

**FORM
& TEKNIK**



**KONSTRUKTIONS
LÄRA**



Kursutvärdering

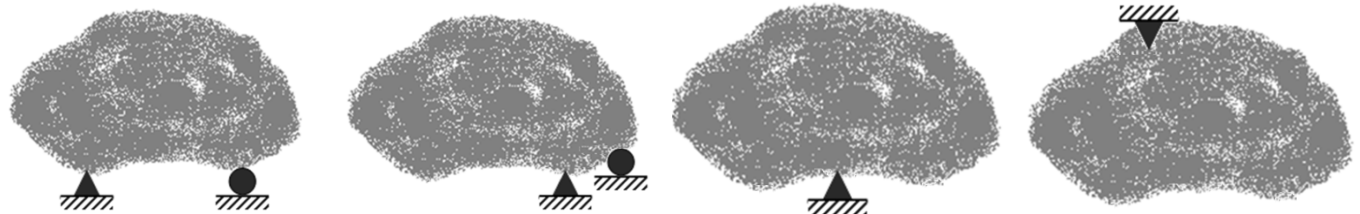
Vid kursstart	Kursnämndsrepresentanter bestäms Kursutvärderingens upplägg går igenom
Onsdag 10/2	Allmän avstämning kring genomförande och arbetsklimat
Torsdag 4/3	Utformning av kursenkät
Fredag 19/3	Gemensamt kurssamtal
Vecka 14-17 alt. September	Avslutande kursnämnd

STRUKTURERS GRAMMATIK

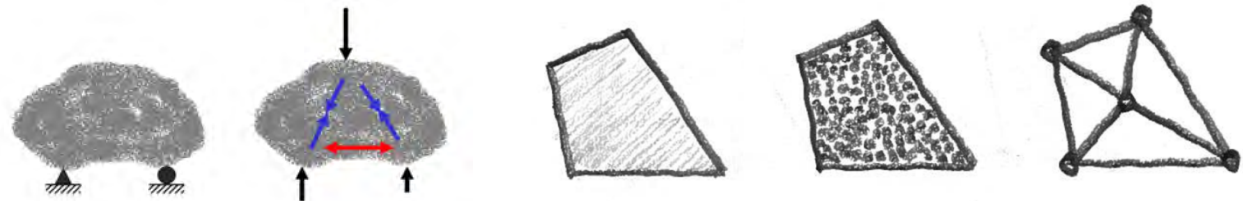
MÄNNISKA
gravitationen
som livsmiljö



MATERIELL
KROPP
balans
stabilitet
rörelse



STRUKTUR
topologi
inre stabilitet
kraftmönster
effektivitet

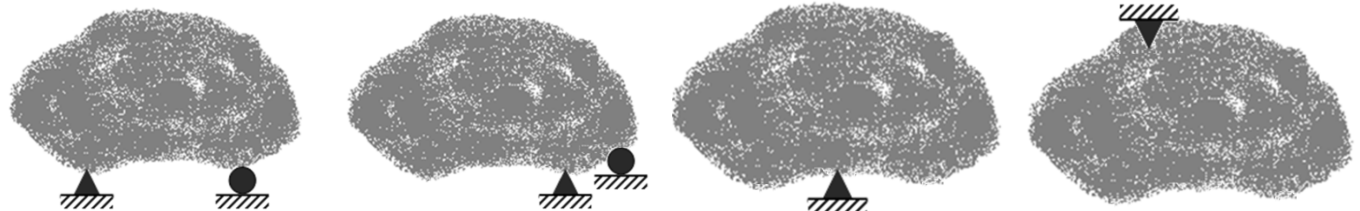


STRUKTURERS GRAMMATIK

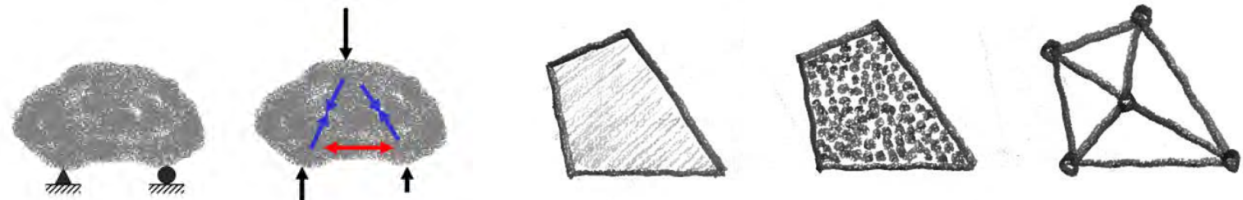
MÄNNISKA
gravitationen
som livsmiljö

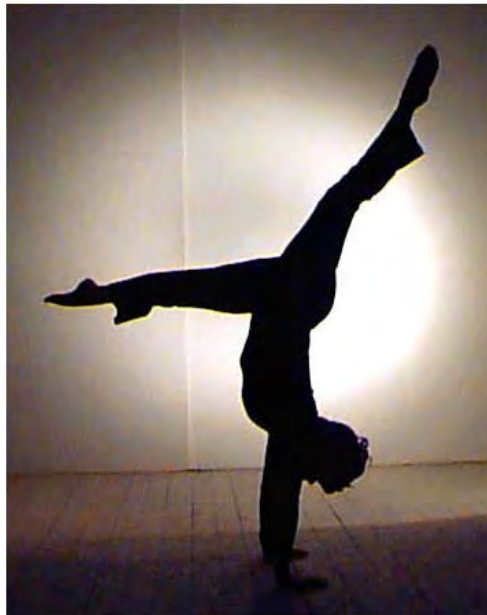


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effektivitet





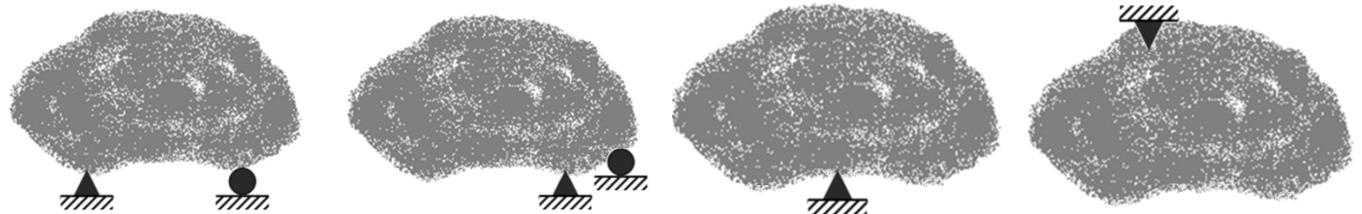
Kraft
att i balans bära
ett helt liv

STRUKTURERS GRAMMATIK

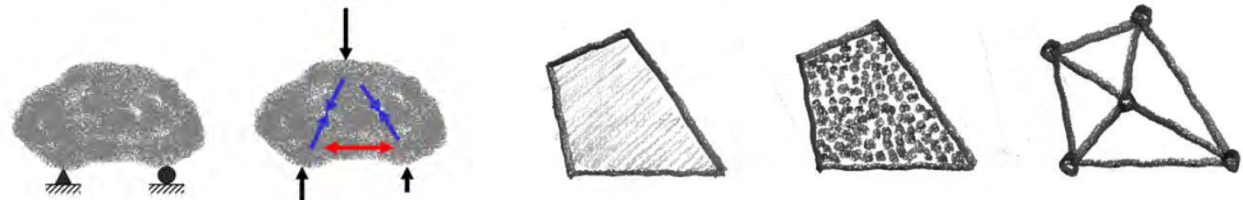
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gravitationen
som livsmiljö

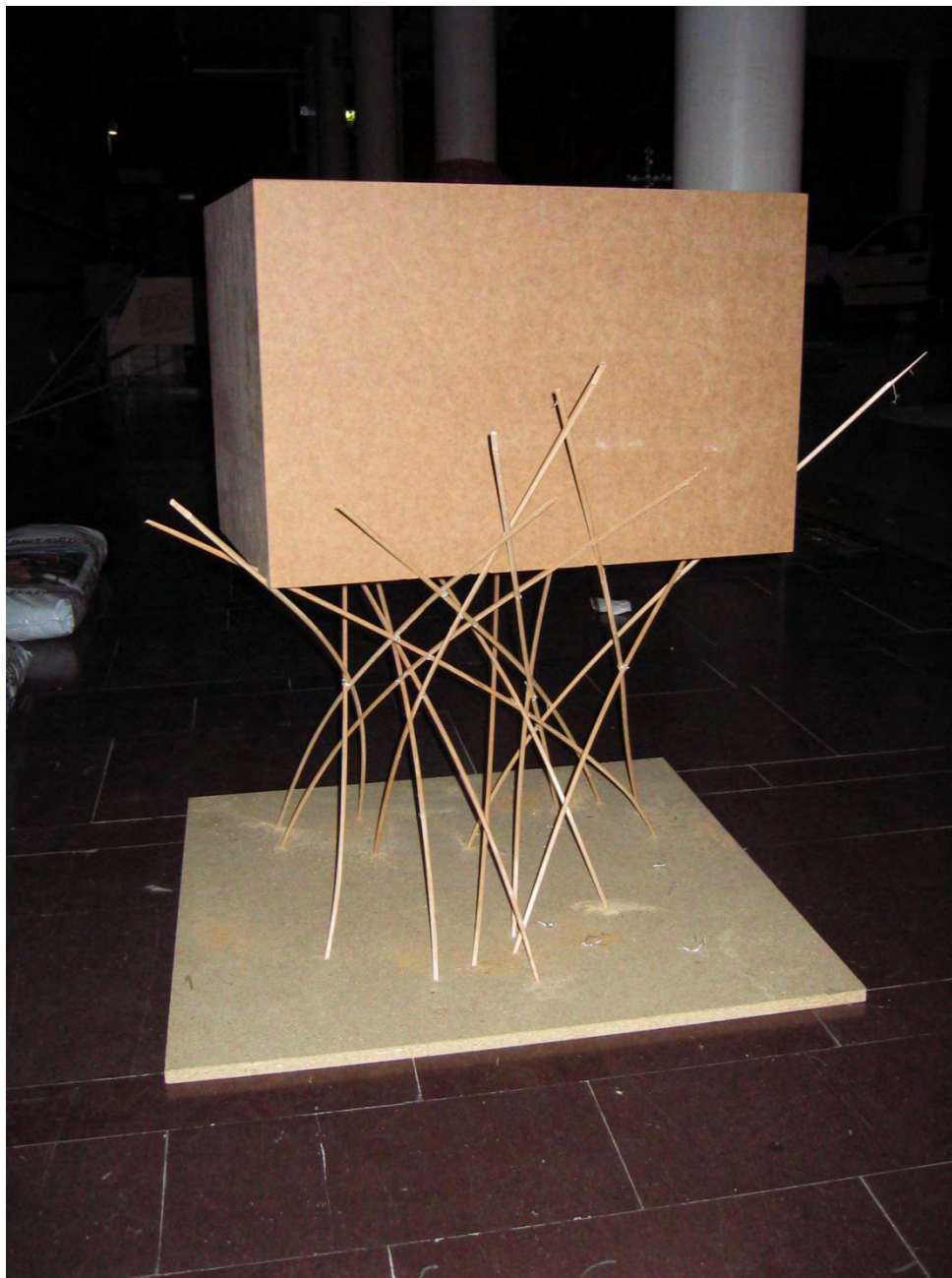


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stabilitet
rörelse



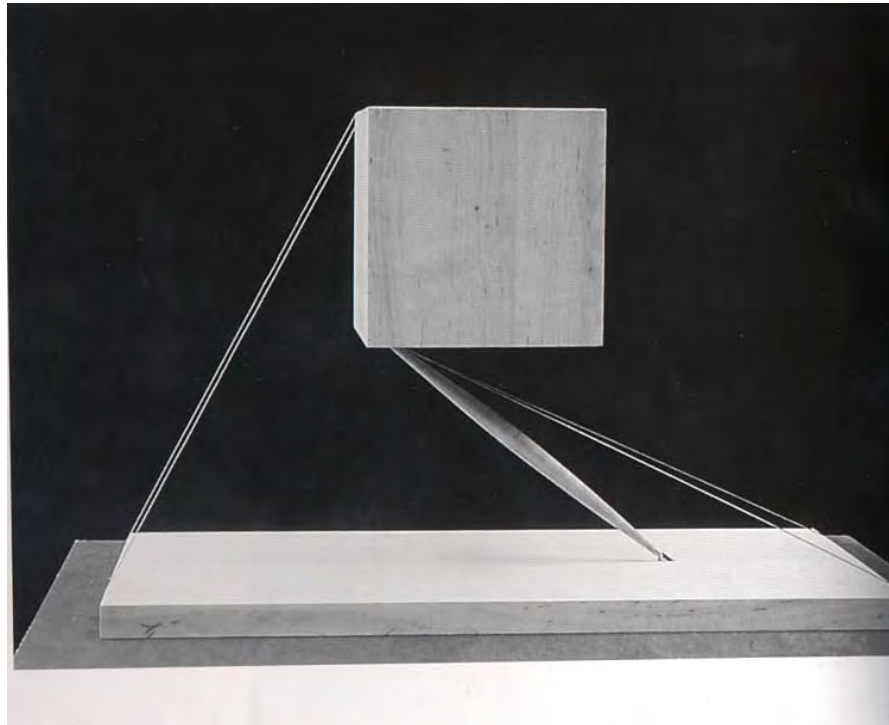
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effektivitet





Fler stöd
än nödvändigt
för yttre stabilitet

Nödvändigt antal stöd för yttre stabilitet

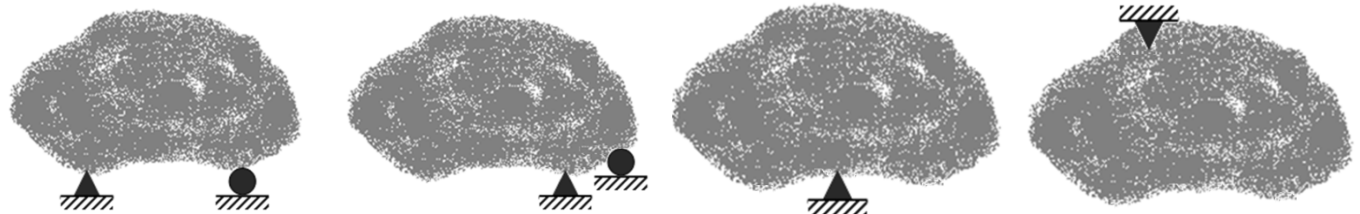


STRUKTURERS GRAMMATIK

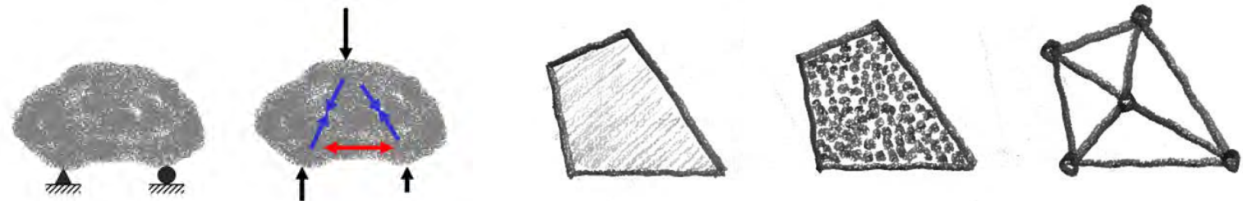
MÄNNISKA
gravitationen
som livsmiljö

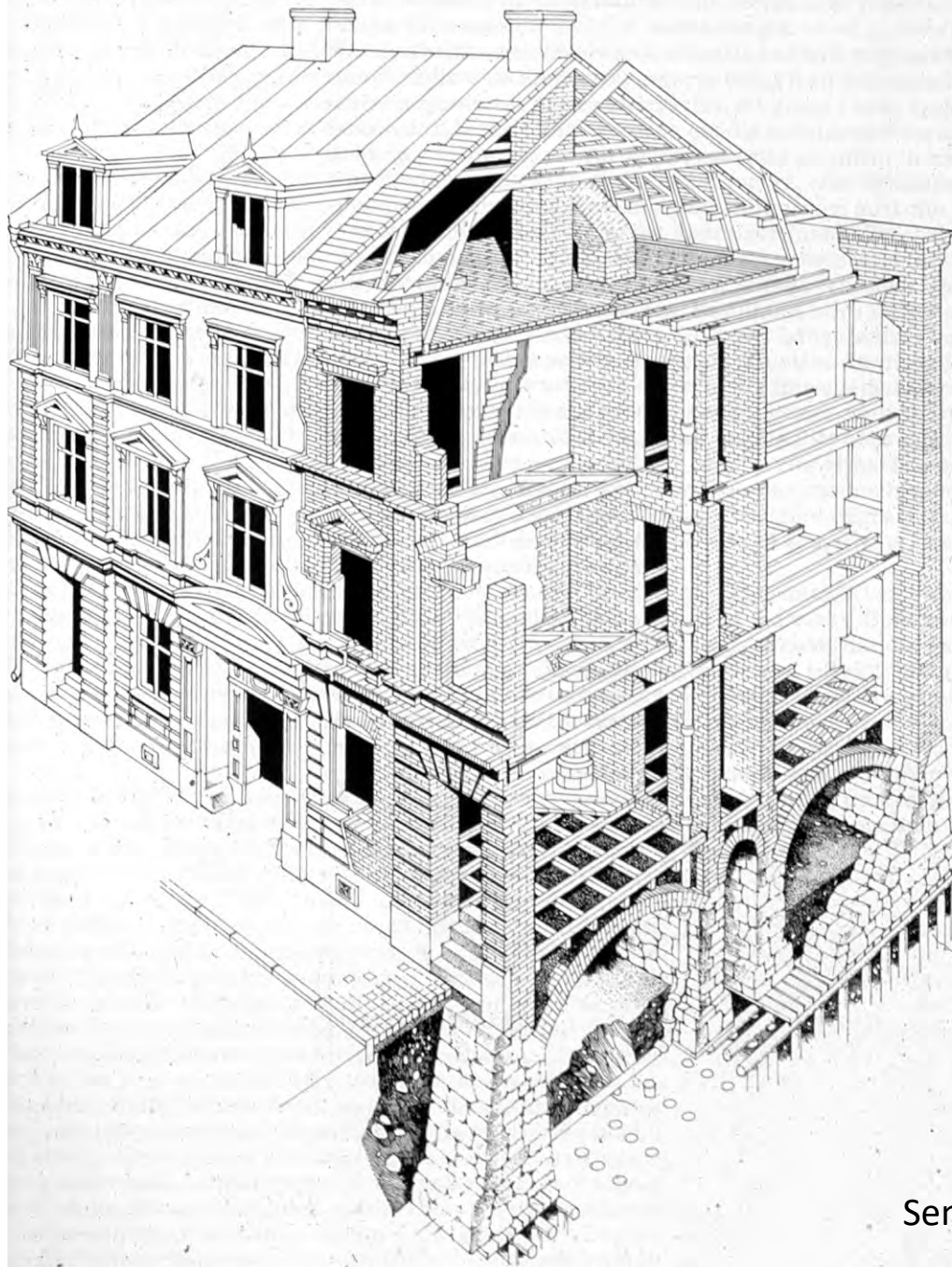


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inre stabilitet
kraftmönster
effektivitet





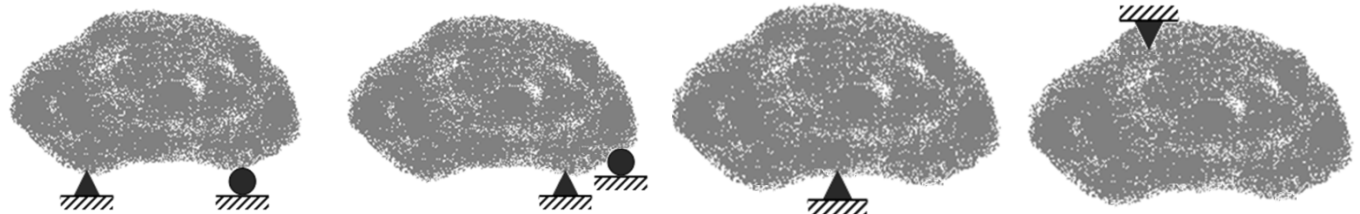
SPRÅK – LOGIK – VERKNINGSSÄTT

i sökandet av RUM / KARAKTÄR / GESTALT

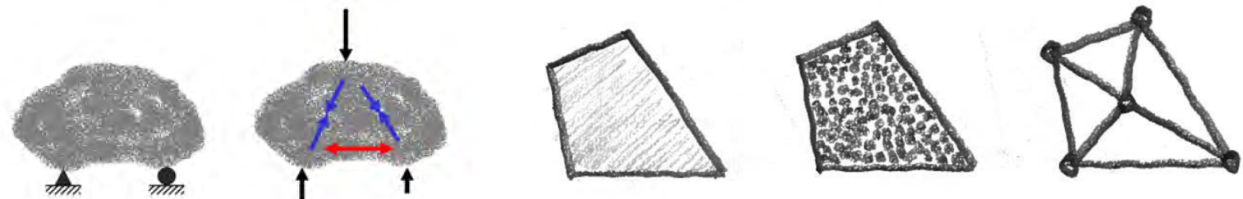
MÄNNISKA
gravitationen
som livsmiljö



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kraftmönster
effektivitet



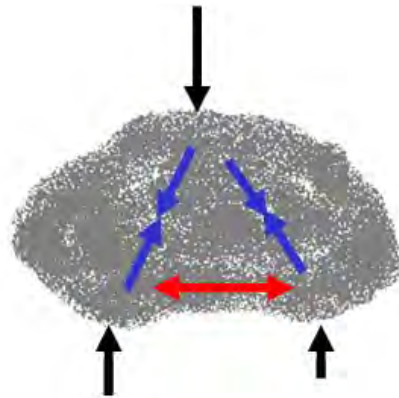
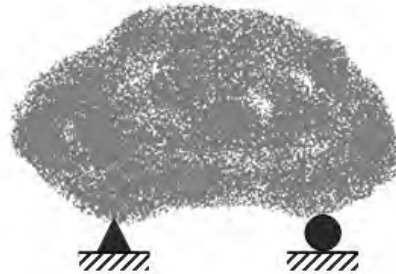


**Byggnaden
som bärande
system**

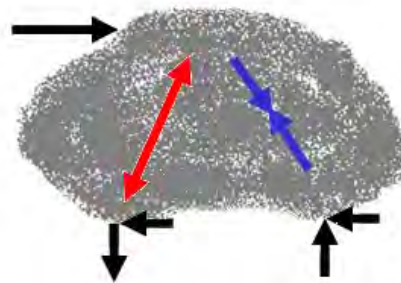
-

**om att forma
och läsa
strukturer**

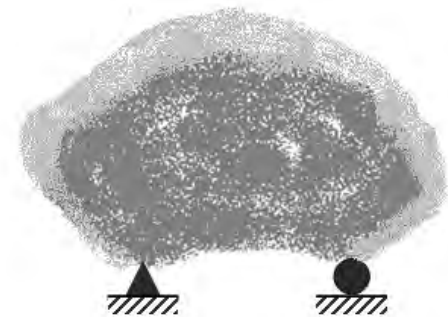
Tre uppgifter för en byggnad ...



