

RESEARCH on the APPLICATION of CONCRETE/STEEL PANELS in a
COMPOSITE BUILDING CONSTRUCTION SYSTEM

by

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a la memoria de MANUEL D. SANCHEZ LORVAJAL

acknowledgments

Beatriz Lapp
Fundacion Gran Mariscal de Ayacucho
Waclaw Zalewski
and to all those who believe in technology

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preface

This work is an investigation into the possibility of using cold formed steel sections as formwork, where concrete is poured and placed. Once the concrete is cured, it becomes the finished product; a concrete panel with metal edges.

The cold formed steel sections behave as partial reinforcement necessary to supplement additional steel rods or mesh.

The methodology applied in this research breaks down to definition of the problem, an analysis of existing construction methods, and finally a presentation of an alternative solution.

The solution is a Composite building System.

Application and reduction on costs were key considerations in the developement of this work.

The sole purpose for the work done was to offer a feasible alternative to the construction industry, minimizing labor and time.

a need for industrialization

Right now, more than ever before, the correct understanding of the concept of industrialization in architecture is paramount.

With the increasing population explosion, infant mortality reduced to minimum figures plus an augment on the life span, there is a housing deficit escalating to astronomical magnitudes.

It is imperative to state from the very beginning that a need for housing should not mean new slums or poorly designed and built buildings; Industrialization as a viable alternative should also mean designing above the minimum quality standards for human living.

The knowledge of fast and good should be one word, one principle.

Different actions have been taken by the government in all countries; Federal, state and local agencies desperately trying to cope with this macroproblem are issuing new legislations, change of zonings, renovations of either old or run down existing urban areas, but these have not been sufficient measurements to cope with the demand of housing.

Alarming increases of the number of tenants under one roof, where single families dwelled before, is not the solution.

The use of industrial methods at all stages of production and even automation for the more technically advanced countries is one way to alleviate the otherwise uncontrollable housing nightmare.

Developing industrialization is the rational panacea

The concept of industrialized housing today should emphasize quality, fair price and code compliance.

existing housing building systems

Industrialization could be defined as a process by which the same identical components are fabricated; requiring minimum of time to manufacture them on a line production for later assembling.

Many building systems are being used in different countries. There are numerous modern methods of production in construction and housing edification but for classification purposes, basically three identifiable categories would best suit this analysis:

- one: load bearing walls, either external or internal (crosswalls),
- two: frame structures, composed by post & beam with panel infill or slab & column,
- three: box concept with all its variables.

Applications, costs and time investment are always top considerations on any industrialized method of construction.

Building systems have first, an alphabet of elements and components; Second, production characteristics; Third, materials plus performance; Fourth, transportation requirements and fifth, erection and assemblage.

Various degrees of technology for the production of components in architecture have always been in existence, therefore, the concept of industrialization in the construction business is not a new one.

What is understood today as industrialized construction methods is only an actual and revised version of the old knowledge of putting buildings together.

In not all industrialized systems (on line production) the components are factory produced; which means components produced under a roof at a distance from the chosen site requiring some use of transportation. Sometimes there are particular reasons why components are to be produced in situ, adjacent to the future assemble spot.

Industrialized housing systems can be of low, medium or high degree of technology.

On line production is accepted as very efficient, mainly due to standardization and fast manufacturing with a minimum time.

Any industrialized building method is proved successful when it achieves the lowest number of components. This then becomes a key factor for time investment; Time to manufacture the components as well as time required to assemble them.

Simplicity is the name of the game.

All shapes of components and sizes are being fabricated for the market also an endless combination of joints

and materials are used.

Steel and reinforced concrete are basic materials used in the prefabrication of components, although the same materials are used on conventional types of architecture.

Steel has a linear characteristic while concrete has a plane characteristic.

Steel as a structural element is capable of becoming a beam, column or joist, found in the market as sheets or as angles, channels, tees, zees and rails. Steel rebars and cables once placed inside the concrete becomes the reinforcement of it.

Reinforcing concrete can be presented either as a structural component or as a non structural one. As a structural component it can be foundation, column, wall, beam, floor and roof; and also non structural, like partitions and parapets. Concrete is an extremely flexible material because of its own properties, capable of generating the infills.

The size and number of components gives the potential capacity for more or less flexibility on any building system.

For a better understanding of large or small components it is important to recognize the advantages and the disadvantages.

The same ones are not necessarily to be found on both sizes simultaneously. Large components have less connections or joints with fast assemblage, but lack flexibility in the arrangement requiring large and costly cranes.

Components that are small in size do not require heavy equipment for erection on one hand, and they allow high flexibility (multidirectional). On the other hand, small components have more joints, reduce the speed of erection and increase precision, requiring more tolerances.

description of the system proposed

All the goals and objectives defined from the beginning of the research to visualize an alternative, have been mentioned. They can be summarized thusly, the fewer number of components, the better.

The final solution responds well to the need, it arrives almost to one universal component, which once assembled, creates the walls, floors and roof for housing units.

The system is nothing but, and only, a cold formed steel section used as formwork functioning also as structure with concrete infill. these two elements once together become a load bearing wall panel.

Because of the interaction of elements the system is called a composite one.

Incorporation of steel, not only reinforces but also serves as the definitive frame for the concrete panel.

The marriage of both materials was the answer to the advantages, of them individually. Needless to say that the performance of one is enhanced by the other and viceversa.

This concept is believed valuable if the potencial for assembling is realized.

Concrete panels with this new metal edge can be connected easily during erection, minimizing tolerances and offering a clean dry joint.

Two concrete panels facing each other make the walls for the building.

Nuts and bolts as fastening elements are adopted because they are fast, inexpensive and a minimum technology.

The size of the panel was established after physical space requirements were met. The size was also developed remembering human force as a possible substitute for heavy

equipment.

If in the factory, during the manufacturing of the concrete panels, a metal joist is embedded on the concrete, the result will be the floor and roof components.

It is interesting to observe how this particular system, using the basic concrete panel and little variation, can configure all the components needed to enclose a space. Also it provides all the necessary tissue for housing projects.

This new system saves material, which makes the component lighter. It allows total flexibility and complete adaptability. The design has been simplified to a maximum but keeps structural stability.

The total time investment from production line to the final assembling is shortened.

And last but not least it provides a permanent quality shelter.

illustrations

- 13 Basic wall panel B.W.P., structural component
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basic wall panel

B.W.P.

Physical and structural properties.

Dimensions: Depth 6 cm.
 Length 300 cm.
 Width 120 cm.

Net area: 3.6 mts²

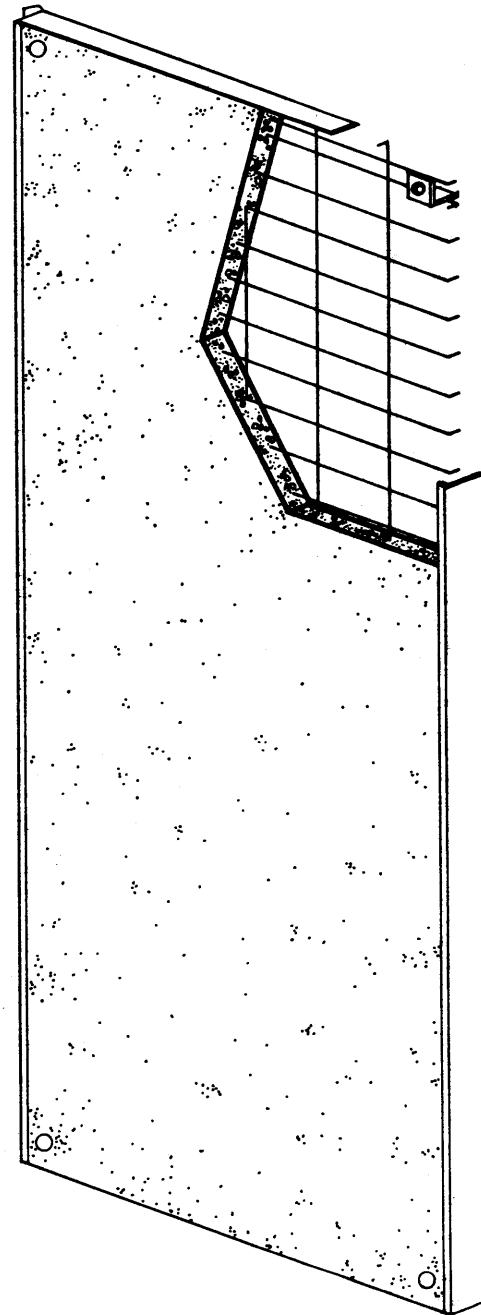
Composition: Concrete.
 Normal or lighth weight
 Steel. Cold formed
 L section 0.01 cm.
 Reinforcing bars.
 Rods ϕ $\frac{1}{2}$; $\frac{3}{4}$
 Steel plate $1\frac{1}{2}$ x $2\frac{1}{2}$ x $\frac{3}{16}$

Finish product:
 All different exterior and interior
 concrete textures.
 All colors, with concrete pigments.
 Paint.

Description of the wall panel.

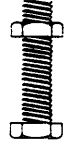
It is factory produced and transported to the site.
Two (B.W.P.), facing each other and joint together make a 15 cm. structural sandwich; It becomes a load bearing wall.
There are different gap possibilities between the two (B.W.P.), according to requirements.
The panels are assembled in situ.

They are conected while erection with special conectors, and fastened using nuts and bolts.



floor panel

15



Physical and structural properties.

Dimensions: Depth 6 cm.
 26 cm. with joist incorporated
 Length 300 cm. minimum
 600 cm. maximum
 Width 120 cm.

Net area: 3.6 mts.²; 4.32 mts.²; 5.76 mts.²; 7.2 mts.².

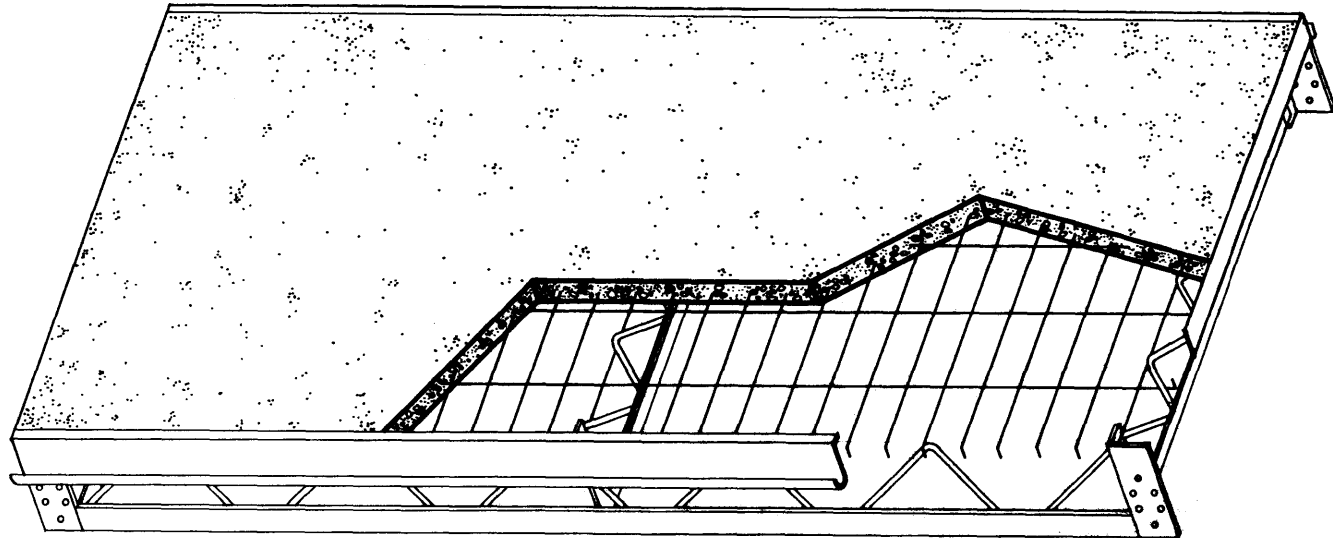
Composition: Concrete.
 Normal or lighth weight
 Steel. Cold formed
 L section 0.01 cm.
 Reinforcing bars.
 Rods 0 4/8; 5/8
 Steel joist 4
 Steel angle 6 x 4 x 4

