

Modul I	Do. 17. September	Obendrauf
Modul II	Do. 24. September	Zubau/Sanieren
Modul III	Do. 01. Oktober	Im Hof
Modul IV	Do. 08. Oktober	Baulücke

Modul I – Obendrauf

Do. 17. September 2020

_Peter Bauer, werkraum ingenieure zt gmbh

_Paul Track, Woschitz Group, Wien

_Johannes Zeiningger, @ zeiningger architekten, Wien

Dieses Modul wird unterstützt von



storaenso

Modul I – Obendrauf

Leicht/Schwer: Erdbebensicherheit Bauweisen und Konstruktion

Peter Bauer, werkraum ingenieure zt gmbh

Laterale Gebäudeaussteifung
erforderlich

wegen

- ungewollte Schiefstellungen
- Wind
- Erdbeben

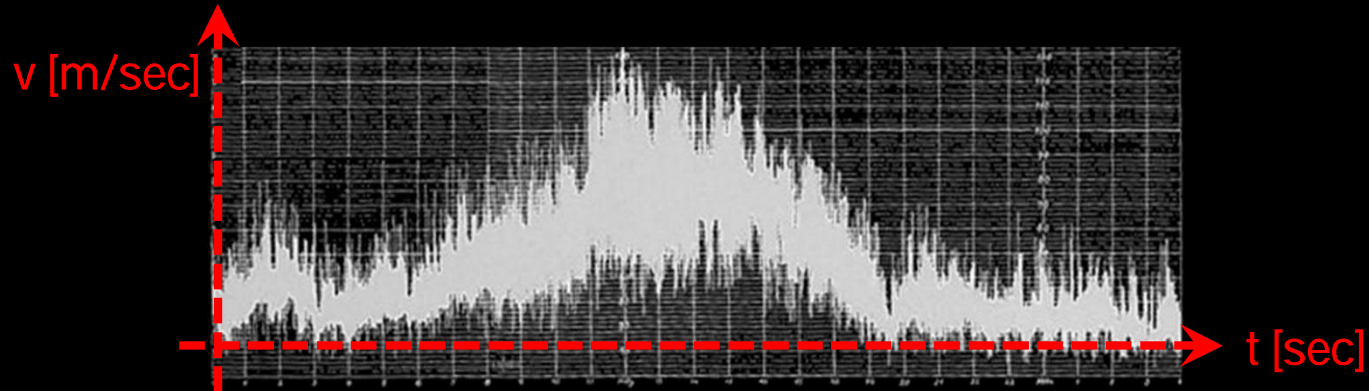


Stabilisierungskräfte

Statisch,
Variabler Anteil: Nutzlast
Richtung: Konstant (Abhängig von der Schiefstellung Ψ_0)

Wind

„Statisch“
Variabler Anteil: „Gesamt“
Richtung: Konstant (Abhängig von der Windrichtung)