Att bära
vertikala laster

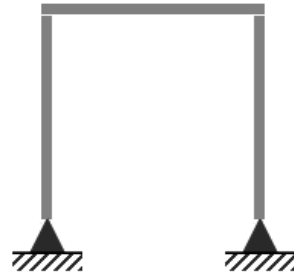


Att bära
horisontella laster

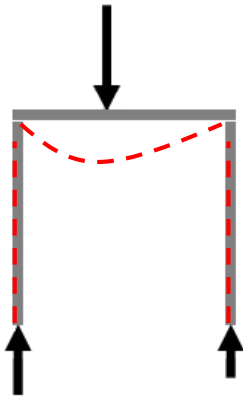


Att kunna röra sig
temperatur- och fuktlast

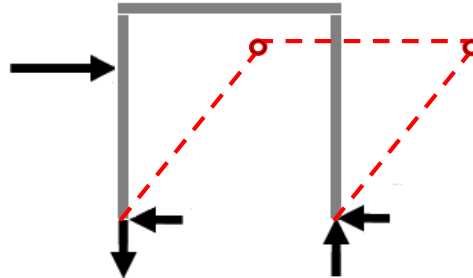
... tolkade på en vanlig byggnadsdel



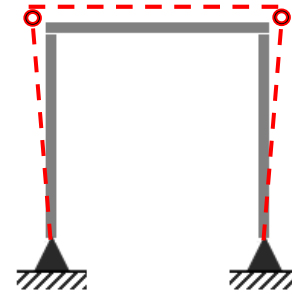
Balk fritt upplagd
på två pelare



Vertikala laster



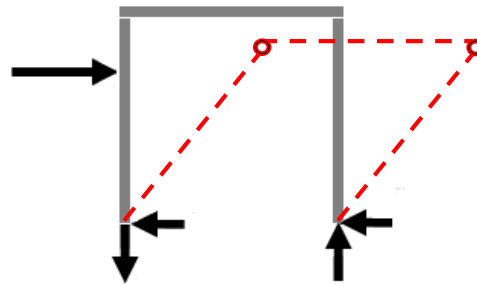
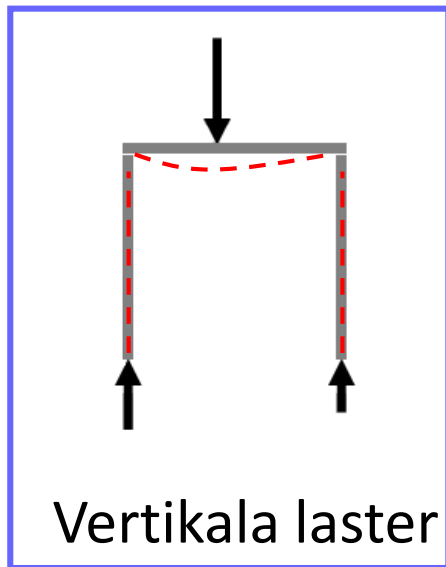
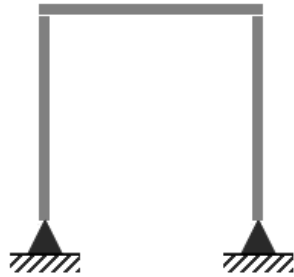
Horisontella laster



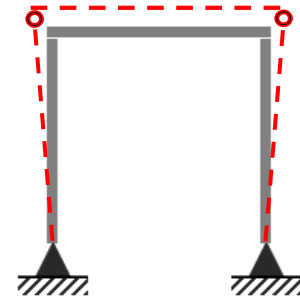
Temperatur
och fuktlast

Mekanism!

Vi börjar med vertikala laster oftast "formgivande"



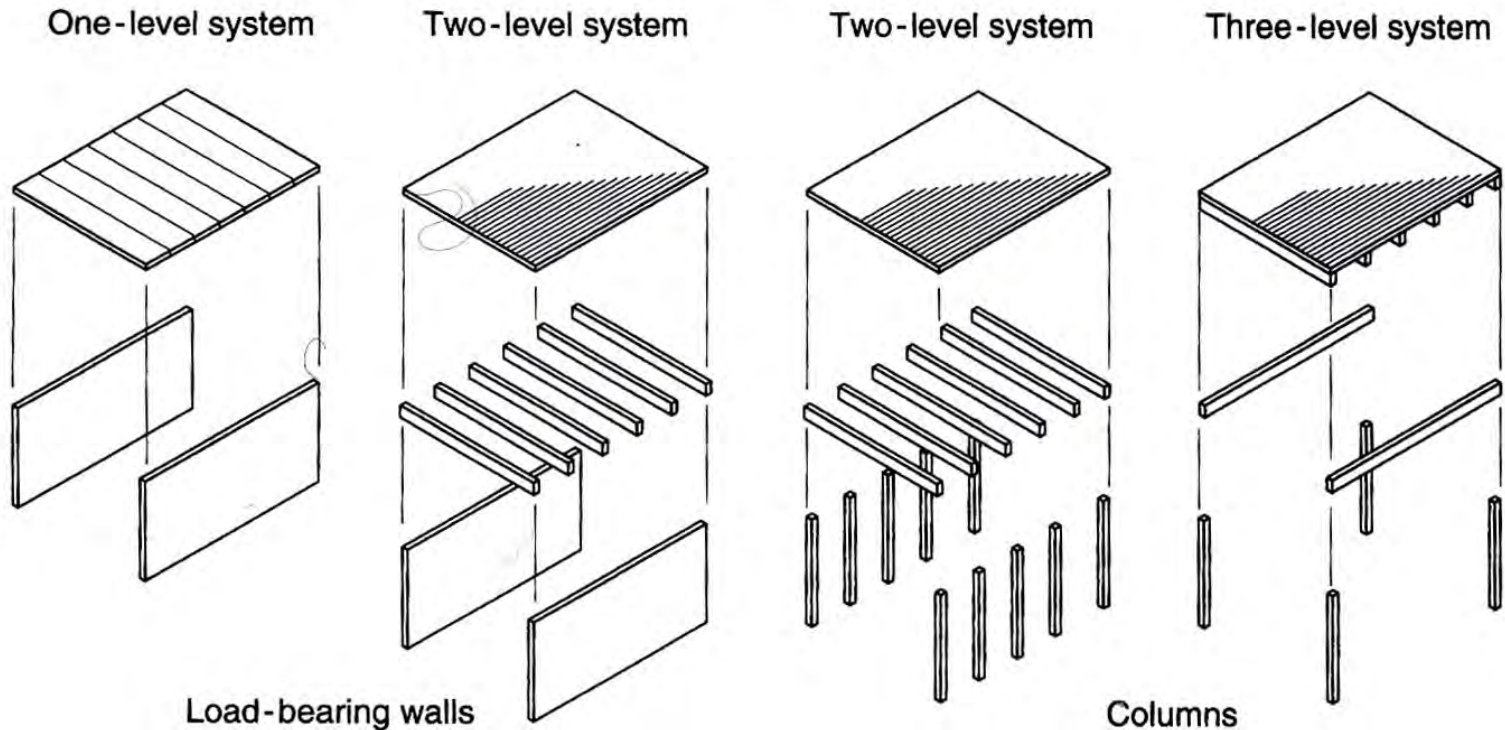
Horisontella laster



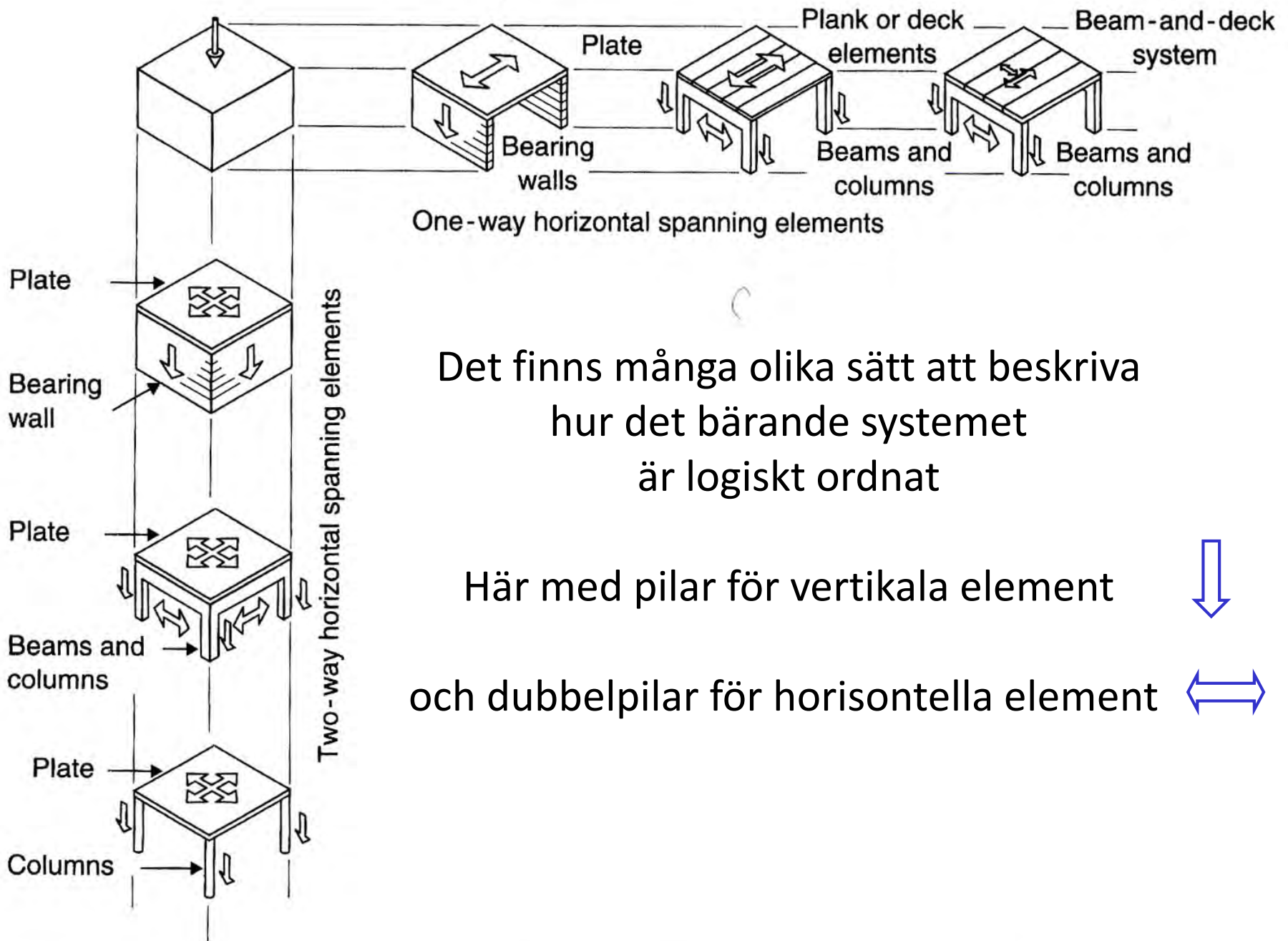
Temperatur
och fuktlast

Mekanism!

Att ordna strukturen för vertikal last



(a) Common types of horizontal spanning systems (one-, two-, and three-level systems) used in relation to different types of load-bearing wall and columnar vertical support systems.



Det finns många olika sätt att beskriva
hur det bärande systemet
är logiskt ordnat

Här med pilar för vertikala element
och dubbelpilar för horisontella element



Mies van der Rohe

Crown Hall 1950-56

Illinois Institute of Technology

Innehåller sektionerna för arkitektur, stadsplanering
och design



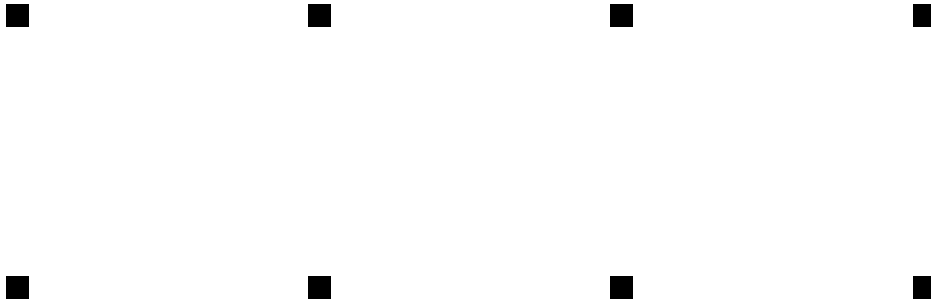


'Less is More'



I en plan
kan strukturens inre
ordning beskrivas:

- Vertikala stöd



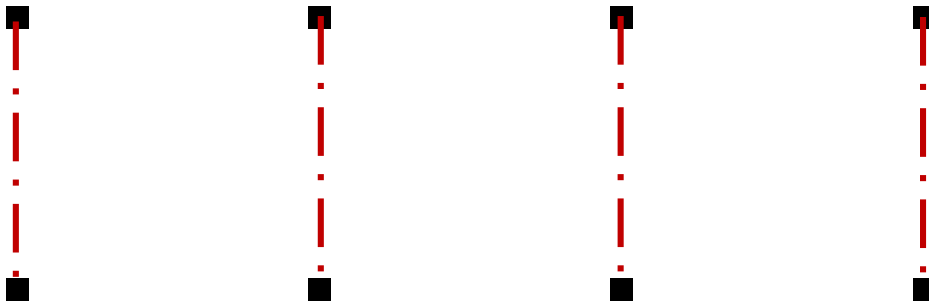


I en plan
kan strukturens inre
ordning beskrivas:

- Vertikala stöd

— . — Primärbalkar

”systemlinje”
representerar
balken



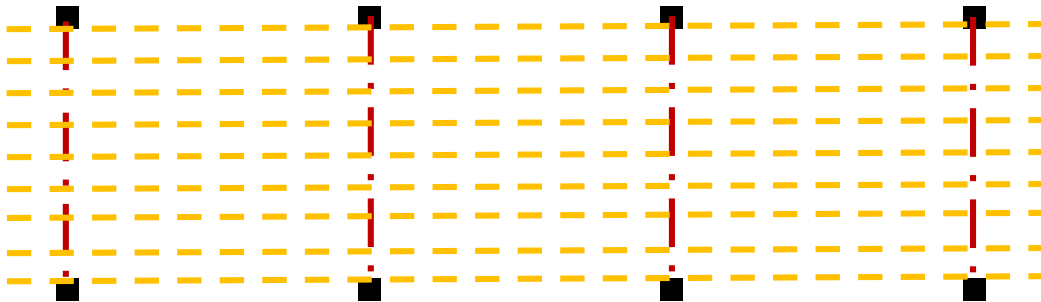


I en plan
kan strukturens inre
ordning beskrivas:

■ Vertikala stöd

— · — Primärbalkar

- - - Sekundärbalkar





I en plan
kan strukturens inre
ordning beskrivas:

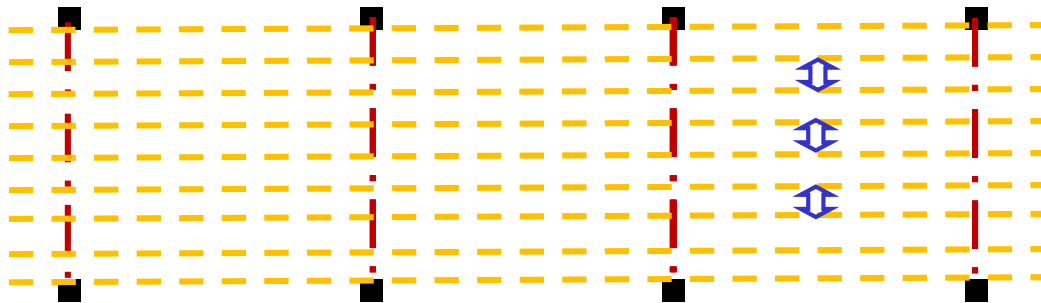
■ Vertikala stöd

— · — Primärbalkar

- - - - Sekundärbalkar

----- 3:e ordningens
balkar, etc.

⇔ högsta
ordningen

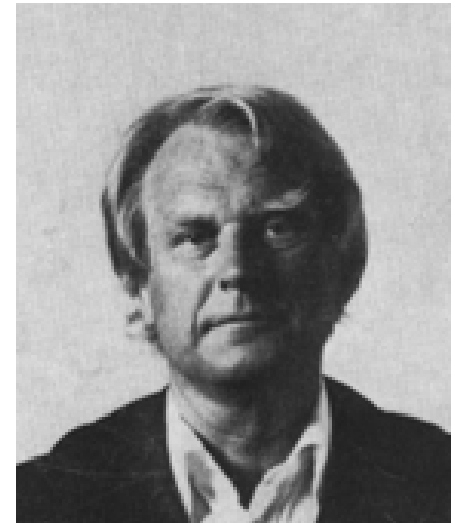


För horisontell last (vind)





Det nordiska ljuset

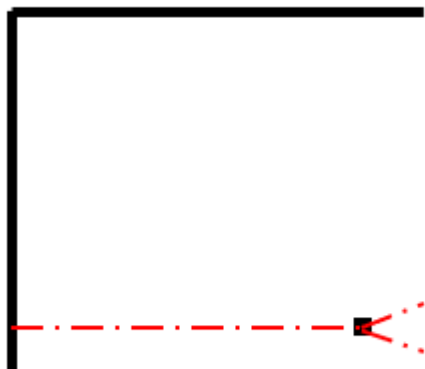


Sverre Fehn

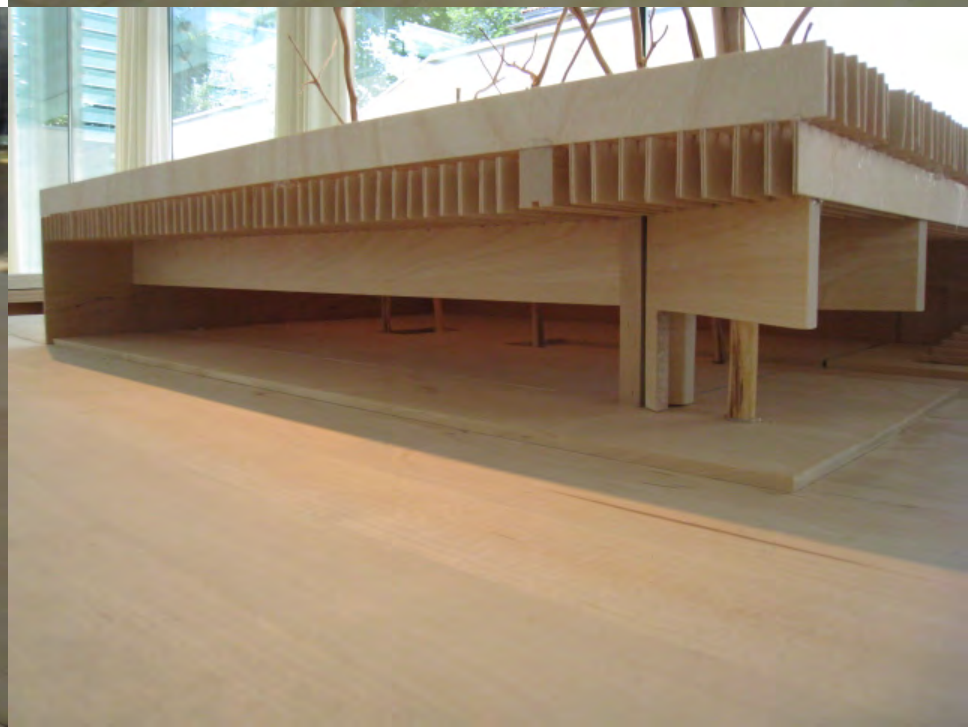
Skandinaviska
paviljongen

Biennalen i Venedig 1962





Grov tumregel för en balk $H/L = 1/20$

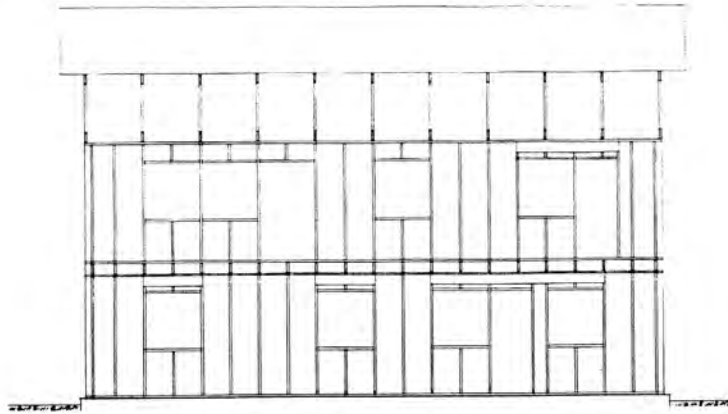




Om att bryta en lastväg - avväxling



En vanlig villa

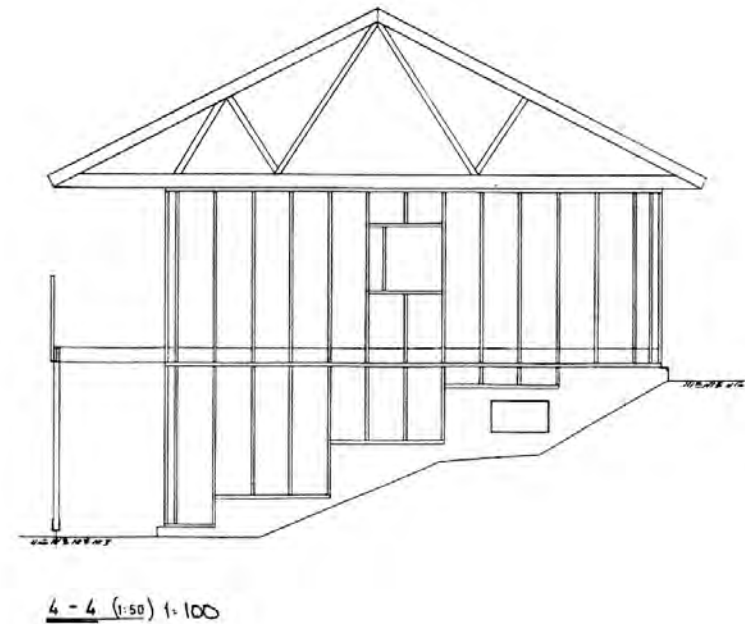
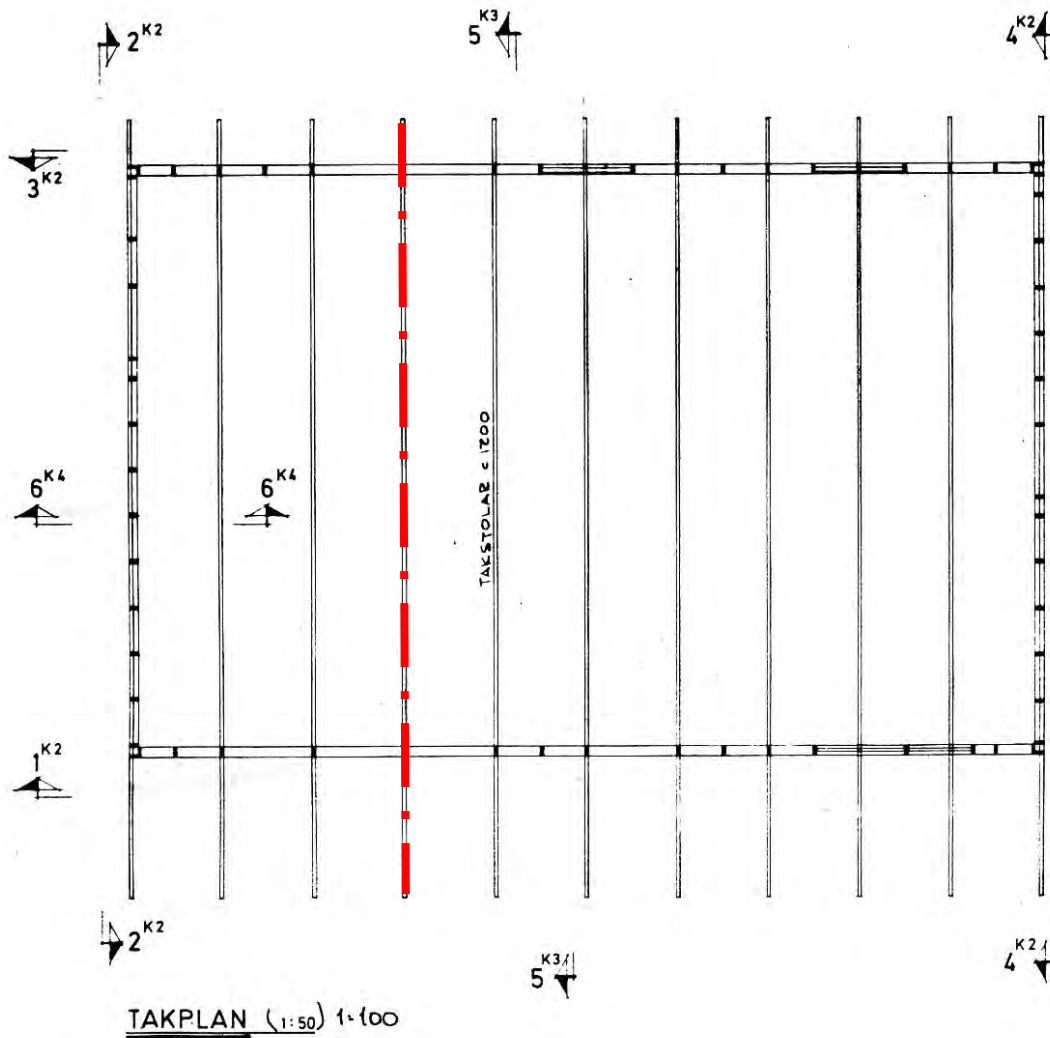


