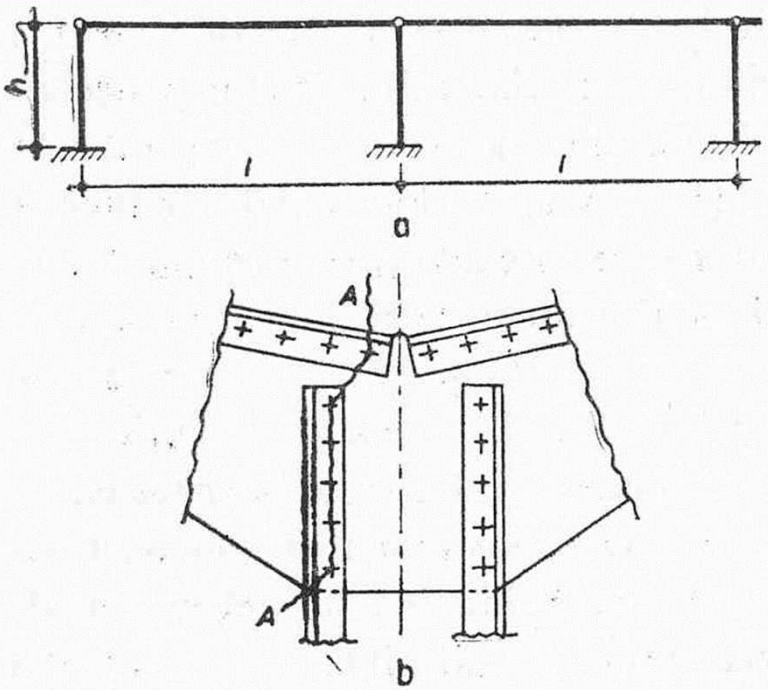


Fig. I.8. Cadru metalic cu fisuri la guseul de reazem :
a — schema cadrului ; *b* — nodul de reazem ; *A-A* — ruperea guseului.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- The design computations require beside theoretical engineering knowledge, also mastering of execution technologies and experience. Designer should adopt the optimum structural system to respond at overall concept, the best shape and form of the structural elements, to size them considering the execution technologies and capabilities.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- It is needed to mention the erection order to avoid some damages

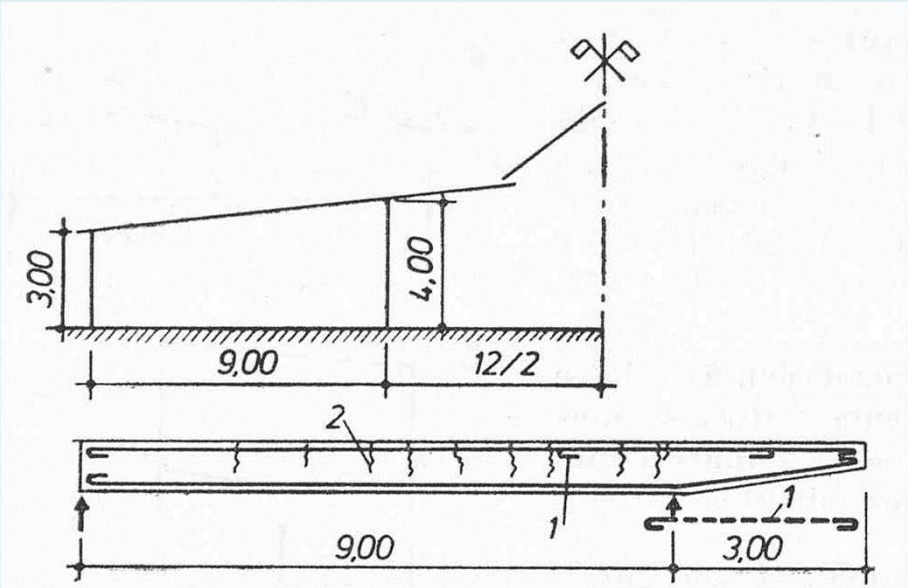


Fig. I.9. Grinzi cu console fisurate :
1 — armătură deplasată ; *2* — fisuri.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Choosing the type of material or material properties. Not in all the cases are suitable all materials due to their mechanical, chemical or physical properties. This is important also at intervention works

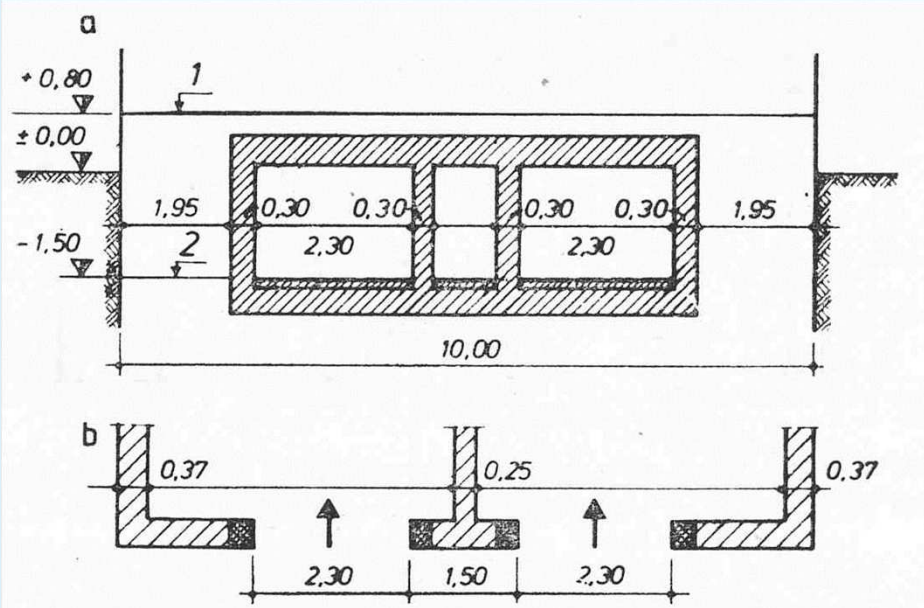


Fig. I.10. Gol în zid consolidat prin întărire cu beton armat : *a* — vedere ; *b* — secțiune prin zid ; *1* — nivel parter ; *2* — nivel subsol.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Construction works that seemingly simple and less important are insufficient treated – simple sketch without any calculations

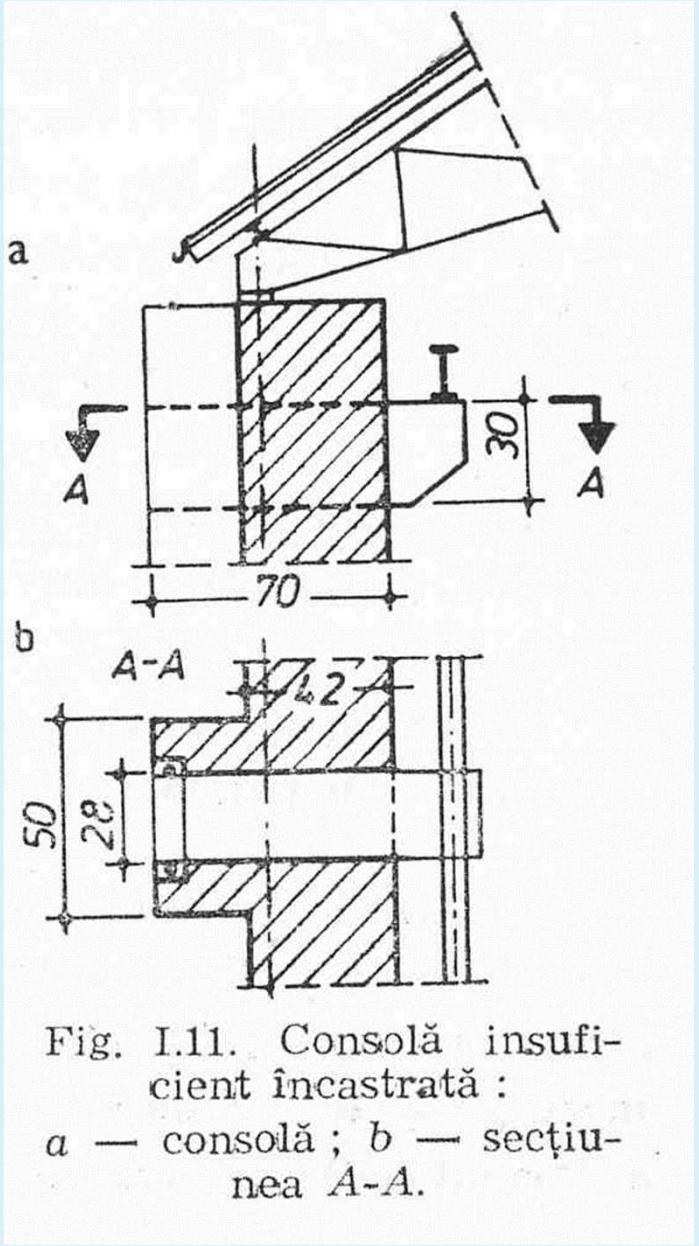


Fig. I.11. Consolă insuficient încastrată :
a — consolă ; *b* — secțiunea *A-A*.

FAULTS DUE TO DESIGN

Among faults with catastrophic consequence:

- Simple design scheme for complex structures may result in unfavorable effects or irrational design

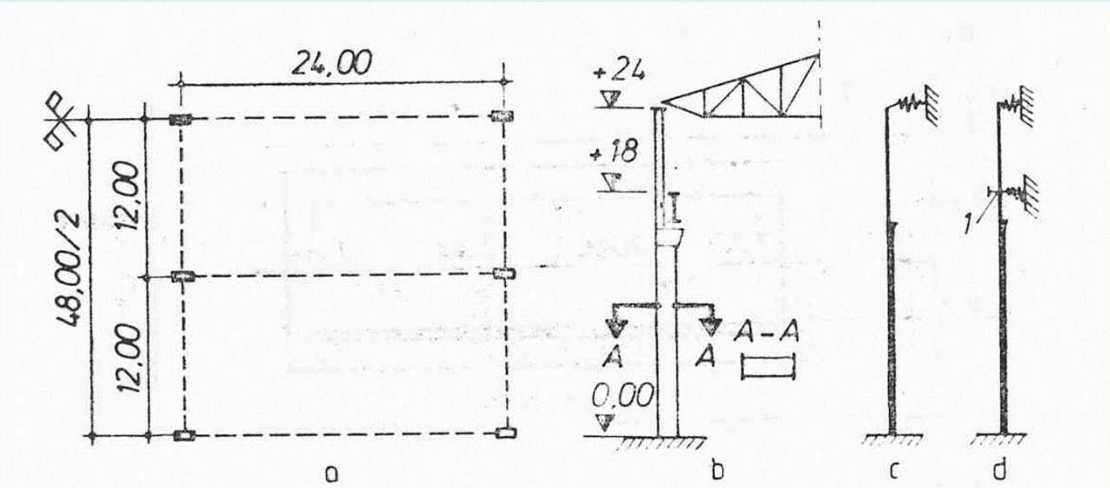


Fig. I.12. Schimbarea soluției structurii la o hală :
a — plan ; *b* — soluția necorespunzătoare ; *c* — stîlpii în soluția veche ; *d* — stîlpii în soluția adoptată.