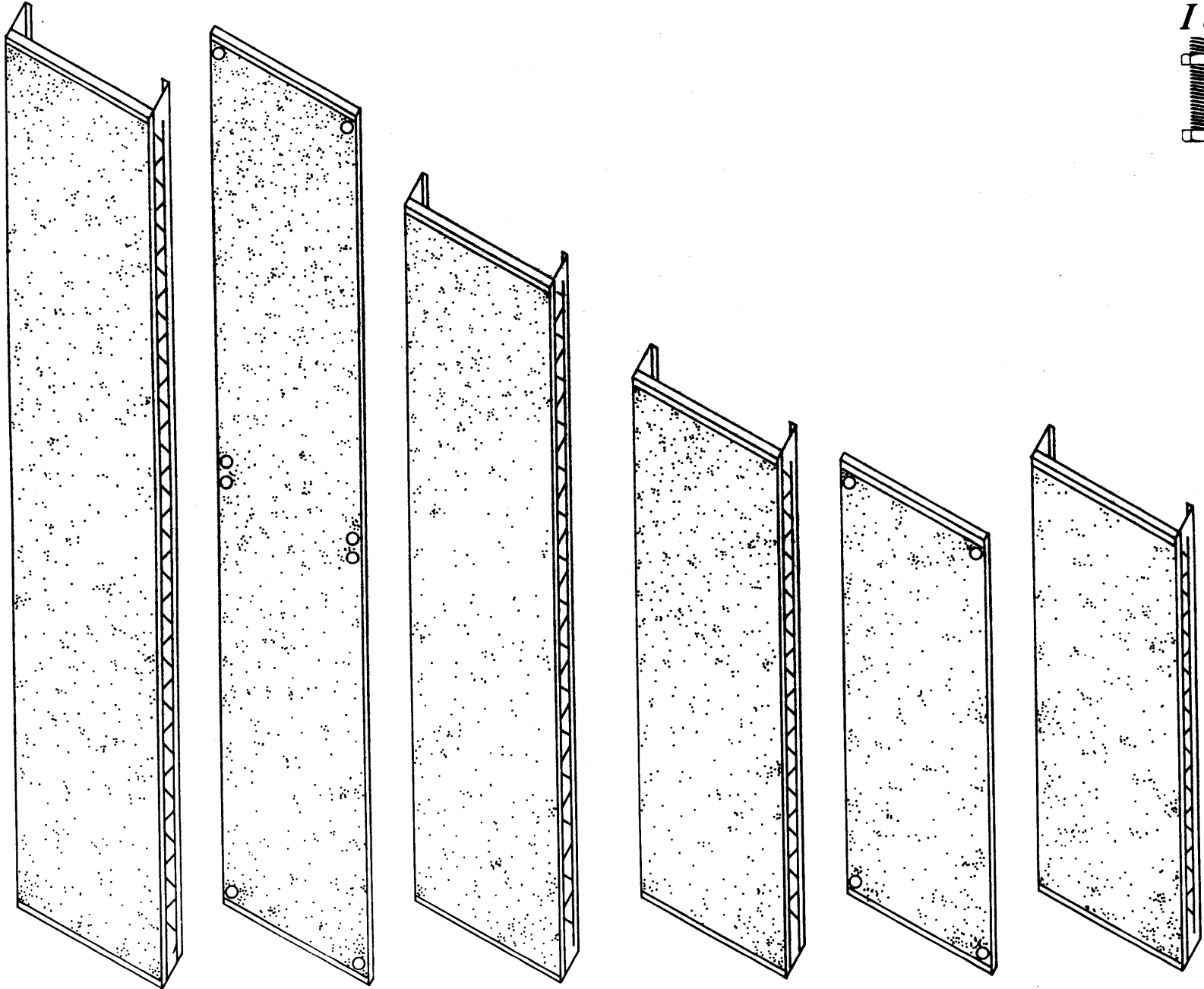
Finish product: All different floor coverings.
 Vinyl and carpet.

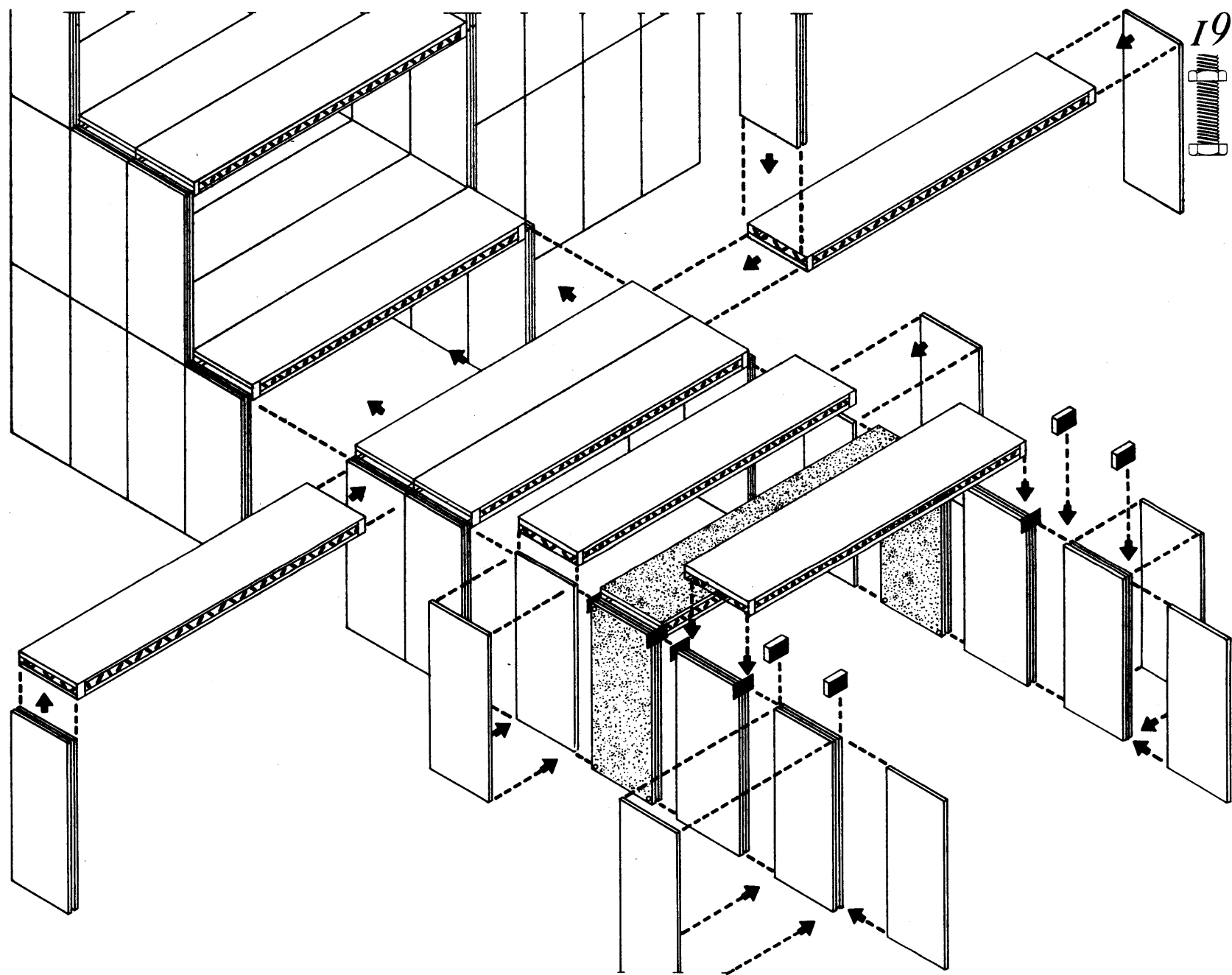
Description of the floor panel.

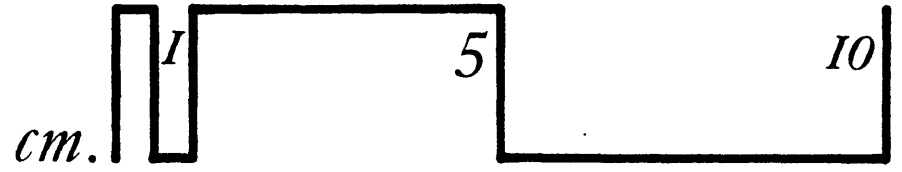
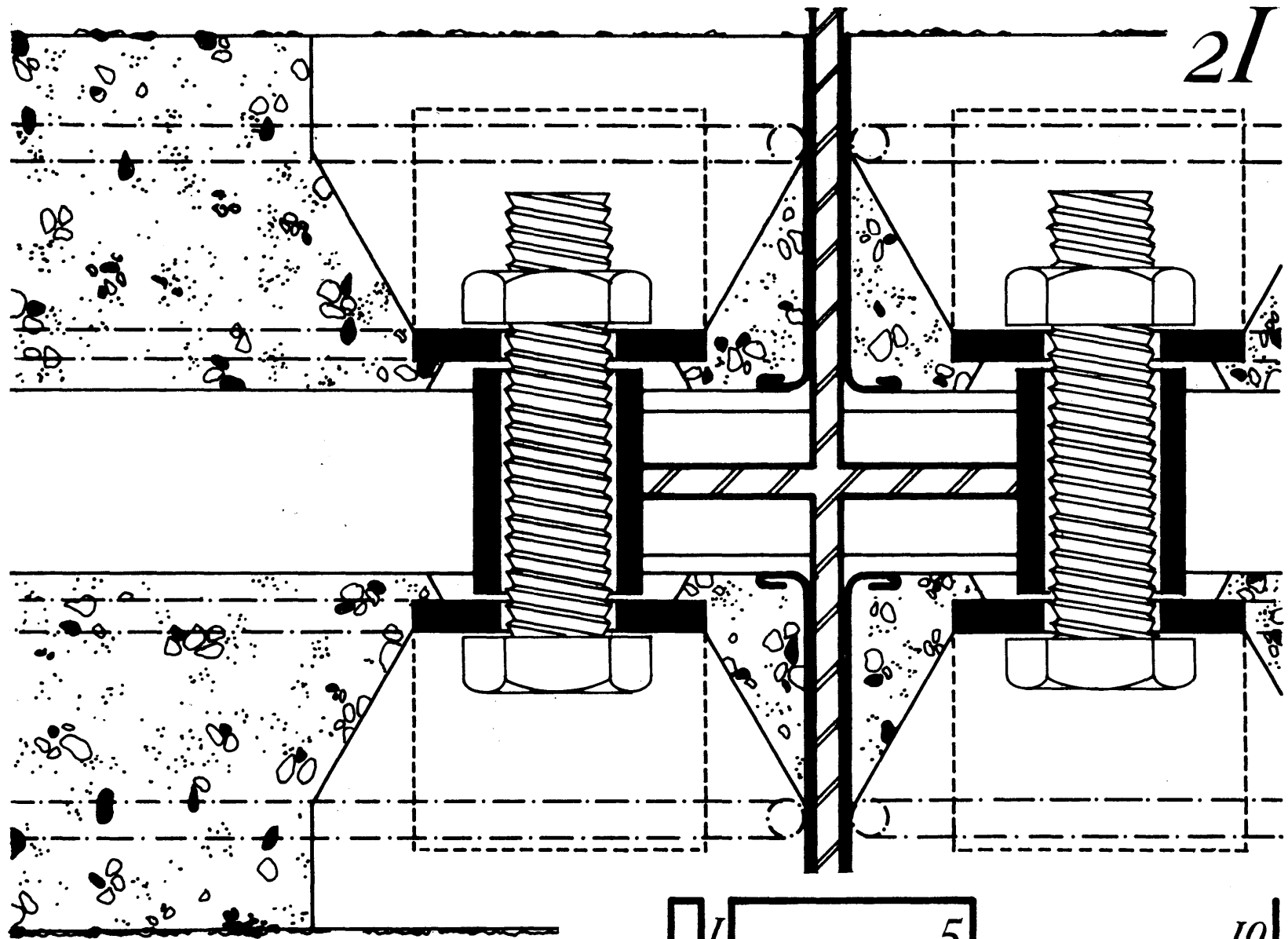
It is factory produced and transported to the site.
Same floor connectors are used to connect them simultaneously to the wall panels.
The panel accept perforations at any place. All floor panels are assembled in situ and fastened with nuts and bolts.

The same (B.W.P.) is used to manufacture The floor panel. It is the (B.W.P.) with a joist embedded in the concrete.