3 - 3 (1:50) 1:100

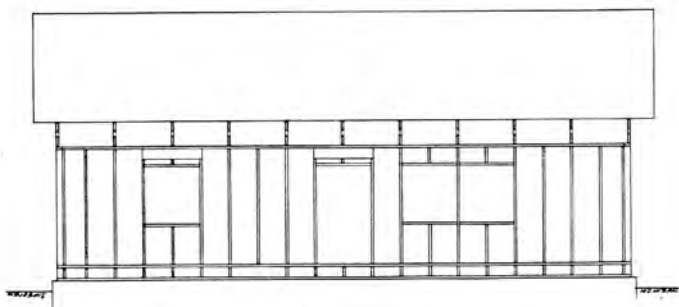
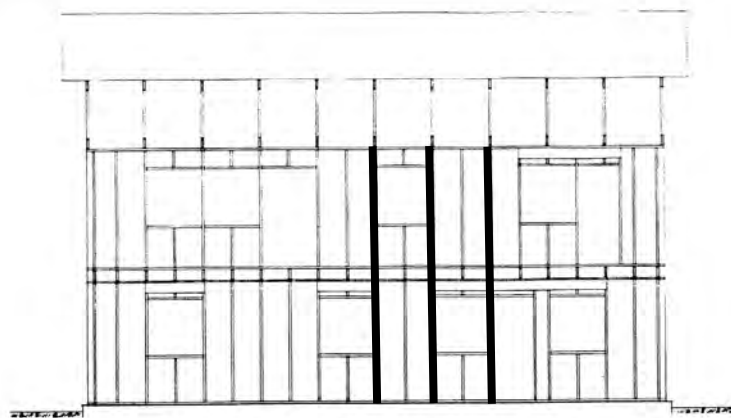


4 - 4 (1:50) 1:100

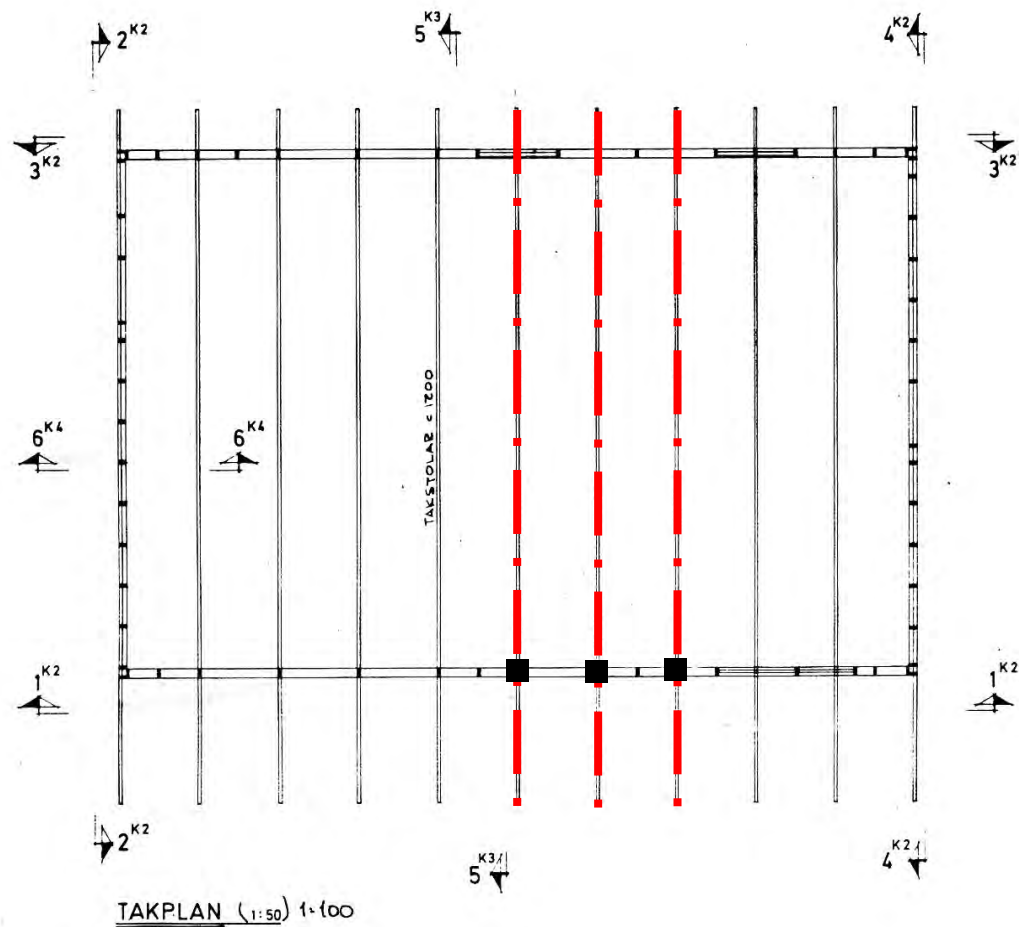
Takstolen är en primärbalk ...



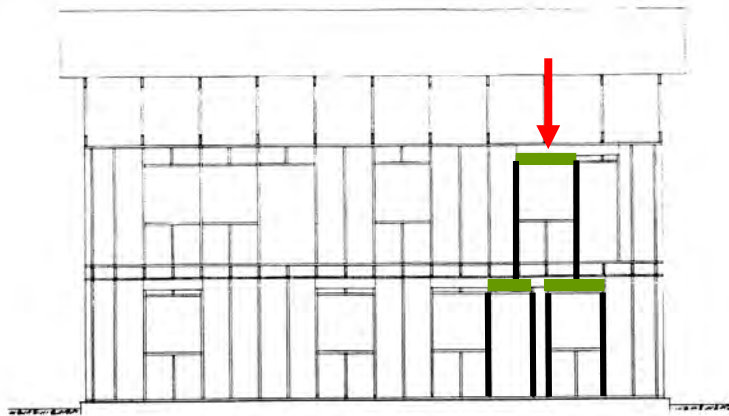
...som vilar på vertikala regler



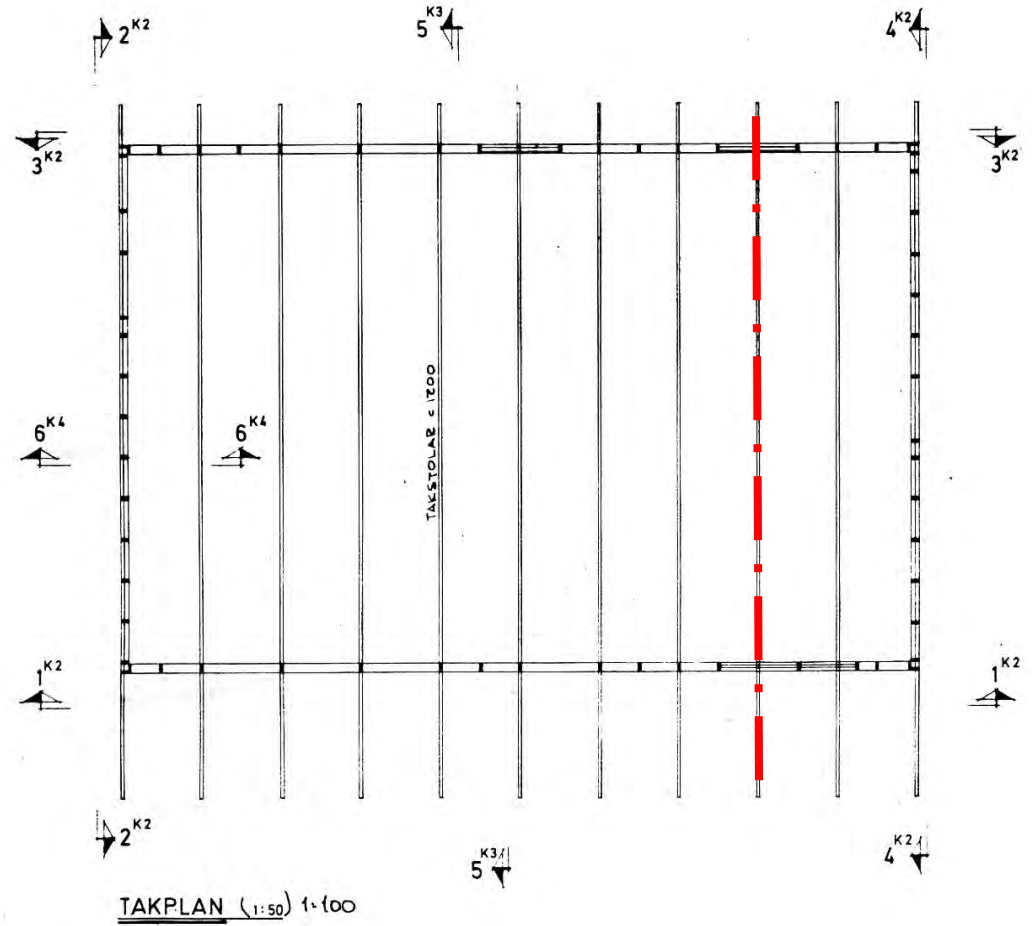
3 - 3 (1:50) 1-100



Avväxling



3 - 3 (1:50) 1+100









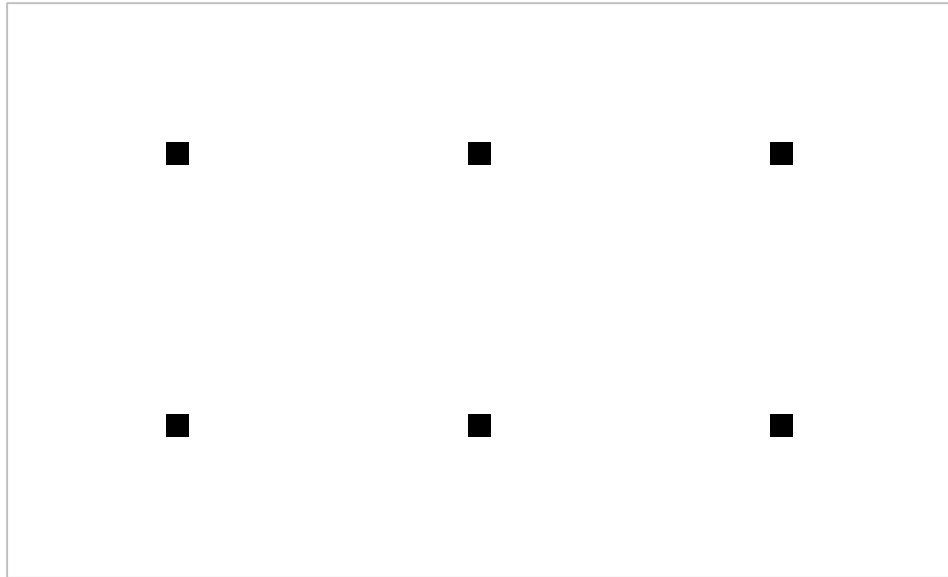
Schulhaus Leutschenbach



Christian Kerez, Architekt ETH/SIA, Zürich



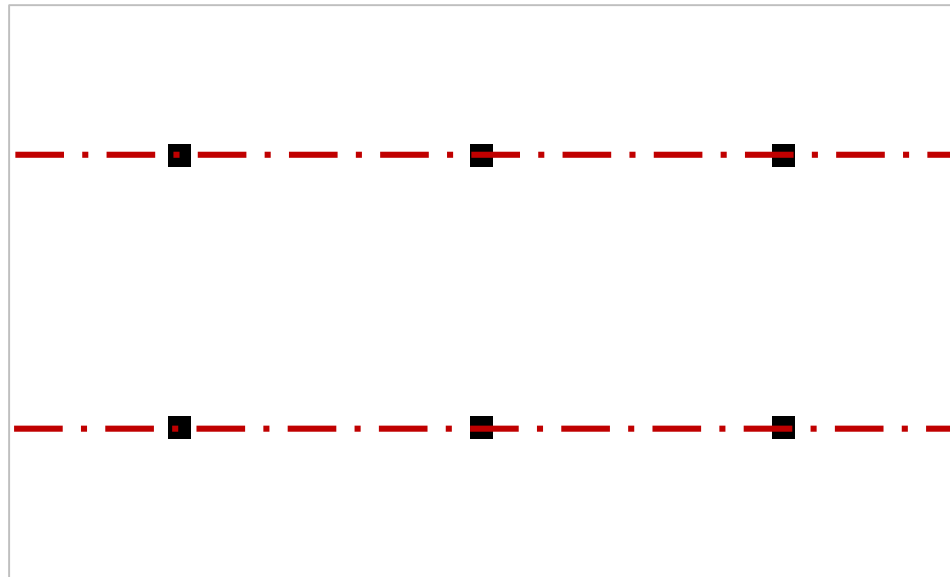
■ Vertikala stöd







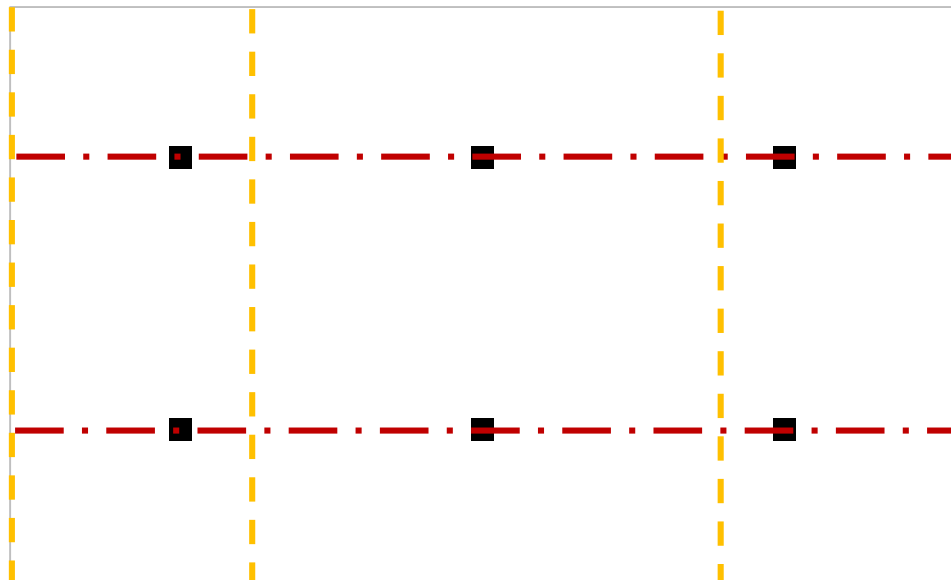
- Vertikala stöd
- · — Primärbalkar







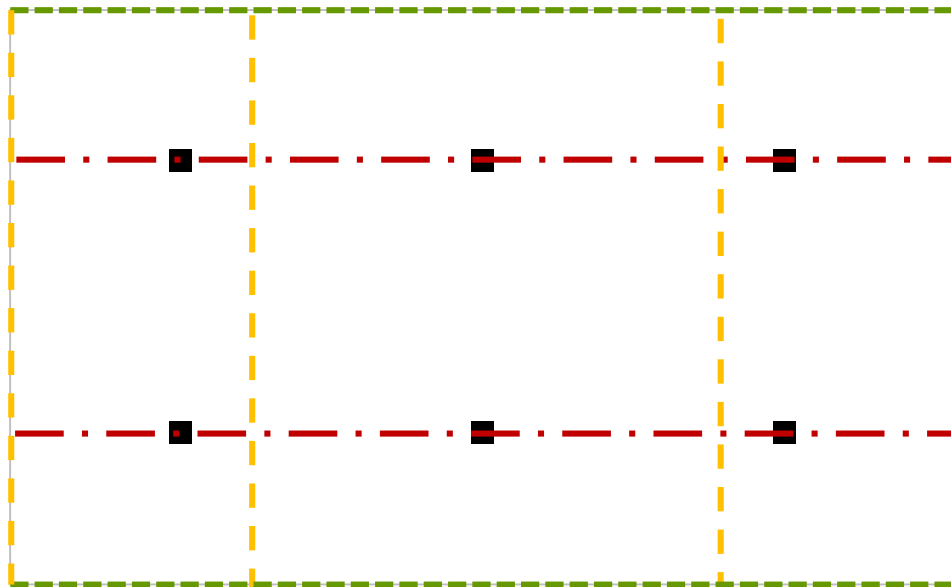
- Vertikala stöd
- . - Primärbalkar
- - - Sekundärbalkar





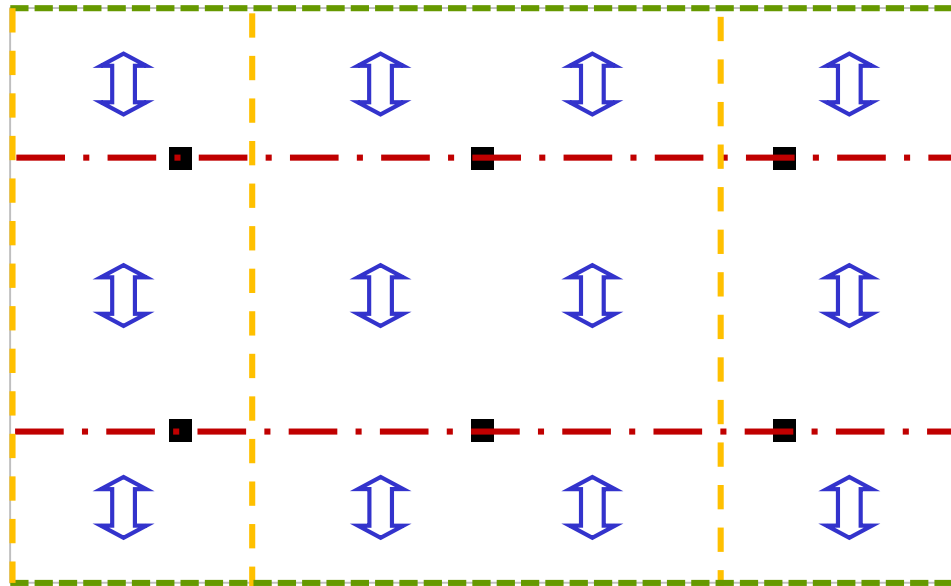


- Vertikala stöd
- · — Primärbalkar
- - - Sekundärbalkar
- - - Tredje ordningens balkar





- Vertikala stöd
- · — Primärbalkar
- - - Sekundärbalkar
- - - Tredje ordningens balkar















