

BUILDING REHABILITATION

1. INTRODUCTION OF BUILDING DIAGNOSTICS

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BUILDING DIAGNOSTICS



Building diagnostics is the process of determining the causes and solutions to problems in buildings. Building diagnostics is the process of data collection methods and techniques regarding inspection and analysis, and of future prediction of faults, abnormalities and defects in the condition, internal environment and performance of a building or structure, extending to services offered in the building



BUILDING DIAGNOSTICS PROCESS TYPES



Building diagnostics process types are:

- **Unaided** (visual inspection – naked eye) - non-destructive method
- **Aided** by different technologies (thermography, material tests, crack mapping, deflection and settlement measurements etc.) - destructive testing and non-destructive methods

Results are collected in **building inspection report**



CIRCUMSTANCES DETERMINING THE CONDITION OF A BUILDING

Climate

- Winter-summer temperature difference (- 20...+35 °C lowest and highest ambient air temperature – but on the surface of building structures, -25...+80 °C can be monitored)
- Indoor-outdoor temperature difference (- 20...+24 °C)
- Daily temperature swings (+10...+30 °C at late spring/early autumn time)
- Frost cycles (20...100/year in Hungary – harmonised test method: only 30)

Usage mode

- Exposure (careful or careless use, residential, public buildings, industrial buildings)
- Proper/normal or improper use/abuse

Maintenance

- Regular maintenance, preventing maintenance
- Repair works
- Reconstructions, rehabilitation

Life cycle

- Loadbearing structures: 50, 100, 150 years
- Finishings: 25 years or less
(rendering: 2-3 years in public buildings)



CONSEQUENCES, FAILURES

Factors determining condition of a building

- Natural wearing, attrition, ageing
- Design mistakes
- Construction mistakes
- Failures due to improper use or maintenance

Failure consequence of different structures

- Loadbearing system failure: severe consequences
- Failure of a finishing: limited consequences but when it is not repaired, even the loadbearing structures can be damaged (f.i. water penetrations, frost problems)

Main failures

- Movements (inequal settlements, thermal movements)
- Water penetrations
- Building physics (thermal bridges, condensations, acoustic problems)
- Biological deteriorations (fungal infection, insects)



FOUNDATION FAILURES



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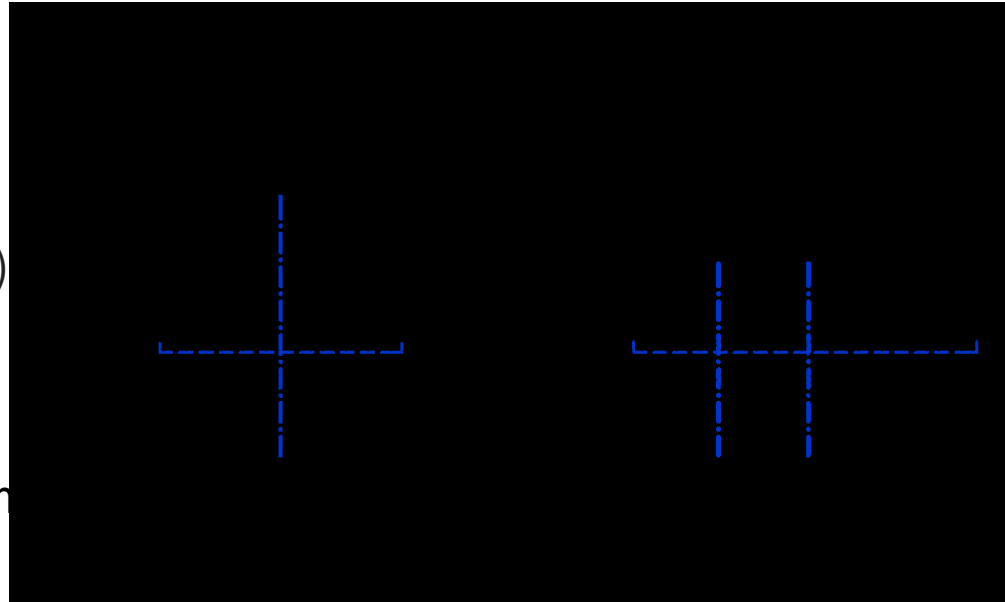
FAILURE OF LOADBEARING STRUCTURES - FOUNDATIONS

Building failure symptoms

- Cracks (width, orientation)
- Inequal settlements, leanings
- Collapse (structural integrity failure)

Possible reasons:

- Load differences
- Failure of public utilities (water main sewage pipe)
- Inadequate subsoil quality
- Improper extension - bulb pressure overlap
- Improper internal construction works
- Frost problems, frost heaving
- Subsoil water level change
- Aggressive subsoil water



joint in the foundation is obligatory



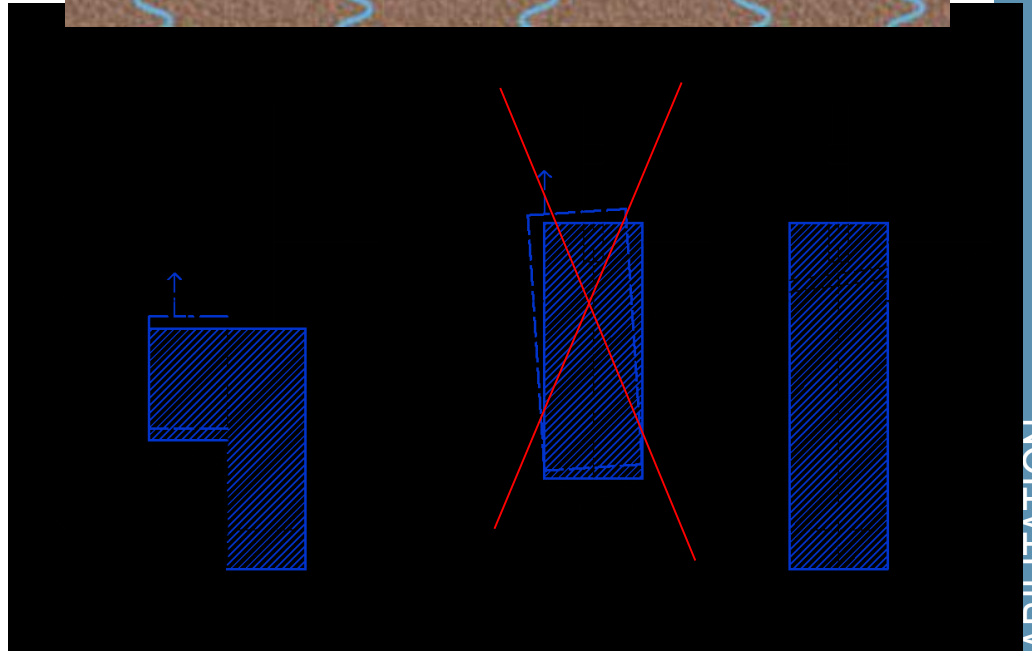
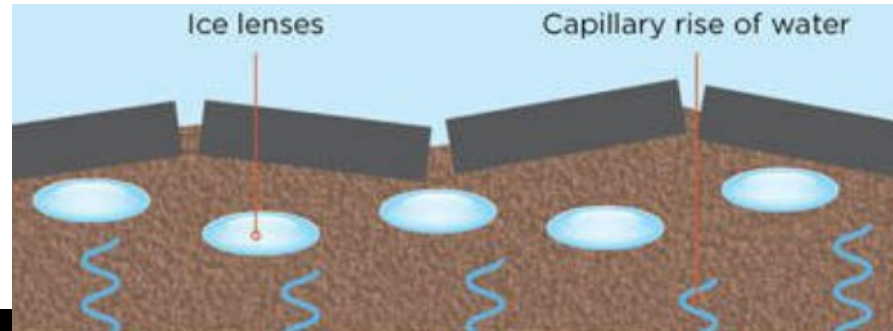
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Wrong/right solution
Foundation of a barrier/retaining wall