FAULTS APPEARED AT EXECUTION

The quality of structures erection is highly influence not only by the erection process itself by also by all the mistakes made until then in the design process or elements or subassemblies manufacture.

Common faults are:

- Topography staking.
- Assembly the structural elements.
- Positioning the steel rebar.
- Concrete casting.
- Connections.
- Waterproof insulation.
- Low quality materials, replacing elements.

FAULTS APPEARED AT EXECUTION

At topography construction staking one span resulted smaller

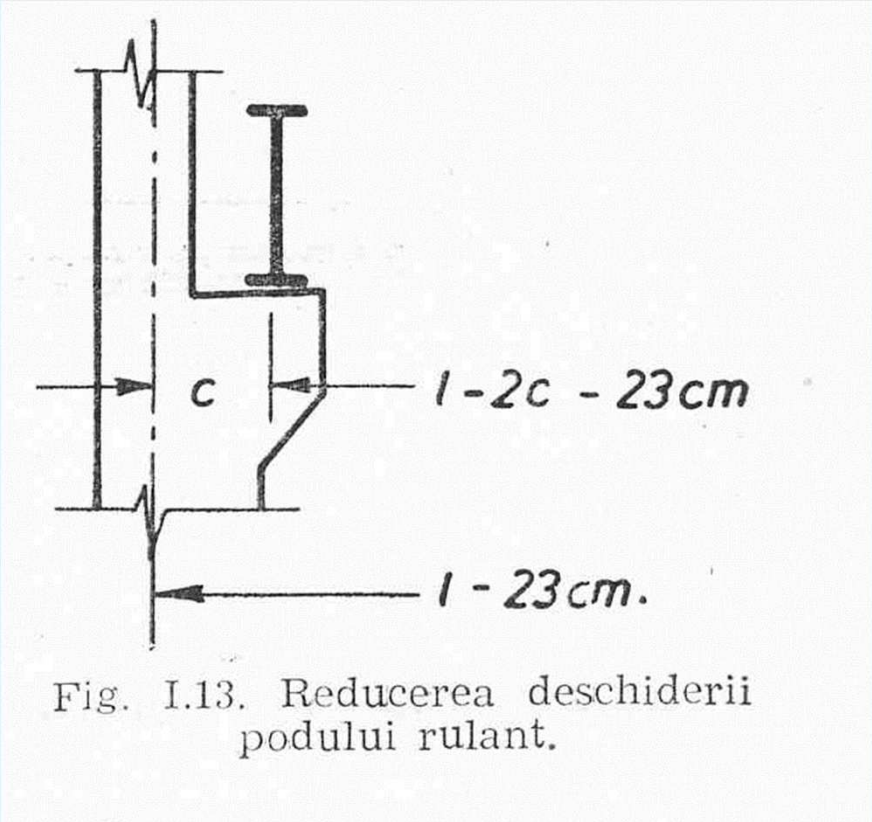


Fig. I.13. Reducerea deschiderii podului rulant.

FAULTS APPEARED AT EXECUTION

At positioning some reinforced concrete columns along longitudinal axis

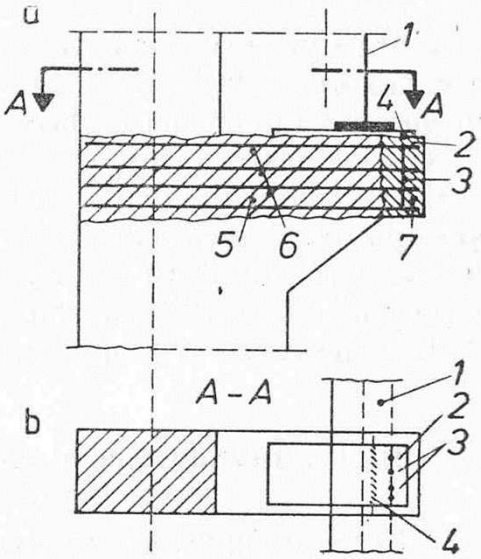


Fig. I.14. Console consolidate : *a* — completarea consolei ; *b* — secțiunea *A-A* ; *1* — grindă metalică ; *2* — placă ; *3* — bare verticale pentru prinderea plăcii ; *4* — sudură placă adăugată ; *5* — tencuială cu mortar de ciment ; *6* — armături consolă adăugată ; *7* — beton consolă mărită.

FAULTS APPEARED AT EXECUTION

Positioning the columns with deviation cumulated with the deviation appeared at transversal beams

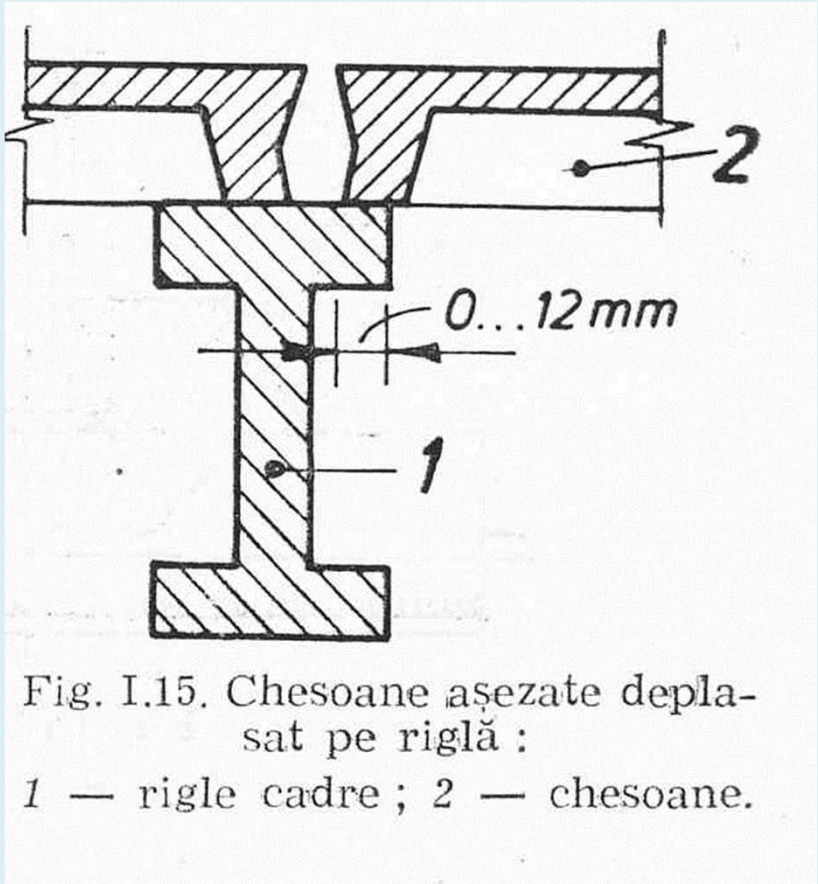


Fig. I.15. Chesoane așezate deplasat pe riglă :
1 — rigle cadre ; *2* — chesoane.

FAULTS APPEARED AT EXECUTION

Inconsistent rebar layout at supports for a cast in place reinforced concrete cantilever balcony

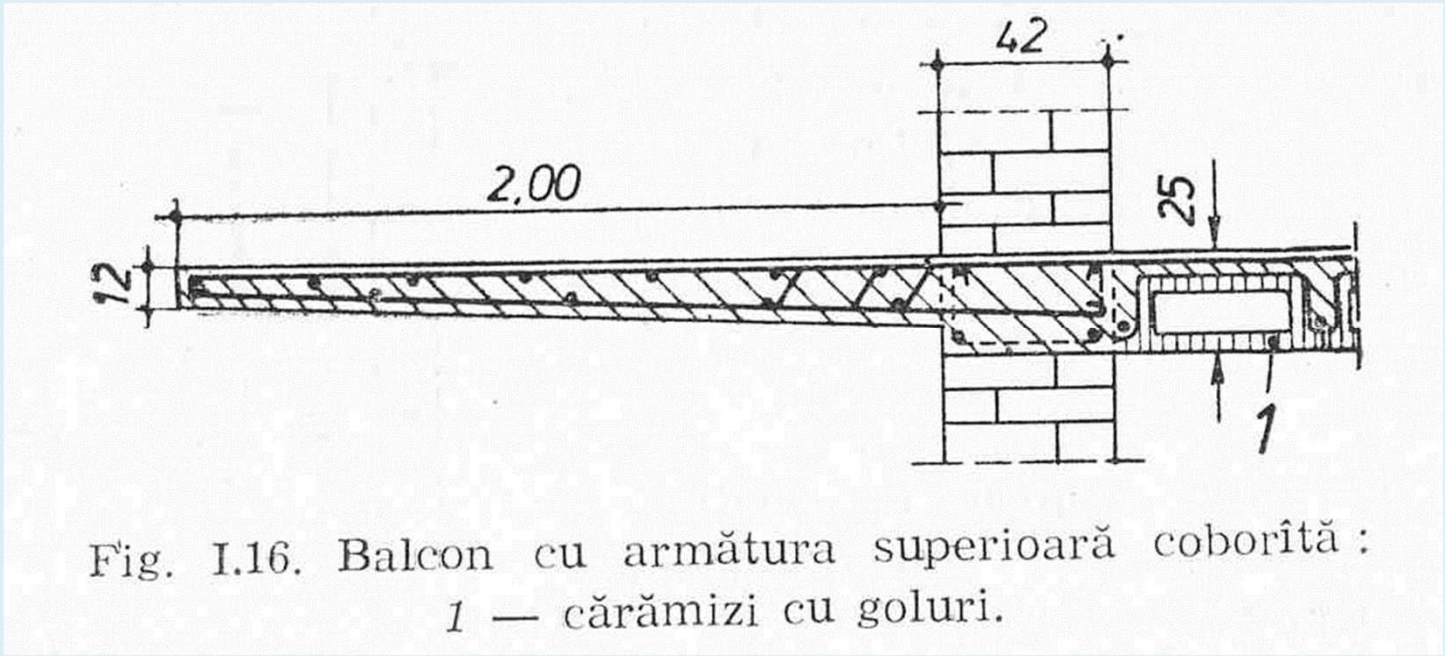


Fig. I.16. Balcon cu armătura superioară coborîtă :
1 — cărămizi cu goluri.