Vertikal bärning kan vara tryckt eller dragen

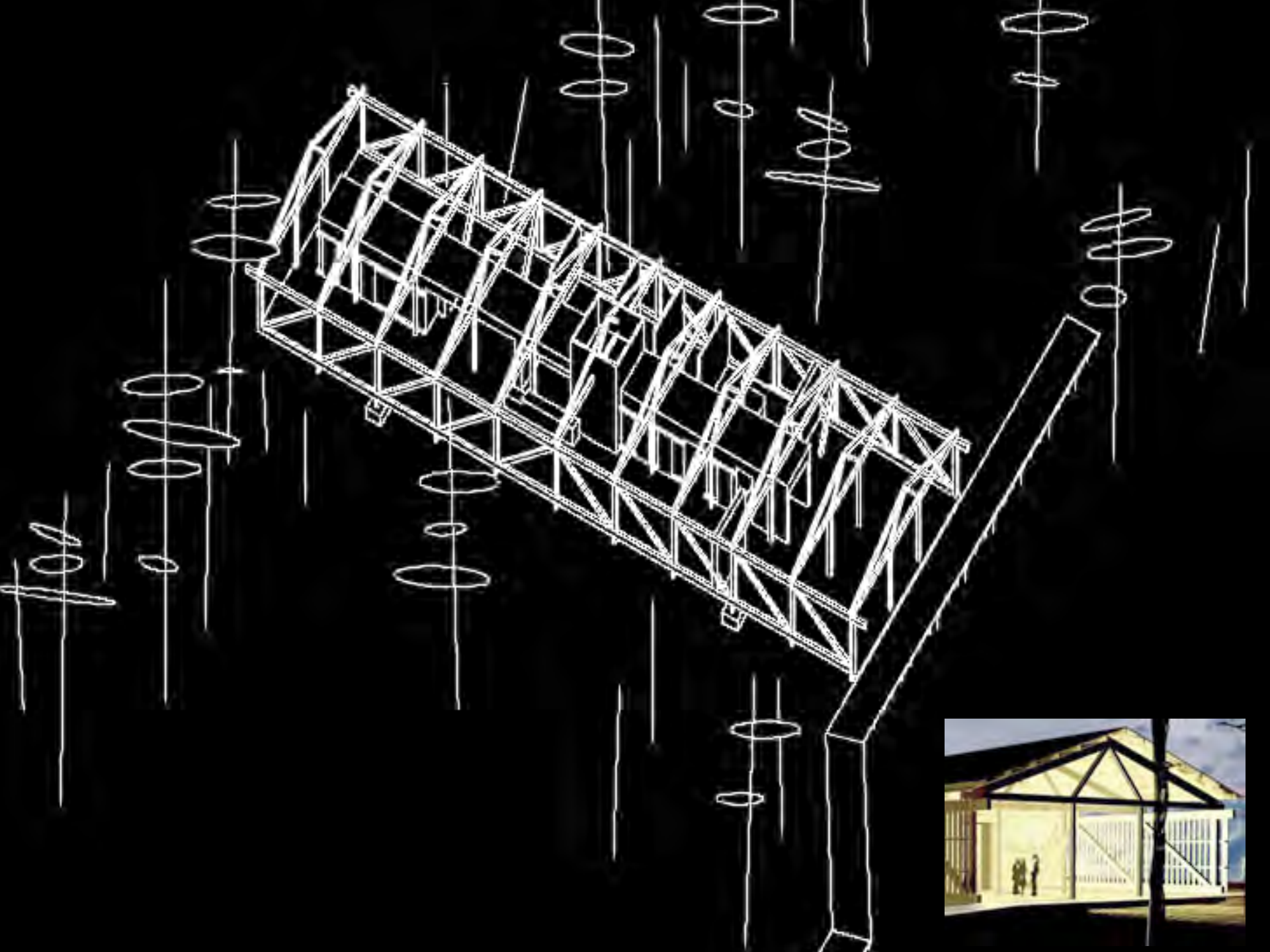


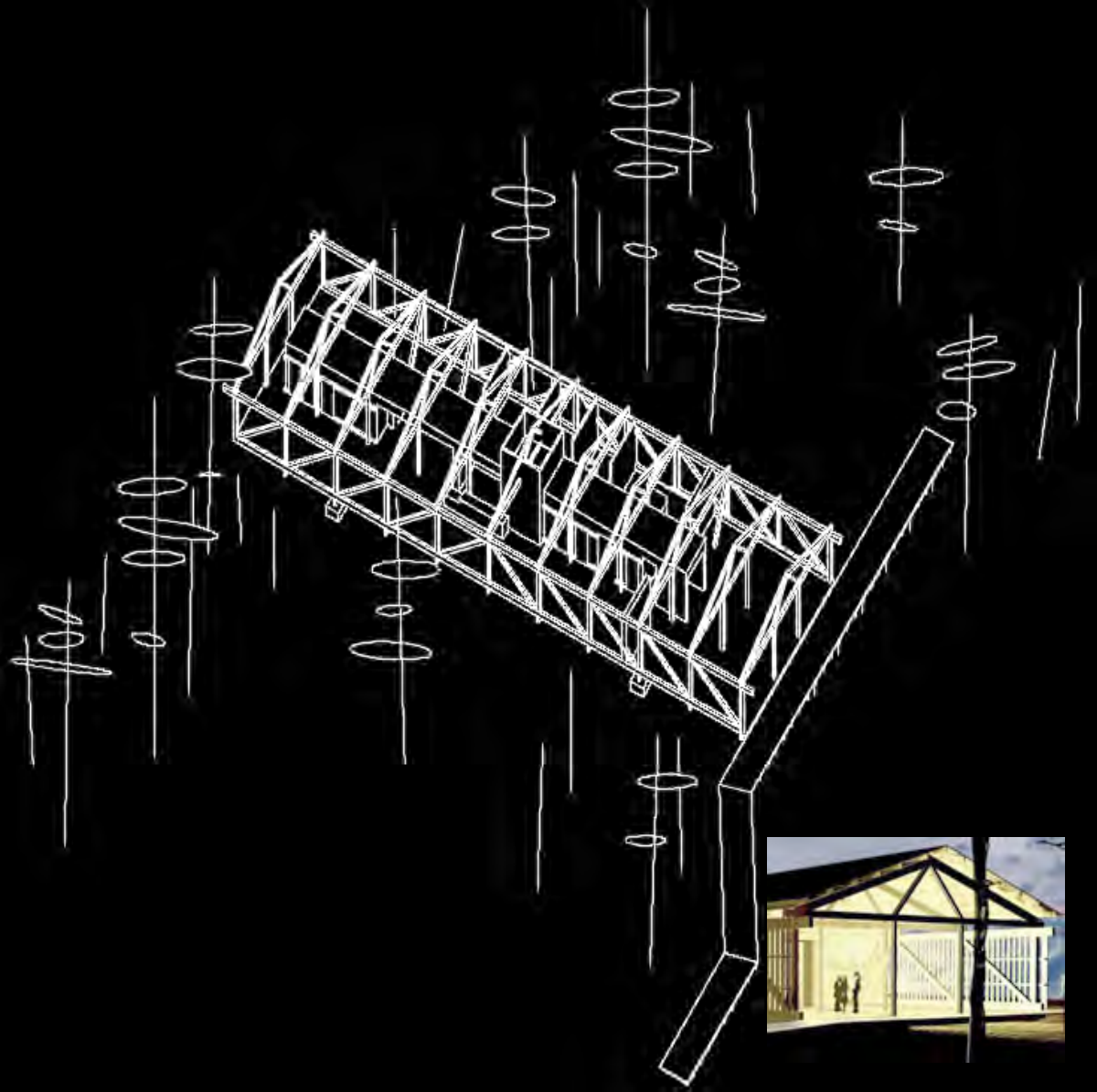
Store mosse



Ulla Antonsson
Mattias Lind







Takplan
Bottenbjälklag
Sektion

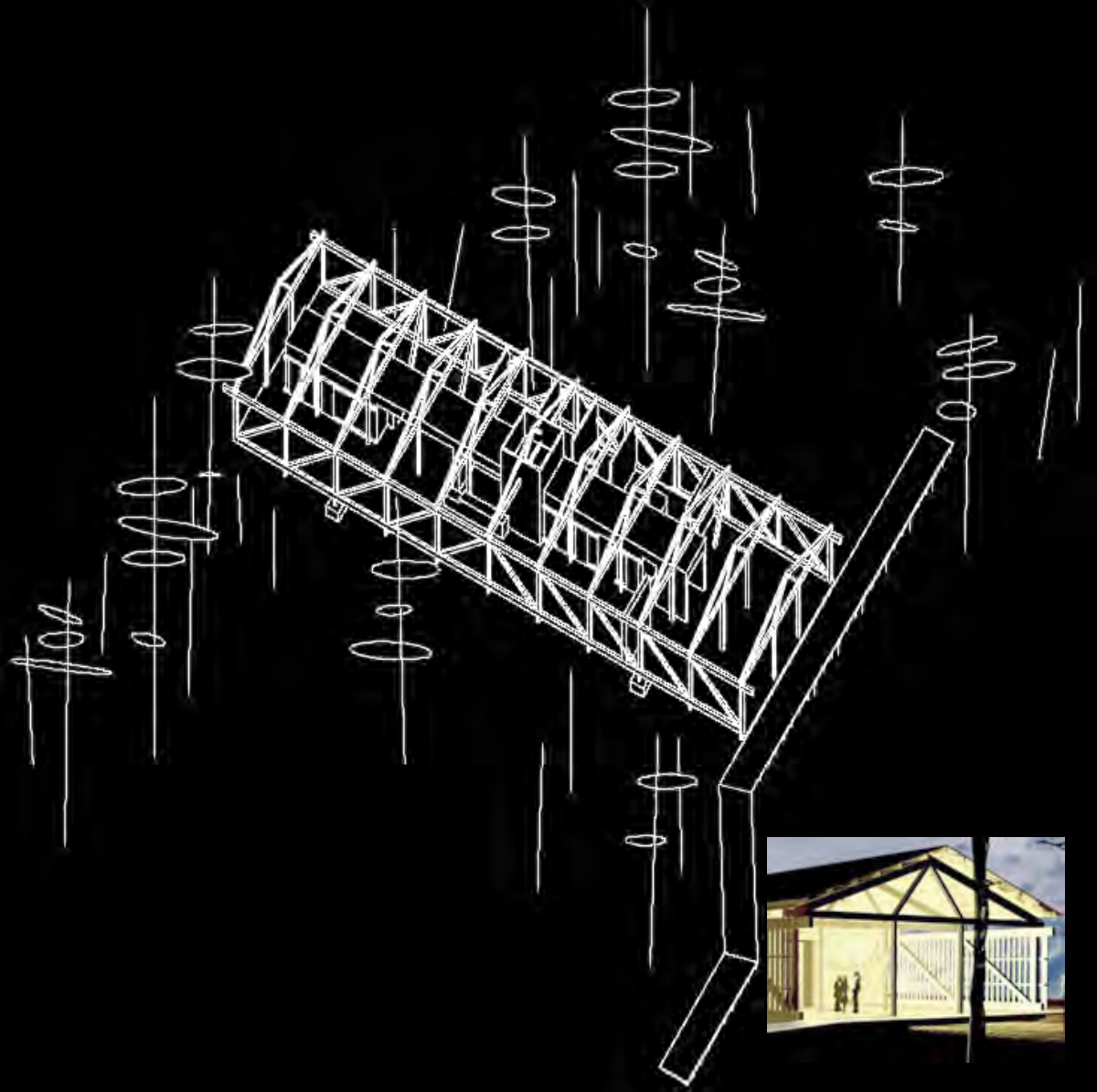
■ Vertikalt stöd
underifrån

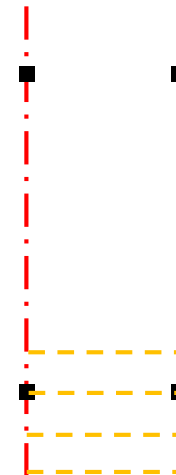
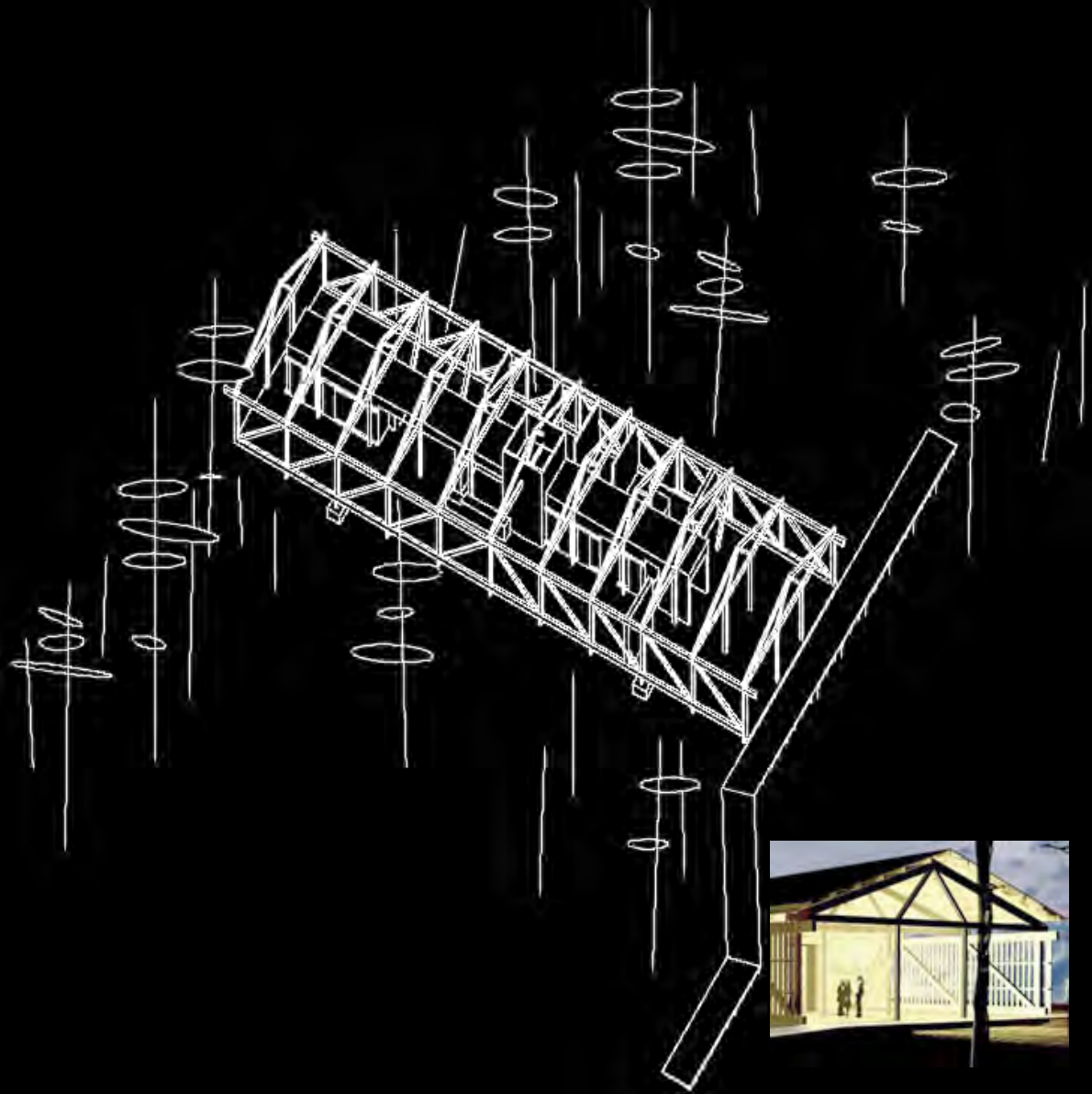
● Vertikalt stöd
ovanifrån

— · — Primärbalk

- - - Sekundärbalk

⇔ OSV....





Sekundärbalkar på två nivåer:

Den övre vilar bara på ytterväggarna



Den undre vilar på ytterväggarna
och hänger samtidigt i den övre



3.000 år sedan

Kapitel 11 Att sila mygg 2.000 år sedan

Vandrarven biten av en blåkrigs bössa och smeten blir en riklig löstheten



Kapitel 12 Lagd lagg ligger 1.000 år sedan

Timmerman 37 fäst ligger en brett som skapar skuggan av ett blad



Korpen

ockasiner

Ett oskrivet blad







Cecil Balmond Informal

The Formal marches to strict rhythms.



Why the necessity to space out structure equally, like soldiers marching on a parade ground?

Is the design of structural framing limited to the bar pattern of a cage; is space so dull that punctuating it means only the regular monotonous beat of verticals and horizontals? Why not relax and move towards a slip or jump in the arrangements of things?

Let the *informal* in. Have a syncopation – a rat-ta-tat – instead of the dull metronomic one-two – repeat of post and beam that rises up and runs along our buildings in stark structural skeletons.



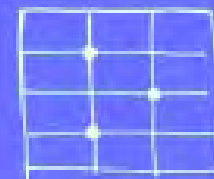
Why not skip a beat? Incline the vertical, slope the horizontal. Or allow two adjacent lines of columns to slip past each other. Let space entertain us. Let's see other possibilities, other configurations of how buildings may be framed and stabilised.

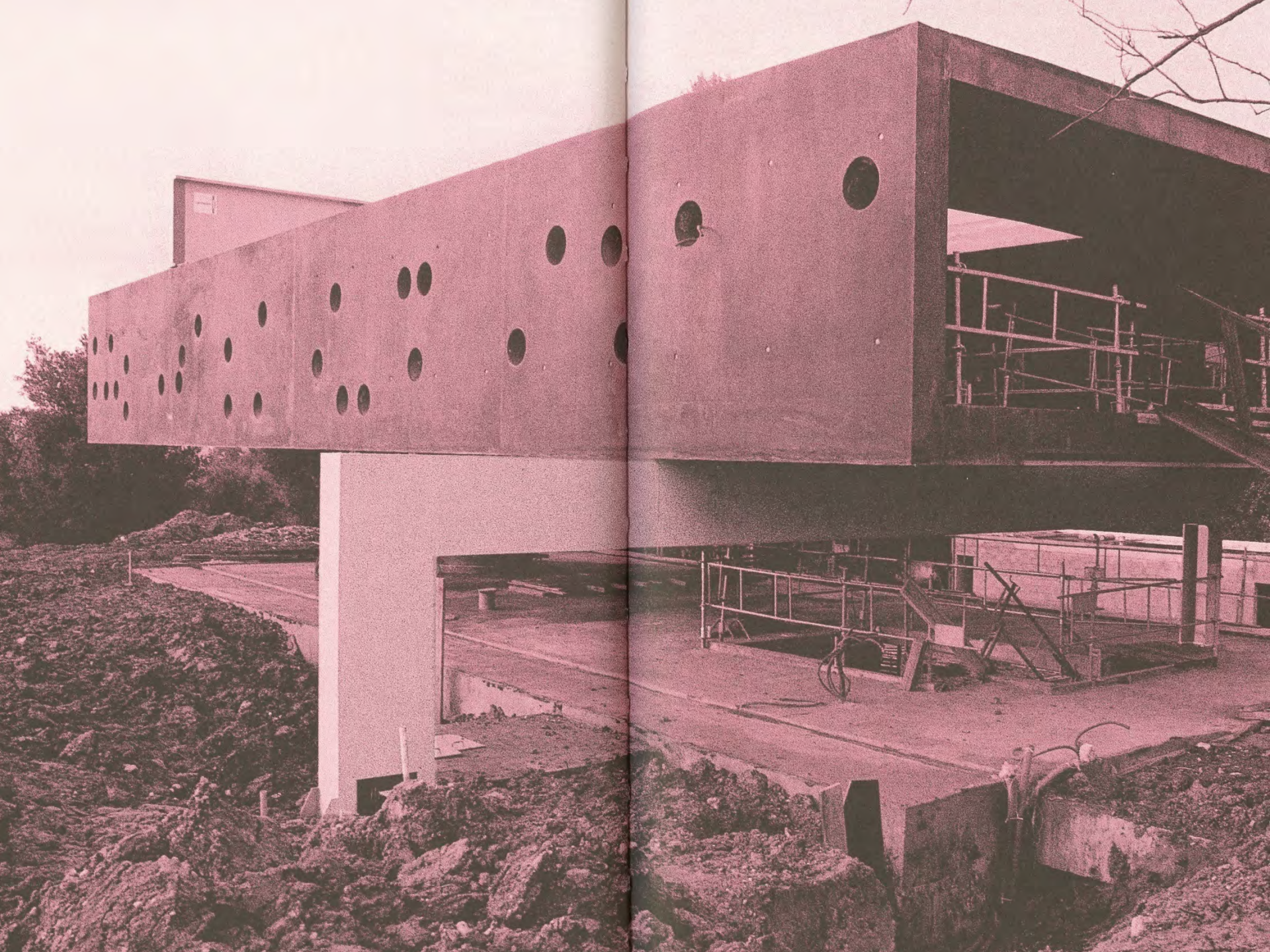
And interruptions to 'sameness' do not mean heavy penalties. A specific framing with angularities, inclinations or whatever, may be cheaper. A considered unique path of structure is often more valid than the unquestioned assumption of a distributed solution, subdivided equally through a cross-section or plan.

regular



informal







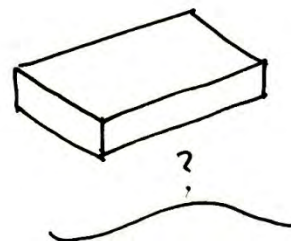
Rem Koolhaas phones me. As usual the voice is urgent, full of convictions and ambitions, the language poised beautifully on extreme polarities. He has an unusual request, to make a villa in Bordeaux 'fly'.



The project is on a fantastic site with panoramic views over the rich, wine-laden city stretching along the river.

Rem says the client is seriously disabled from a recent car accident but is fighting back, determined to have a new life. And the house has to be a special one that can accommodate his needs with those of his wife and two children. They have a large town house, but now under different circumstances the family wants a new villa, up on the cliff edge, overlooking the city.

And I had that reaction when one first hears of a project – the immediate excitement, a new challenge and with it the start up fear – will it succeed?



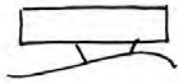
In the event, the answer was quite unexpected.

If a weight suspended above the earth should somehow levitate, the risk-answer must lie in the breaking of symmetry.

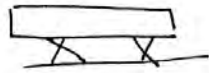
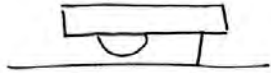
I sketched out various solutions, trying to set the mass 'free'.



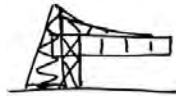
Columns were stuck well underneath to give a feeling of free edge.



In some cases the ground came up to disguise the support.



In other instances raking columns initiated oblique lines to take away the feeling of direct support.

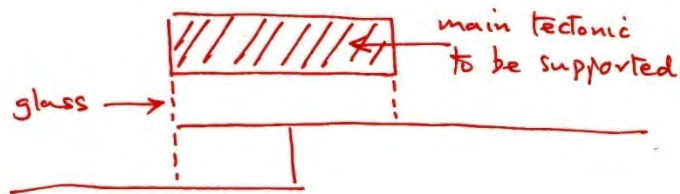
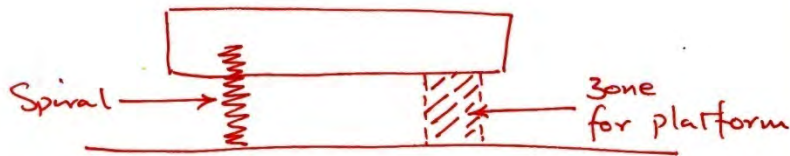
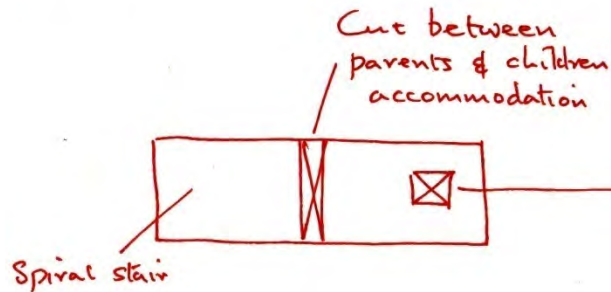


I tried top hung support as well but that felt alien and inappropriate for the site.

None of the ideas really satisfied. I still felt confined. The picture of the site kept imposing its own dynamic, challenging a better solution. No matter how the columns were placed beneath the load the generic concept of table came back, and with it the imprint of an 'anchor' killing off the ambition.



Generic Issues



We meet in Bordeaux. The setting is something else – a hotel designed by Jean Nouvel overlooking the fields of Floriac, just a few miles outside the city.

We work at first in a ground floor reception room. No one seems to be about.

OMA's team of Jerry and François are here and sketches of the site and ground plans lie all over the place. They outline the brief to me.

hole for life platform through ground and first

A family house, for husband and wife, plus two children. The design must give access to the disabled person, to release the full potential of the house. The principle tectonic is to be a box, up in the air, where the bedrooms will be located. Below this are the living spaces, surrounded by glass. The glass may open out onto the landscape and vanish; below the living space is a partial basement, cut into the earth on one side but open to an entry courtyard on the other. There is to be a special lift, a moving part of the house really to reach all levels.

INTERROGATION:

To ask a mass to levitate is not a new question; there is always an architectural demand for a lightness of being, *tabula rasa* visions with nothing to account for gravity. Structure in these situations simply gets in the way, becoming an enemy of promise.

But gravity is a tyrant. Its pull cannot be avoided, and the usual response for supporting a load in the air is to configure legs to hold the weight up from below. There is a directness of purpose to this configuration but there is also a complacency to look for nothing else.



Something else was needed.

The idea of *launch* came to mind, to energise the building as momentum. Two lateral moves broke with symmetry.

Move one:



what if the supports in plan are displaced beyond the boundary, well outside the box?

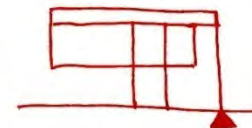
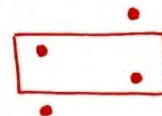
Move two:



what if the supports 'flip' in elevation, one top hung, one bottom fixed?

Suddenly we had the dynamic we wanted. The side-way shifts in plan and jumps in elevation brought a skewed tension to the solution. They stretched the concept of balance to the edge of the predictable, towards a moment of instability, setting up a precise danger point.

At one end the box sits on a shelf beam. At the other end its weight hangs off a roof girder, precarious and scary. The cable that restores balance is placed outside the plan, mimicking the movement of the displaced column at the shelf support end. Each cross-section is the reverse of the other.



A contradiction is offered in how the load is perceived. The solution pulls one way and then the other. The weight of the box is both supported from the ground and hung up in the air, in plan and elevation the exaggerations deny any conventional reading of balance.

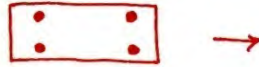
The idea of a table is destroyed. Instead, the dynamic is *launch*.

In my mind's eye I already saw the villa flying.

Something else was needed.

The idea of *launch* came to mind, to energise the building as momentum. Two lateral moves broke with symmetry.

Move one:



what if the supports in plan are displaced beyond the boundary, well outside the box?

Move two:



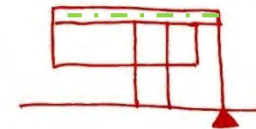
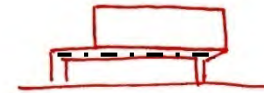
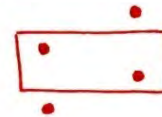
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Suddenly we had the dynamic we wanted. The side-way shifts in plan and jumps in elevation brought a skewed tension to the solution. They stretched the concept of balance to the edge of the predictable, towards a moment of instability, setting up a precise danger point.

26



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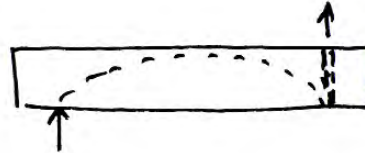
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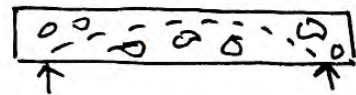
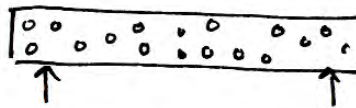
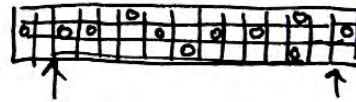
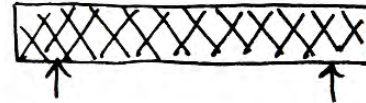


The roof and floor spanned 11 metres onto longitudinal wall beams. These beams in turn had two supports, and cantilevered beyond them at each end. Though thin in section the depth of these walls gave adequate stiffness and the gable ends of the box could be kept open if needed. On the wall beams, lines of principal stress were marked so that holes could be cut out without complications to the structural action.

Keep it simple – that was the aim.