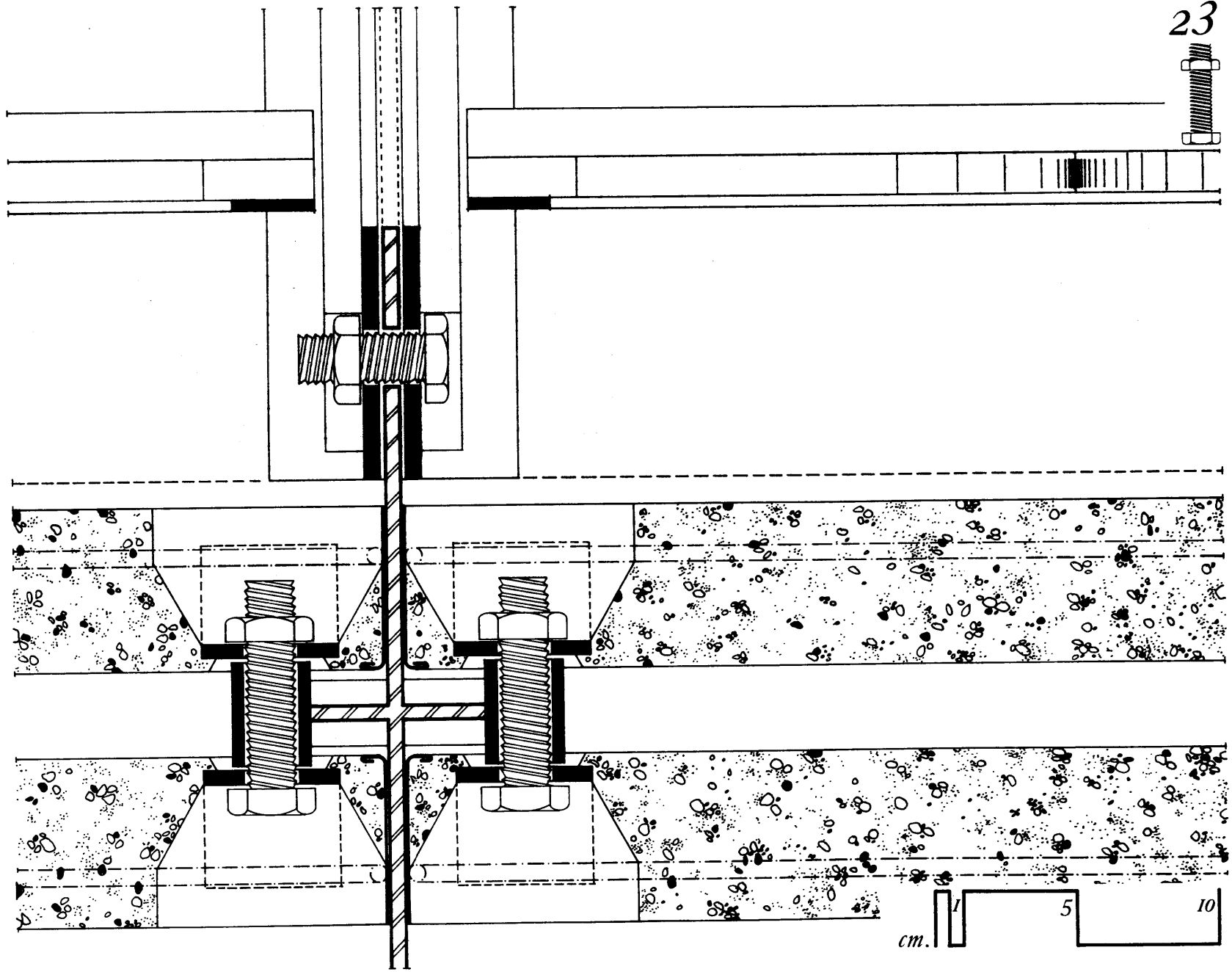






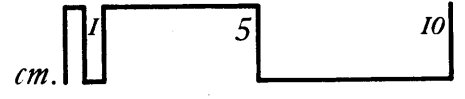
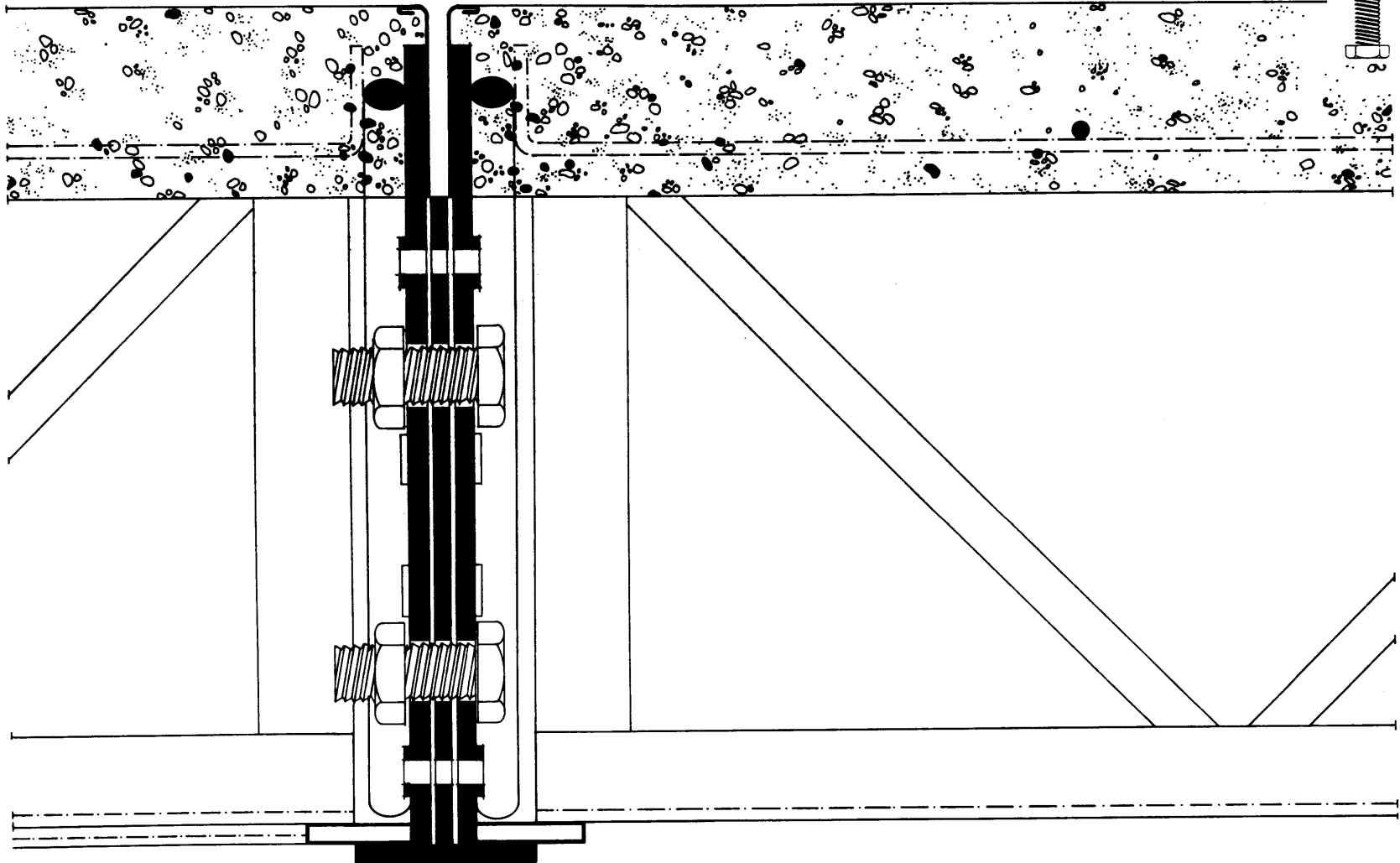


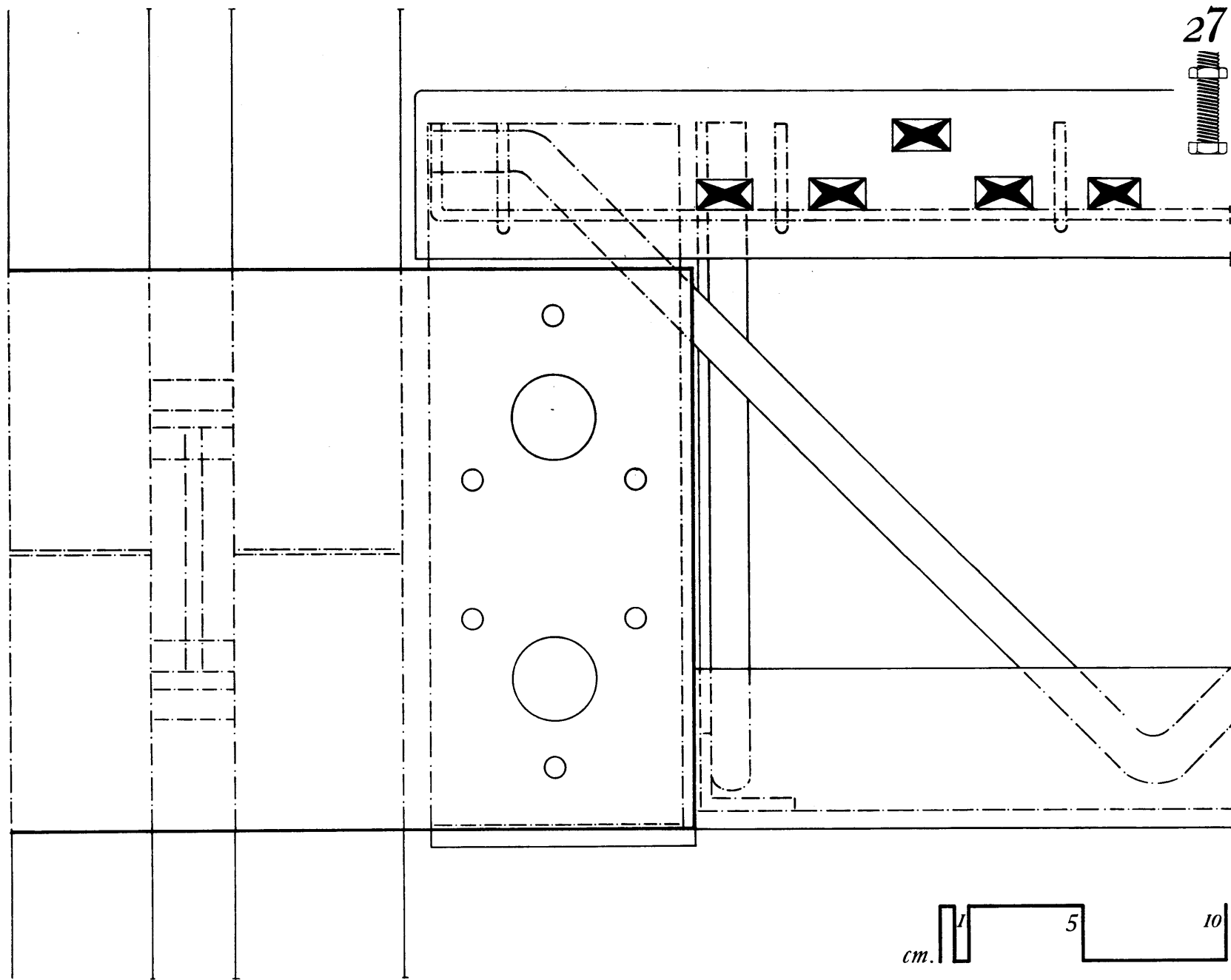
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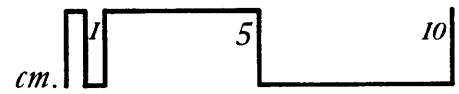
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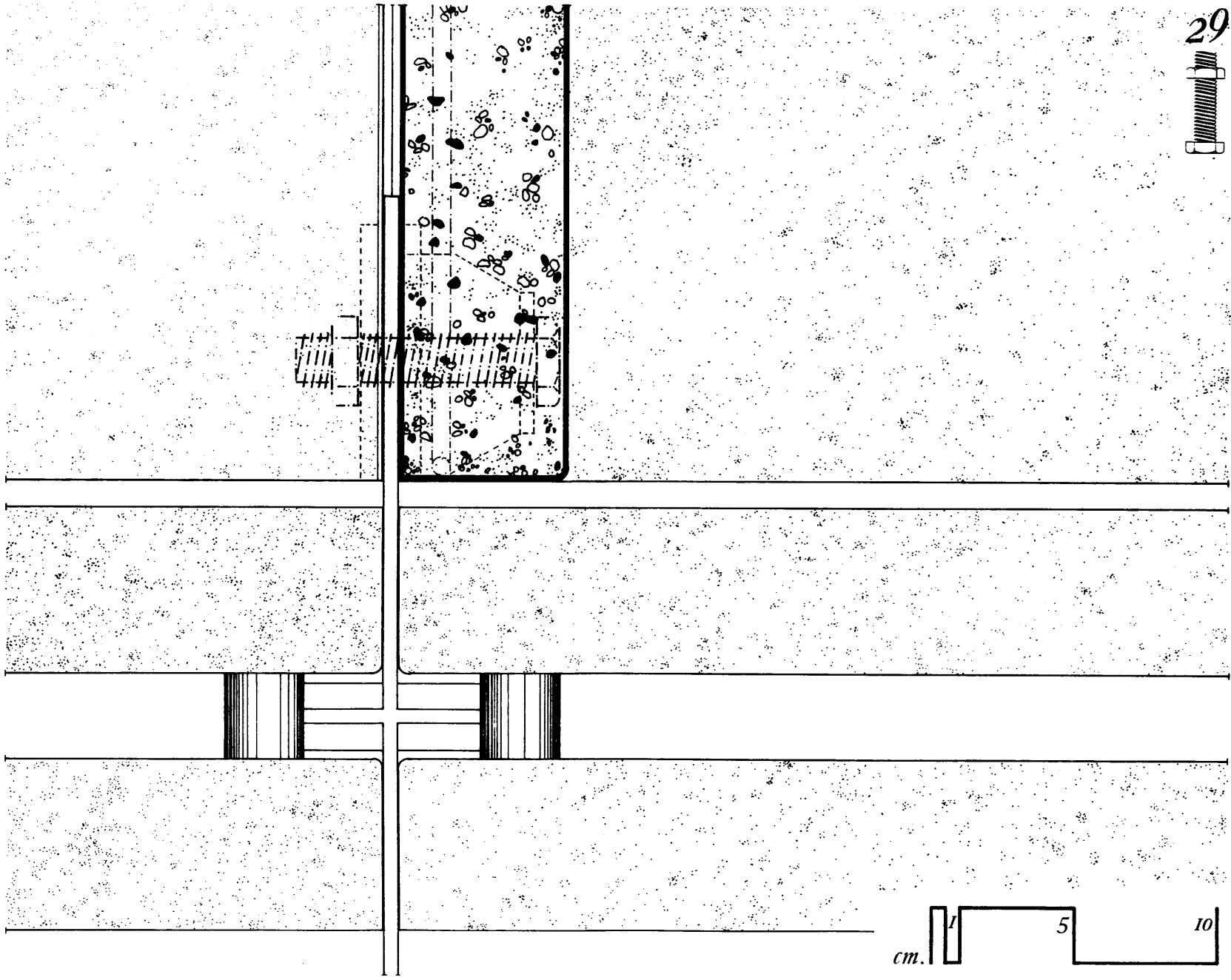
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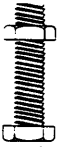