FAULTS APPEARED AT EXECUTION

In workshop at a steel truss girder connection on the upper chord was added a steel gusset plate partially welded

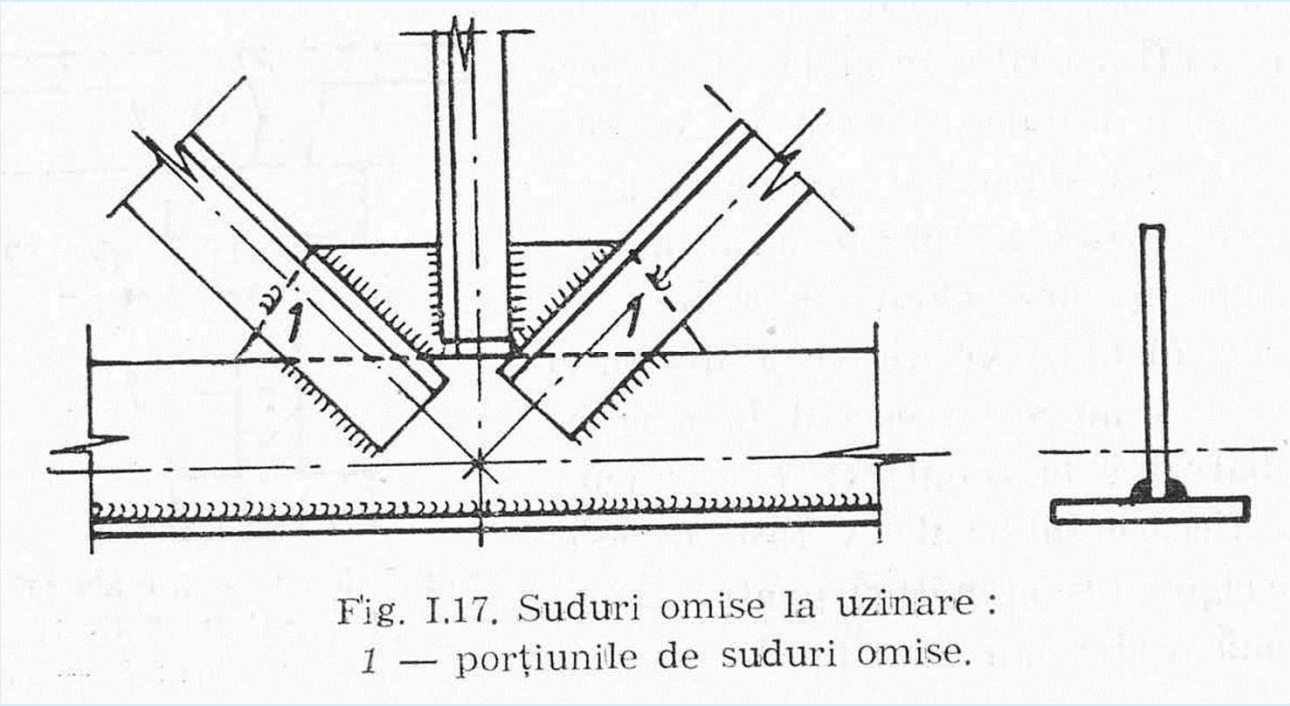


Fig. I.17. Suduri omise la uzinare :
1 — porțiunile de suduri omise.

FAULTS APPEARED AT EXECUTION

At a cast in place reinforced concrete pipeline, the reinforced concrete the casting reinforcement was rotated with 90o.

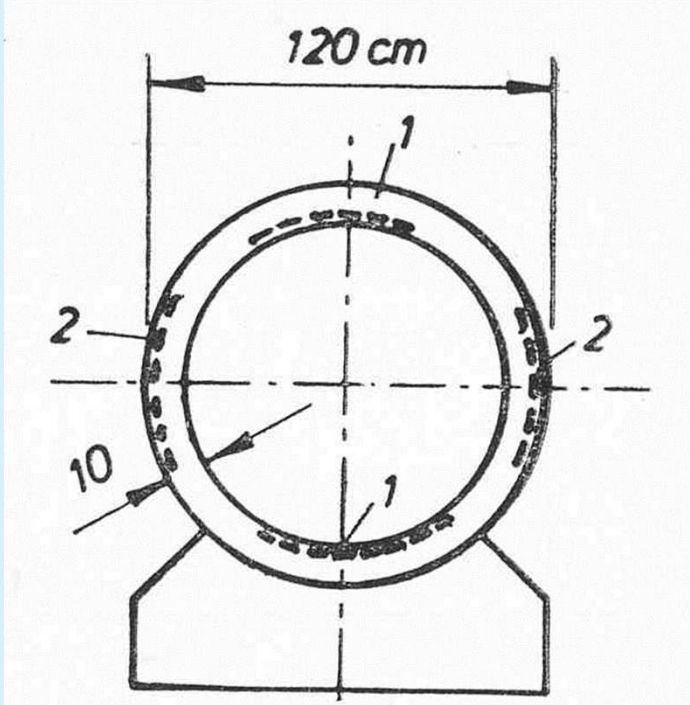


Fig. I.18. Armătura unei conducte rotită cu 90° :
1 — armătură suplimentară interioară ; *2* — armătură exterioară.

FAULTS APPEARED AT EXECUTION

For positioning a pipeline a steel column was cut

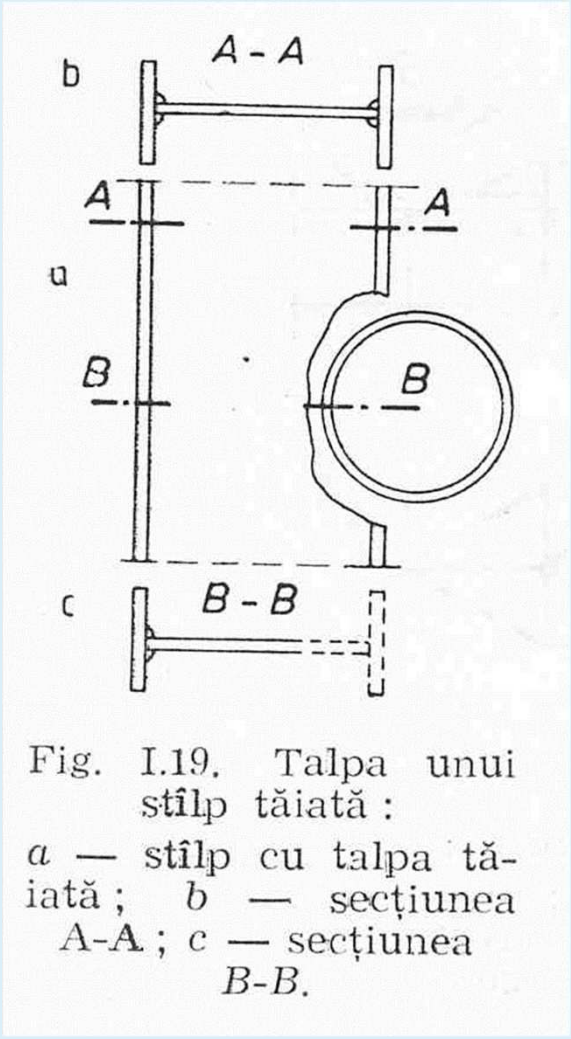


Fig. I.19. Talpa unui stîlp tăiată :
a — stîlp cu talpa tăiată ; *b* — secțiunea A-A ; *c* — secțiunea *B-B*.

FAULTS APPEARED AT EXECUTION

A higher recipient than the industrial hall ground floor, positioned wrong, necessitate cutting the flanges of a slab I beam

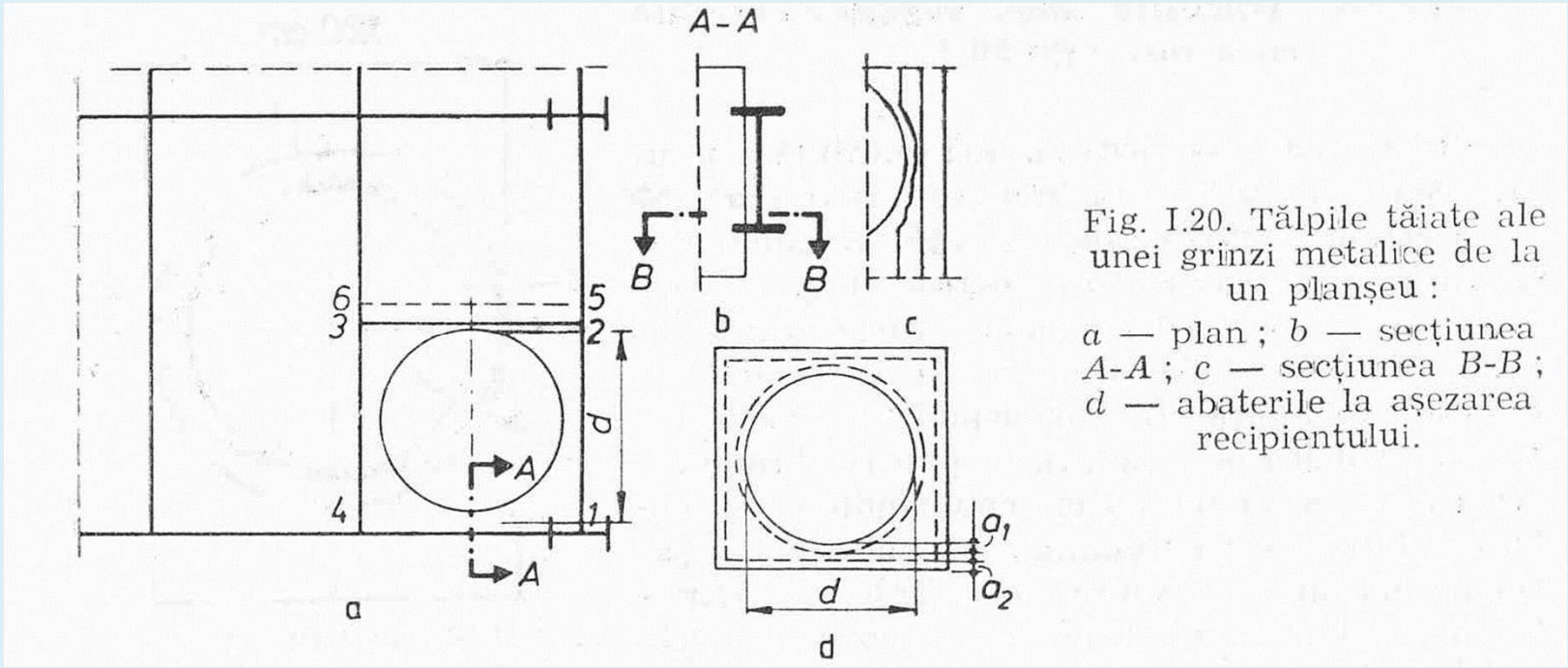


Fig. I.20. Tălpile tăiate ale unei grinzi metalice de la un planșeu :
a — plan ; *b* — secțiunea *A-A* ; *c* — secțiunea *B-B* ; *d* — abaterile la așezarea recipientului.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Provisional scaffolding works damaged due to a flood with ice