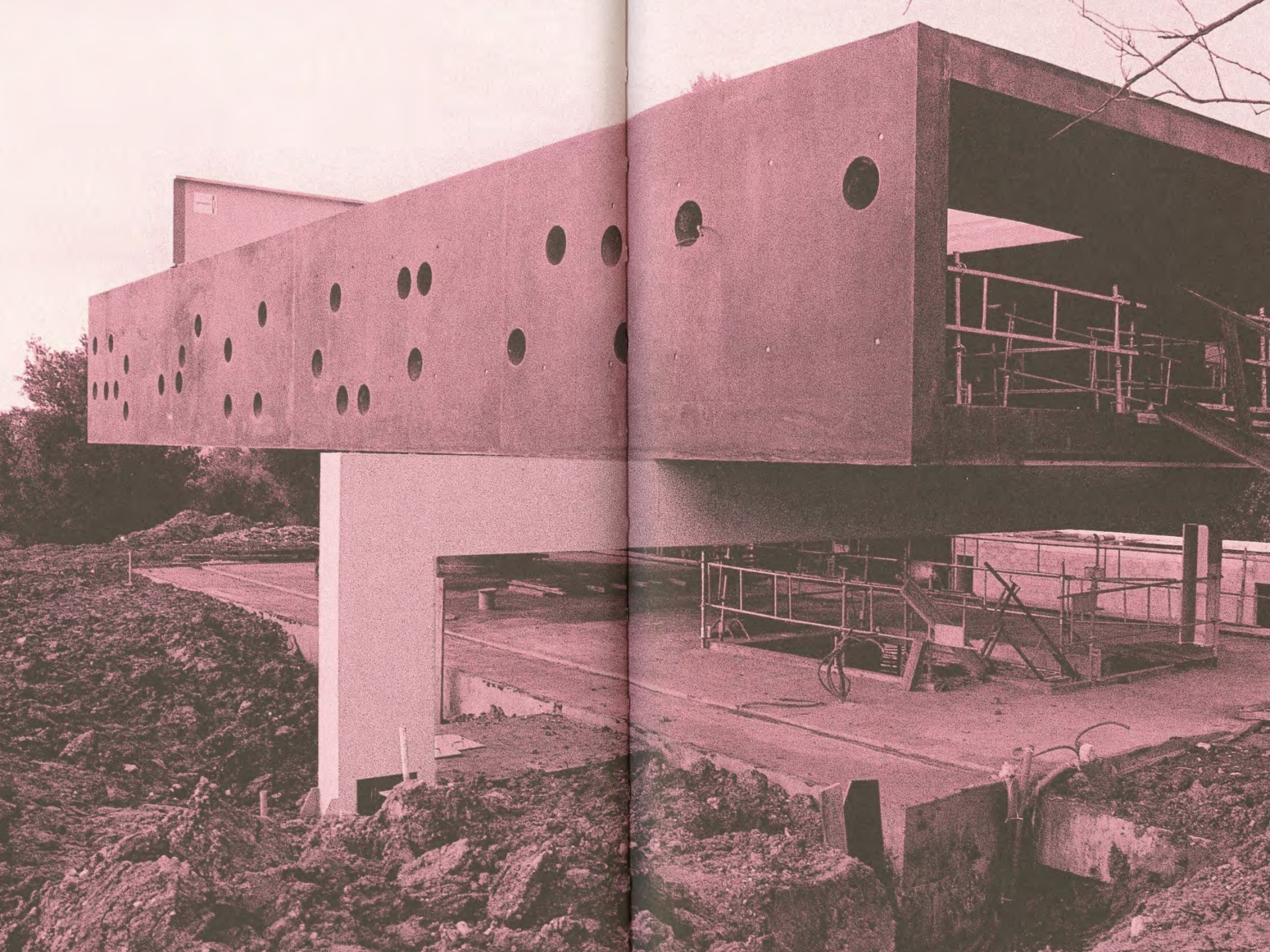
A grid was plotted on the wall elevation to allow a random solution. Rem speculated that small porthole-like windows scattered throughout the elevation would look terrific. We floated small circles, like soap bubble experiments, through the elevation as we tried various punctuations – low level portholes for the client in a wheelchair, and high level vista points for the others.

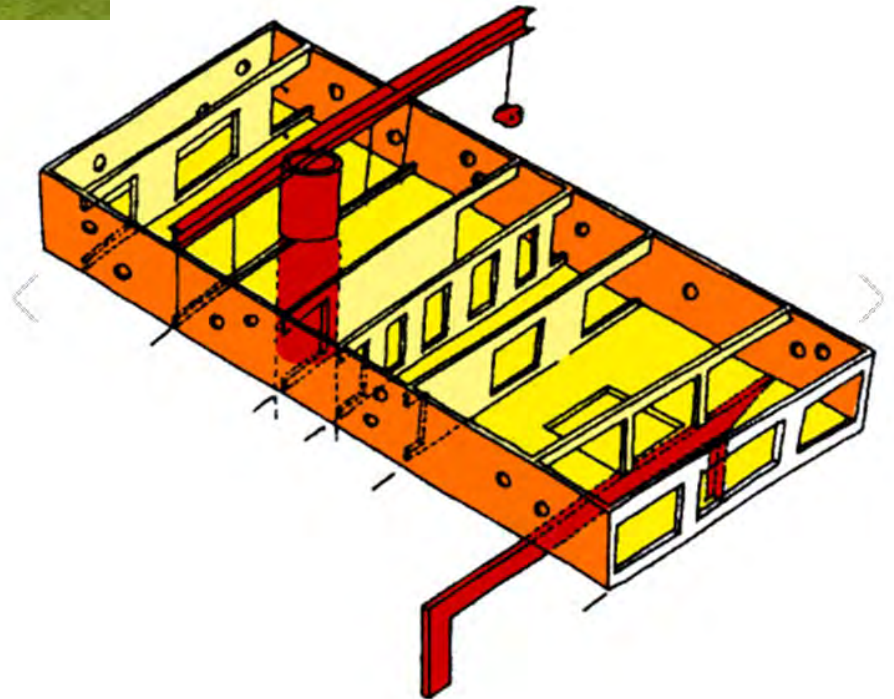


Views were calculated and prescribed.

A beautiful drawing, like a wind rose, took shape in OMA's office.

The design, we thought, was progressing well. The shape, size and configuration were solved, the materiality agreed: we were into the 'Avant Projet Détaillé' stage of design, prior to tender.



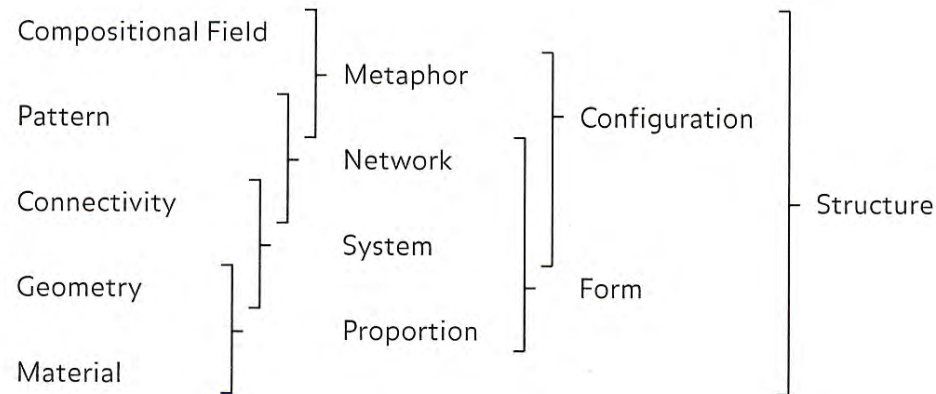


<http://www.svtplay.se/k-special>

When entering a design there are several stages to unravel; a composition field, pattern, the choice of connectivity, geometry and, finally, material.

Cecil Balmond Informal

The overlaps to structure are:



Something dramatic happens when we contemplate the analysis of 'structure'. The world loses its substance: walls, columns, floors and beams shrink and dematerialise to leave an imprint on a small skeletal drawing. The structure becomes just lines connecting nodes – a virtual diagram. The line has no real thickness and the node no size, they are mathematically dimensionless entities of point and line. Precisely because a framework has no substance we can give it any properties we like: weight, area, stiffness etc. Armed with such properties the structural diagram becomes a potent machine, waiting for a set of actions.

Samma plan men olika organisation av den bärande strukturen

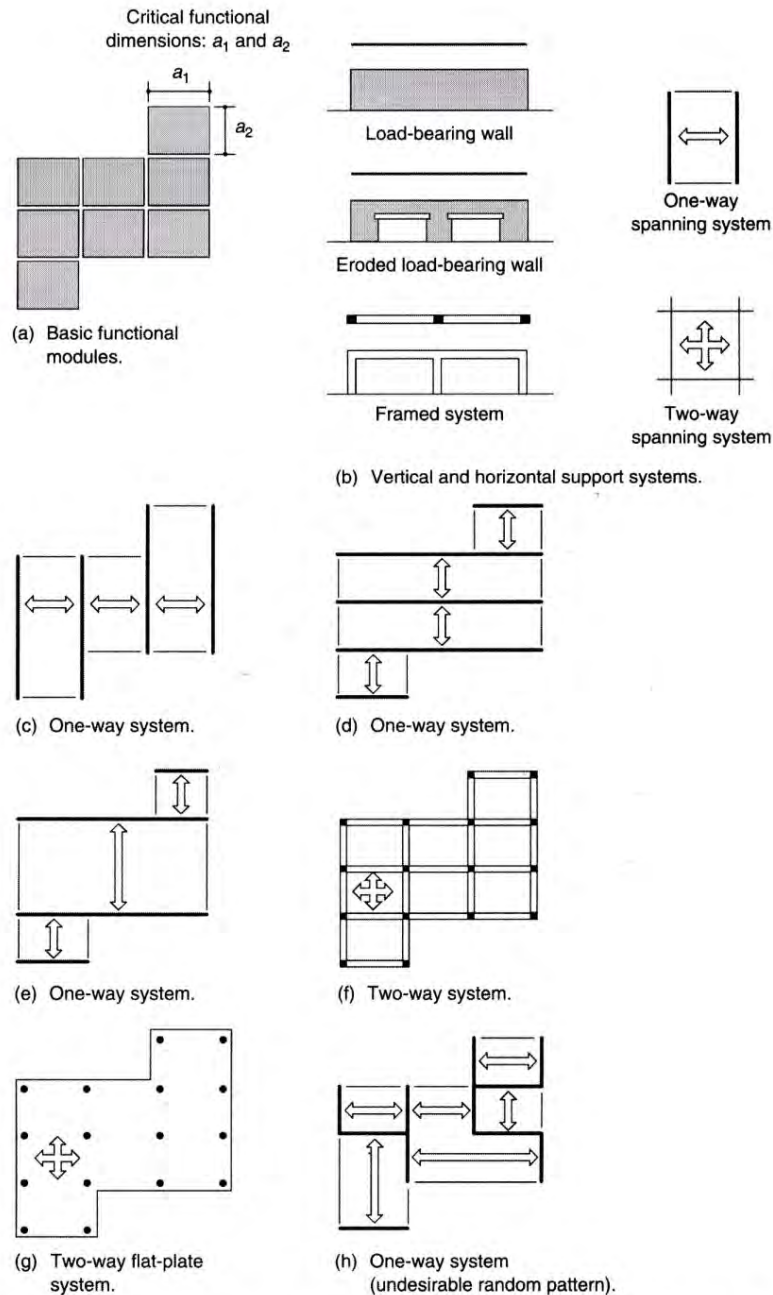
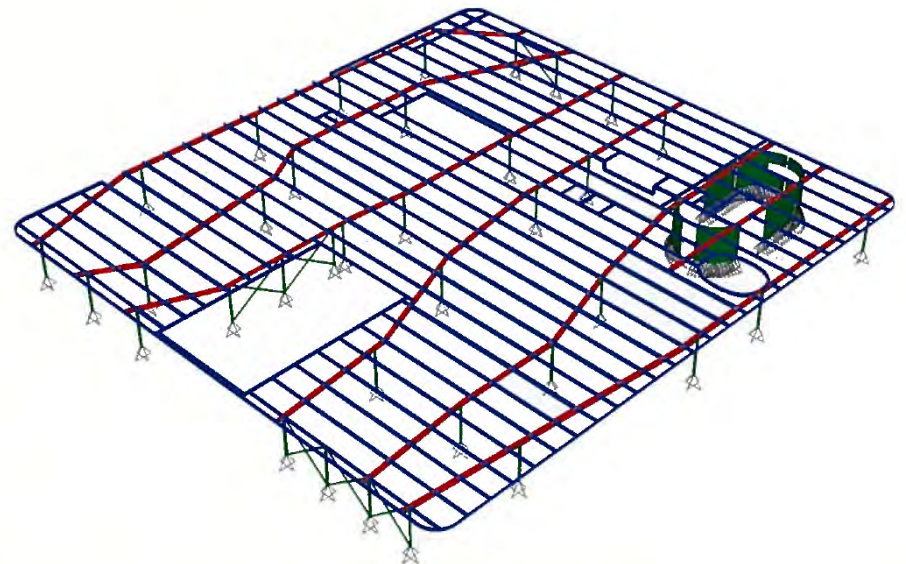


Figure 13.12 Vertical support patterns. Most buildings can be fitted with many different types of structural patterns that correspond to different building configurations and functional needs.



**Glass Pavilion
Toledo Museum of Art
Ohio**





Sendai Mediatheque
Toyo Ito

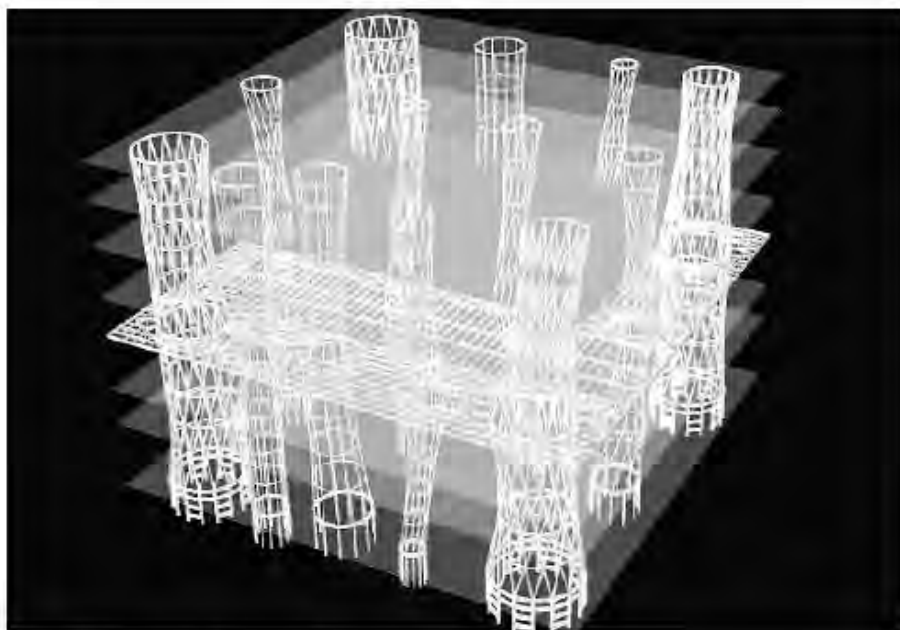


Fig. 3: Structural model

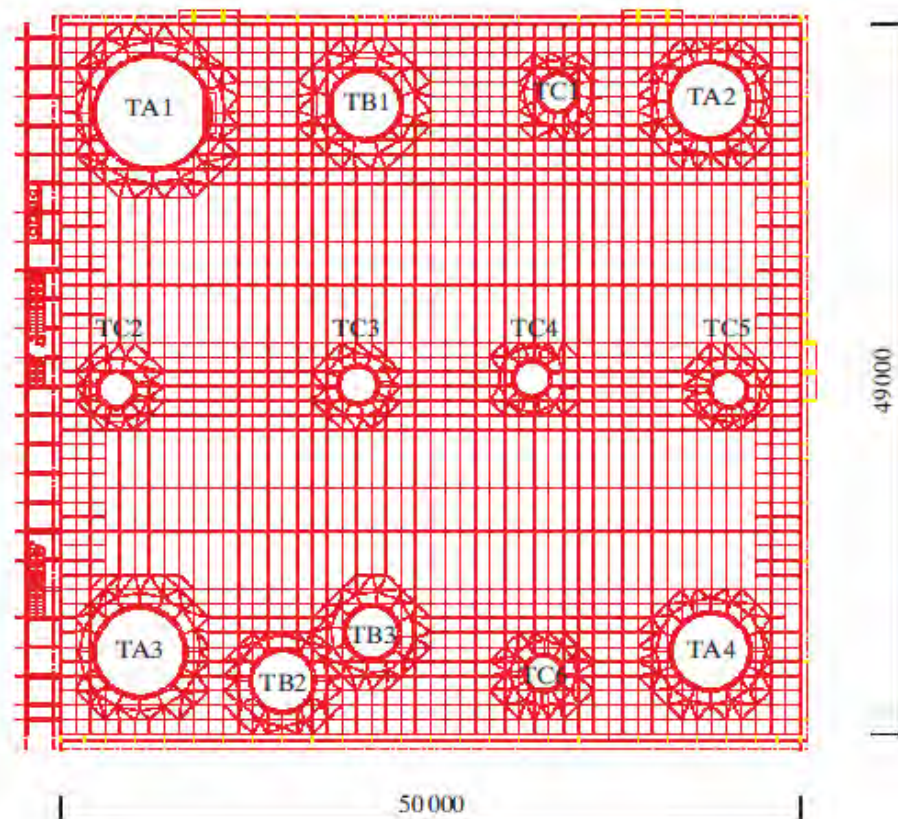


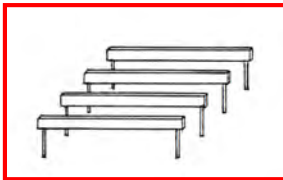
Fig. 4: Floor plan

Vad är en "balk" ?

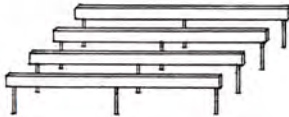
Ett bärverk som bär last vinkelrätt sin egen utsträckning

3.1 Balken-Systeme / Beam systems

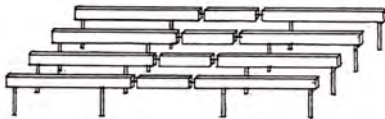
Einfeldbalken
One-bay beam



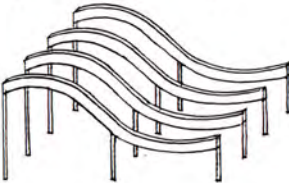
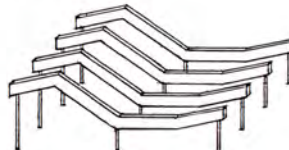
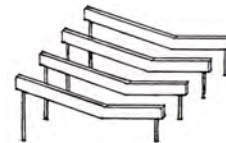
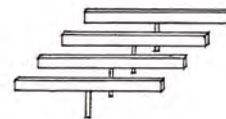
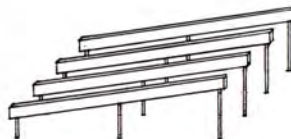
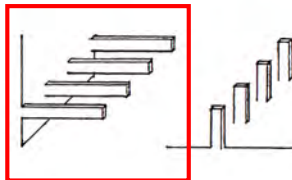
Durchlaufbalken
Continuous beam



Orelenkbalken
Pin-jointed beam



Kragbalken
Cantilever beam



Balktyper

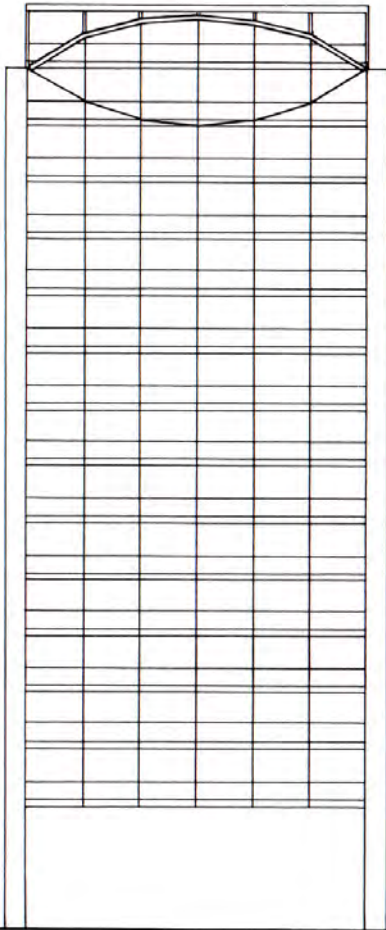
Fritt upplagd balk
 $h = L/20$

Kontinuerlig balk

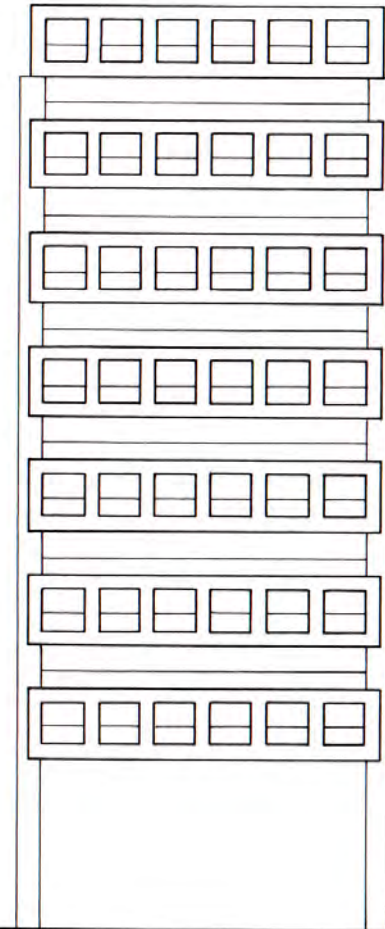
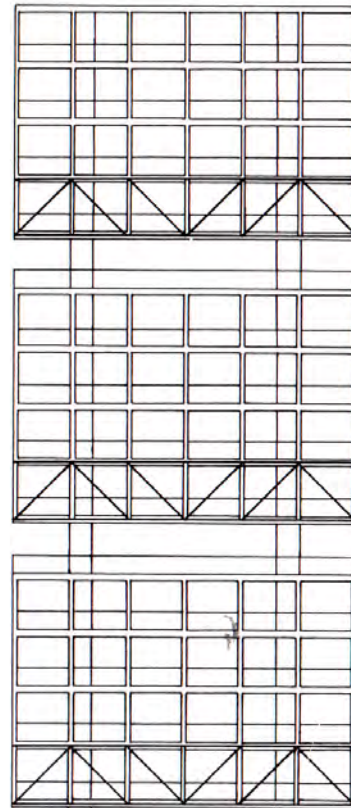
Gerber-balk