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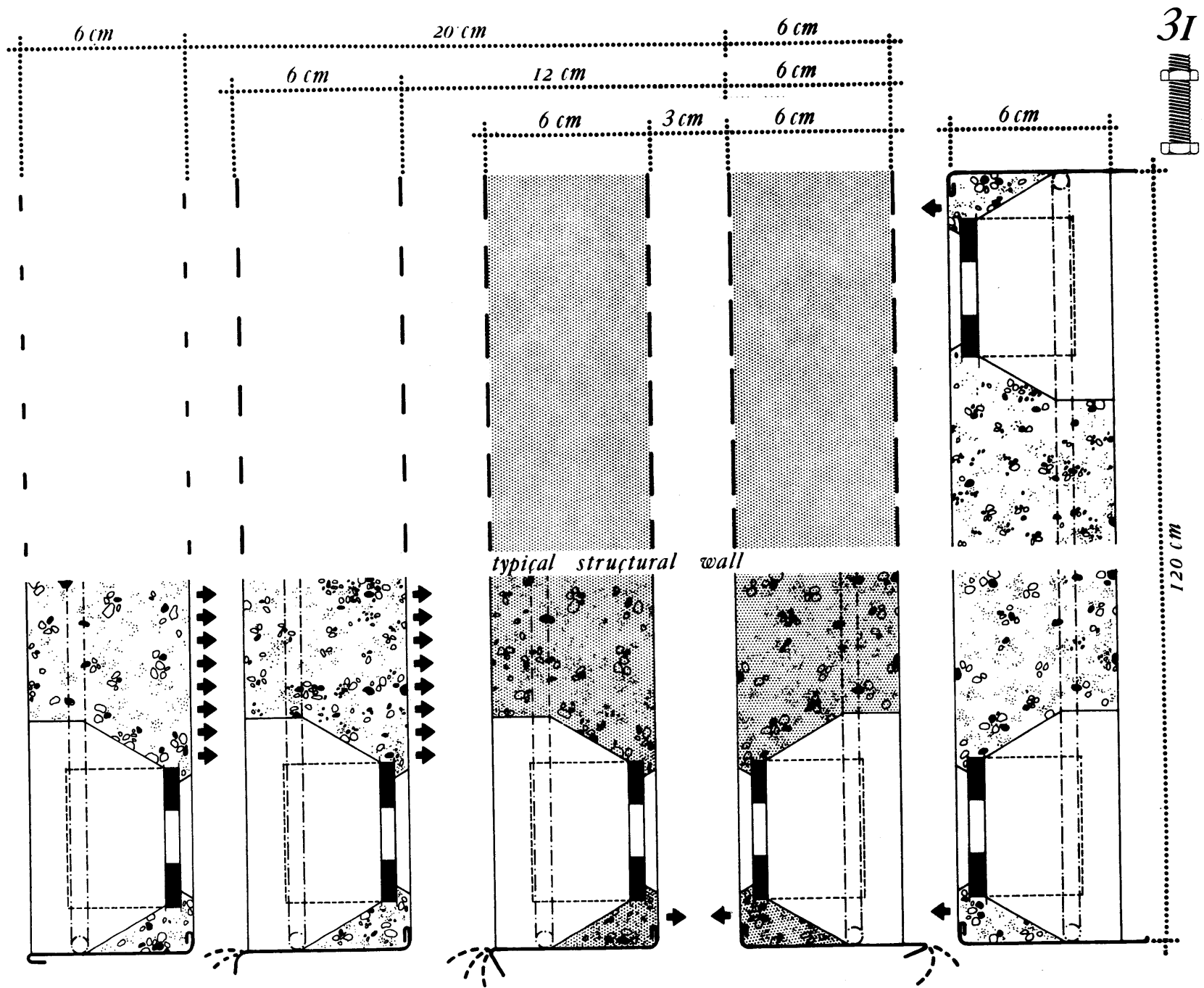


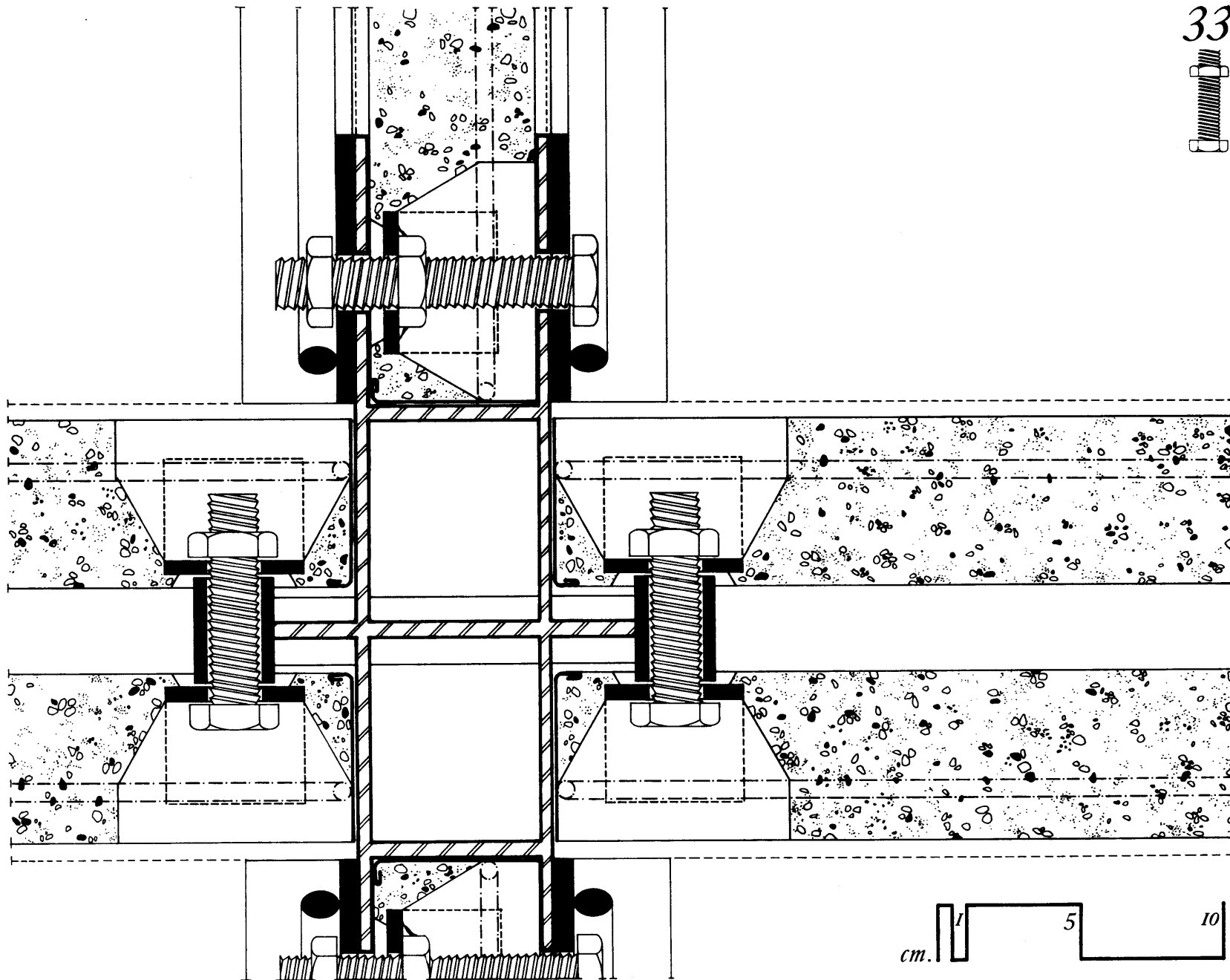
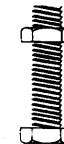


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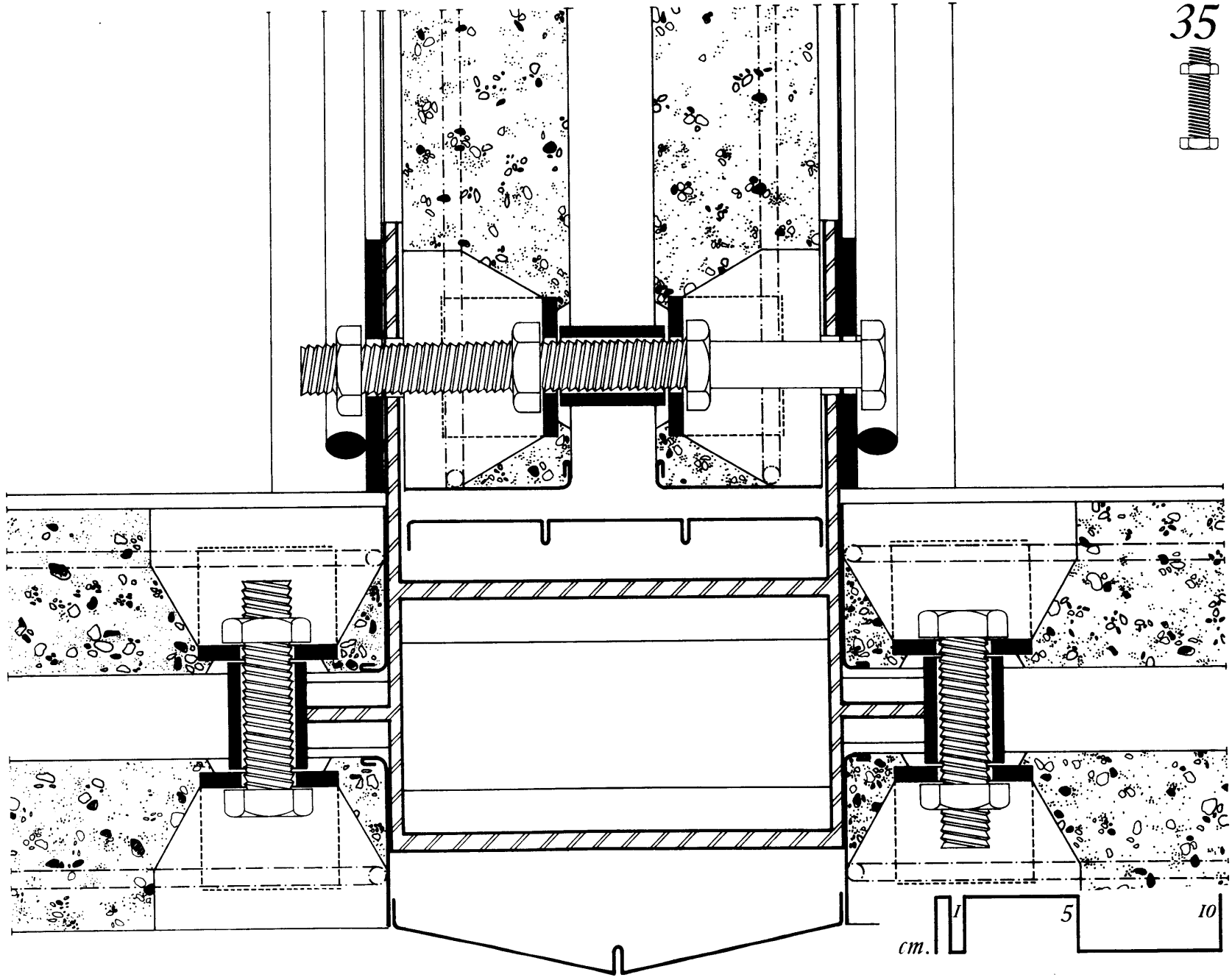
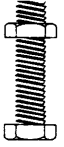
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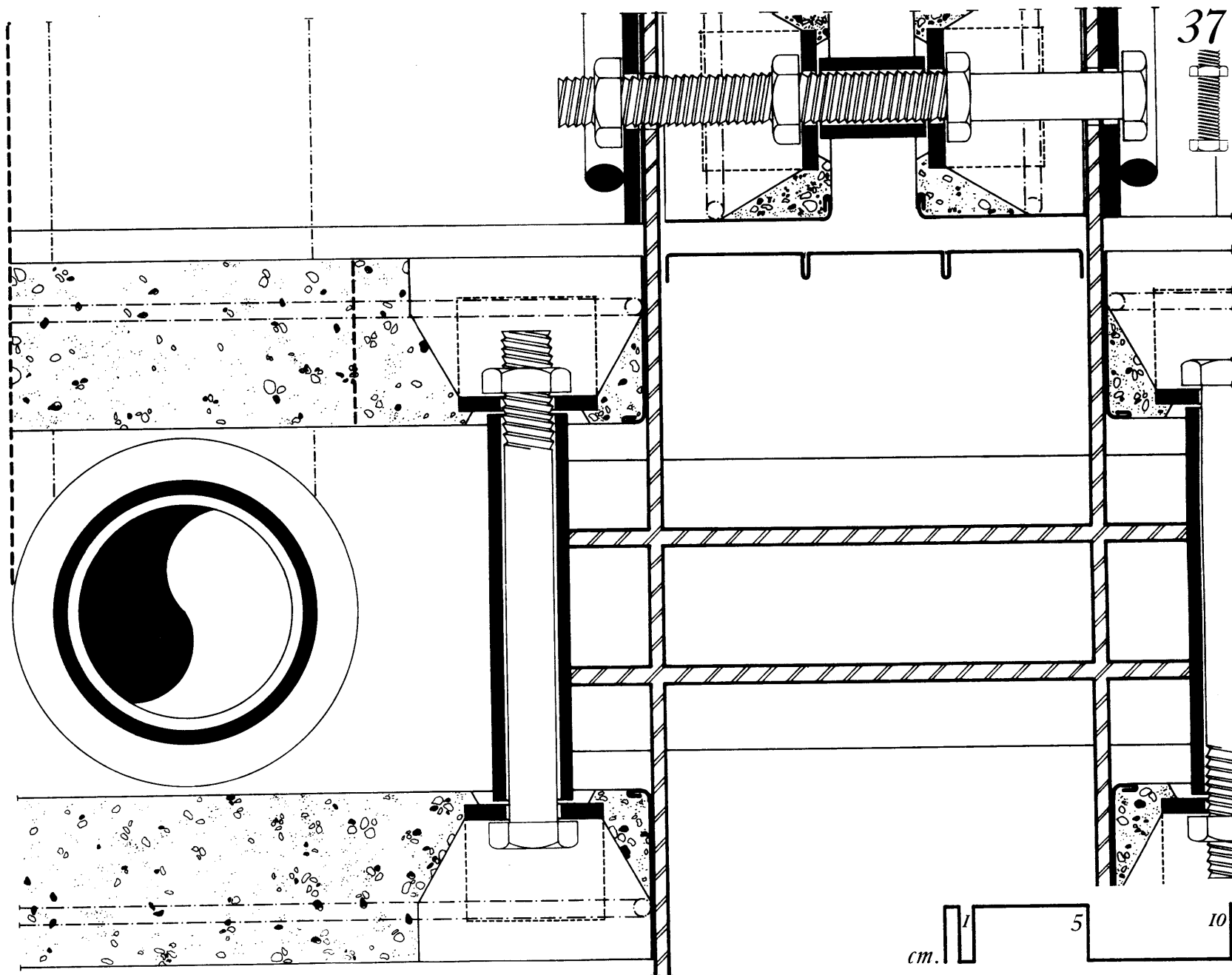