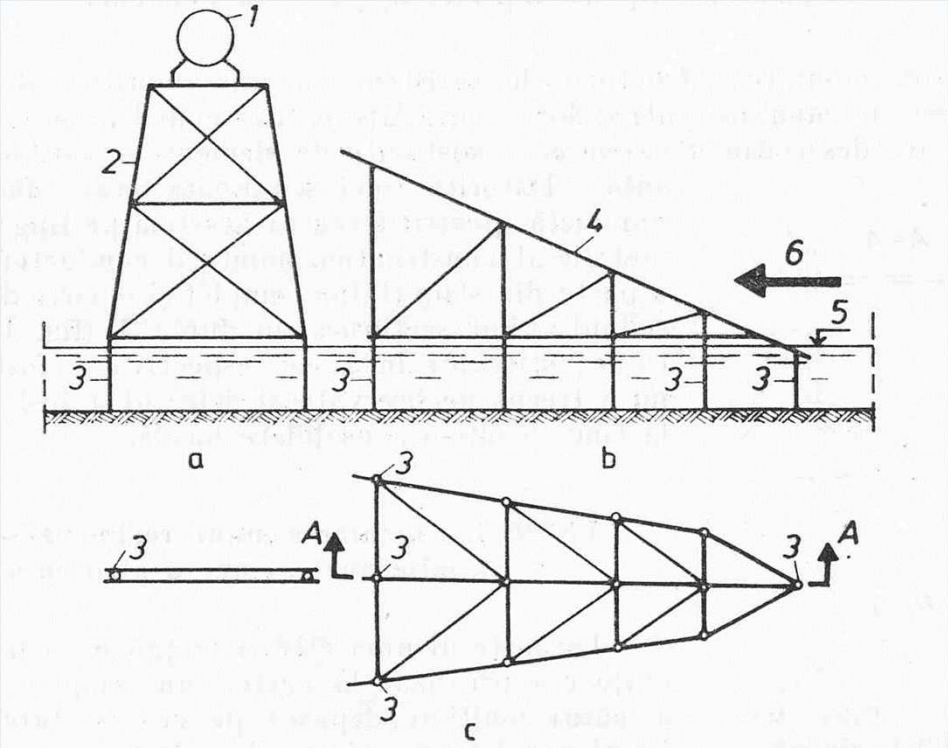


Fig. I.21. Susținere de lemn pentru conducte :
a — secțiune ; *b* — secțiunea *A-A* spargheț ; *c* — plan ; *1* — conducte ; *2* — palee ; *3* — piloți ; *4* — coamă spargheț ; *5* — nivel apă ; *6* — direcția de curgere.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Skylights elements deviation have affected the sealing system compromising the waterproofing

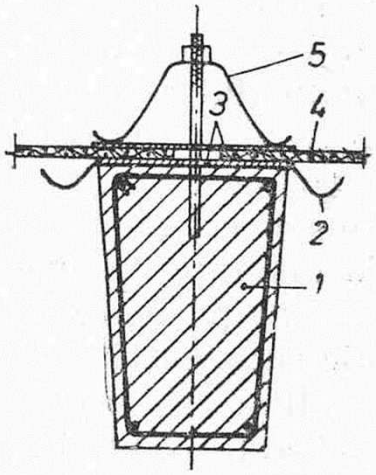


Fig. 1.22. Sprosul luminatorului :
1 — spros ; *2* — tablă jgheab ; *3* — carton asfaltat ; *4* — geam armat ; *5* — piesă de tablă pentru strîngere.

DIFFERENT CAUSES OF FAULTS APPEARANCE

At casting a equipment foundation at the inner bottom part the concrete didn’t have cement

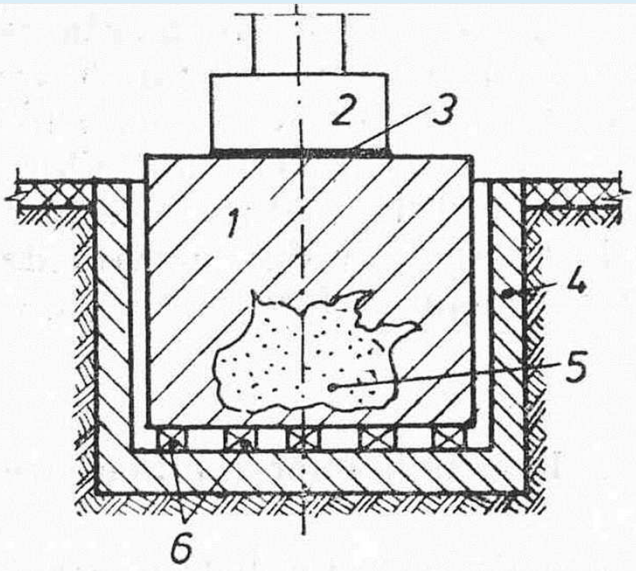


Fig. I.23. Fundația ciocanului : *1* — fundație cu gol ; *2* — șabotă ; *3* — izolare ; *4* — perete cuvă ; *5* — gol.

DIFFERENT CAUSES OF FAULTS APPEARANCE

At execution of some silos with the help of sliding formwork were observed missing steel rebar

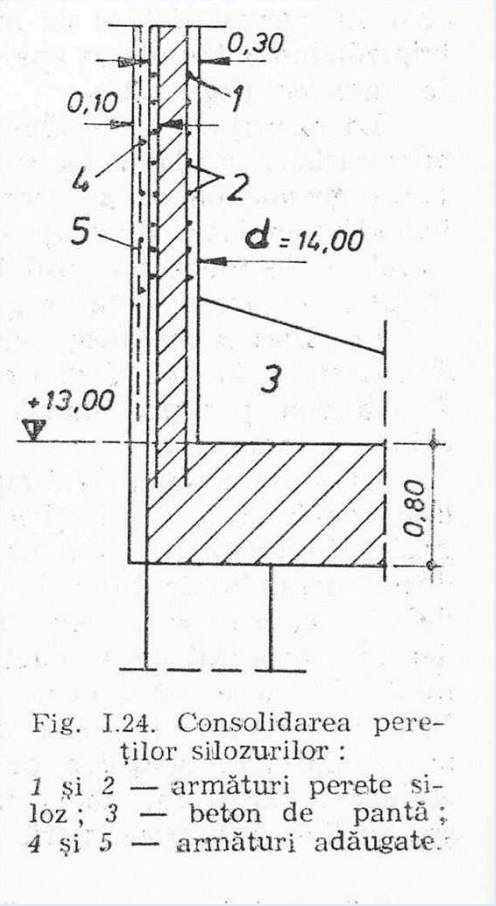


Fig. I.24. Consolidarea pereților silozurilor :
1 și *2* — armături perete siloz ; *3* — beton de pantă ; *4* și *5* — armături adăugate.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Cracks due to the unequal loading conditions resulted at execution

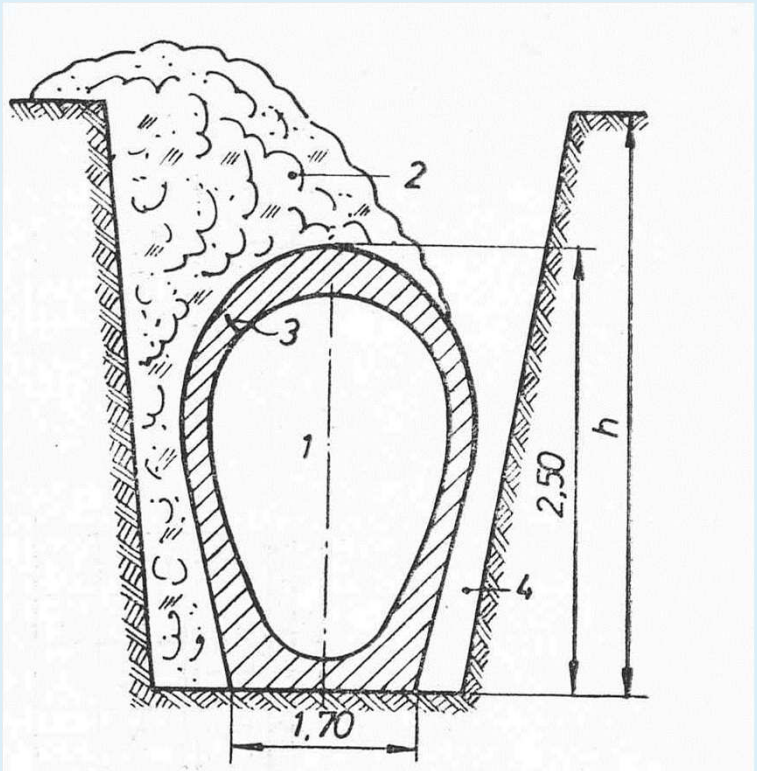


Fig. I.25. Canal de scurgere fisurat ;
1 — canal ; *2* — umplutura executată ;
3 — fisură ; *4* — umplutură laterală.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Failure to correct or remove some provisional elements

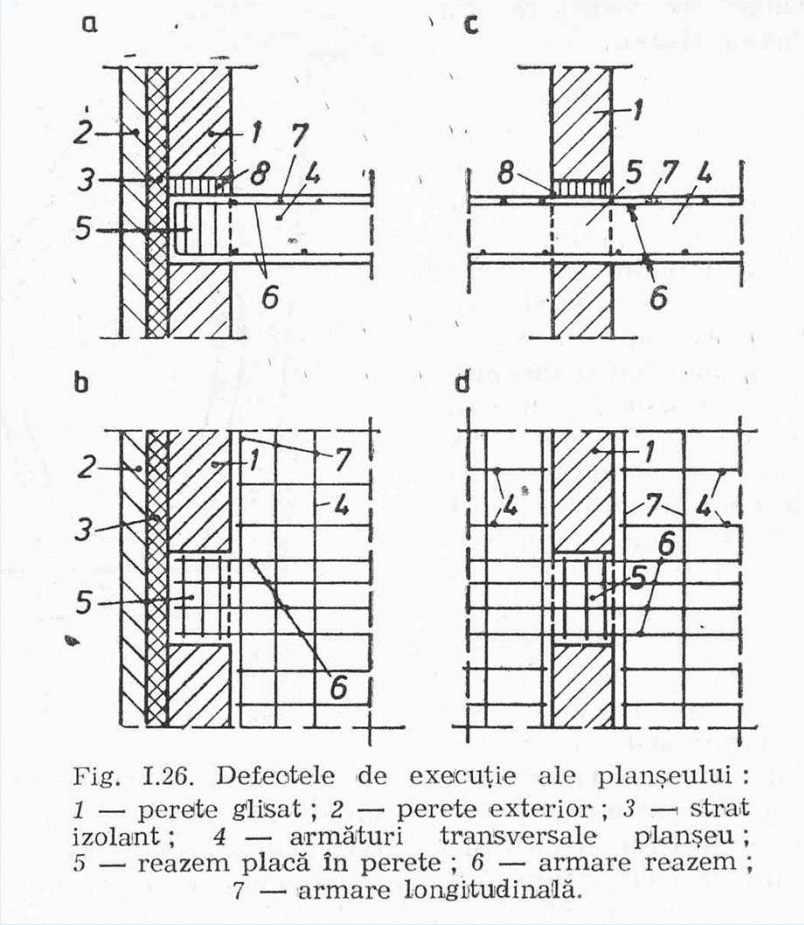


Fig. I.26. Defectele de execuție ale planșeului : *1* — perete glisat ; *2* — perete exterior ; *3* — strat izolant ; *4* — armături transversale planșeu ; *5* — reazem placă în perete ; *6* — armare reazem ; *7* — armare longitudinală.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Assembly some metallic truss girders with missing welds