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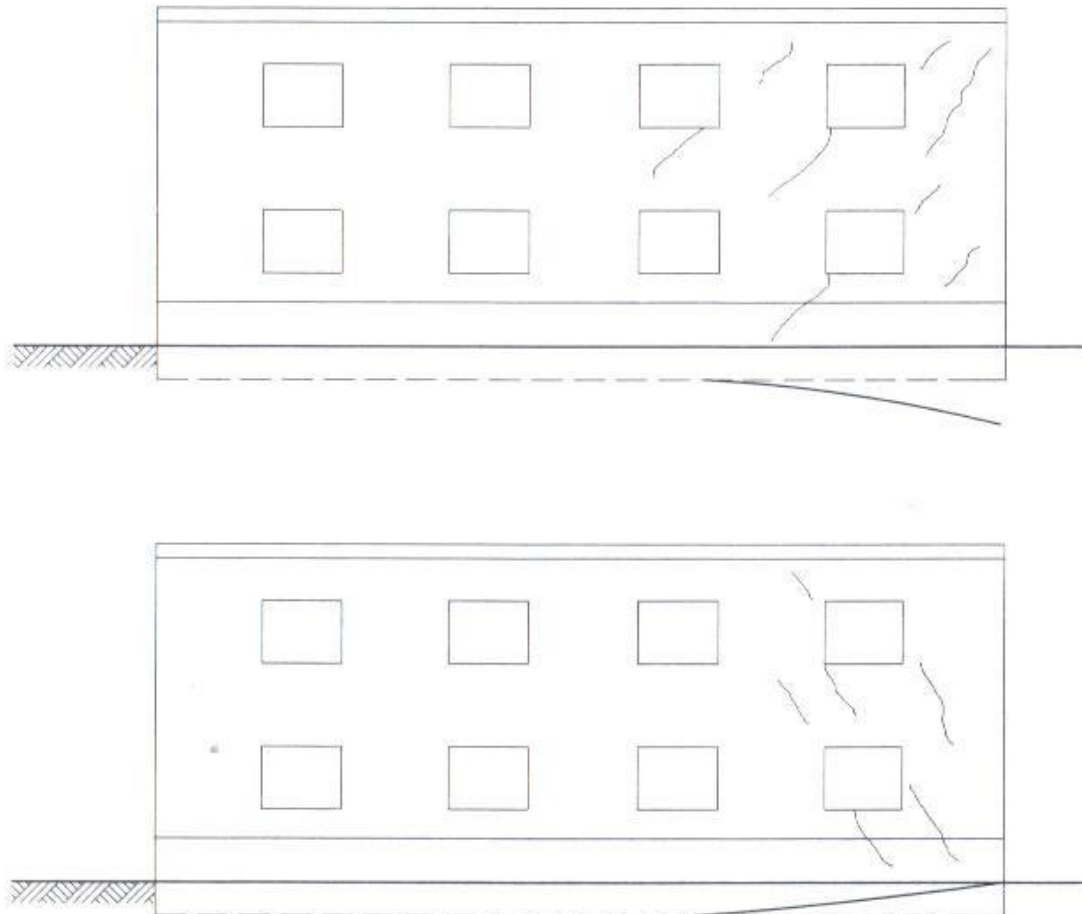
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FOUNDATION PROBLEMS



FOUNDATION PROBLEMS – INEQUAL SETTLEMENT



Possible reasons are:

- Different soil type
- Concentrated water exposure under the bottom level of the foundation
- Inadequate foundation system



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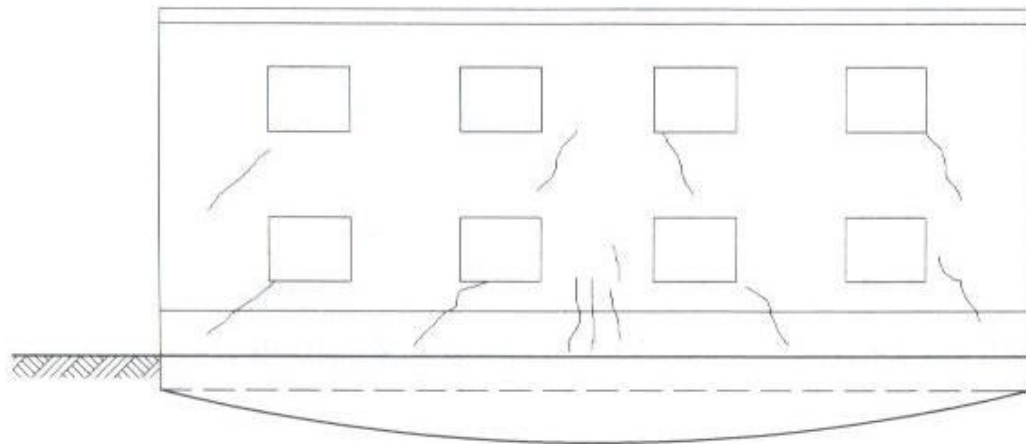
Reason:
broken
downpipe