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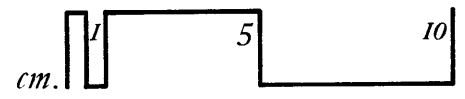
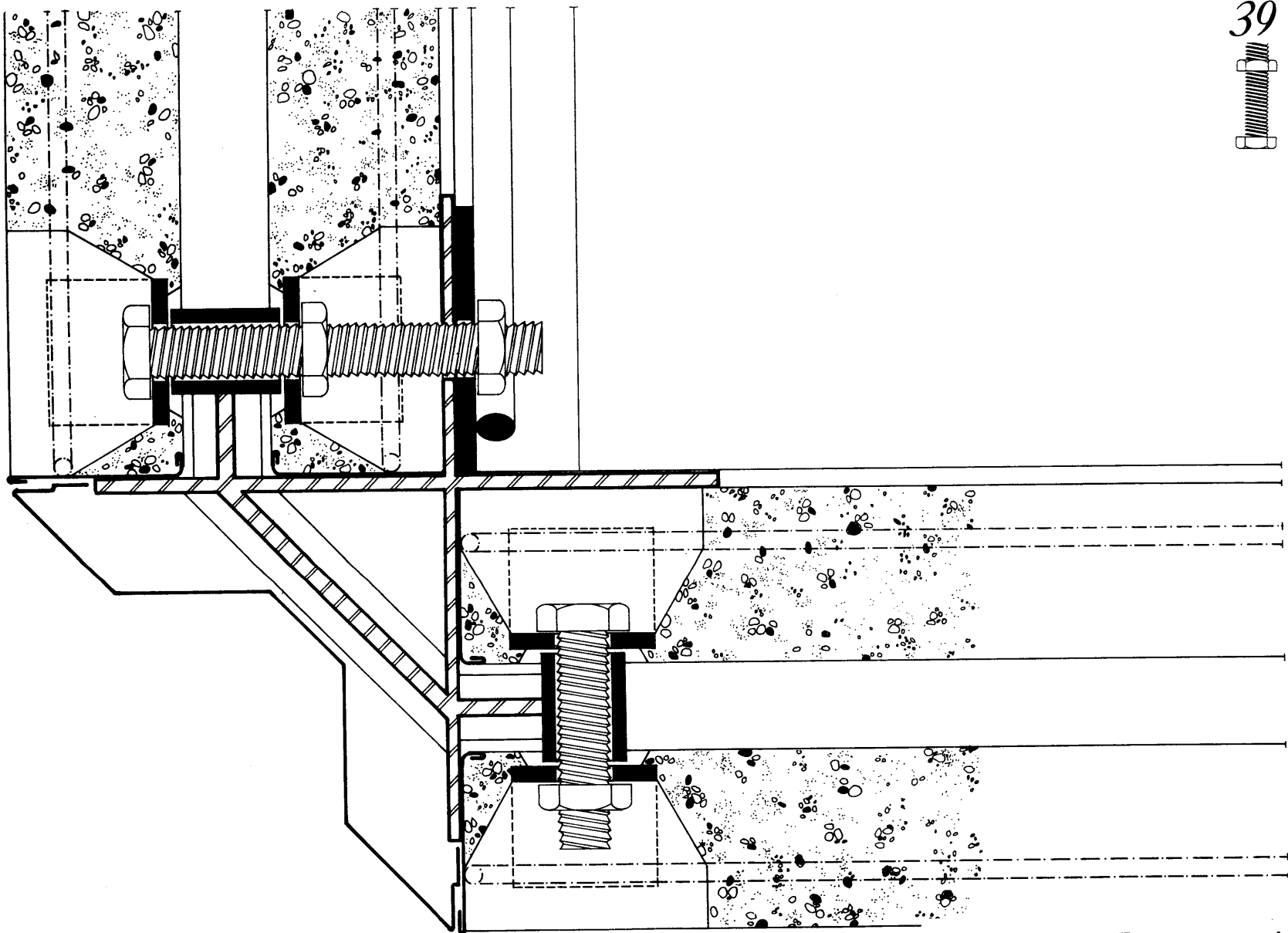
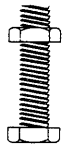


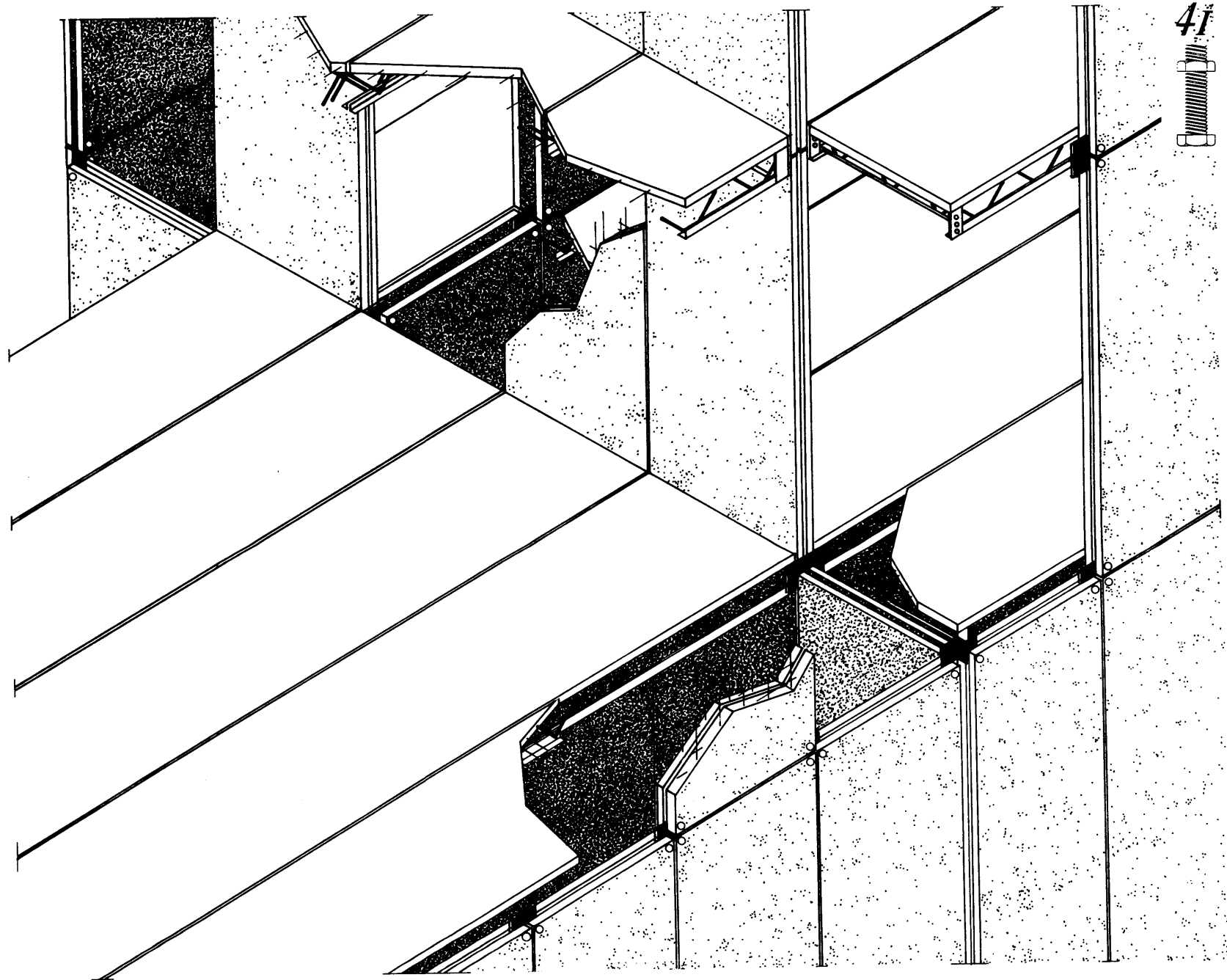


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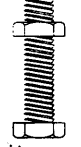
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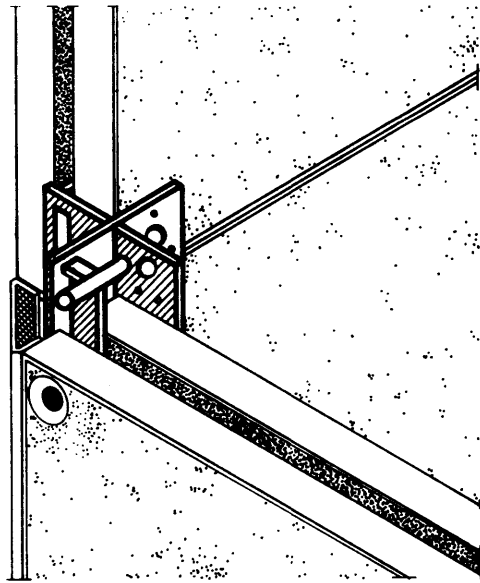