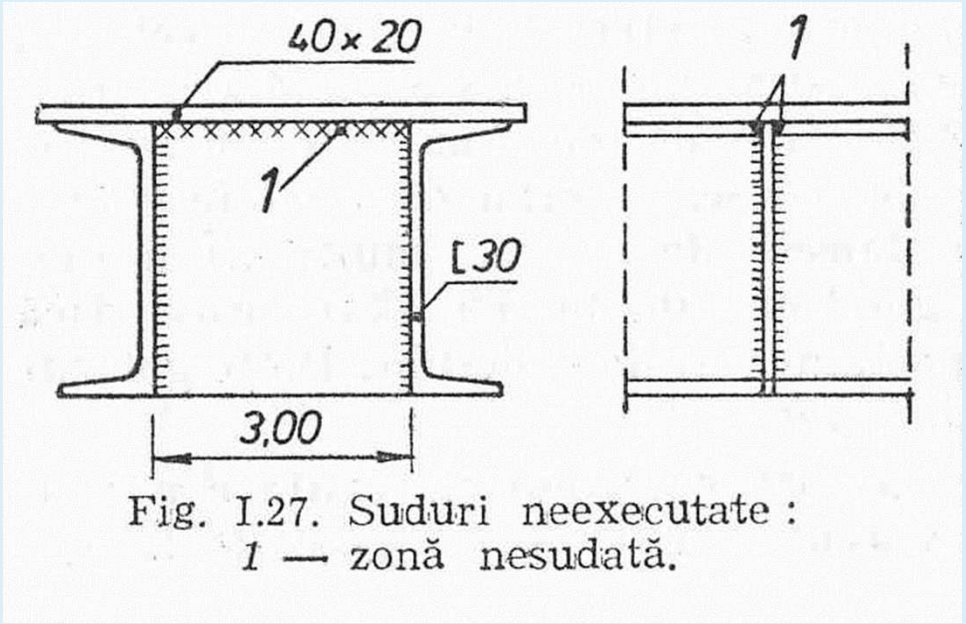


Fig. I.27. Suduri neexecutate :
1 — zonă nesudată.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Because of smaller holes made in workshop for a connection plate, on the site were putted smaller bolts which failed

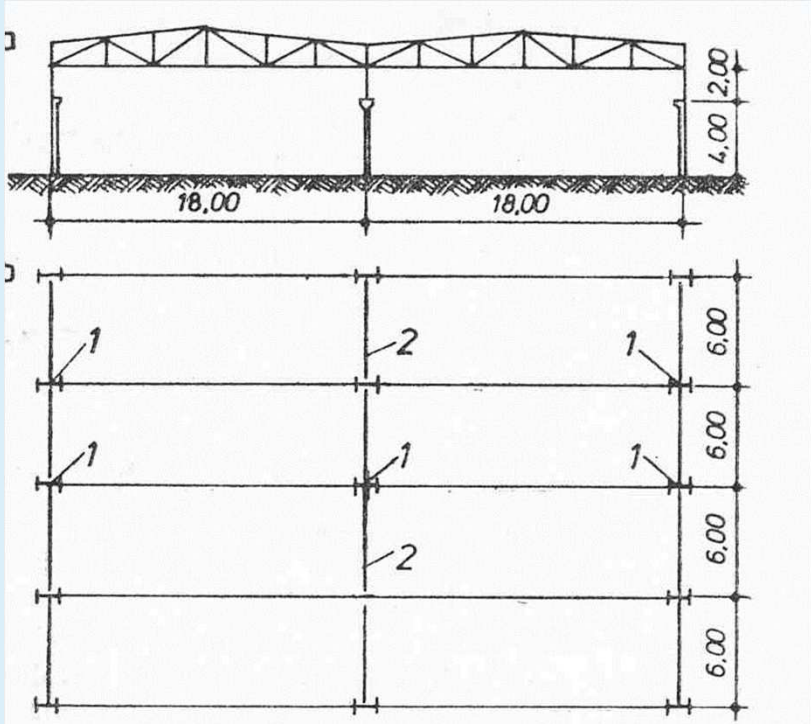


Fig. I.28. Ferme pentru hală cu defecte de uzinare :
a — secțiune ; *b* — plan ; *1* — stîlpi ; *2* — grindă longitudinală.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Damaged due to high temperature of a reinforced concrete column in the vicinity of a furnace for steel

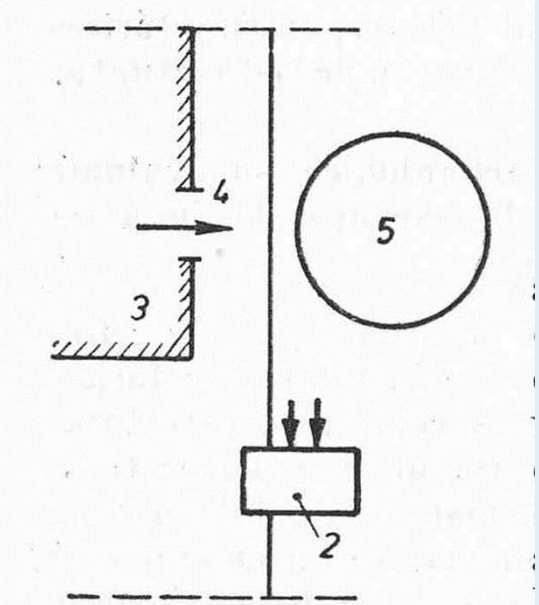


Fig. I.29. Stîlp expus temperaturii ridicate : *1* — platformă ; *2* — stîlp ; *3* — cuptor ; *4* — gură de descărcare ; *5* — oală de turnare.

DIFFERENT CAUSES OF FAULTS APPEARANCE

For an industrial equipment the supporting structure was designed by a different static scheme

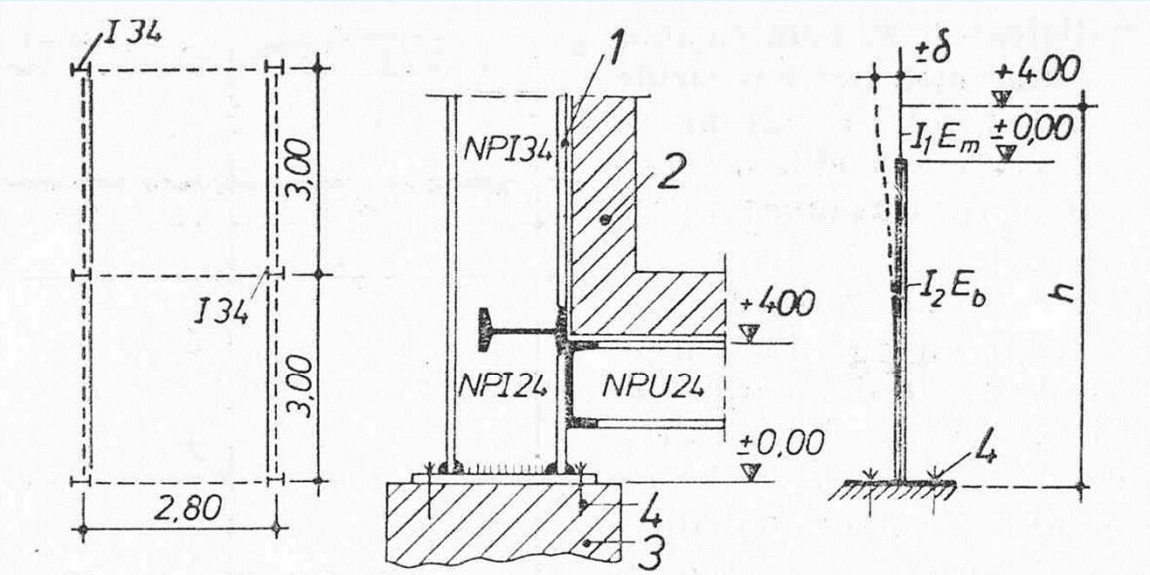


Fig. I.30. Efectele deformațiilor din temperatură tehnologică la o construcție în aer liber :
1 — tablă ; *2* — perete izolant ; *3* — stîlp ; *4* — buloane ancoraj stîlp.

DIFFERENT CAUSES OF FAULTS APPEARANCE

A forging facility foundation was designed at smaller loads that the ones recorded at putting into operation tests

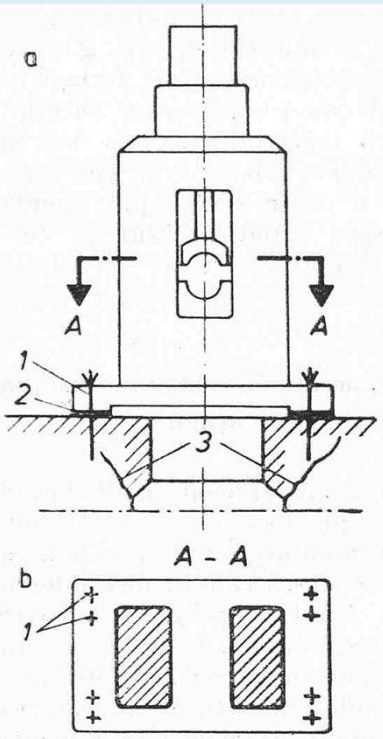


Fig. I.31. Utilaj și defecte la fundație :
a — utilaj ; *b* — secțiunea *A-A* ; *1* — buloane de ancoraj ; *2* — subturnare ; *3* — crăpături.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Inappropriate interruption of the cast in place reinforced concrete arches

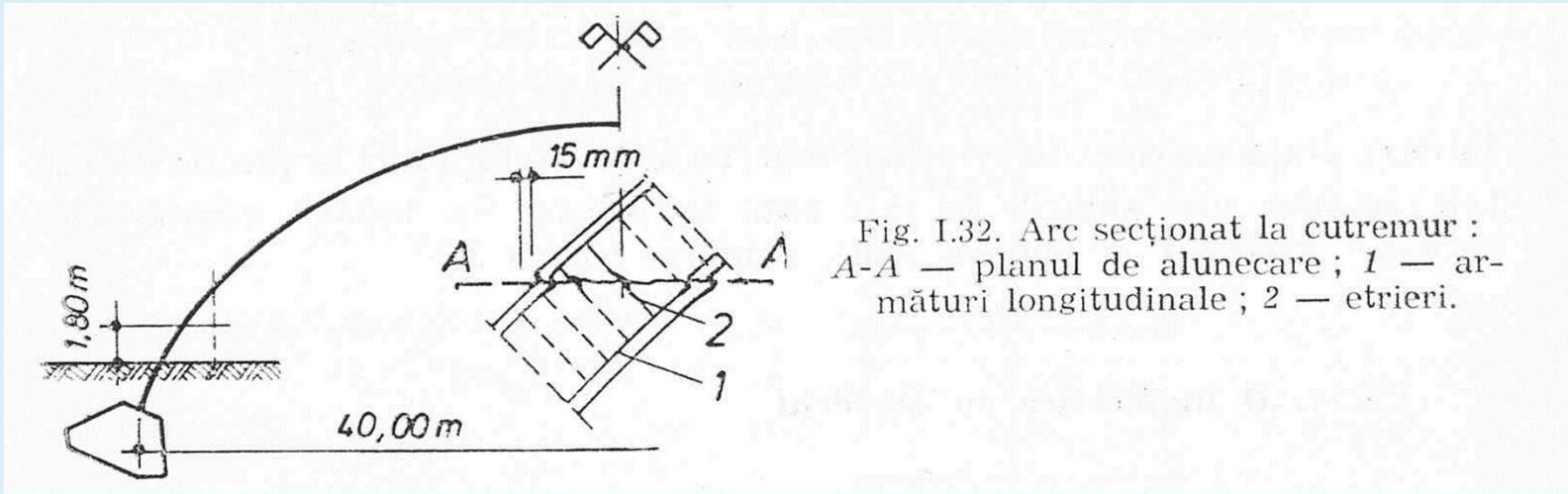


Fig. I.32. Arc secționat la cutremur : *A-A* — planul de alunecare ; *1* — armături longitudinale ; *2* — etrieri.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Cracks results in time that causes which compromise the support initial conditions