Konsolbalk
 $h = L/10$

Vollgeschoß-Trägersysteme in Brücken-Hochwerken



full-story girder systems in bridge highrises

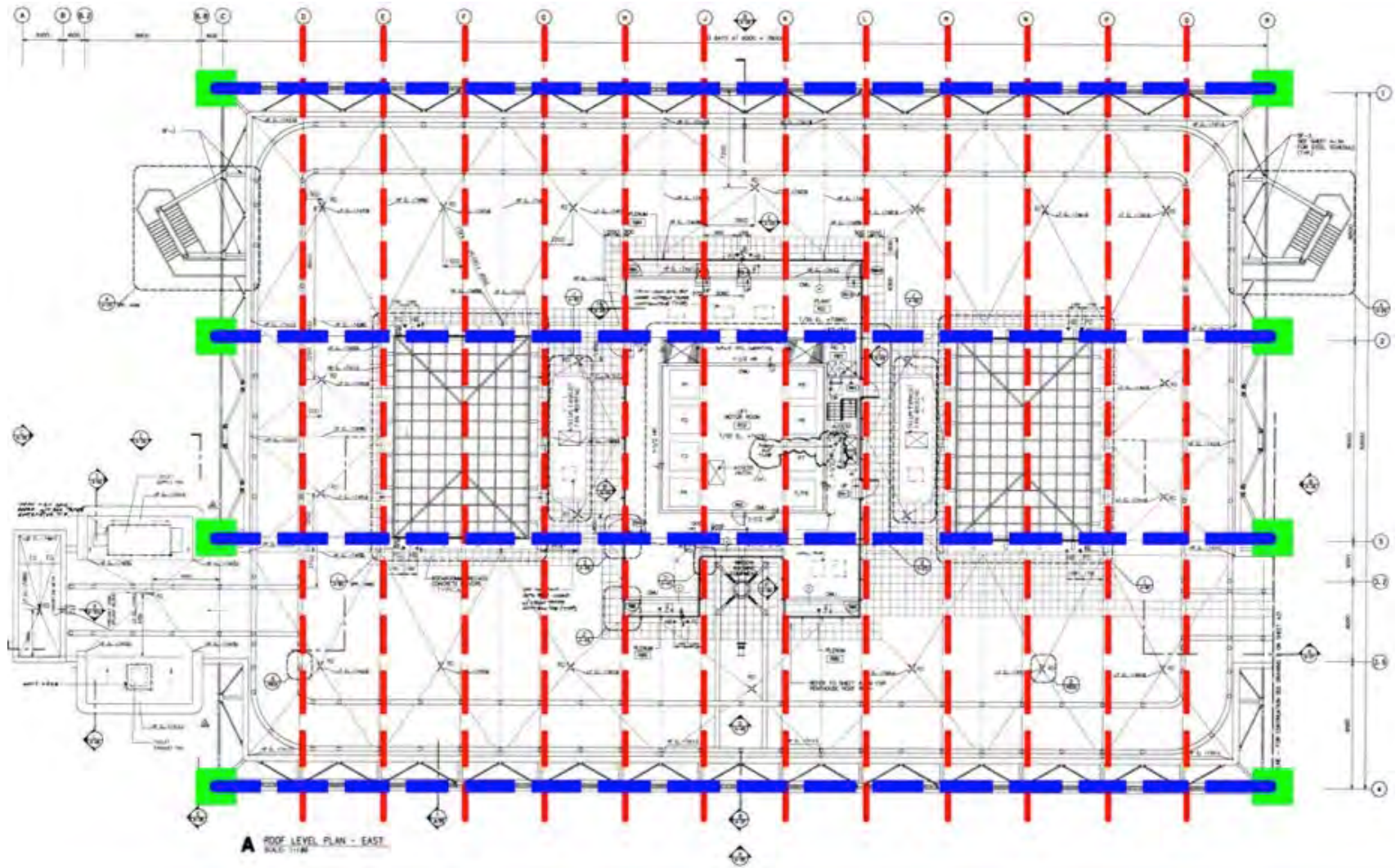




**Federal Reserve Bank
Minneapolis**



**Broadgate Exchange House
London**



Broadgate Exchange House
London

”Sekundärbalken” mellan konstruktion och rum



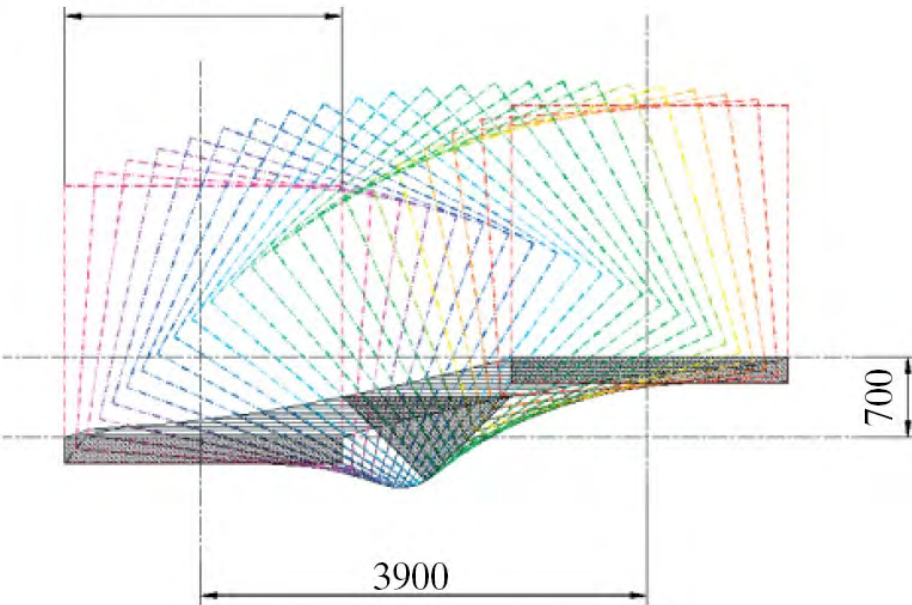


Bridge of Aspiration (Längtans bro)
Royal Ballet School – Royal Opera House 2002
Wilkinson Eyre Architects / Buro Happold

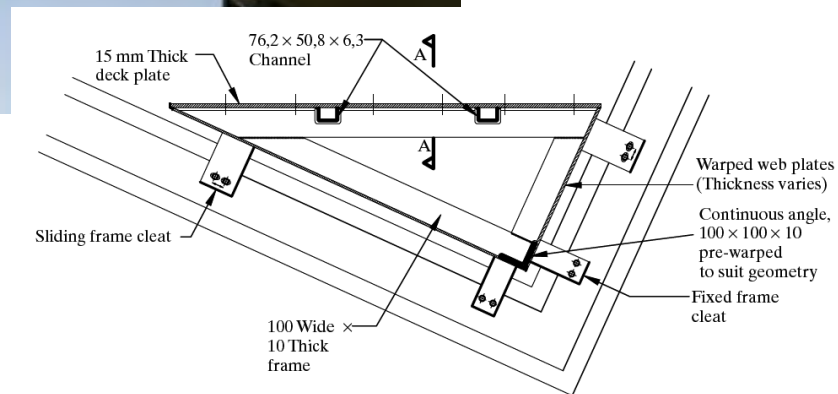
"Primärbalk" och rum
ur en geometrisk lek



Internal square
dimension = 2500



Om växelspelet
mellan konstruktion
och rum/rörelse



Typical section



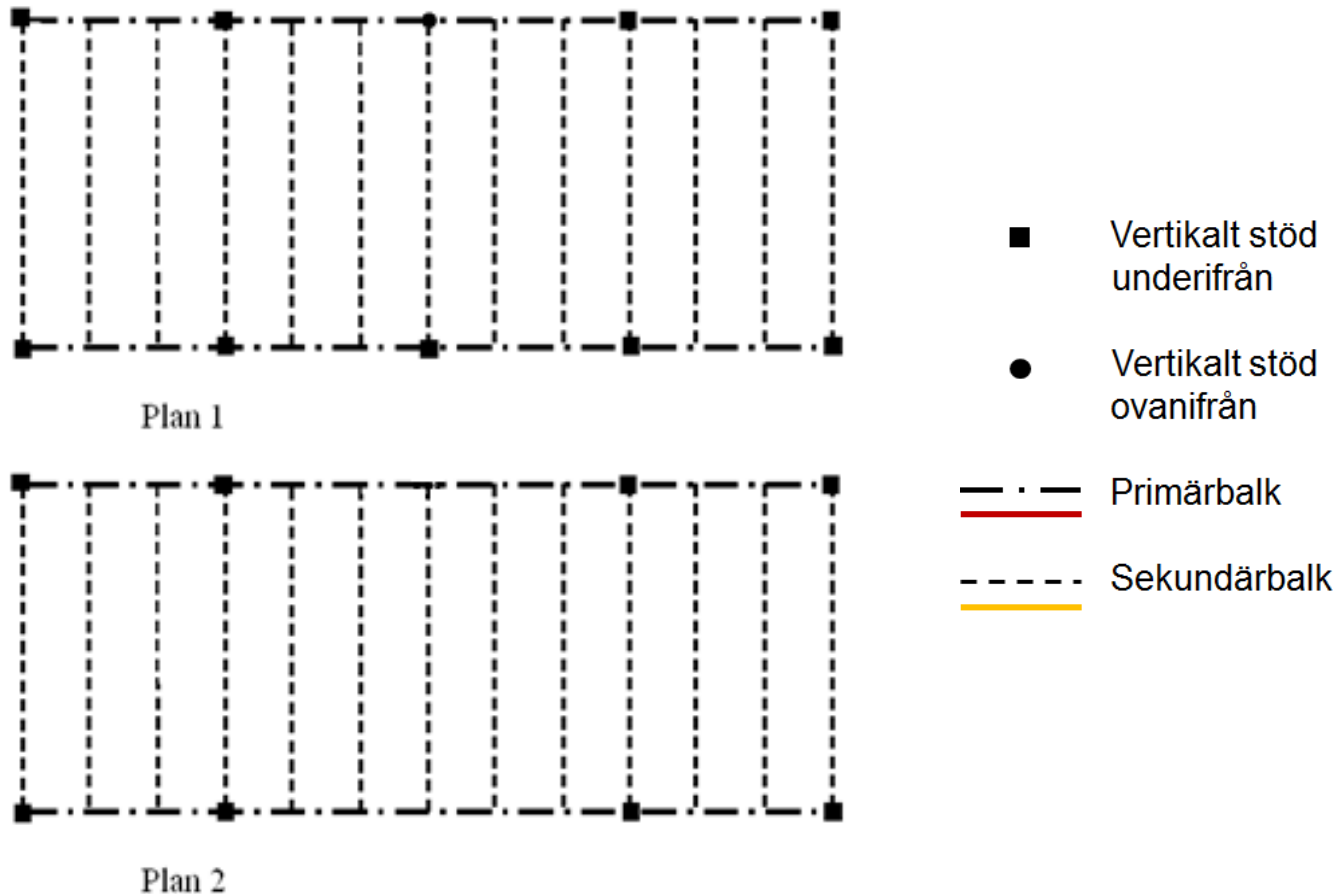


1. Exempel på vertikala laster



Ge exempel på olika vertikala laster som kan belasta en byggnad

2. Strukturer för vertikala laster



I figuren visas ett logiskt system för att bära vertikal last.

Rita en 3D skiss av det bärande systemet.

Resonera kring de olika "balkarnas" höjd (H/L) relativt varandra.

3. Exempel



Välj **två** exempel och beskriv
det vertikalt bärande systemet.

Till exempel

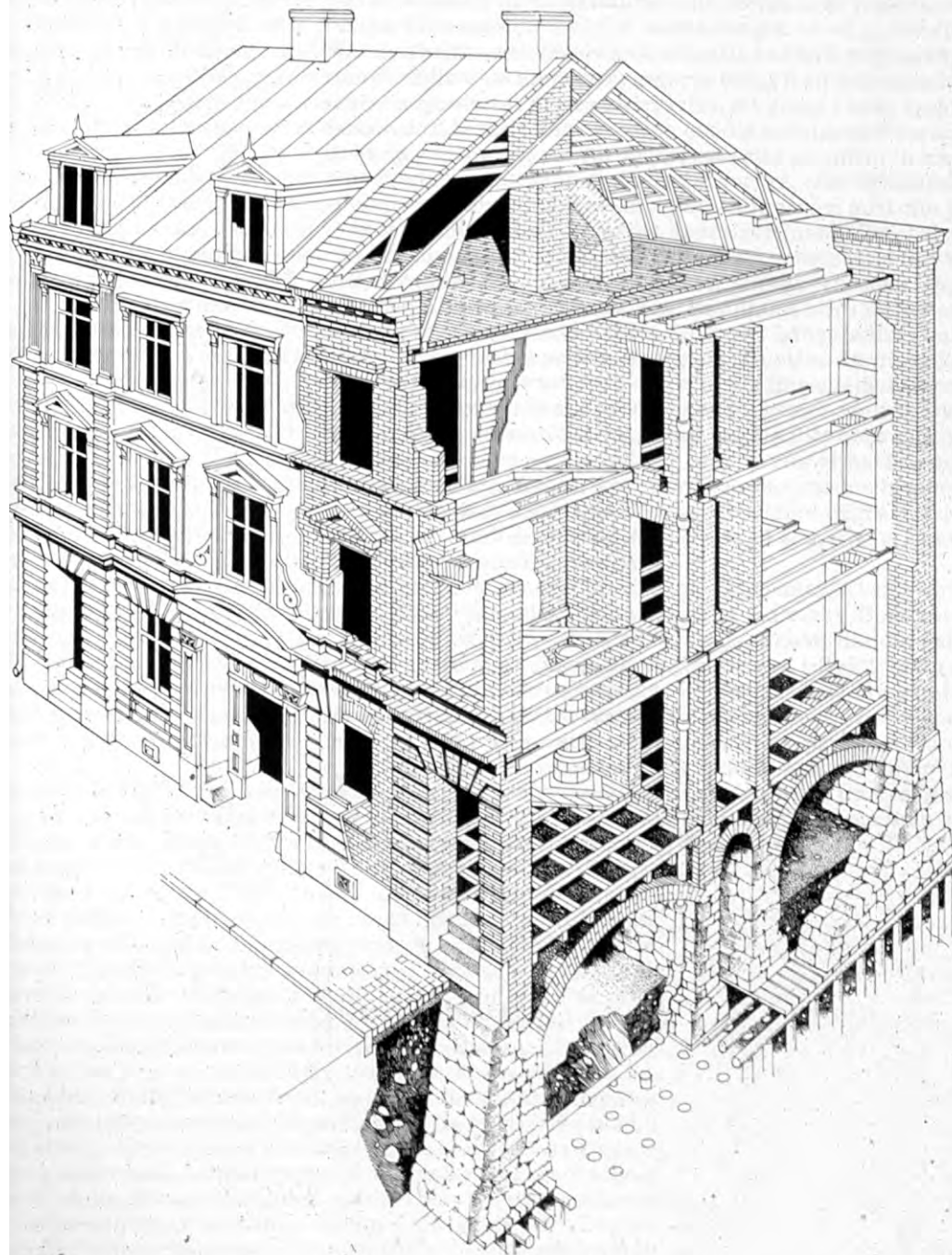
Store mosse

Den franska villan från Cecil Balmonds *Informal*

Kunsthauz Bregenz

Nils Ericsson-terminalen

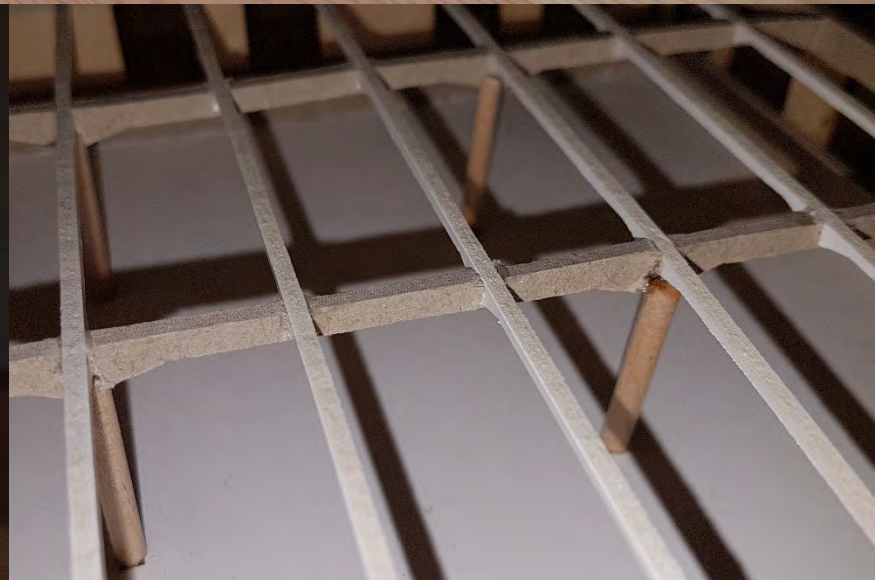




A2 Bevarande och omvandling Kvarnbyn



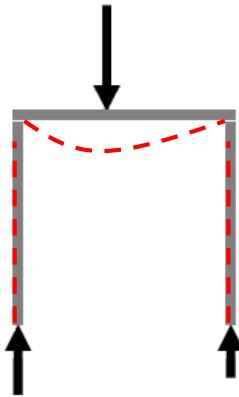
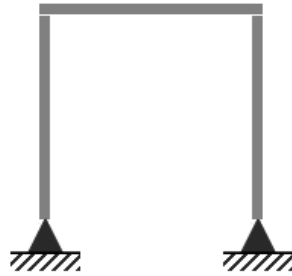
A2 Bevarande och omvandling



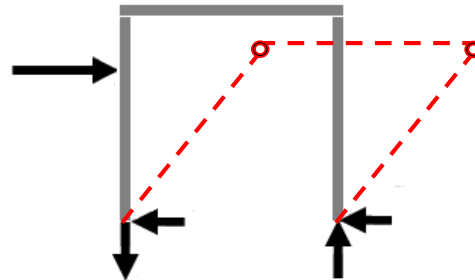
Horisontella laster



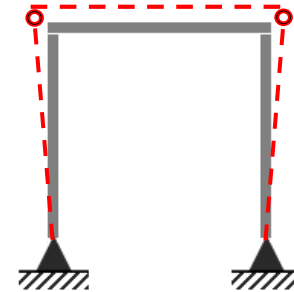
Horisontella laster



Vertikala laster

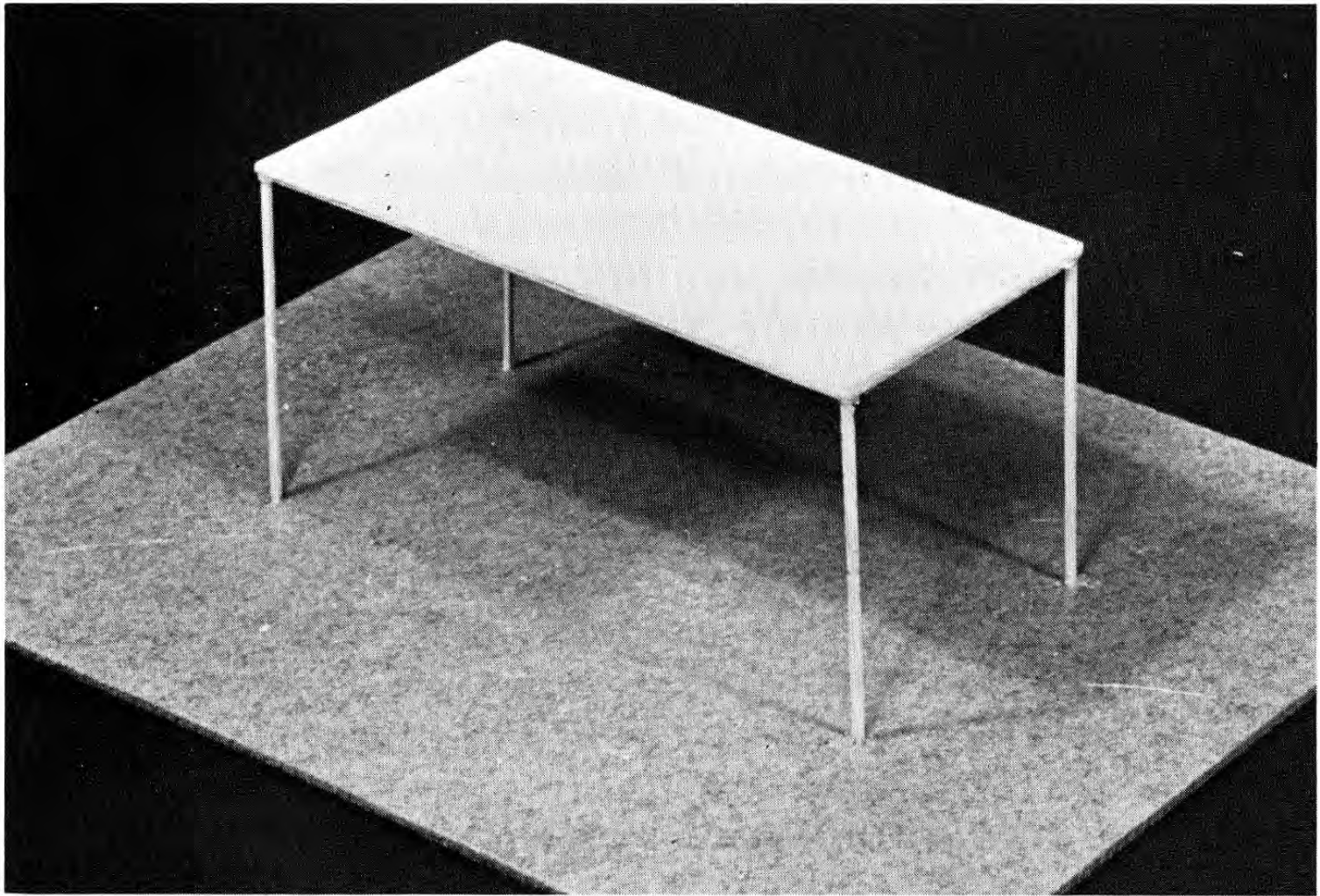


Horisontella laster

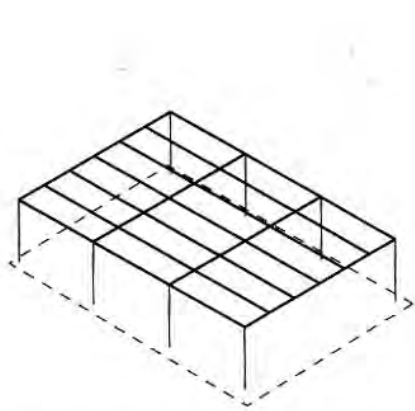


Temperatur
och fuktlast

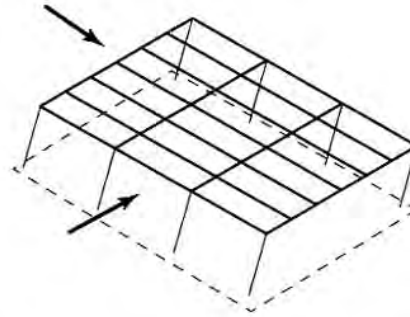
Mekanism!



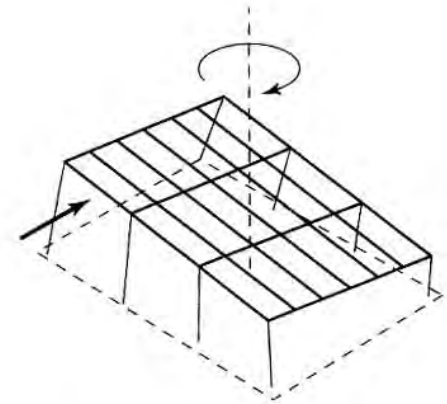
1.1 Model table framework.