FOUNDATION PROBLEMS – INEQUAL SETTLEMENT



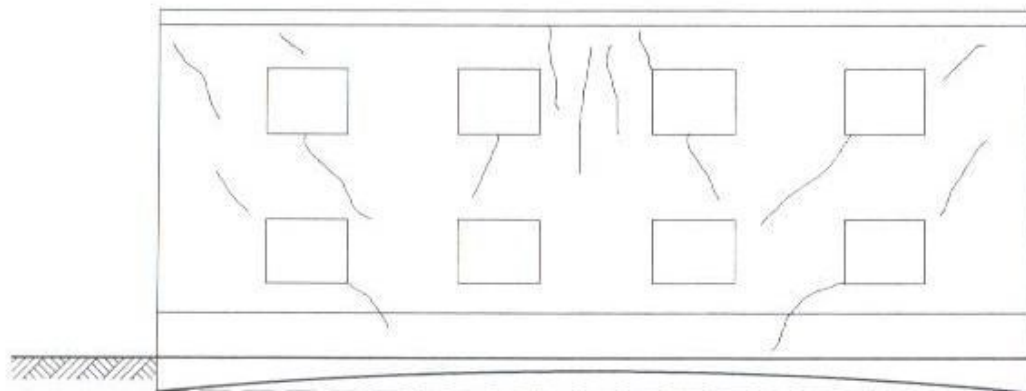
FOUNDATION PROBLEMS – INEQUAL SETTLEMENT



Inequal settlement in the middle of the building and at the edges

Possible reasons are:

- Different soil type
- Concentrated water exposure under the bottom level of the foundation
- Inadequate foundation system



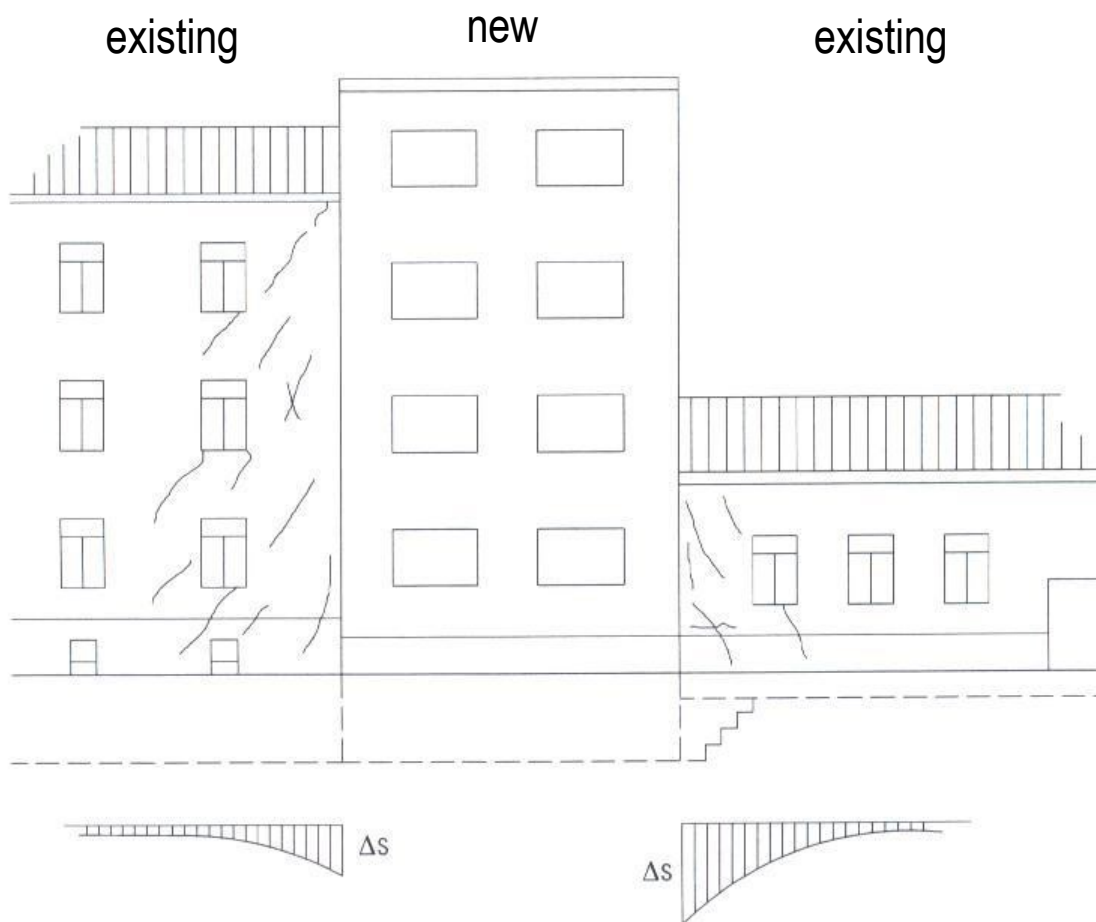
FOUNDATION PROBLEMS – INEQUAL SETTLEMENT



Reason: broken sewage water main



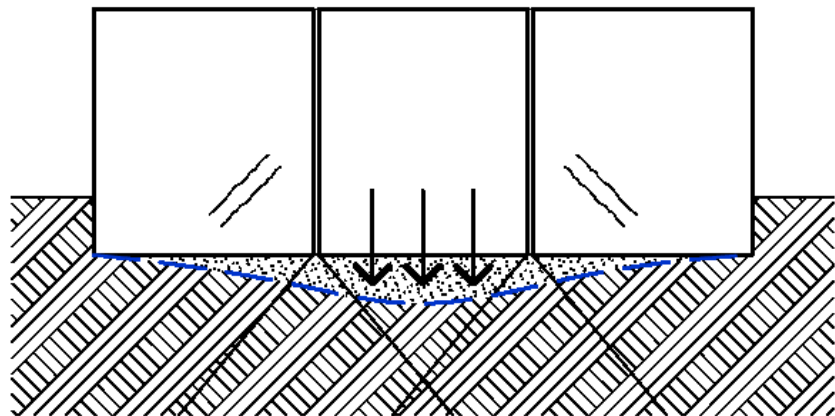
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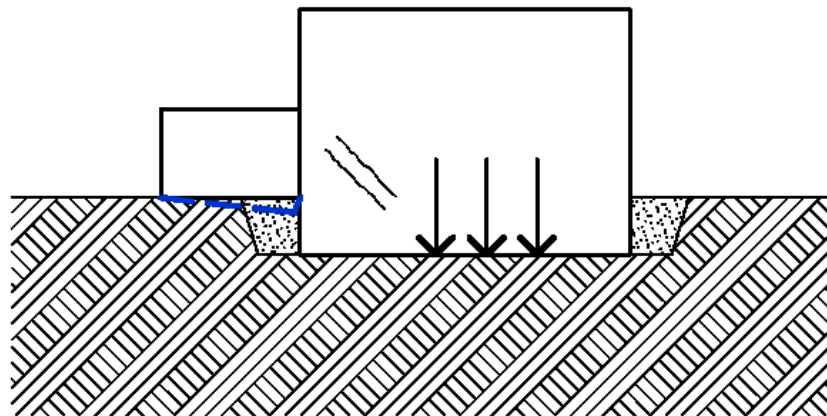
Typical effect of a new building to the existing neighbouring buildings: additional settlements and new cracks