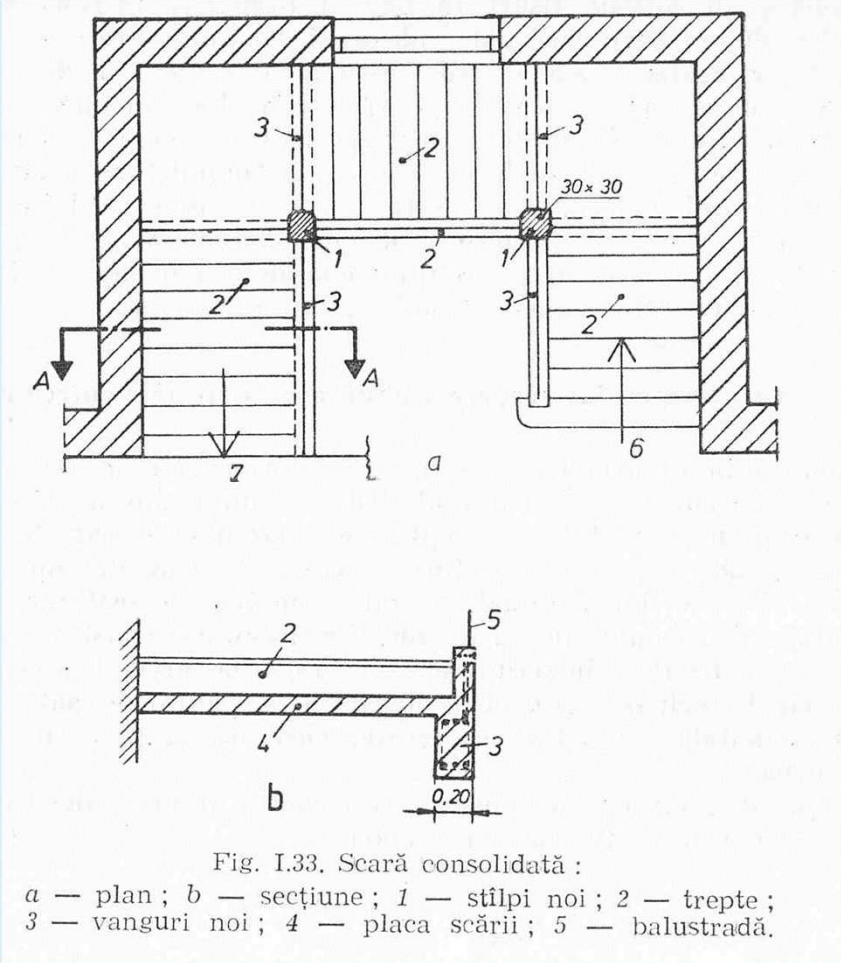


Fig. I.33. Scară consolidată :
a — plan ; *b* — secțiune ; *1* — stîlpi noi ; *2* — trepte ; *3* — vanguri noi ; *4* — placa scării ; *5* — balustradă.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Collapse of elements due to the inappropriate support measures

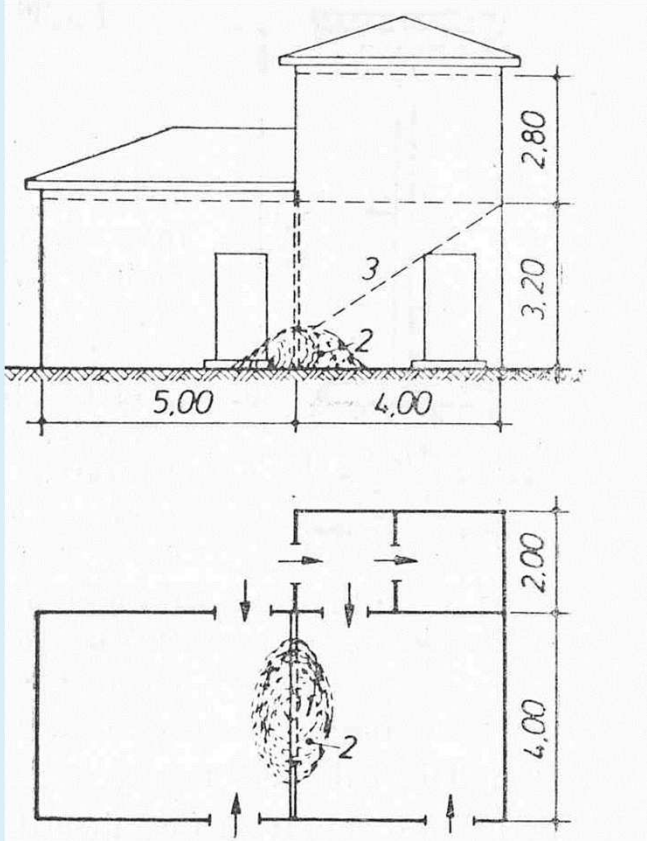


Fig. I.34. Planșeu prăbușit :
1 — gol spart în zid ; *2* — dărîmături ; *3* — planșeu căzut.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Unauthorized demolish of some walls affecting the connection between columns.

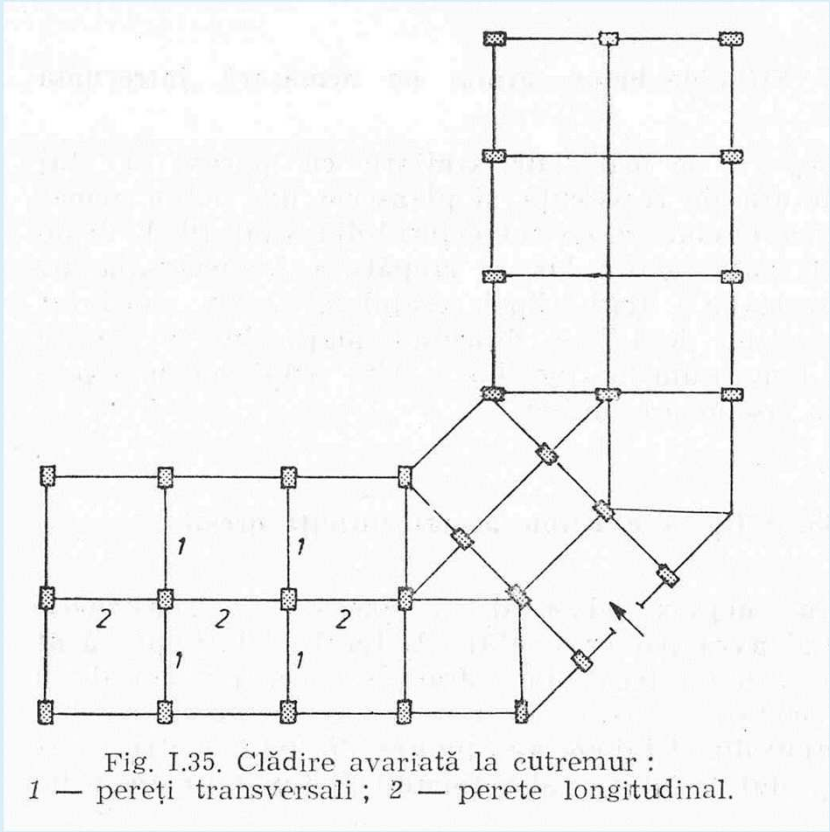


Fig. I.35. Clădire avariată la cutremur :
1 — pereți transversali ; *2* — perete longitudinal.

DIFFERENT CAUSES OF FAULTS APPEARANCE

Modifying the loads by introducing a heavy overhead crane required by new functionalities demands

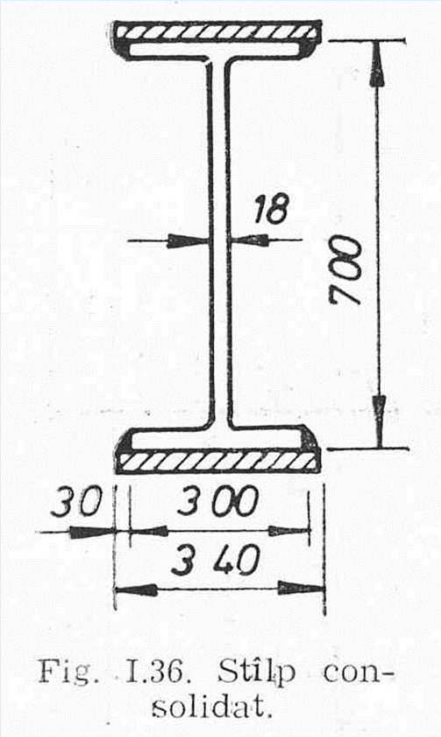


Fig. I.36. Stîlp consolidat.

MAINTENANCE AND SERVICE FAULTS

Can results as results of some:

- Undetected and unrepaired deviations and faults which during service will impair the normal functioning cause even degradation that in time will affect the structural elements.
- Faults that appear during service at significant values of the loads, accounted at design.
- Faults resulted as a direct consequence of bad maintenance or use noncompliance with project.