(a) Basic structure without lateral stability devices



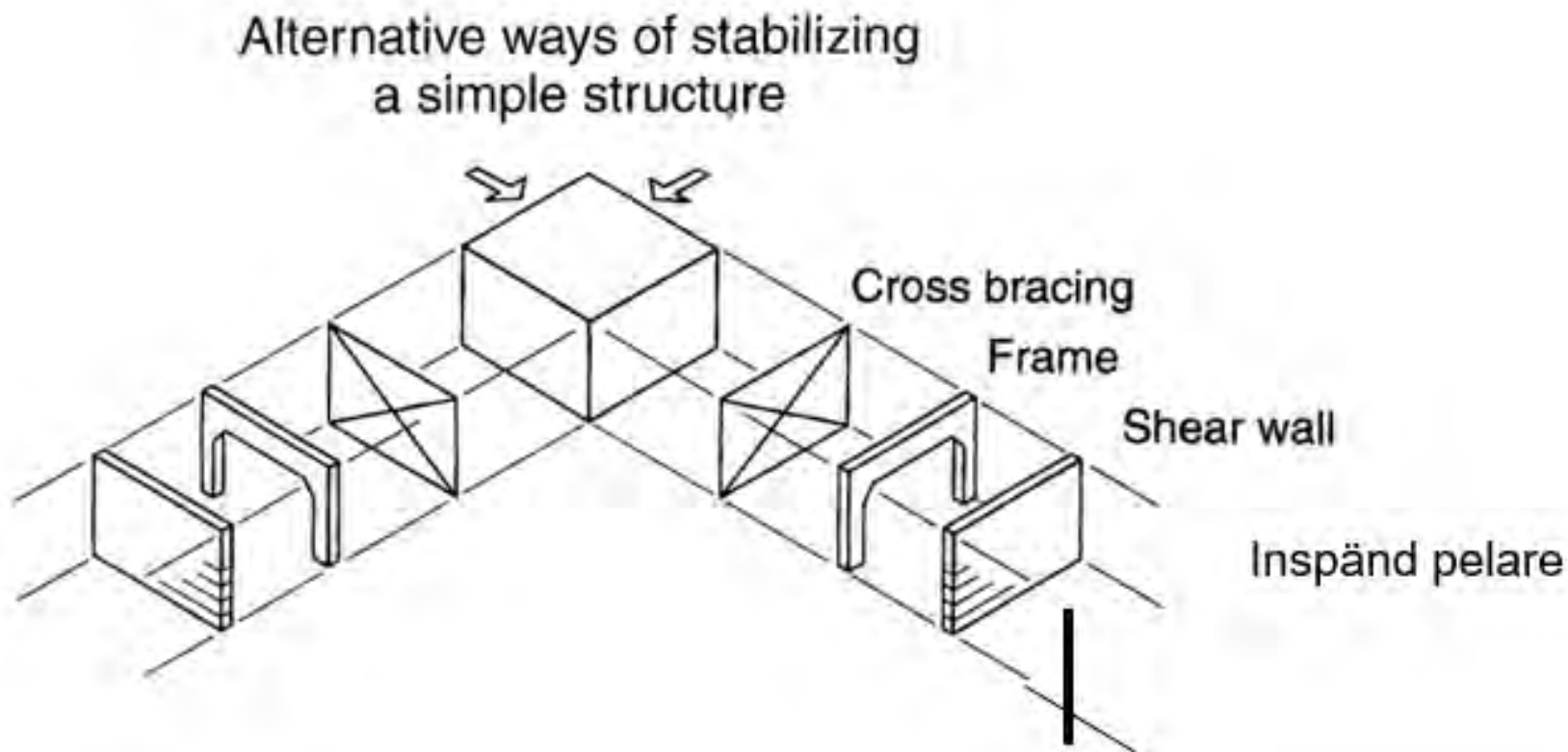
(b) Major lateral deformations ("racking") due to horizontally-acting wind or earthquake loadings.



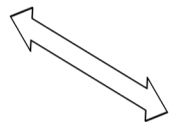
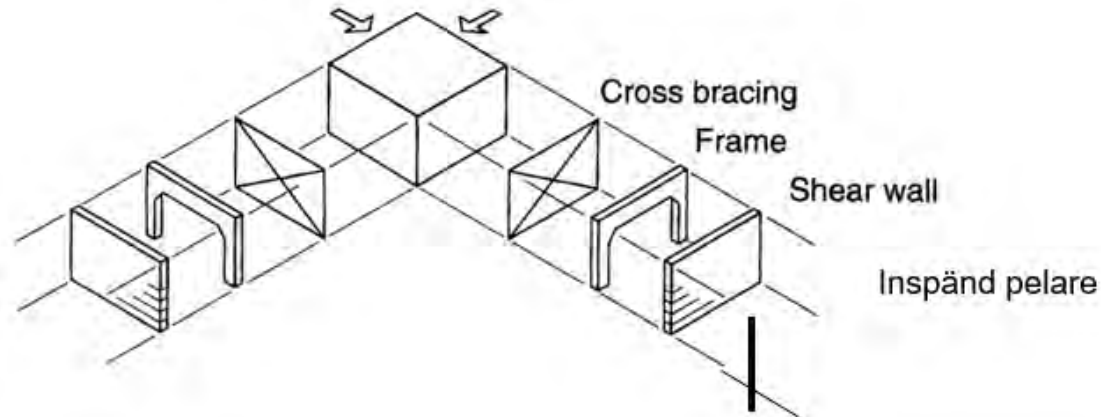
(c) Torsional deformations.

Figure 14.1 Typical effects of laterally acting wind or earthquake forces.

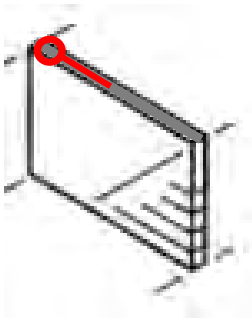
Olika strukturer för stabilisering (fyra grundtyper)



Alternative ways of stabilizing a simple structure

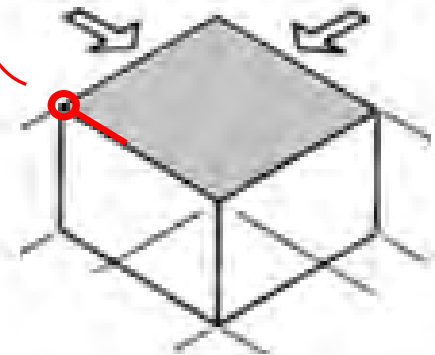


Riktning för förhindrad rörelse
av strukturens horisontella yta

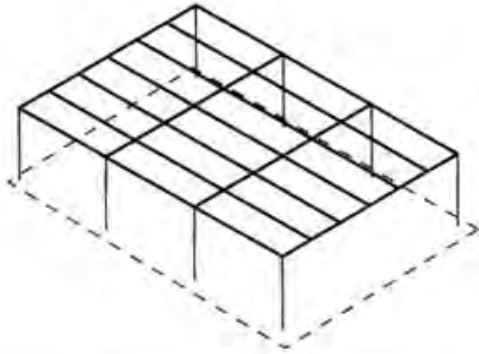


Vägg som förhindrar rörelsen
och därmed stabiliserar strukturen
i denna riktningen

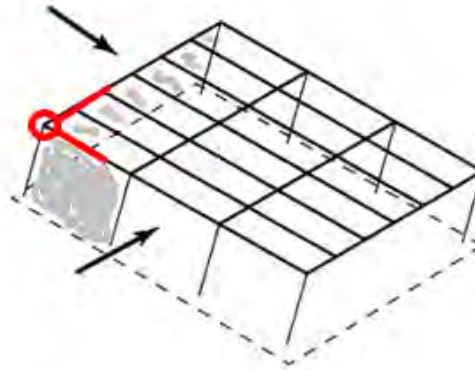
Symbol som visar
den låsta
rörelseriktningen



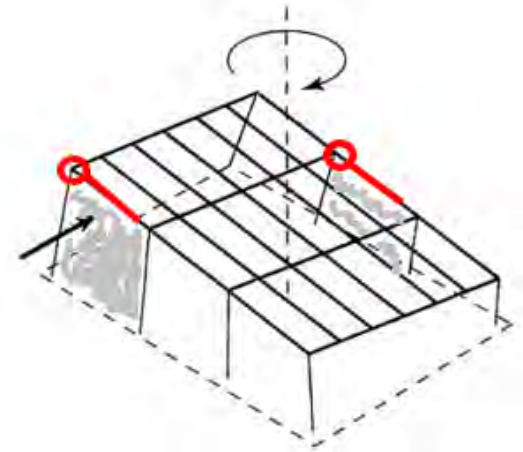
Tre stabiliserande väggar



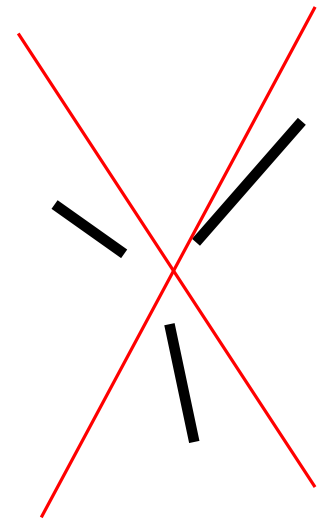
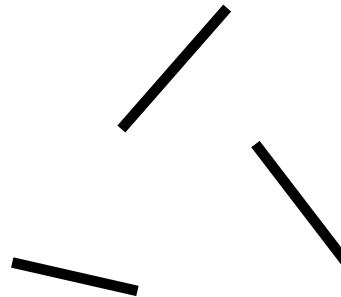
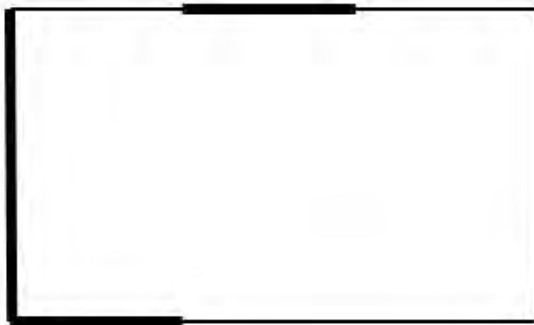
(a) Basic structure without lateral stability devices



(b) Major lateral deformations ("racking") due to horizontally-acting wind or earthquake loadings.

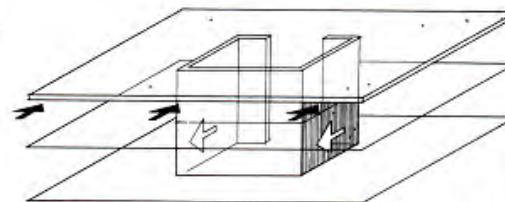
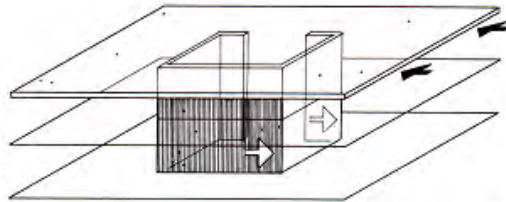


(c) Torsional deformations.

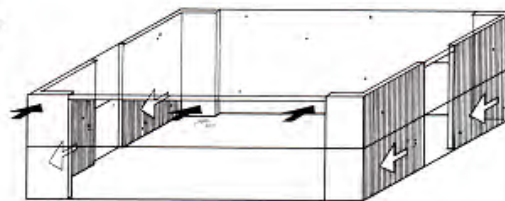
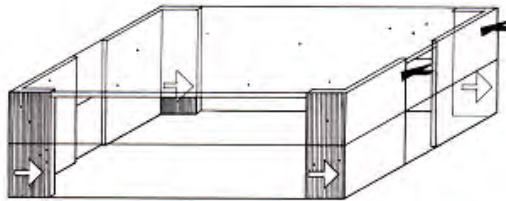


Windaufnahme in Längs- und Querrichtung
(bezogen auf Grundrisse der vorhergehenden Seite)

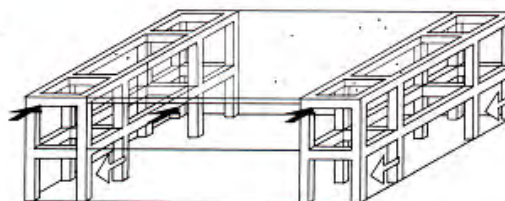
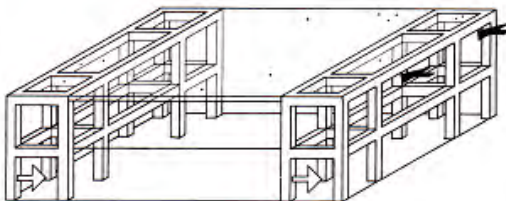
wind resistance in longitudinal and transverse direction
(related to floor plans of preceding page)



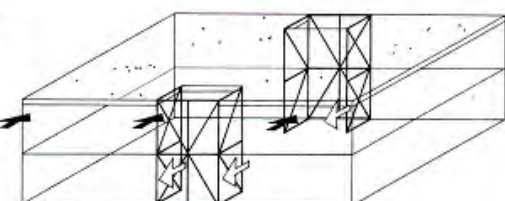
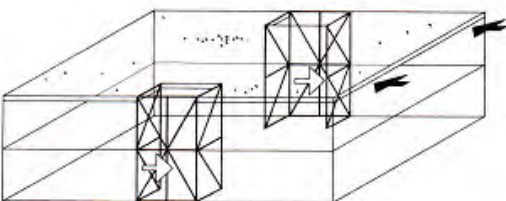
durch Zirkulationskern
through circulation core



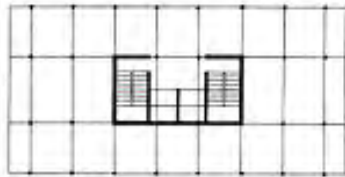
durch Außenwände
through exterior walls



durch Rahmen
through frames



durch Fachwerk
through trussing



mittiger Kern

control core



seitlicher Kern

one-sided core

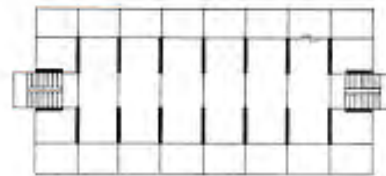
Tragelemente für Windversteifung
structural elements for wind bracing

Wände des Zirkulationskernes
walls of the circulation core



Außenwände

exterior walls



Trennwände

partition walls

Außenwände oder Trennwände
exterior walls or partition walls



Endestützen

end frames



gesamtes Skelett

complete skeleton

Stützen und Träger (Balken)
posts and beams (frames)



Zentrale Treppen

central stair wells

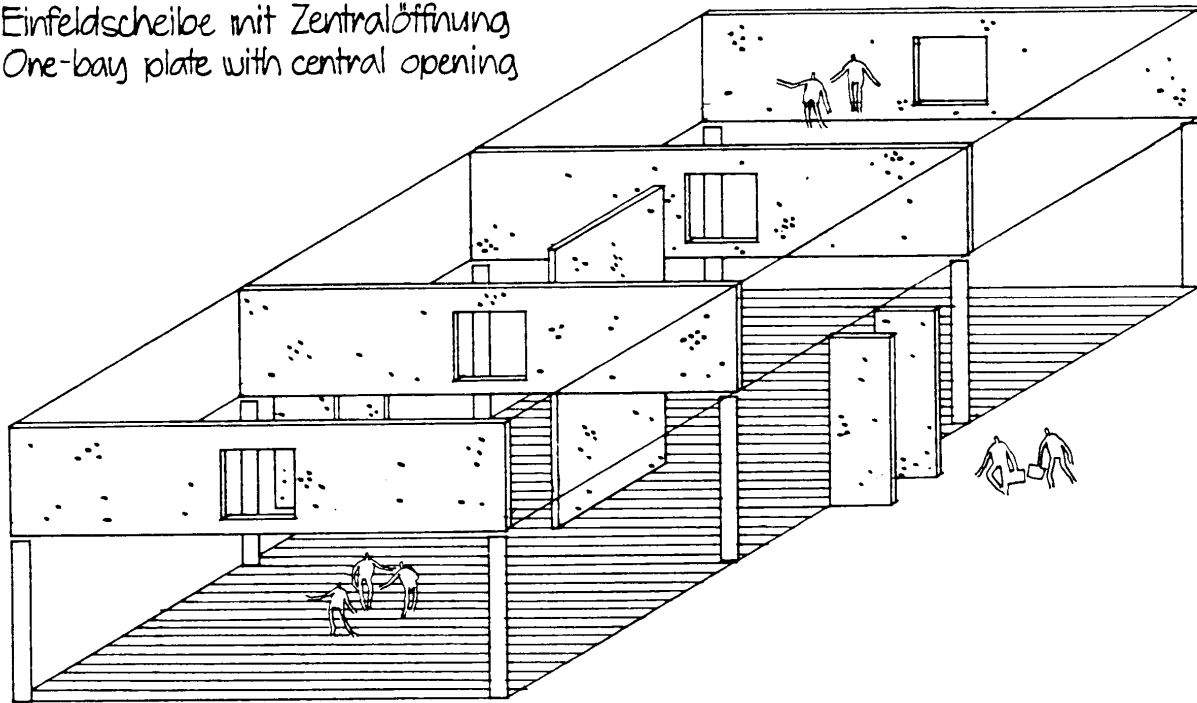


Stirnwand-Treppen

end wall stairs

Teile der Treppenhause/Wand
sections of staircase walls

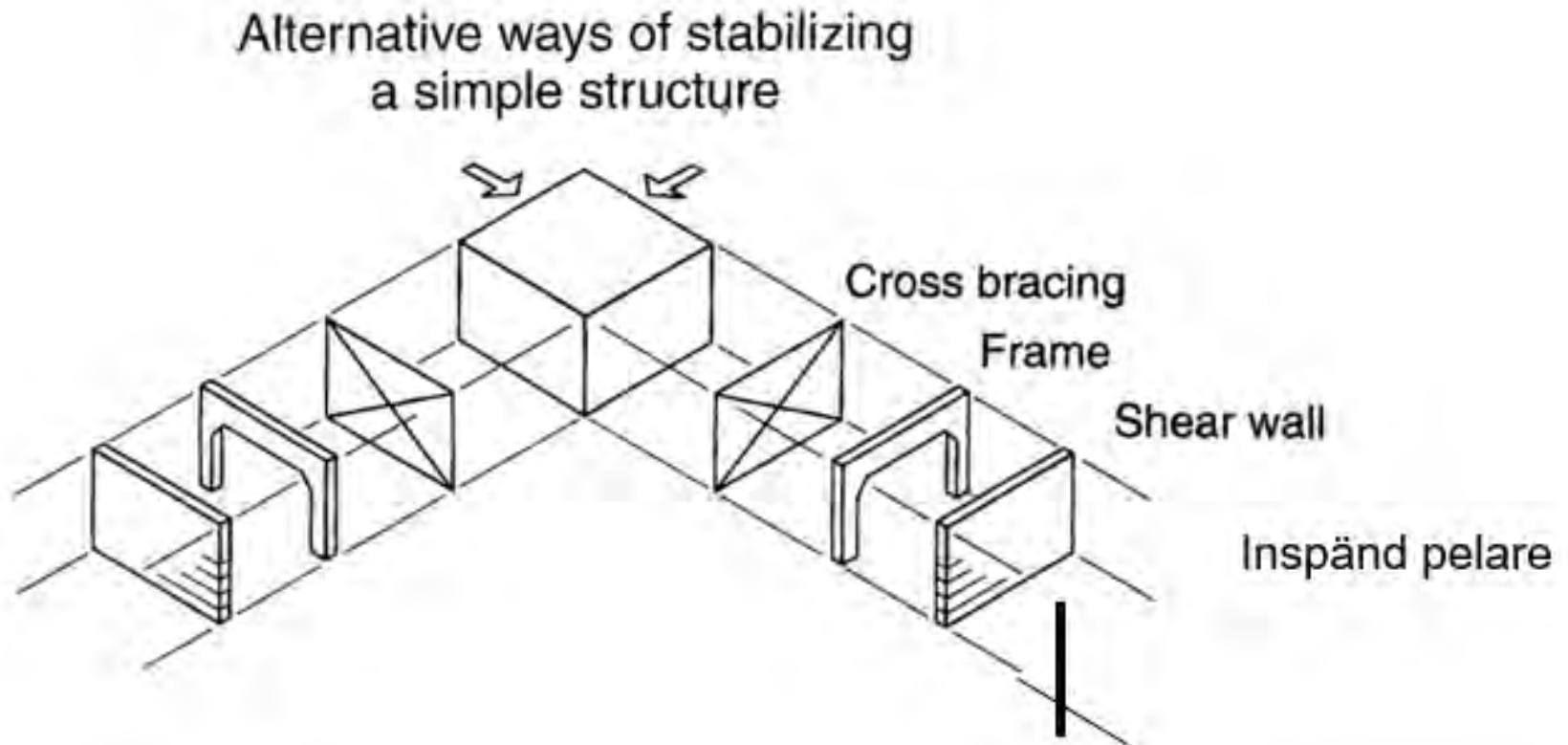
Einfeldscheibe mit Zentralöffnung
One-bay plate with central opening

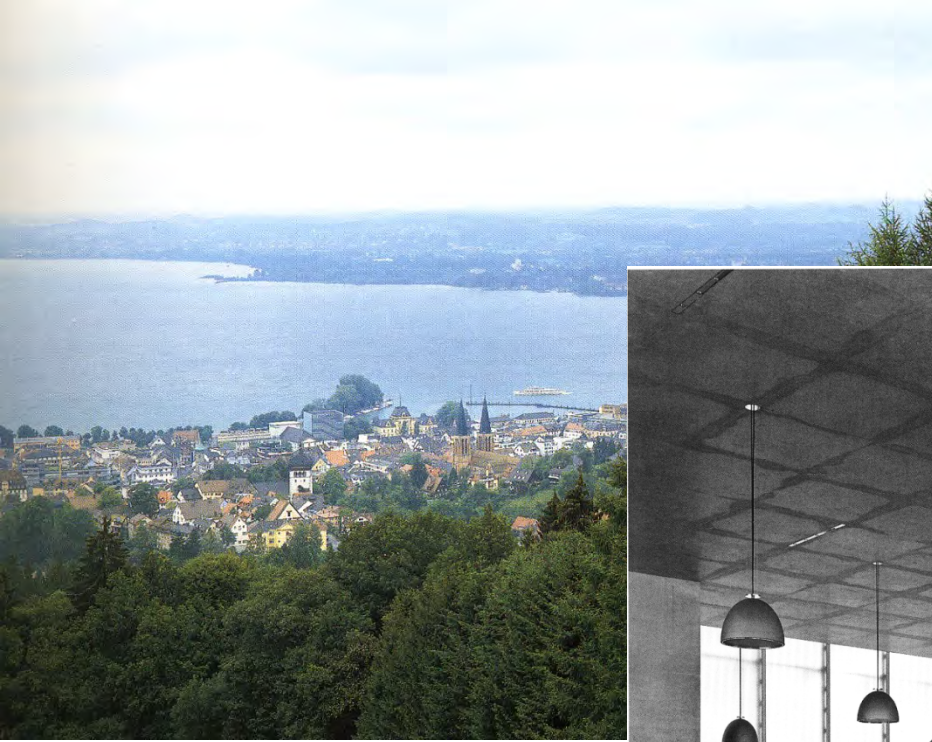


För horisontell last (vind)



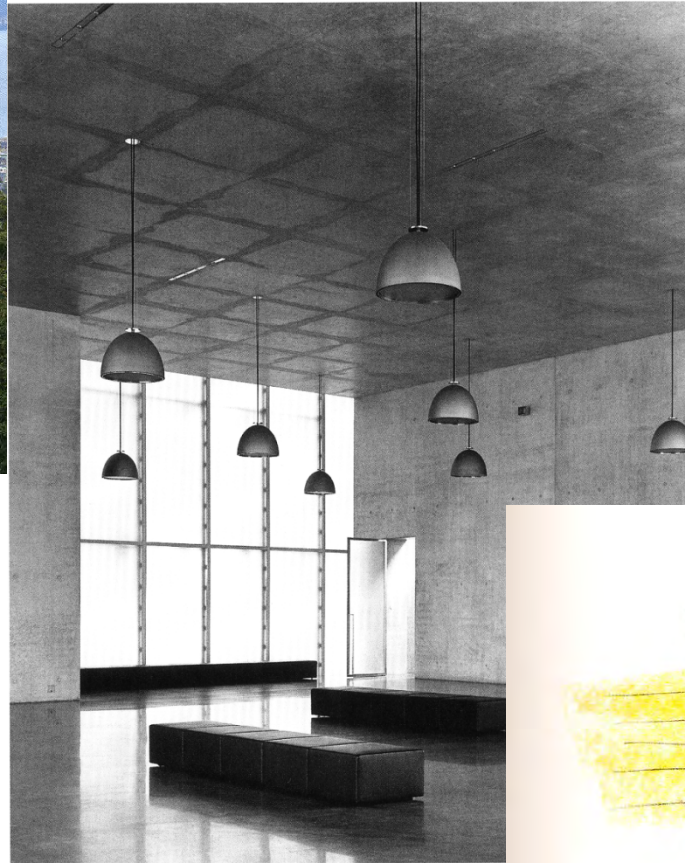
Olika strukturer för stabilisering (fyra grundtyper)