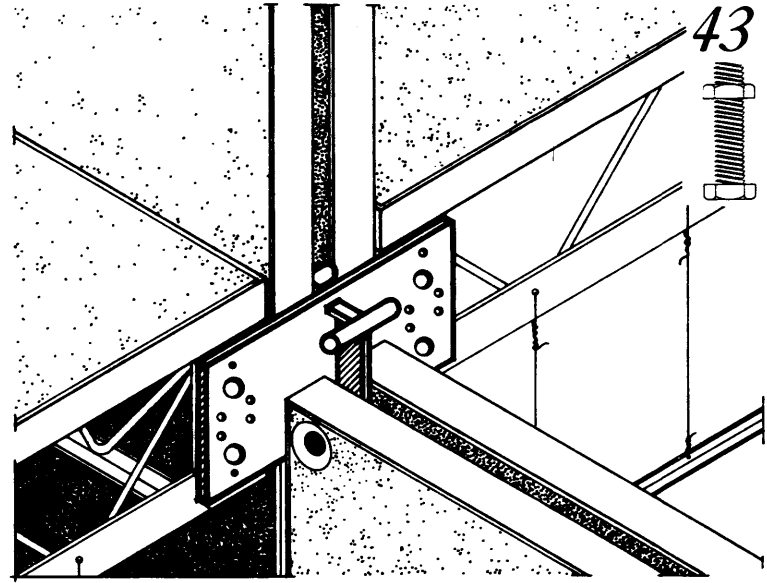
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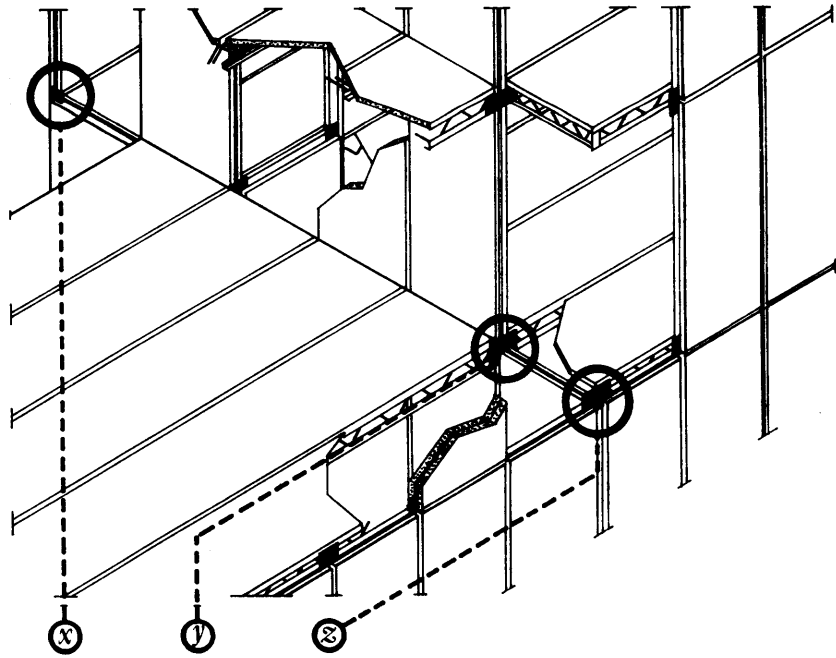
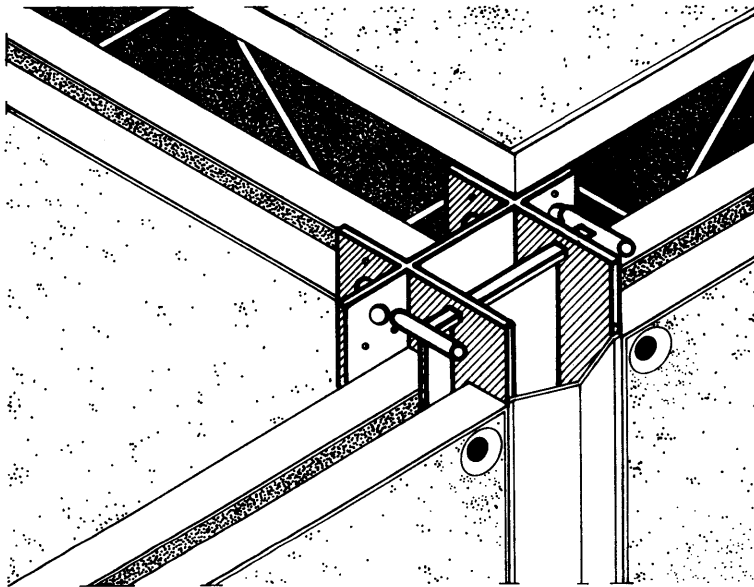
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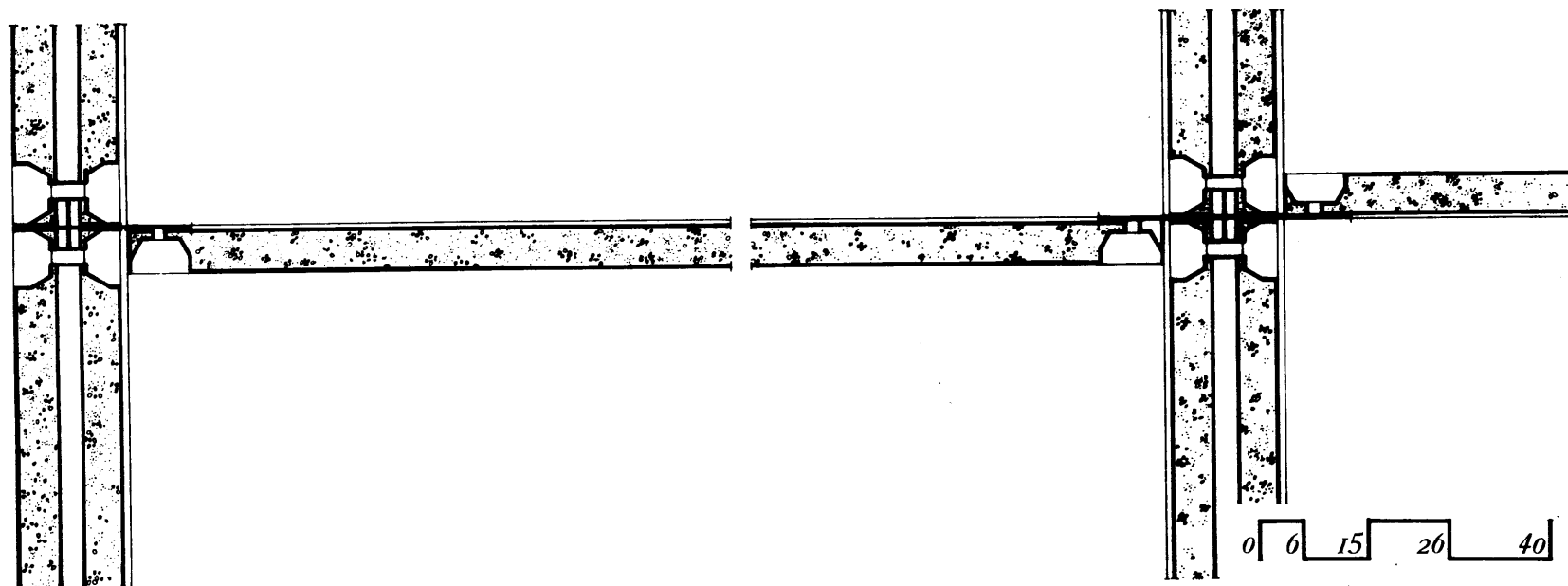
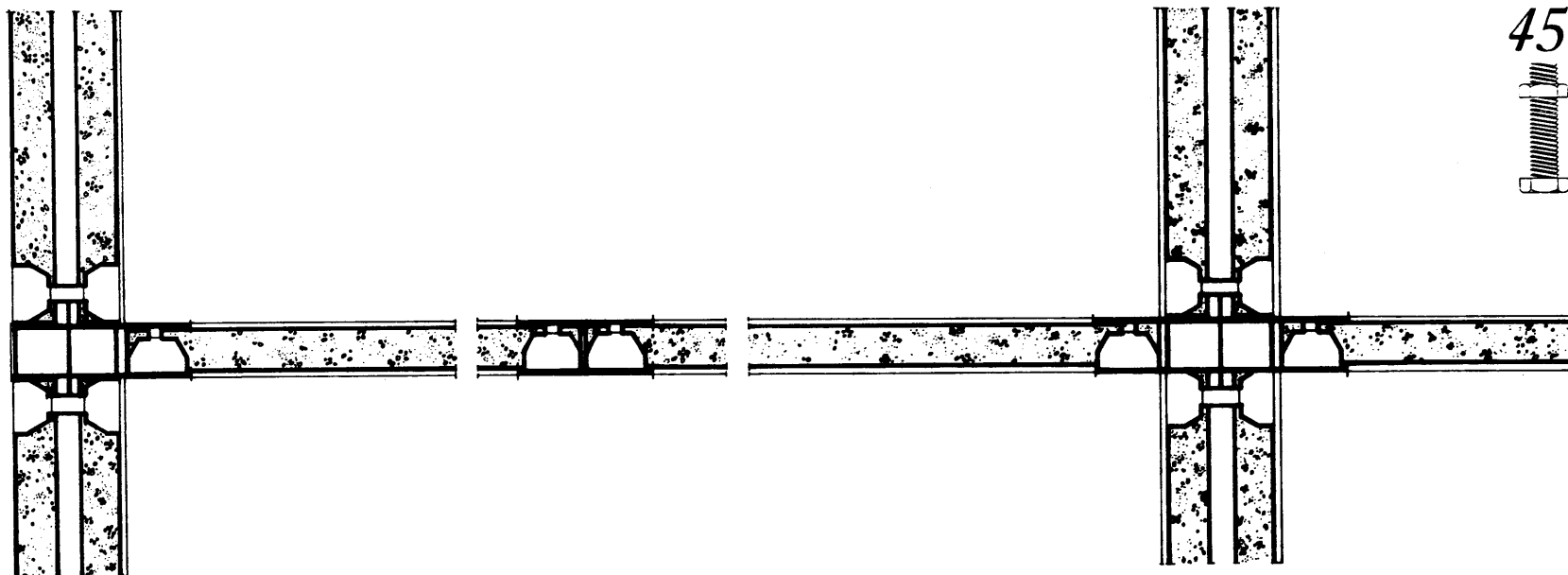
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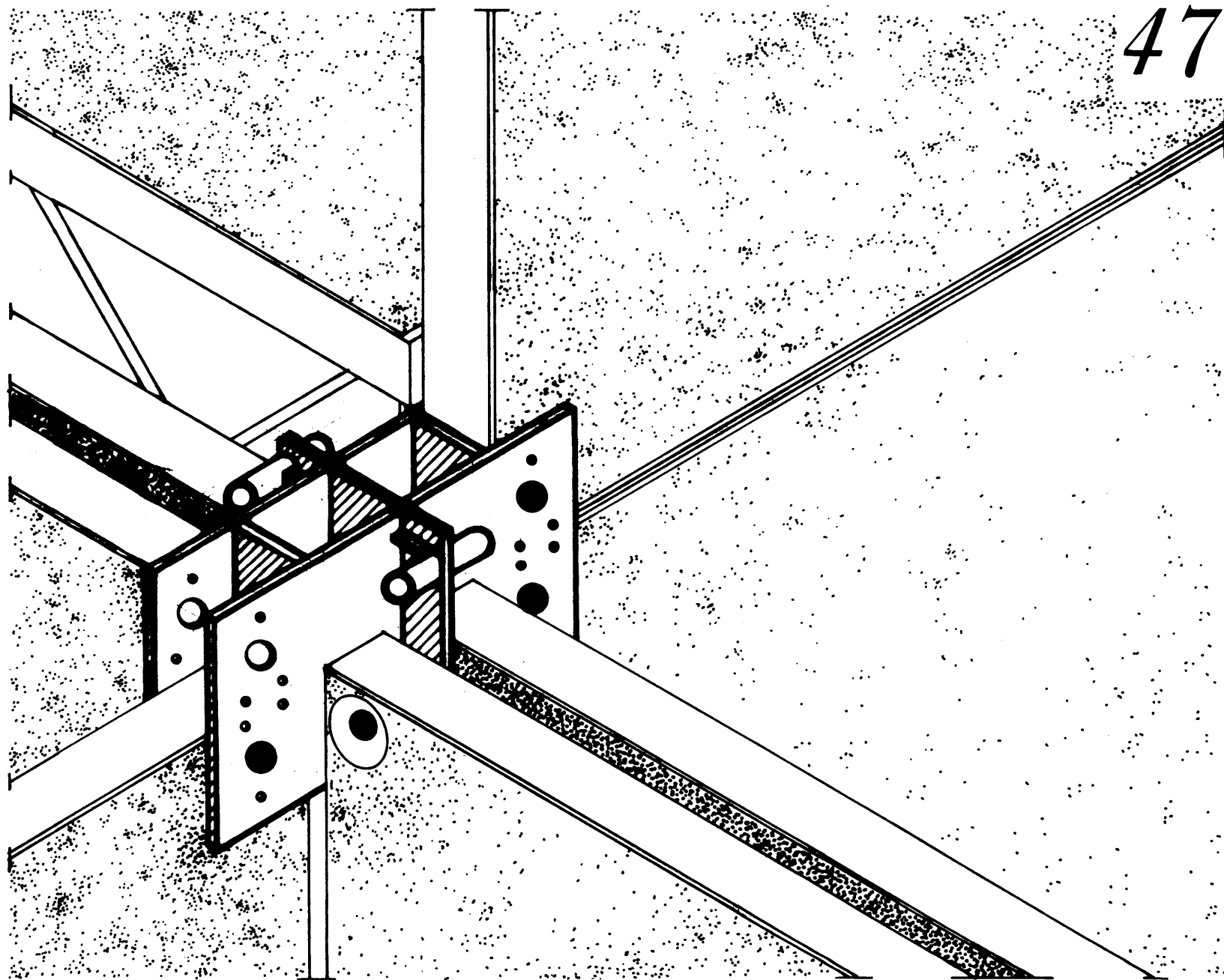
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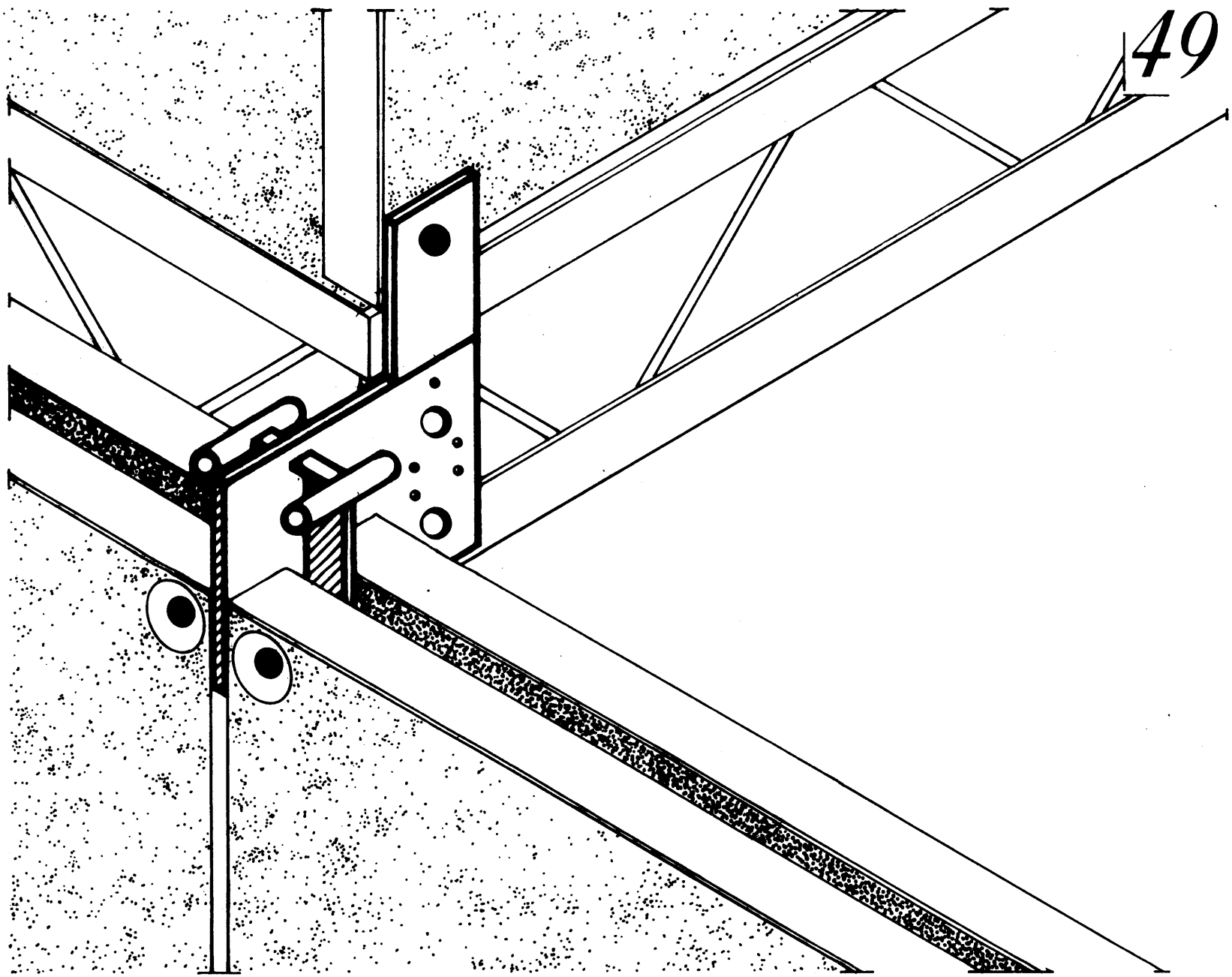