MAINTENANCE AND SERVICE FAULTS

Faults at water installation have caused water infiltration in the ground soil and unequal settlements of the supports

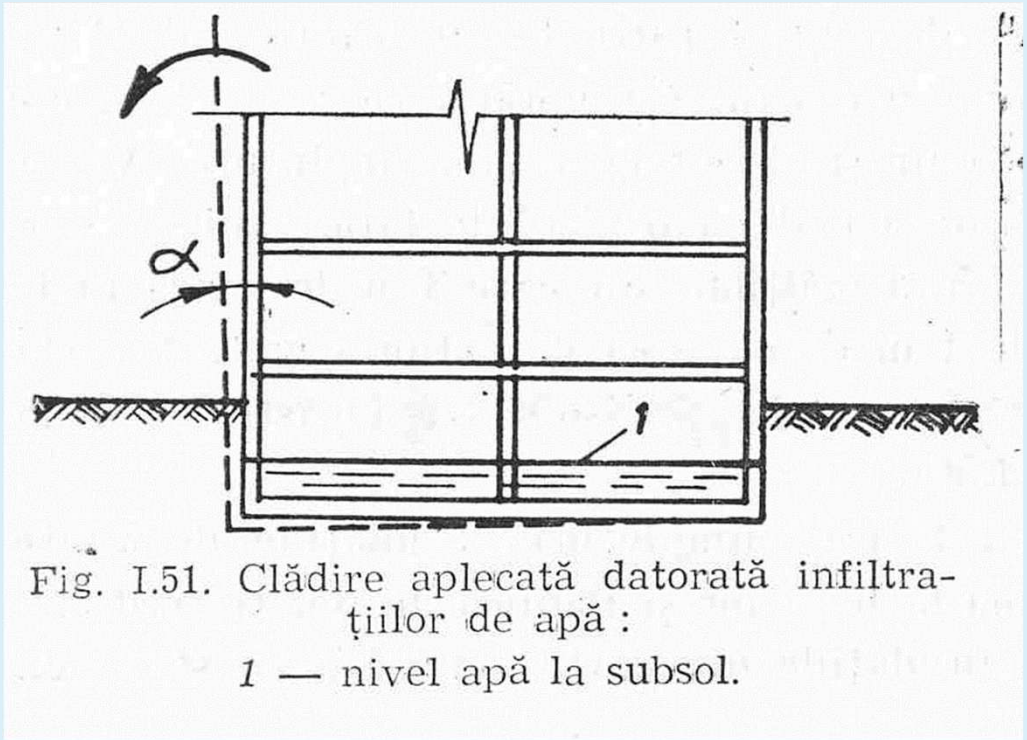


Fig. I.51. Clădire aplecată datorată infiltrațiilor de apă :
1 — nivel apă la subsol.

MAINTENANCE AND SERVICE FAULTS

A damaged fountain with water leaks in time have dug under the near building foundations

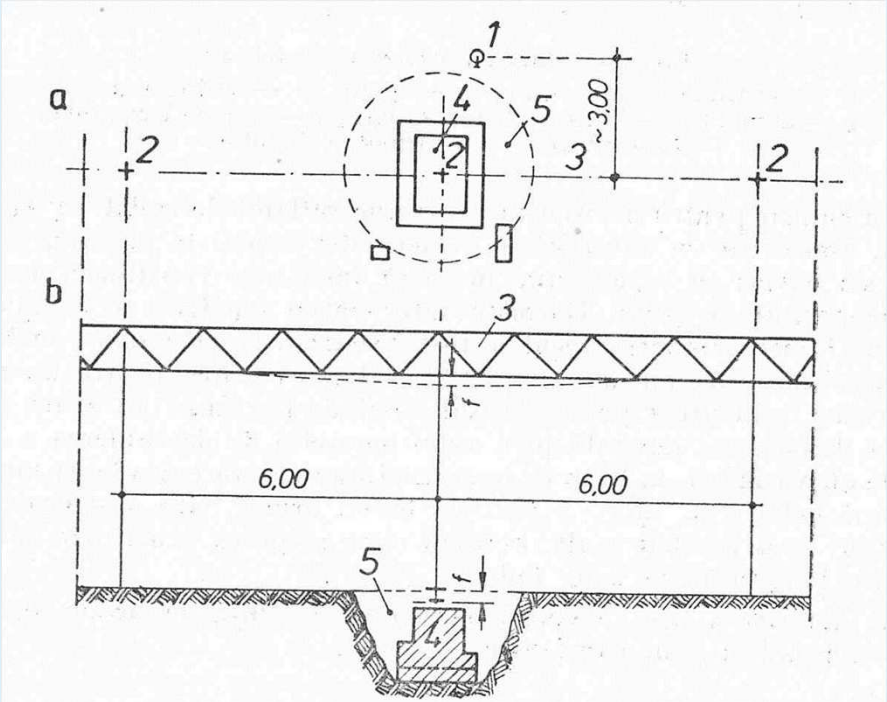


Fig. I.52. Stîlp de hală tasat :
a — plan ; *b* — secțiune ; *1* — cișmea ; *2* — stîlpi ; *3* — grindă longitudinală ; *4* — fundație ; *5* — gol produs de surpare.

MAINTENANCE AND SERVICE FAULTS

Asphalted cardboard on wooden roof deck was set on fire by the maintenance team during the use of an oxyacetylene welding machine

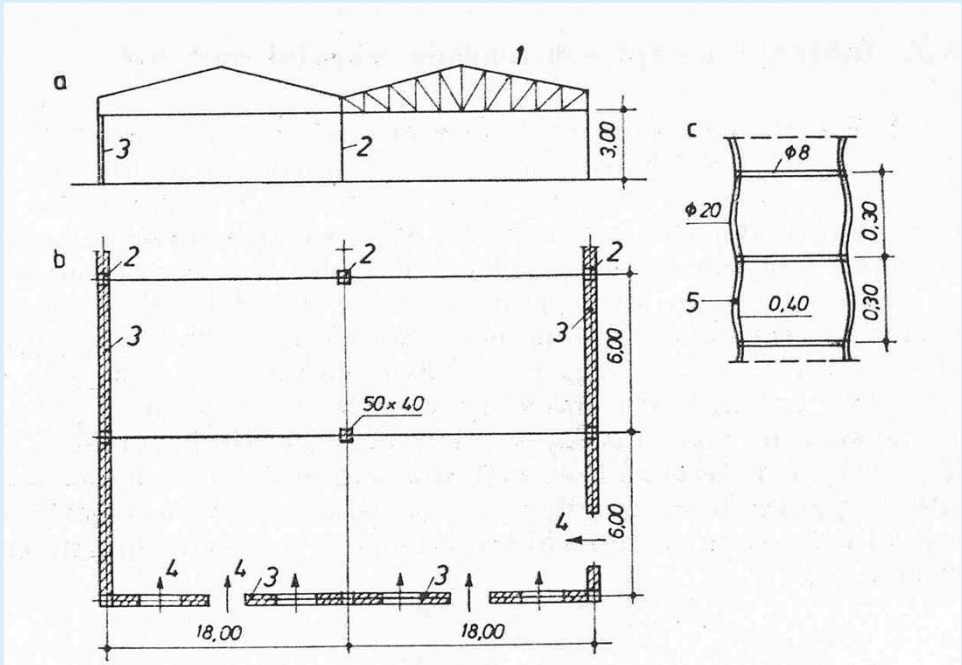


Fig. I.53. Hală cu acoperiș din lemn :
a — secțiune transversală ; *b* — plan ; *c* — stîlp degradat ; *1* — fermă ; *2* — stîlp de beton armat ; *3* — zid de cărămidă ; *4* — intrare ; *5* — armături îndoite.

MAINTENANCE AND SERVICE FAULTS

Introducing a stationary engine with liquid fuel placed under a steel truss, locally heated at +400oC the steel beam which collapse

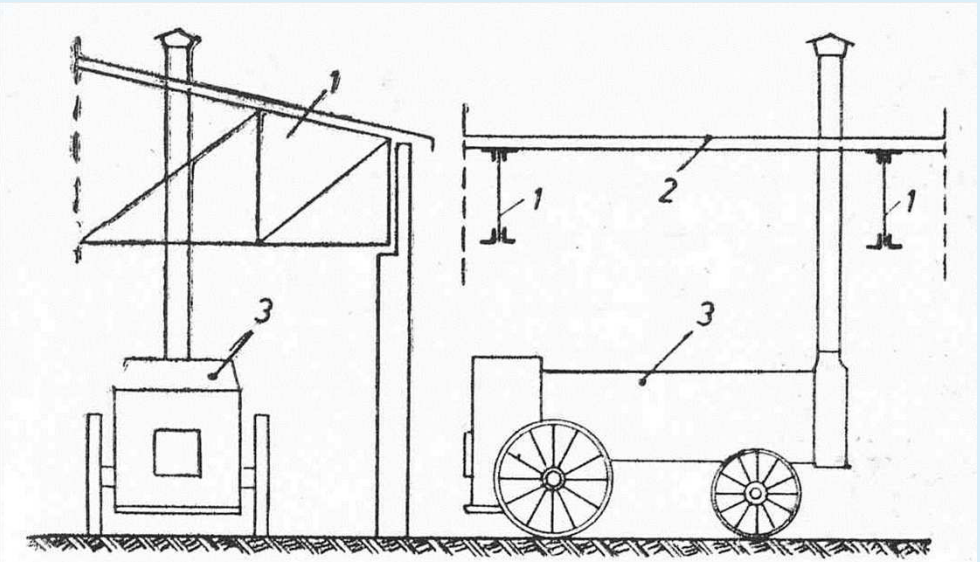


Fig. I.54. Fermă prăbușită datorită incendierii unei locomobile :
1 — fermă acoperiș ; *2* — acoperiș din plăci prefabricate ; *3* — locomobilă.

MAINTENANCE AND SERVICE FAULTS

Storage of granular materials near a brick gable

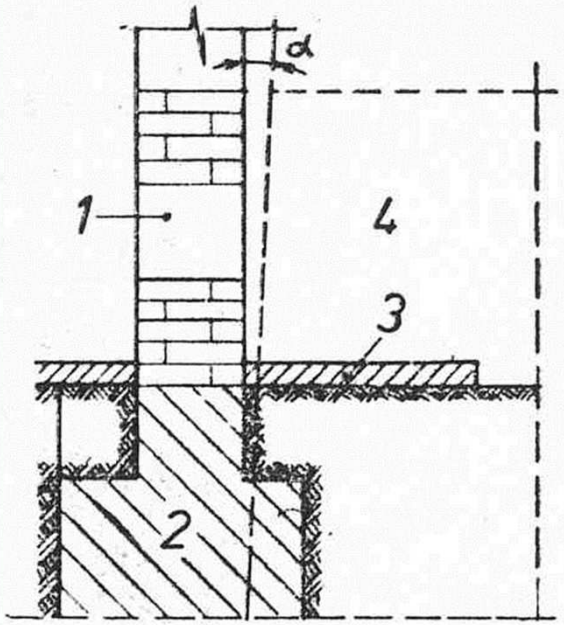


Fig. I.55. Zid aplecat : *1* — zid ; *2* — fundație ; *3* — trotuar ; *4* — depozit laminate.