FOUNDATION PROBLEMS – INEQUAL SETTLEMENT



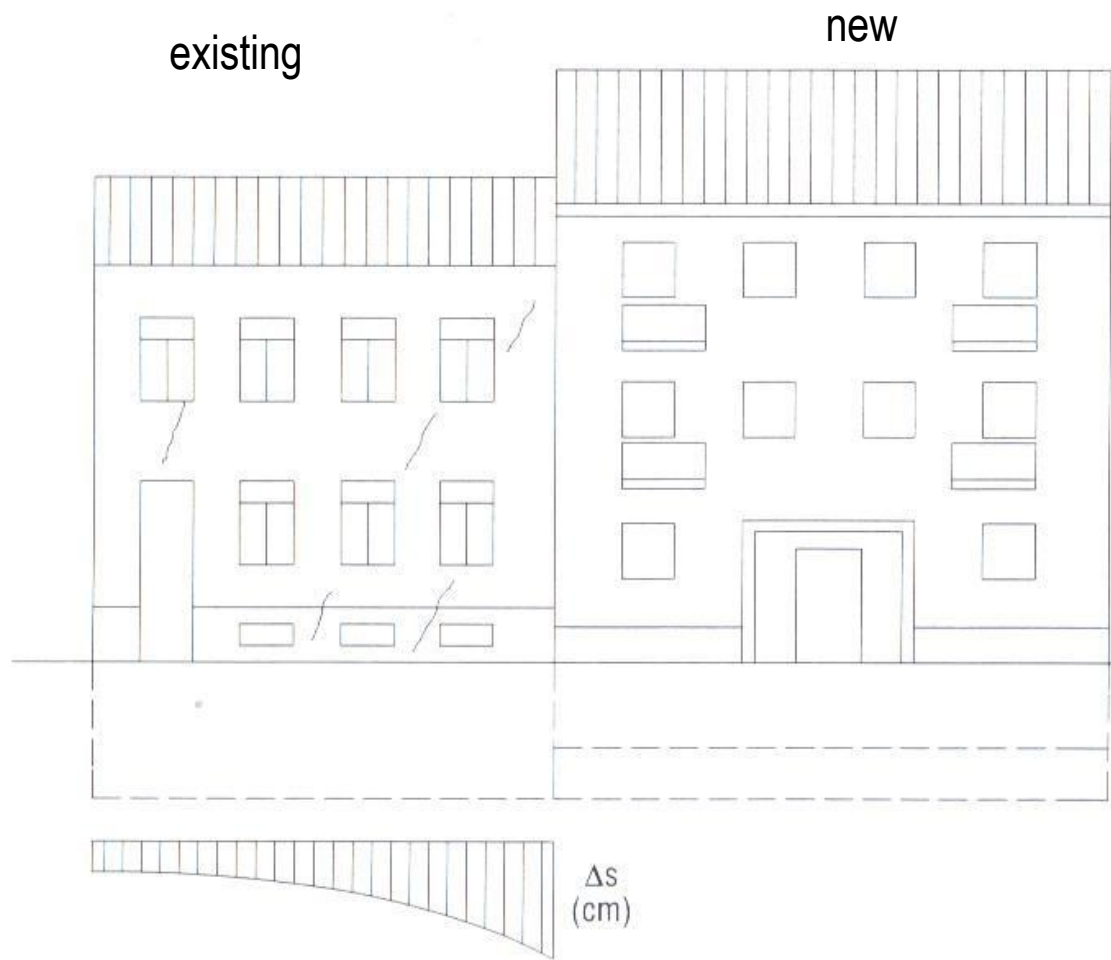
Lock-up in a plot between two existing building which was not built with a building



New building on a soil backfill side-by-side an existing building



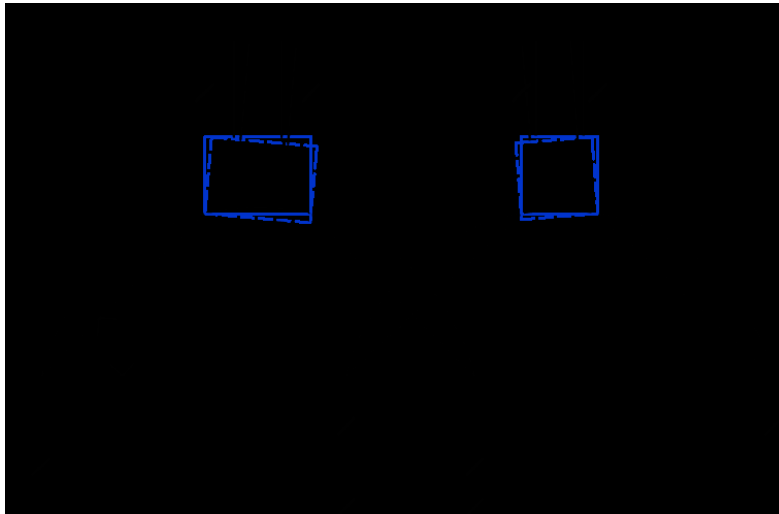
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Typical effect of a new building to the existing neighbouring buildings: additional settlements and new cracks



FOUNDATION PROBLEMS – BULB PRESSURE OVERLEAP



If $a > b$ then the critical level is $2 \cdot a$; bulb pressure hazard:

- at strip foundation $2 \cdot a$
- at pad foundation $1 \cdot a$

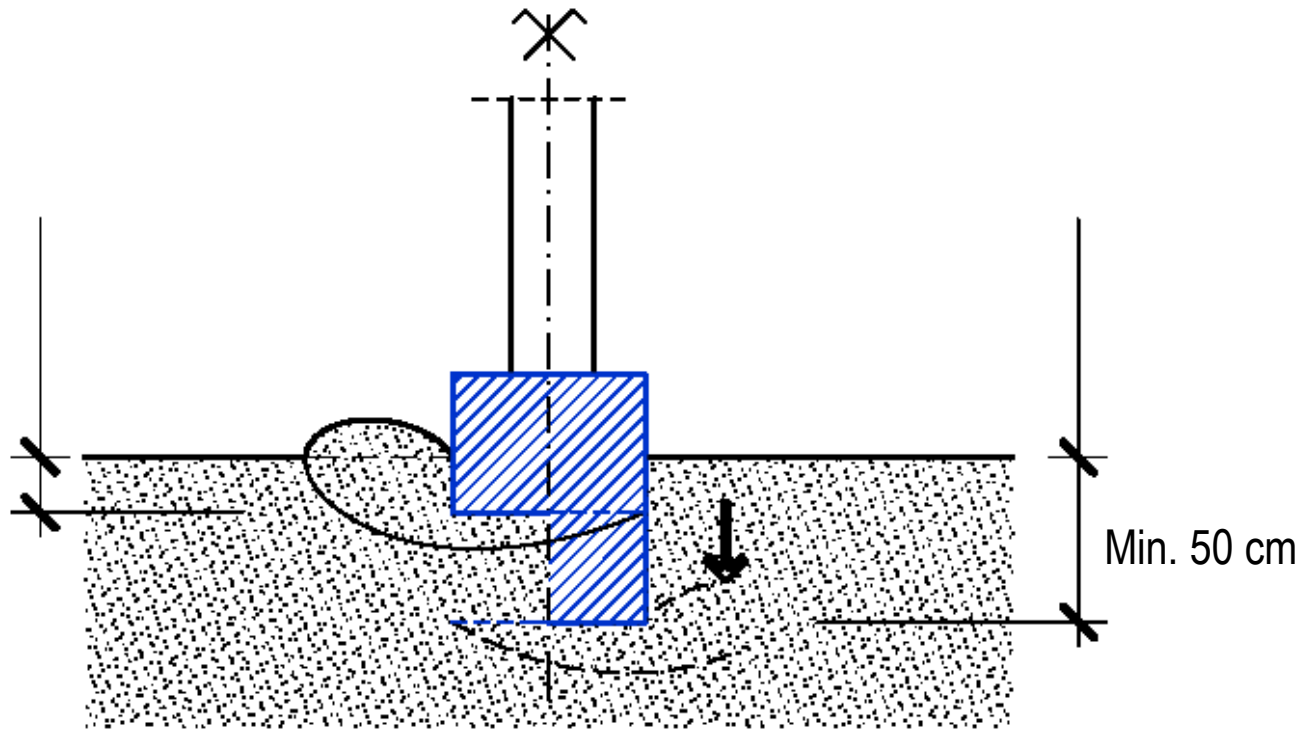
Minimum distance:

- at strip foundation $4 \cdot a$
- at pad foundation $2 \cdot a$

Avoidance of bulb pressure overlap at pad foundations



FOUNDATION PROBLEMS – BULB PRESSURE



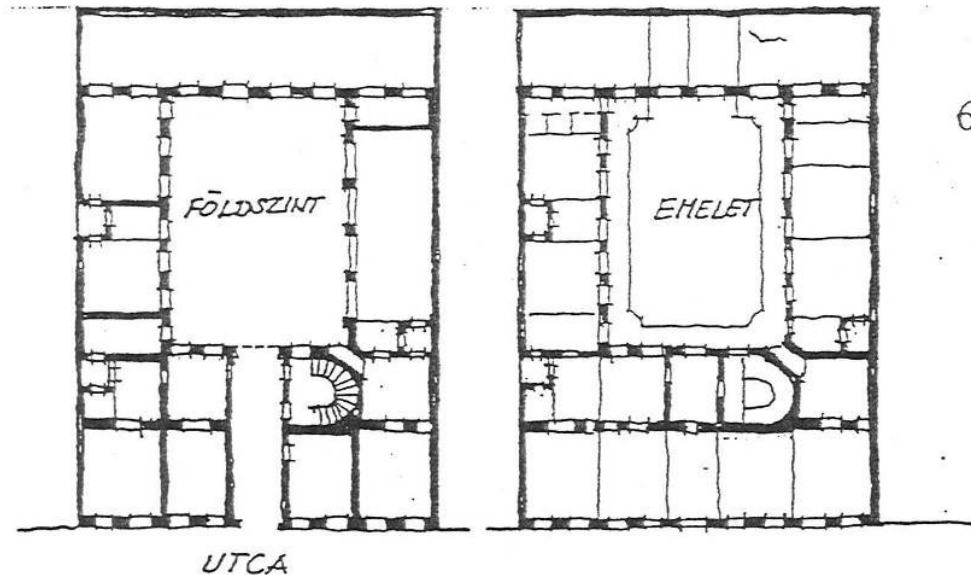
Minimum depth of foundation:

- Frost level (80-100 cm)
- 10 cm below the level of the loadbearing soil
- 40-50 cm.