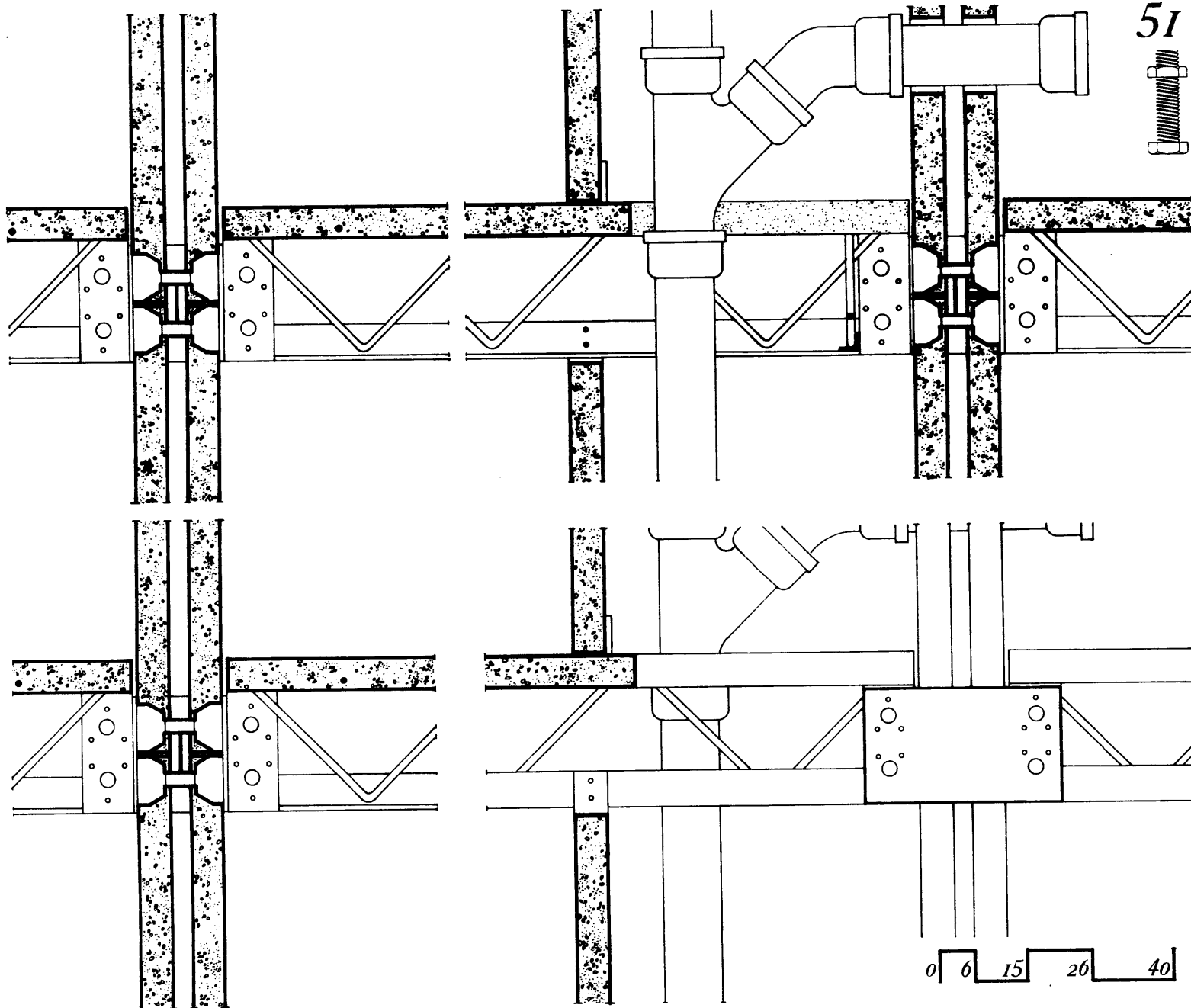
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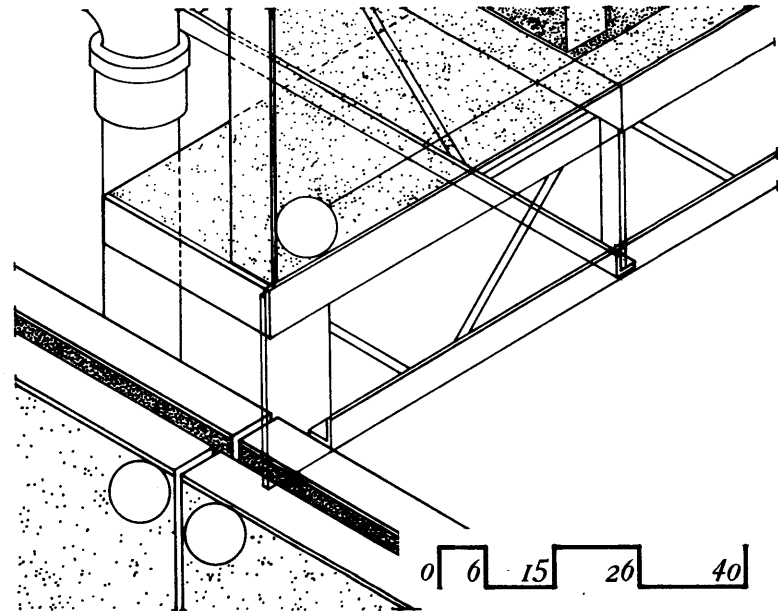
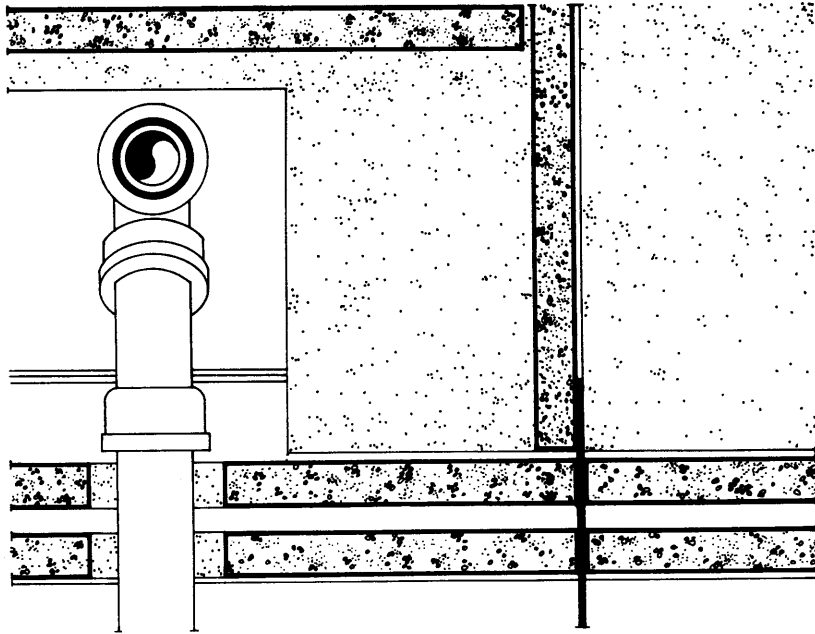
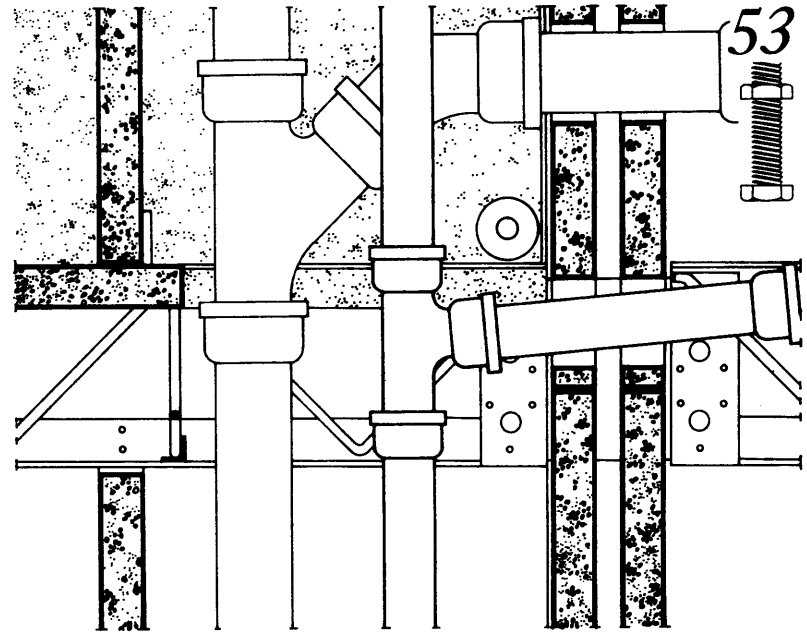
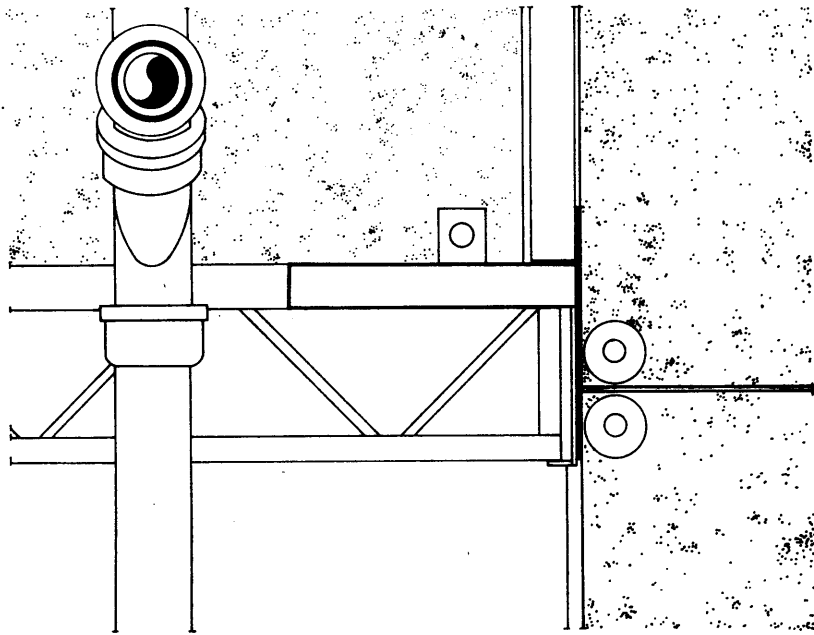