MAINTENANCE AND SERVICE FAULTS

Inadequate maintenance causing malfunction of overhead cranes has caused the emergence of larger loads and damage of the reinforced concrete runaway beams

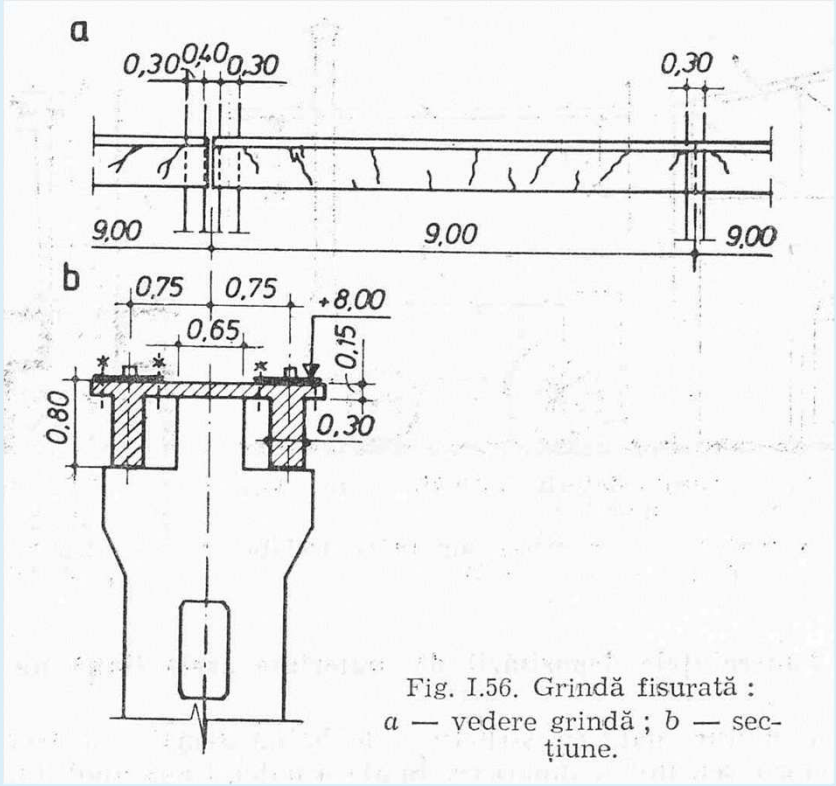


Fig. I.56. Grindă fisurată : *a* — vedere grindă ; *b* — secțiune.

MAINTENANCE AND SERVICE FAULTS

Change to the operation of overhead cranes by increasing the use have cause in time damage at the bolted connections

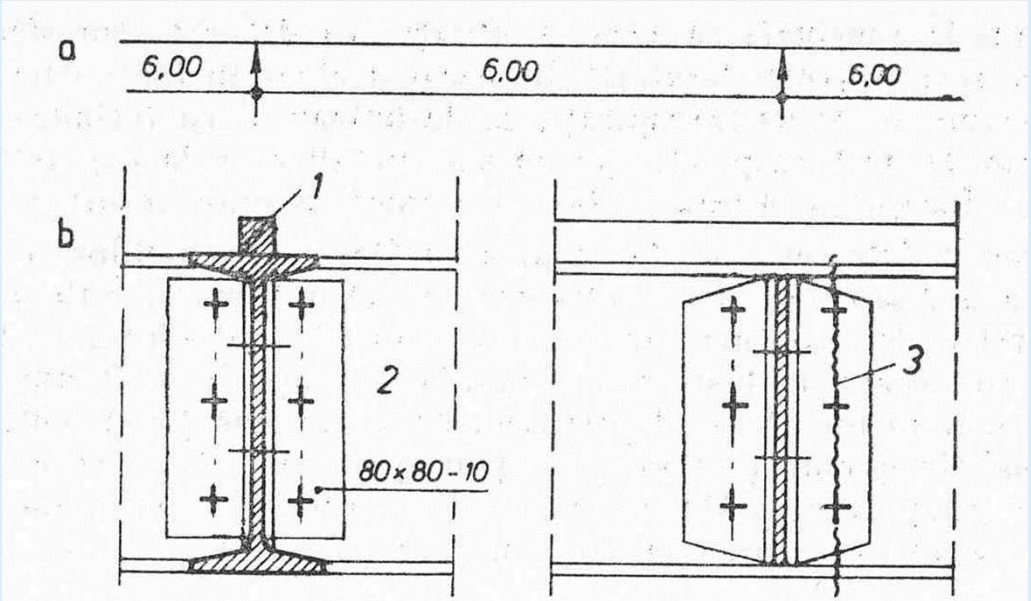


Fig. I.57. Grindă metalică prinsă de consolă :
a — grindă ; *b* — prinderea grinzii ; *1* — șină ; *2* — grindă dublu T ; *3* — fisurarea inimii grinzii.

MAINTENANCE AND SERVICE FAULTS

Changing the destination and increasing the humidity caused corrosion

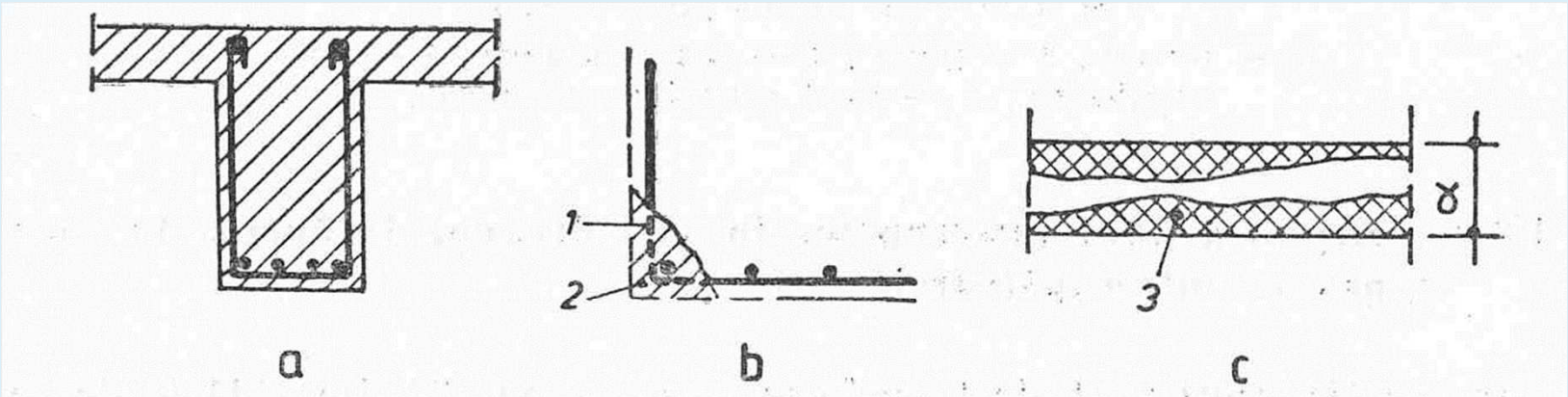


Fig. I.58. Grindă planșeu corodată :
a — secțiune ; *b* — beton și armături corodate ; *c* — armătura longitudinală corodată ; *1* — etrieri ; *2* — colț corodat ; *3* — beton căzut.

EQUIPMENT INDUCED FAULTS

Especially industrial buildings host various equipment's, installations, pipelines, power cables etc. used for manufacturing process.

Malfunction of this equipment's will cause damage in the structure elements.

Sometimes are stored flammable materials, either raw materials or finished products which may cause fire or explosion.

EQUIPMENT INDUCED FAULTS

Due to malfunction of a separation and removal installation a large quantity of industrial dust was drifted on the roof causing a purlin failure

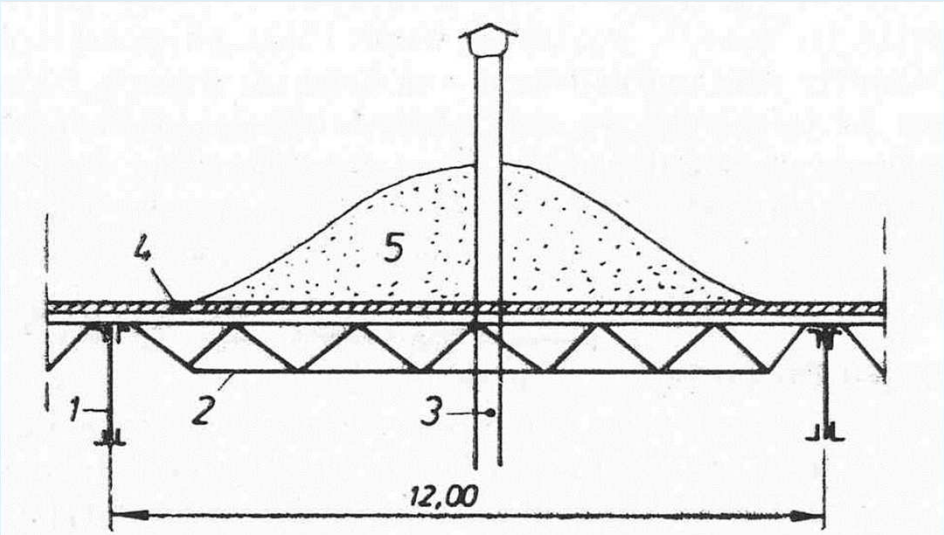


Fig. I.59. Praf depus pe acoperiș :
1 — fermă ; *2* — pană ; *3* — coș evacuare ; *4* — învelitoare ; *5* — praf așezat pe acoperiș.

EQUIPMENT INDUCED FAULTS

On a transformer station an explosion occur in the room with oil circuit breakers

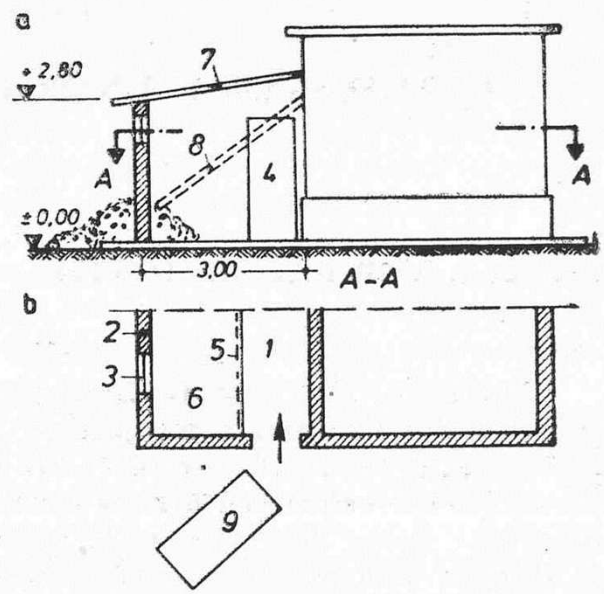


Fig. I.60. Încăpere întrerupători în ulei : *a* — secțiune ; *b* — secțiunea *A-A* ; *1* — culoar ; *2* — perete din zidărie ; *3* — ferestre fixe ; *4* — ușă ; *5* — tablou ; *6* — întrerupători în ulei ; *7* — placă acoperiș ; *8* — placă căzută ; *9* — ușă aruncată.

CONSEQUENCES OF FAULTS

Unallowable imperfections / deviations undetected and not eliminate at time because faults that will endanger the safety of the structures.

Loss of confidence, panic, psychological discomfort.

Abnormal conditions for use of construction.

- Thermal insulation, water vapor condensing annoying air flow,
- Acoustic and phonic insulation,
- Vitiated air exhaust, poor ventilation,

Unfulfilling some storage condition for specific materials

- Microclimate, unsafe storage

Partial or total collapse

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2014