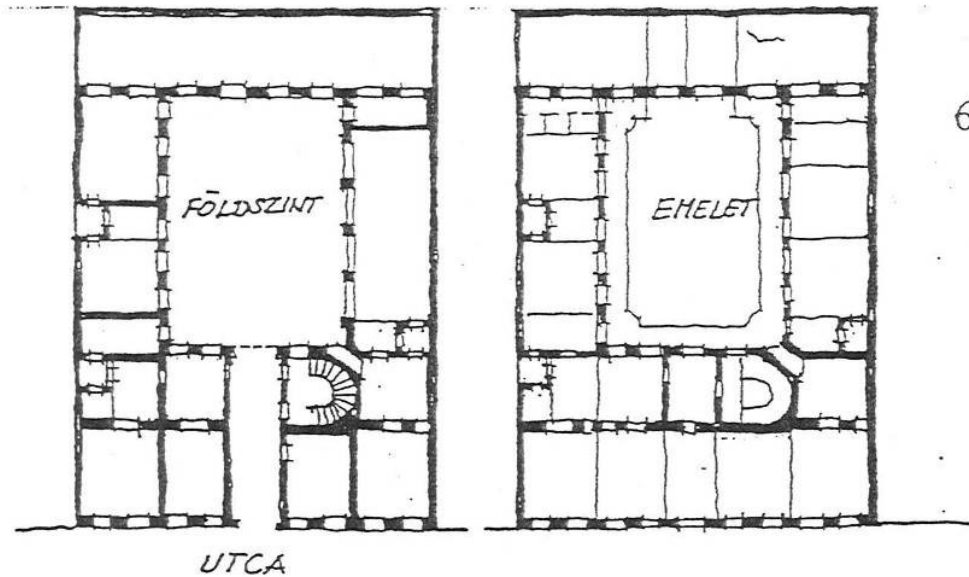
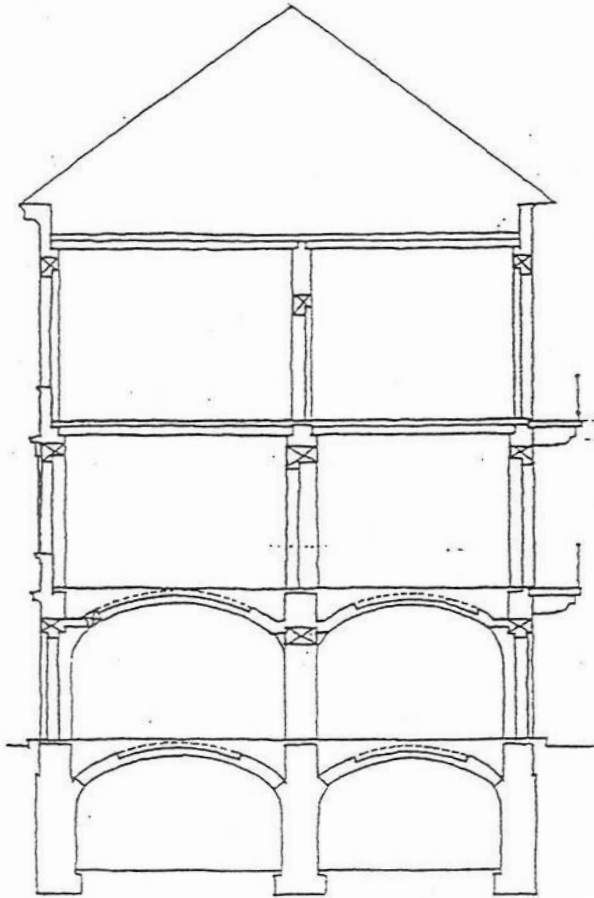
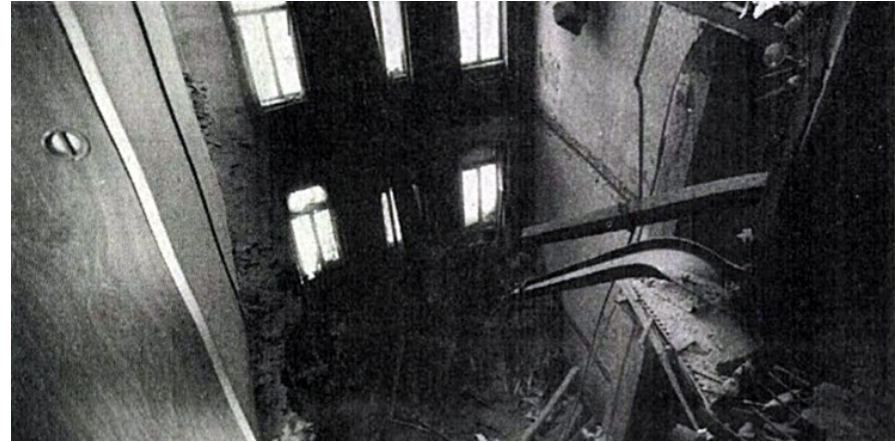
FOUNDATION PROBLEMS - COLLAPSE

Budapest, Ó str. 24. – 1994
Due to soil removal from the basement



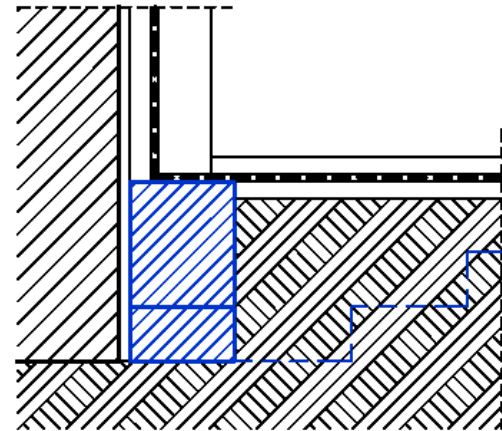
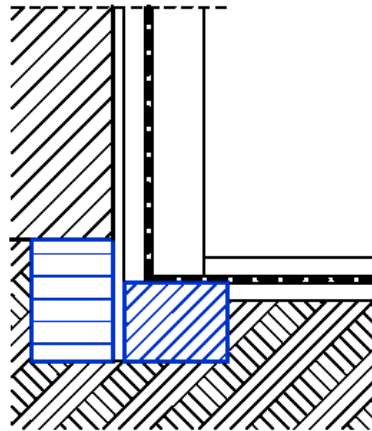
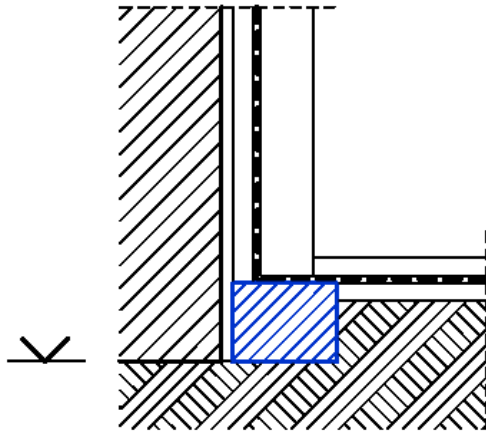
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FOUNDATION PROBLEMS

AVOIDING BULB PRESSURE OVERLEAP



Bottom level of foundation of old and new buildings are the same

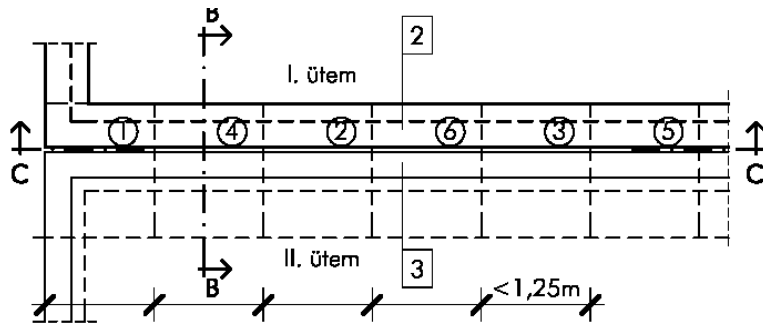
Bottom level of foundation of the new building is deeper
- discontinuous underpin