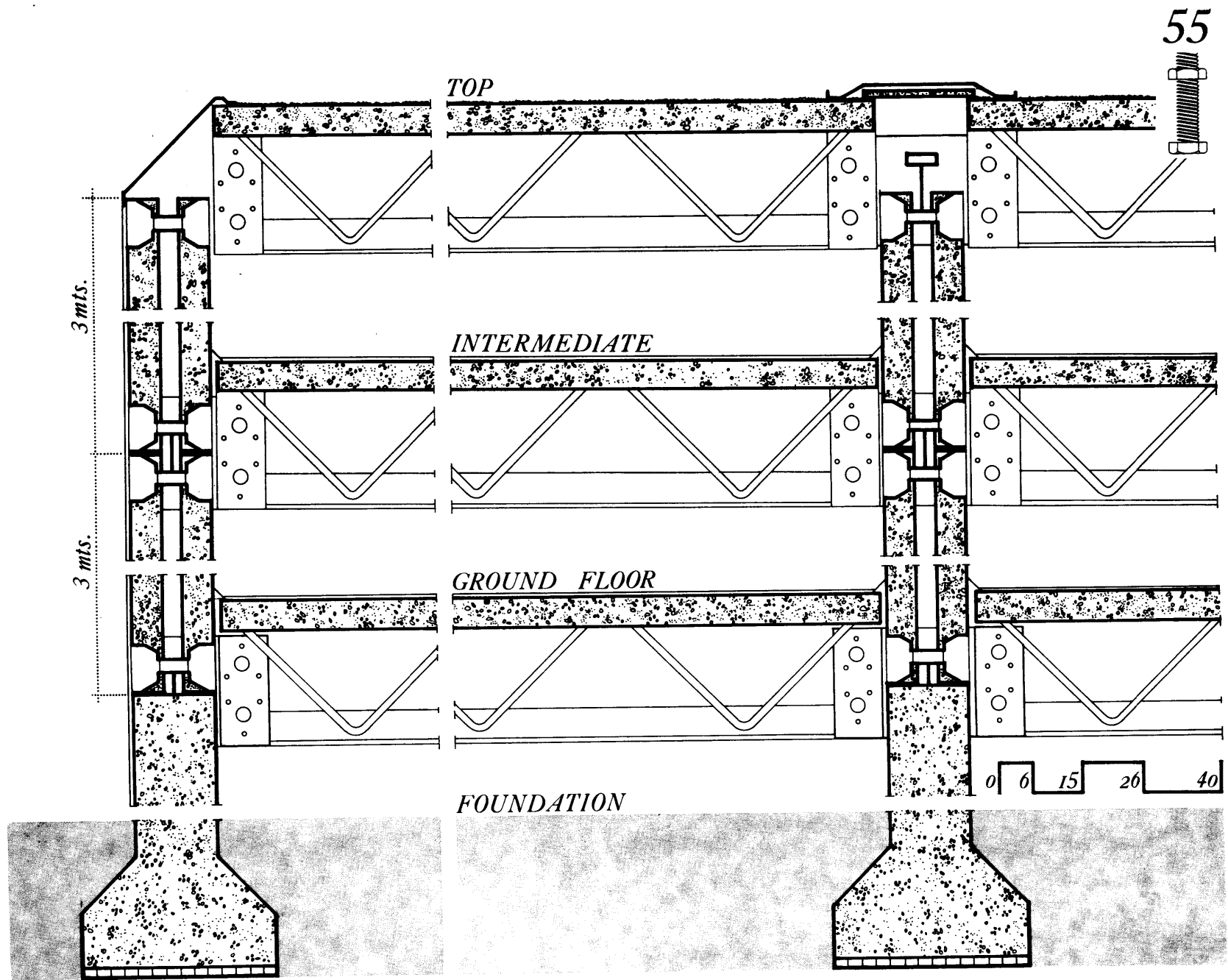
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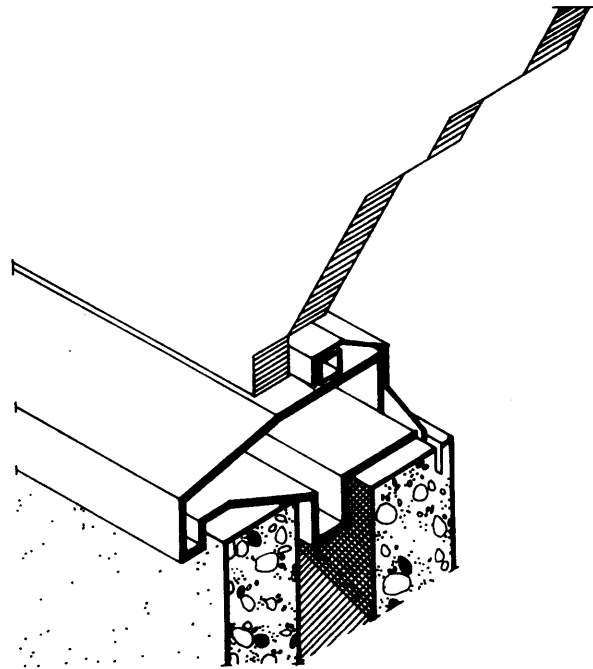
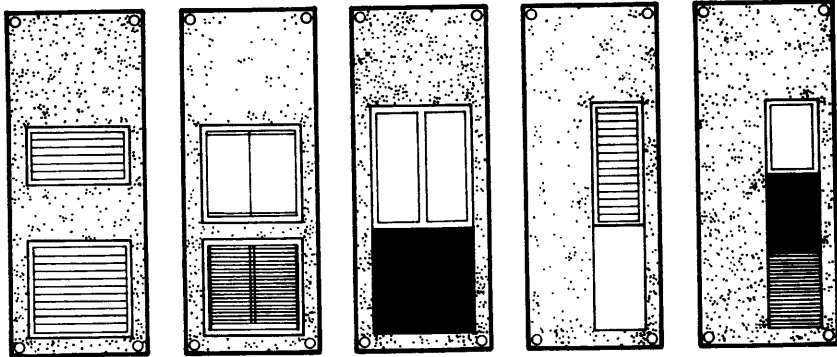
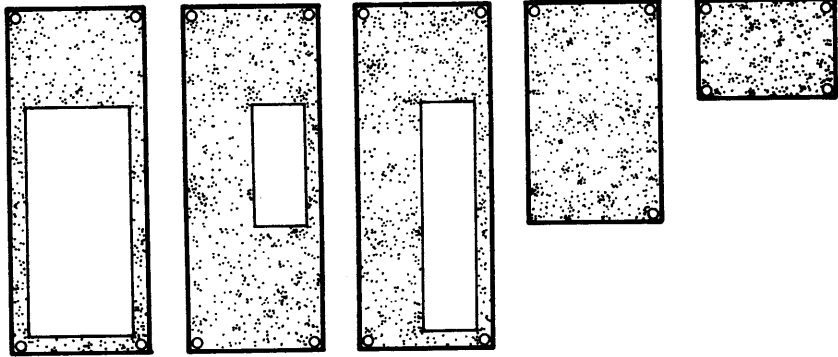
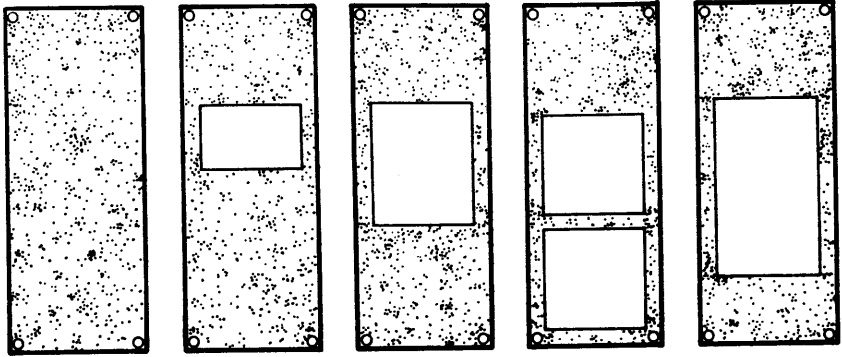


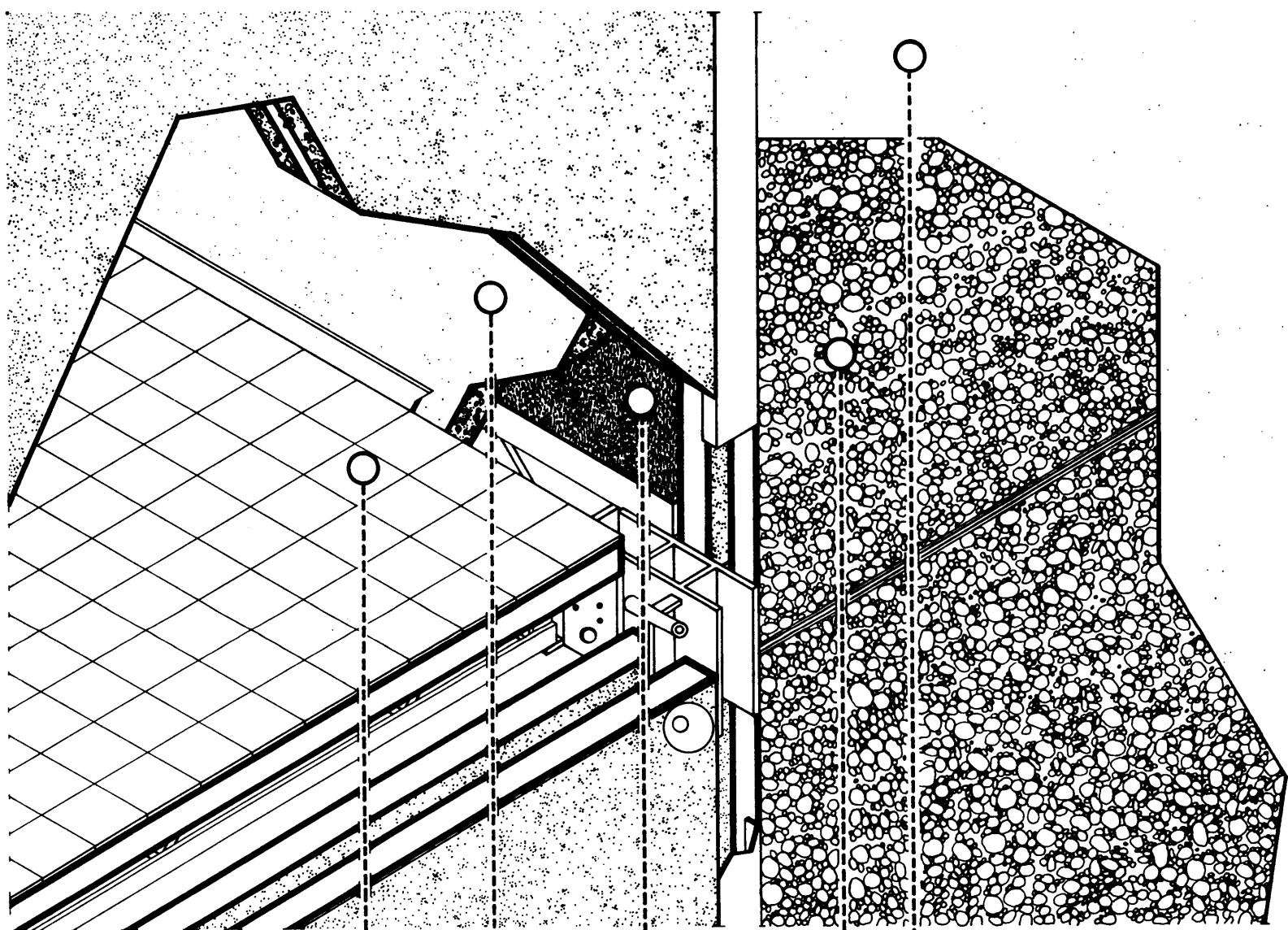






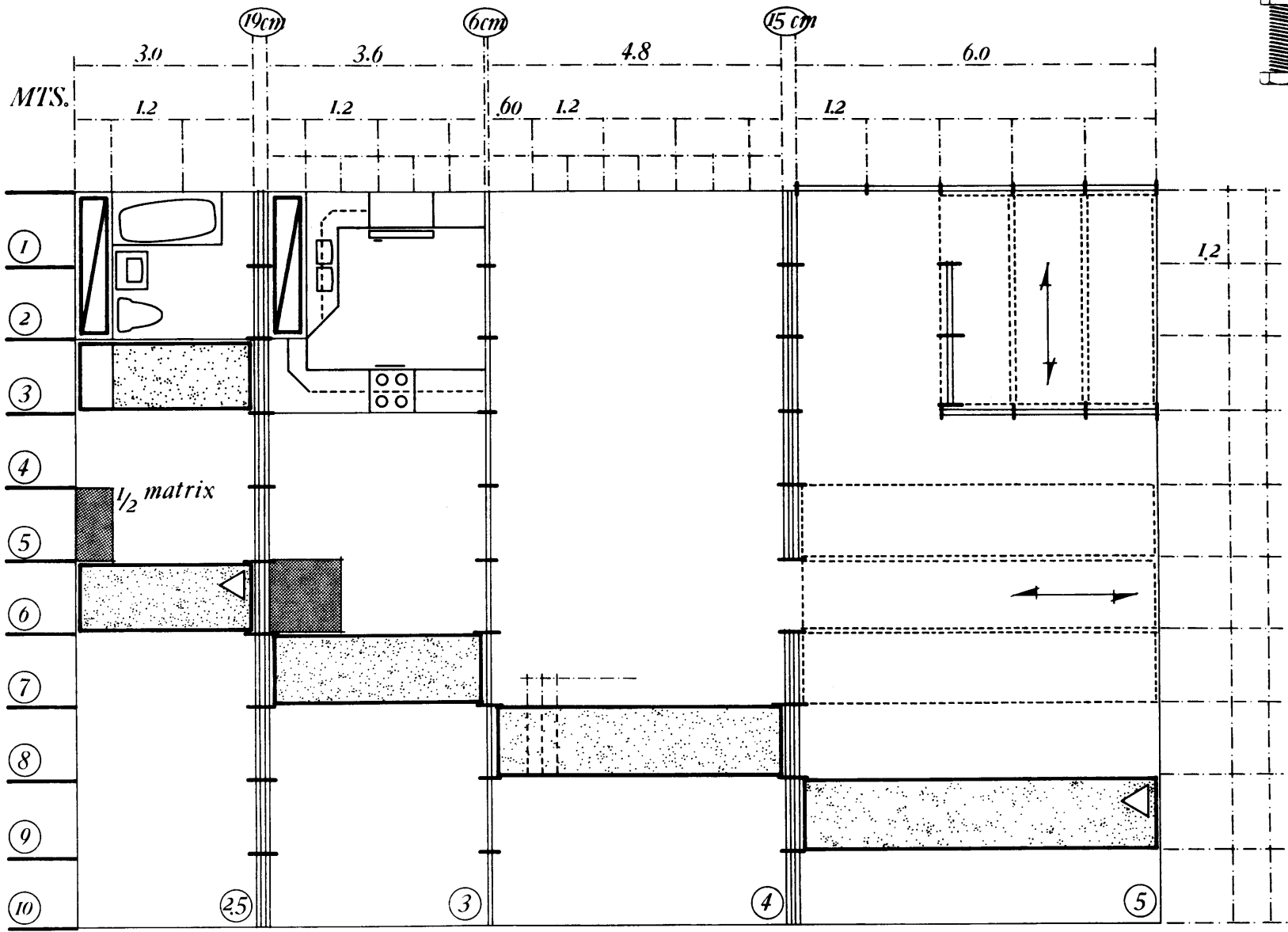






vinyl tiles
interior smooth finish

carpet
fine aggregate finish
exterior concrete



◁ floor & wall Panel