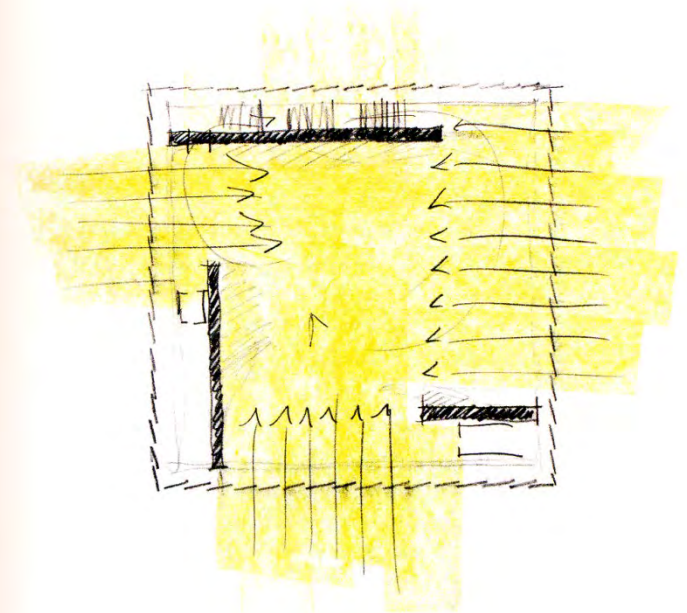


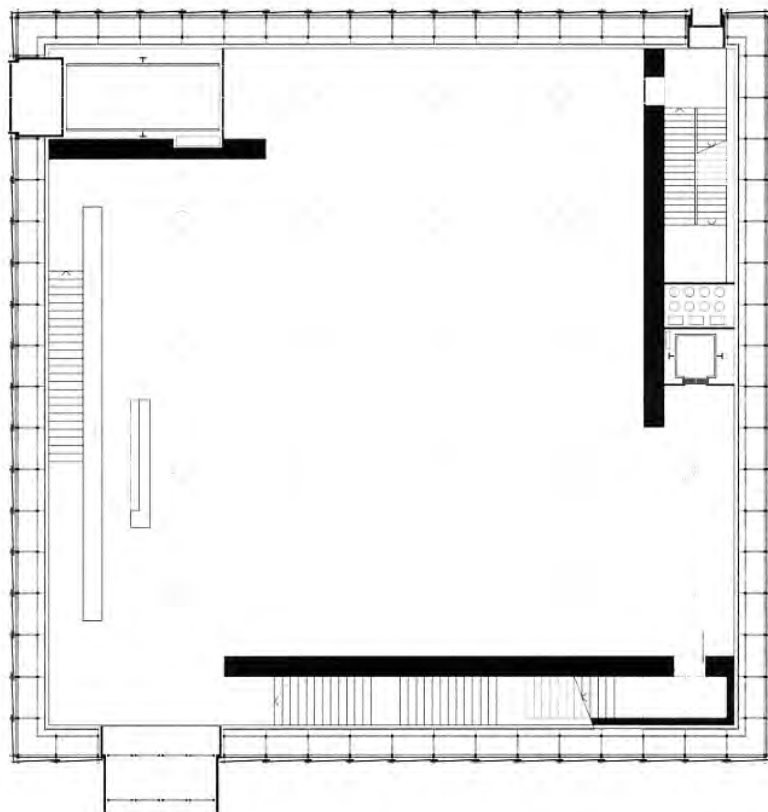
Kunsthhaus Bregenz

Peter Zumthor



Byggnaden som
bärande system



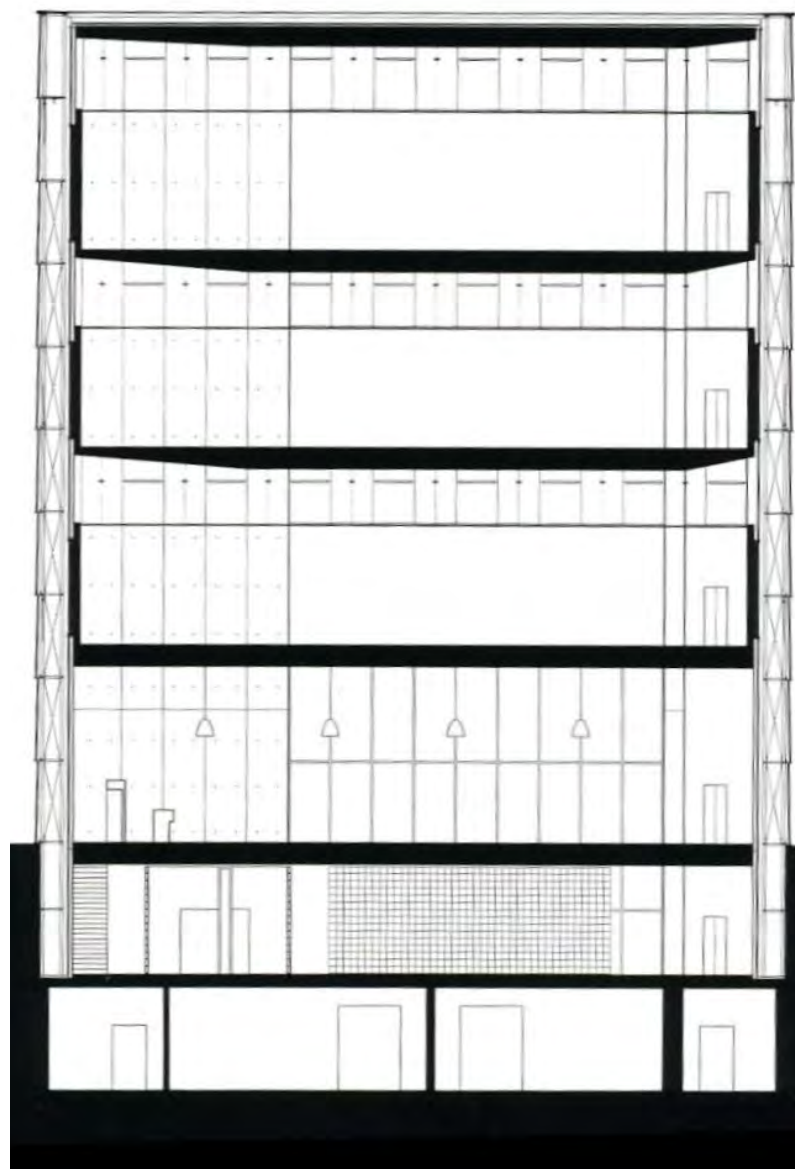


A

B

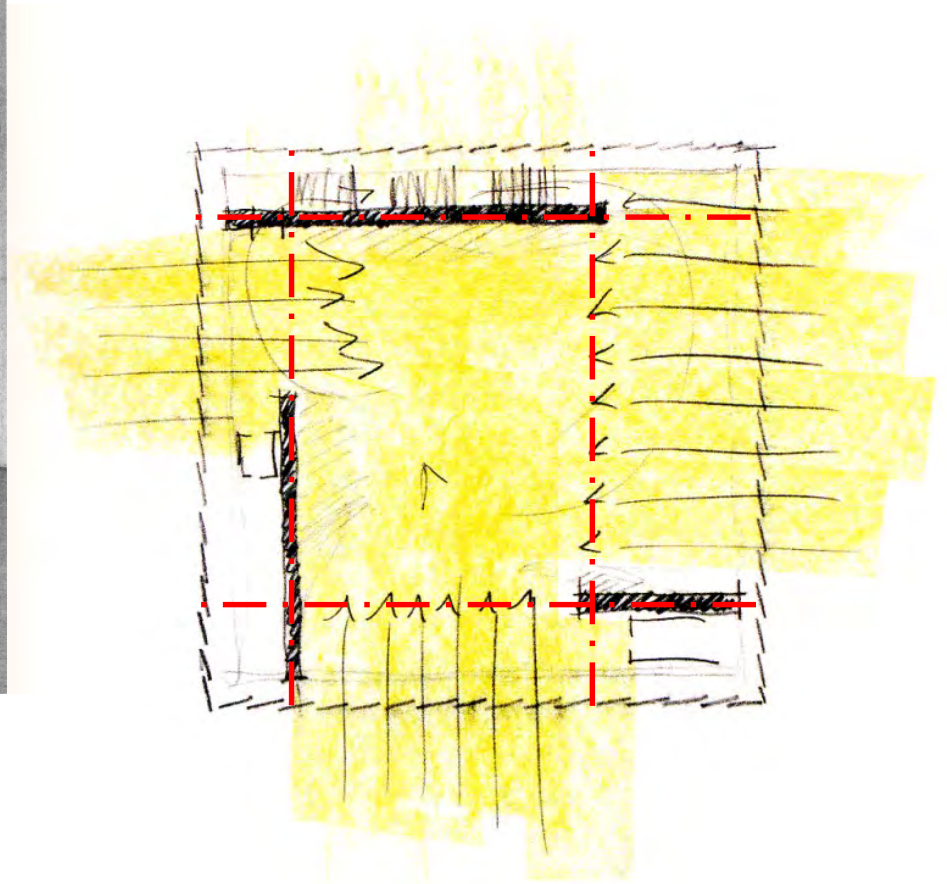








Skivan som stöd för vertikala laster

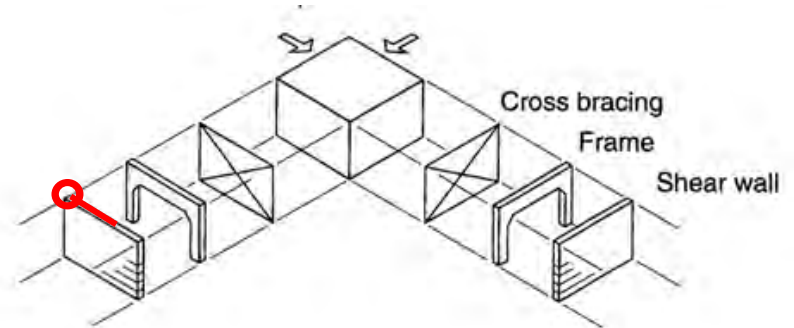
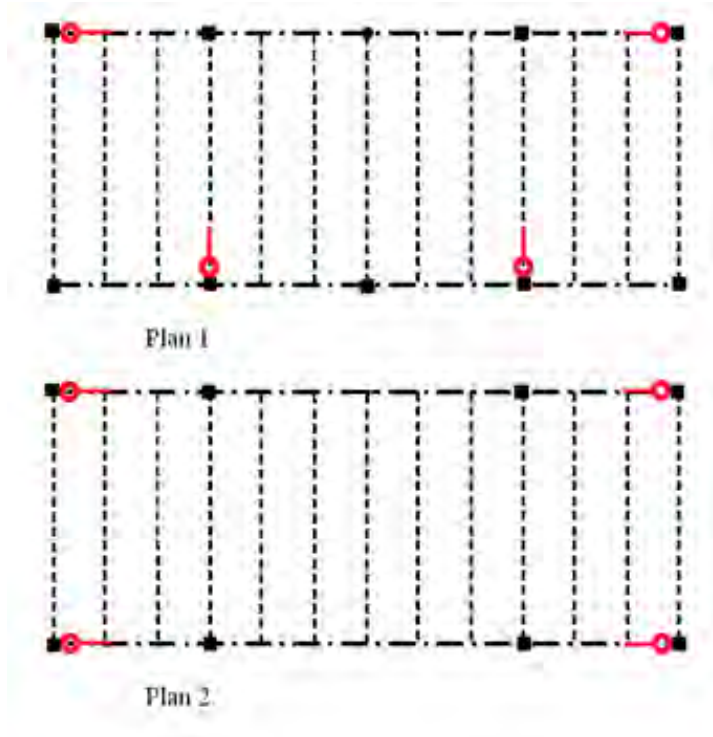


4. Exempel på horisontella laster



Ge exempel på olika horisontella laster som kan belasta en byggnad

5. Strukturer för horisontella laster



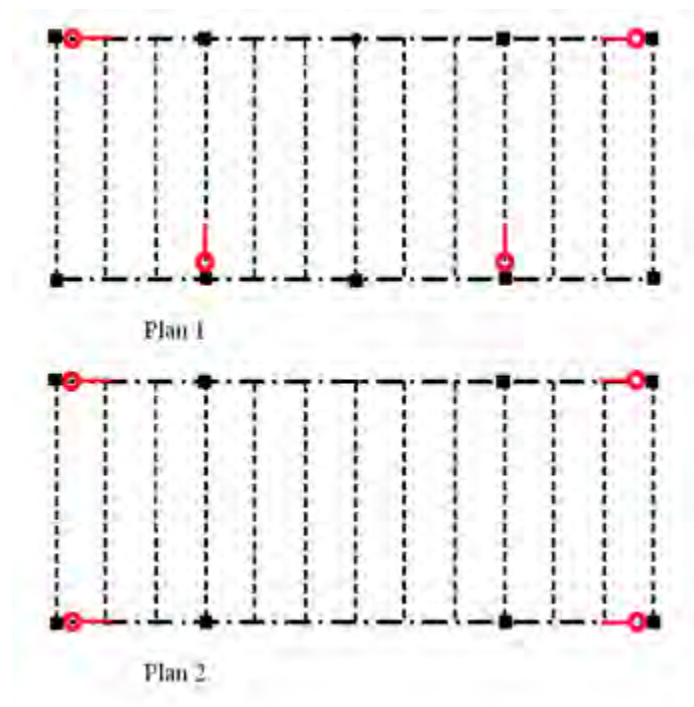
I figuren beskrivs ett bärande system i två plan.

De röda "nycklarna" anger horisontella stöd.

Minst ett horisontellt stöd saknas.

Komplettera figuren med en nyckel så att horisontell stabilitet erhålls.

6. Strukturer för vertikala och horisontella laster



Bygg en fysisk modell av byggnaden med hjälp av:

- 8 cm långa grillpinnar (pelare) **får inte vara kontinuerliga mellan två våningar!**
- dubbla 2 mm grå pappersark på högkant (primärbakar)
- enkla 1 mm horisontella vita pappersark (sekundärbalkar + högsta ordningens bärning)
- enkla 2 mm grå pappersark (stabiliserande väggar)
- sammanfoga med lim

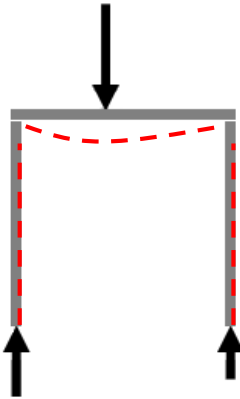
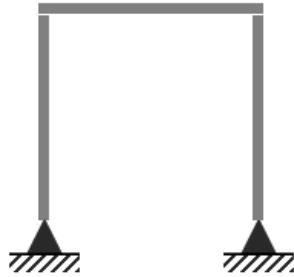
Känn med handen instabiliteten hos de *horisontella bjälklagen* innan de *stabiliserande väggarna* är på plats

7. Exempel

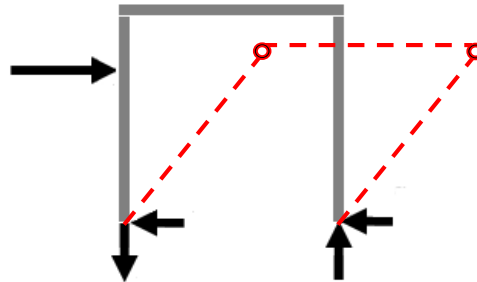


Välj samma **två** exempel som i uppgift 3 och beskriv det horisontellt bärande (dvs. stabiliserande) systemet med hjälp av nycklar.

Temperatur- och fuktlast

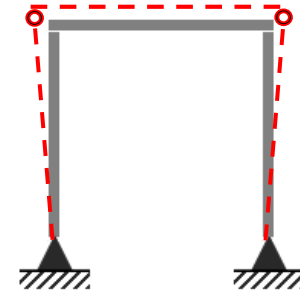


Vertikala laster



Horisontella laster

Mekanism!



Temperatur
och fuktlast

Karaktärisering av strukturer (Föreläsning 2)

Mekanism

instabil

Statiskt bestämd

stabil

en lastväg

fri att expandera/krympa

Statiskt obestämd

stabil

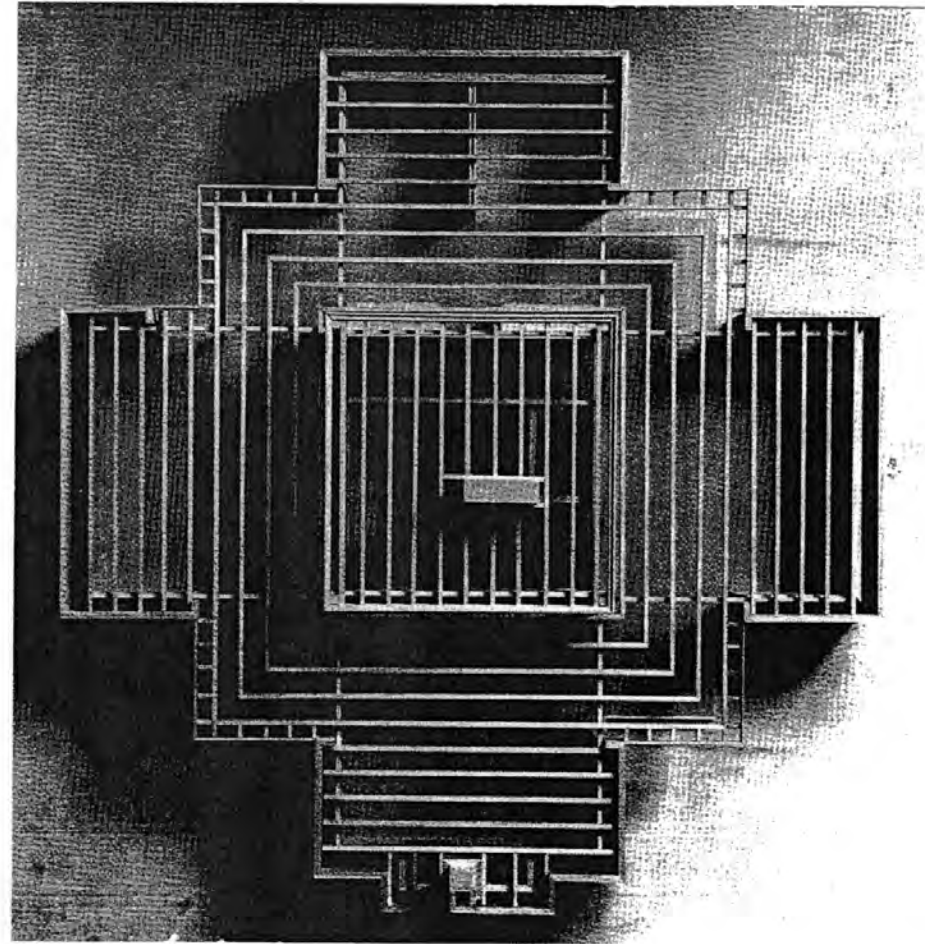
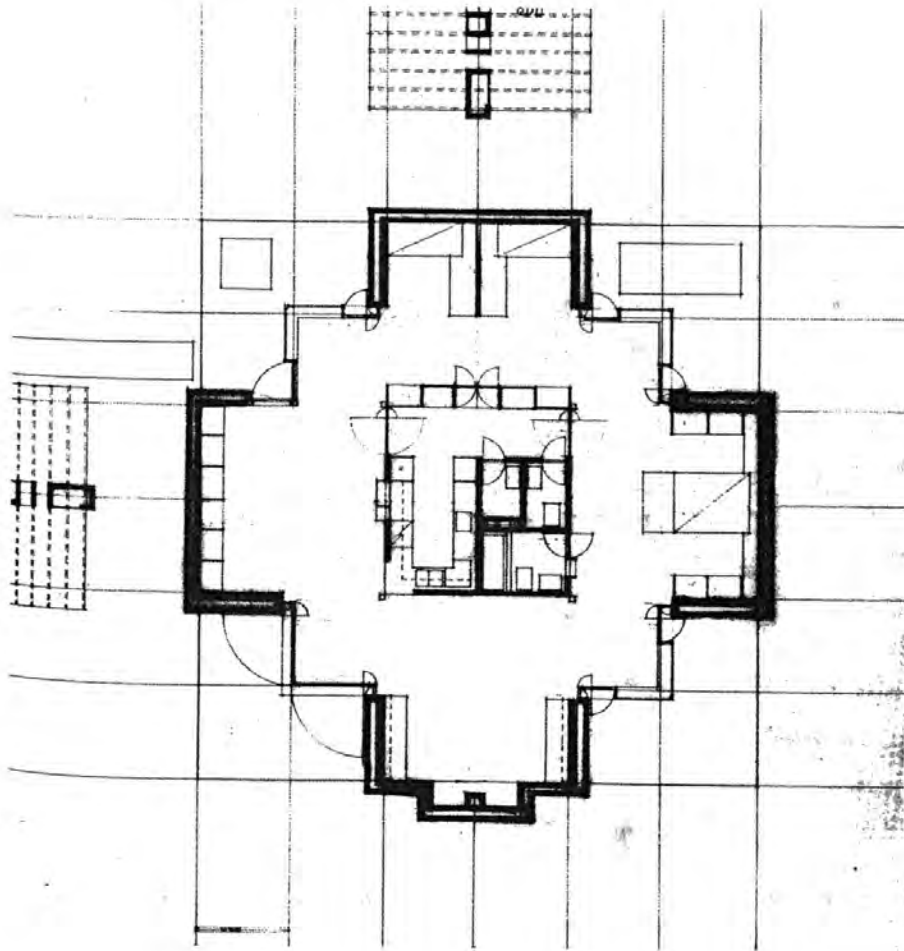
flera lastvägar

inre tvång vid expansion/krympning



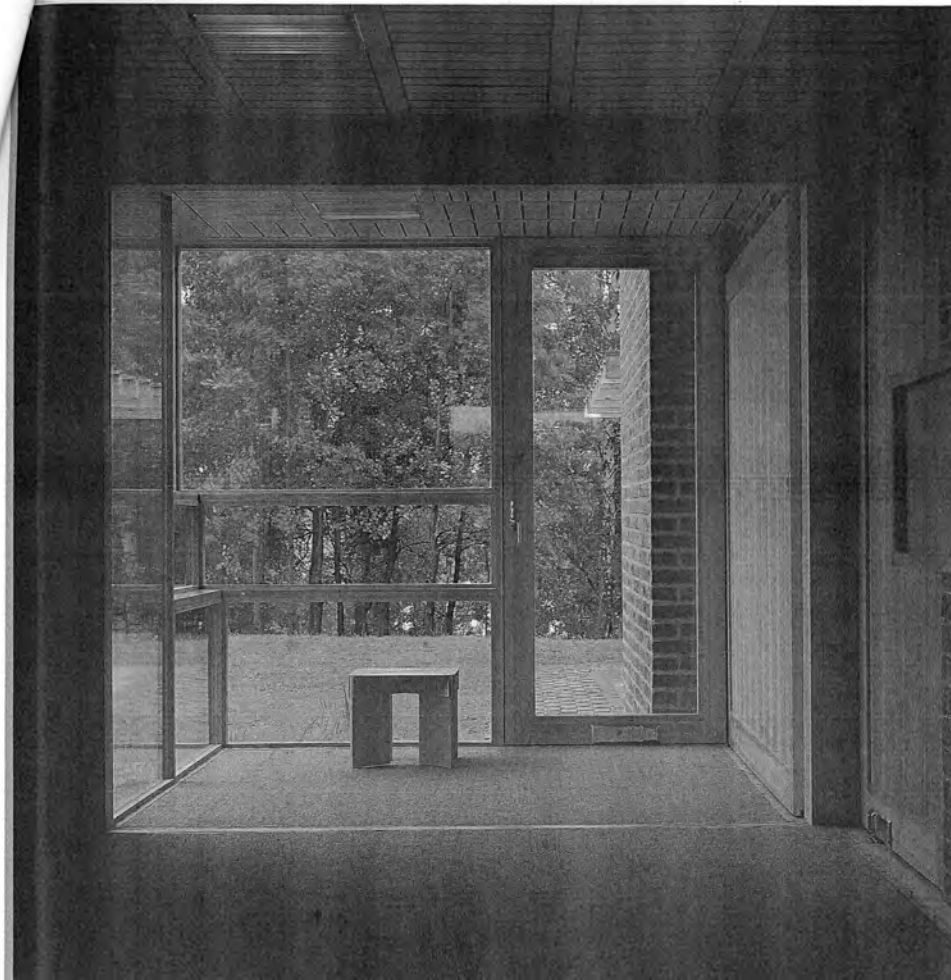
Sverre Fehn

Villa Norrköping 1964





Samtliga fotografier Helena Bergengren





Människan



Poesi



Plats



Material



Struktur, konstruktion



Rum