Bottom level of foundation of the new building is higher

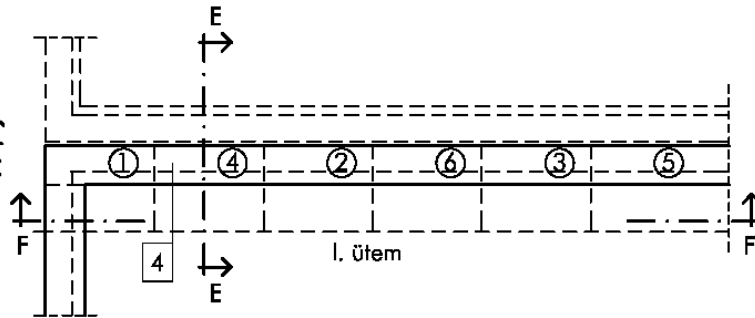


FOUNDATION PROBLEMS

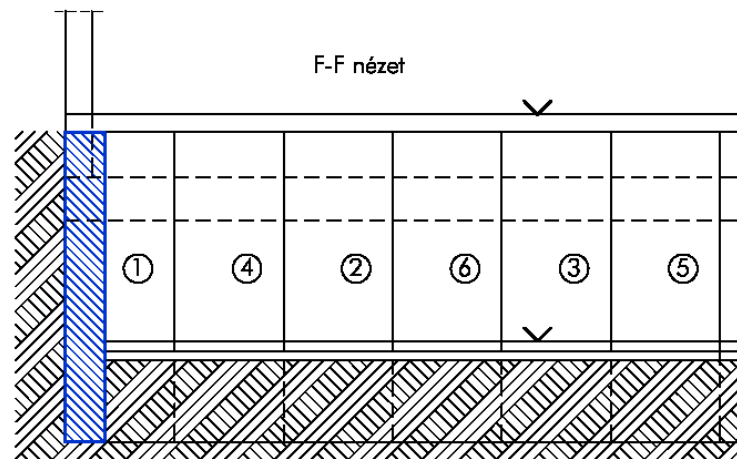
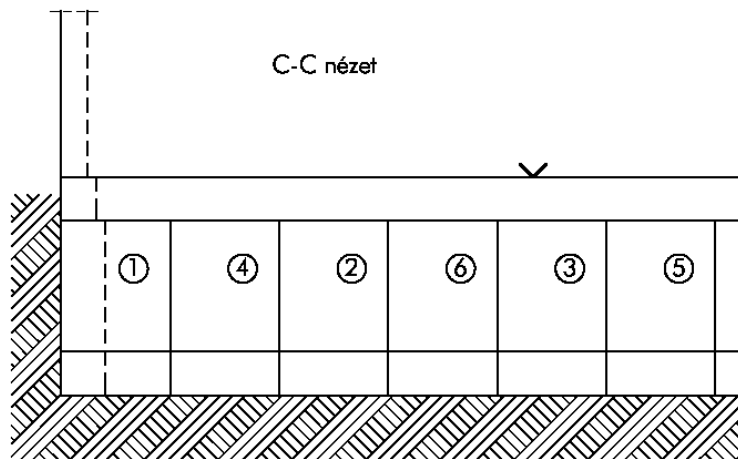
AVOIDING BULB PRESSURE OVERLEAP



Phase I.



Phase II.



Bottom level of foundation of the new building is deeper
- discontinuous underpin



FOUNDATION PROBLEMS – COLLAPSE



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FOUNDATION PROBLEMS – COLLAPSE



FAILURES OF LOADBEARING WALLS, PIERS



FAILURE OF LOADBEARING STRUCTURES – PIERS, WALLS

Building failure symptoms

- Cracks (width, orientation)
- Inequal settlements, leanings
- Building physics problems
- Collapse (structural integrity failure)

Possible reasons:

- Load differences, overloading (mainly at piers – loadbearing walls usually strong enough)
- Improper construction works
- Mechanical exposure
- Corrosion of steel structural members
- Frost problems



FAILURE OF LOADBEARING STRUCTURES – WALLS – FROST



FAILURE OF LOADBEARING STRUCTURES – FROST



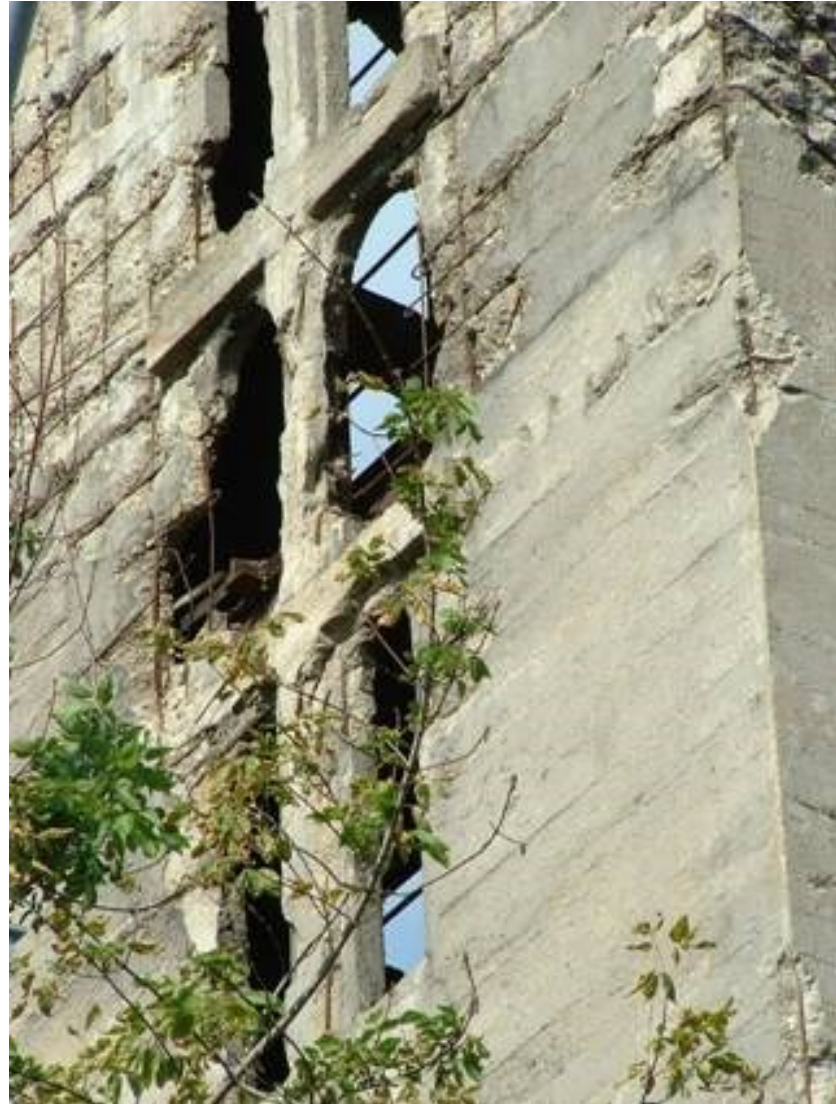
FAILURE OF LOADBEARING STRUCTURES – CORROSION



- Inadequate concrete cover of the steel reinforcements + high vapour content of the ambient air
- Mechanical failures (missing edge protection)



FAILURE OF LOADBEARING STRUCTURES – CORROSION



FAILURE OF LOADBEARING STRUCTURES IMPROPER CRAFTMANSHIP



FAILURE OF LOADBEARING STRUCTURES IMPROPER CRAFTMANSHIP - CONSOLIDATION

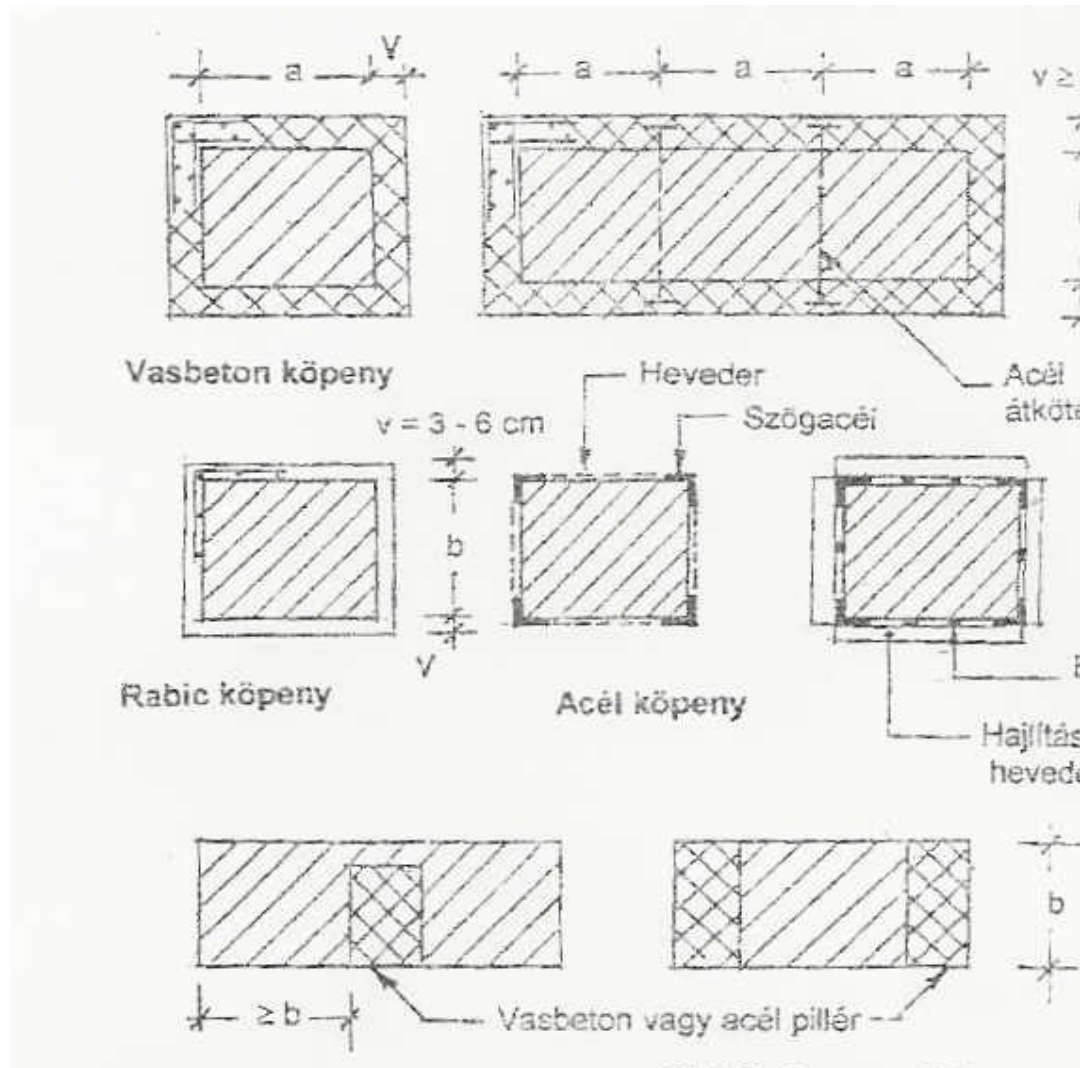


FAILURE OF LOADBEARING STRUCTURES IMPROPER CRAFTMANSHIP - REPAIRING



FAILURE OF LOADBEARING STRUCTURES

IMPROVING THE LOADBEARING CAPACITY

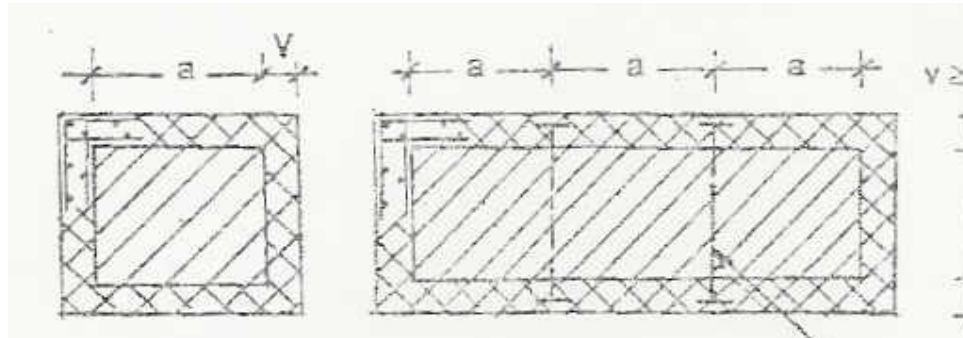


FAILURE OF LOADBEARING STRUCTURES IMPROVING THE LOADBEARING CAPACITY



FAILURE OF LOADBEARING STRUCTURES

IMPROVING THE LOADBEARING CAPACITY



jacking