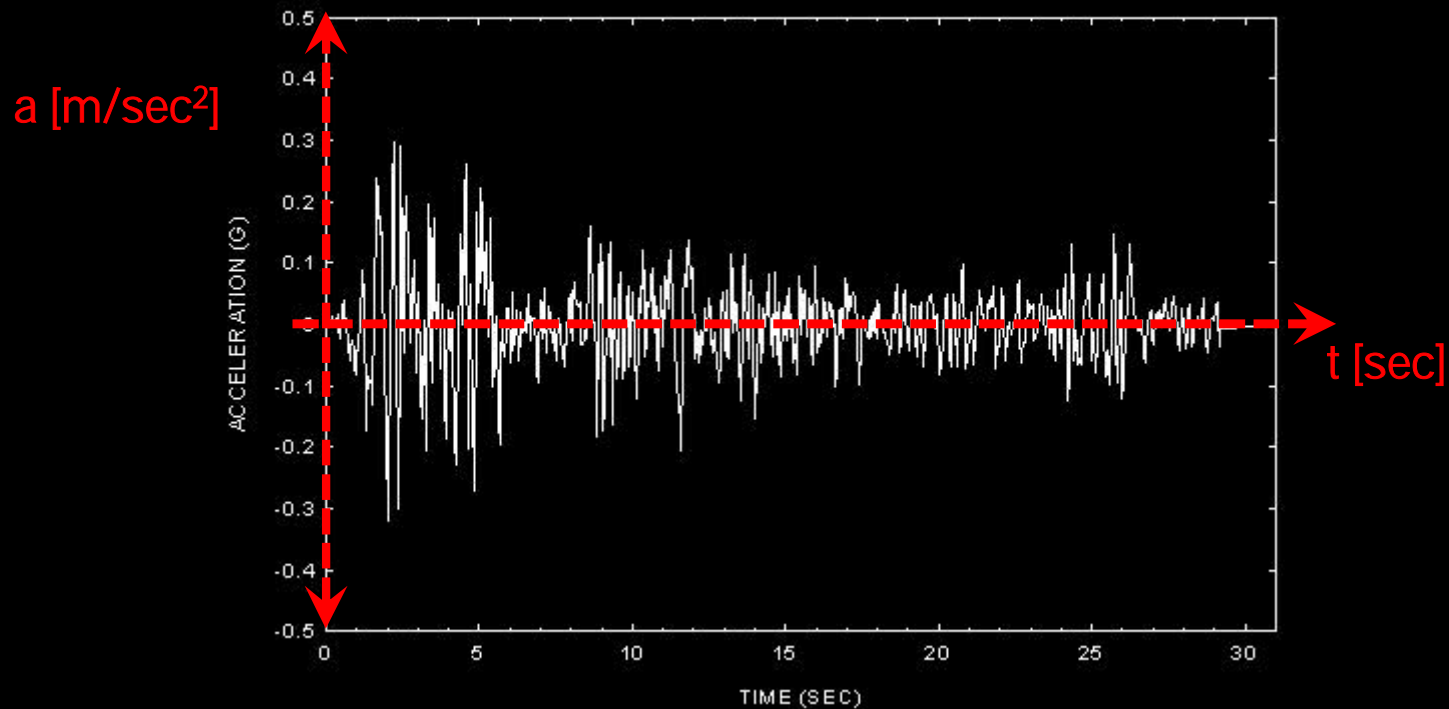


Typischer Windlastverlauf über einen Tag

Erdbeben"kräfte"

Dynamisch,
Variabler Anteil: Gesamt
Richtung: „Zufällig“

EL CENTRO EARTHQUAKE MAY 18, 1940
NORTH-SOUTH COMPONENT



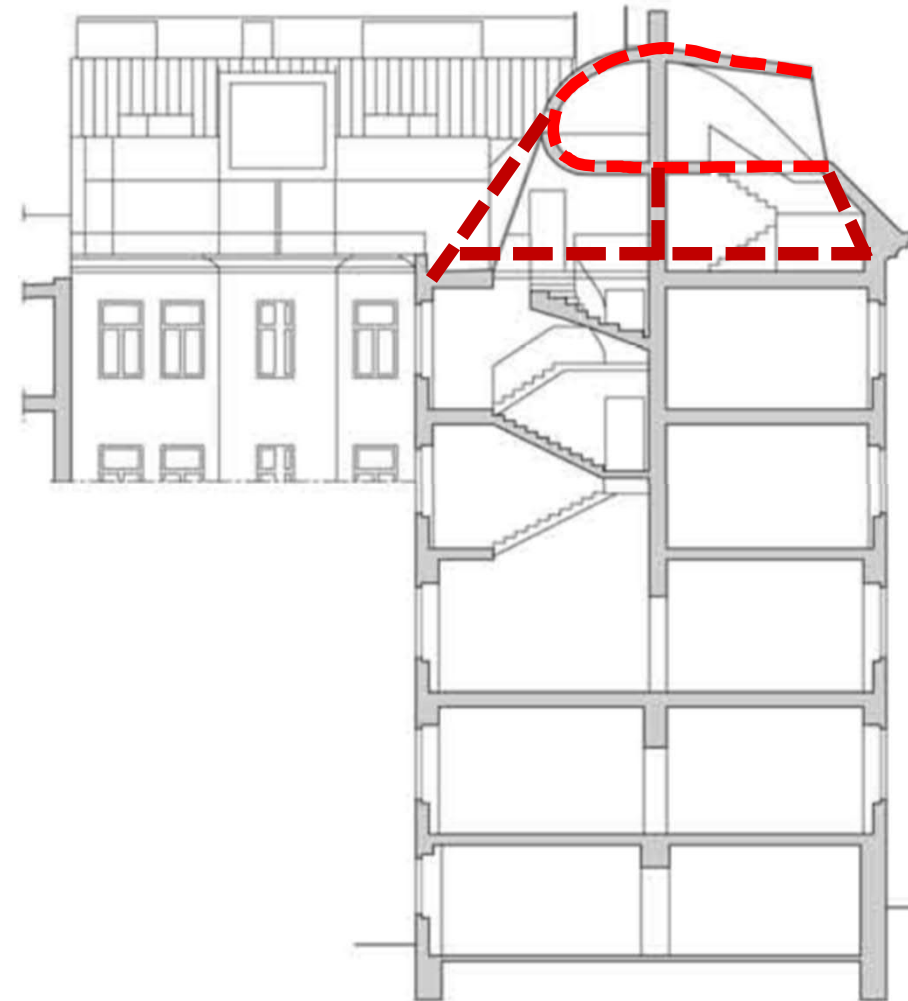
PPAG architects Tunesian Village - Radetzkystrasse







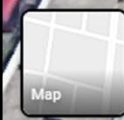
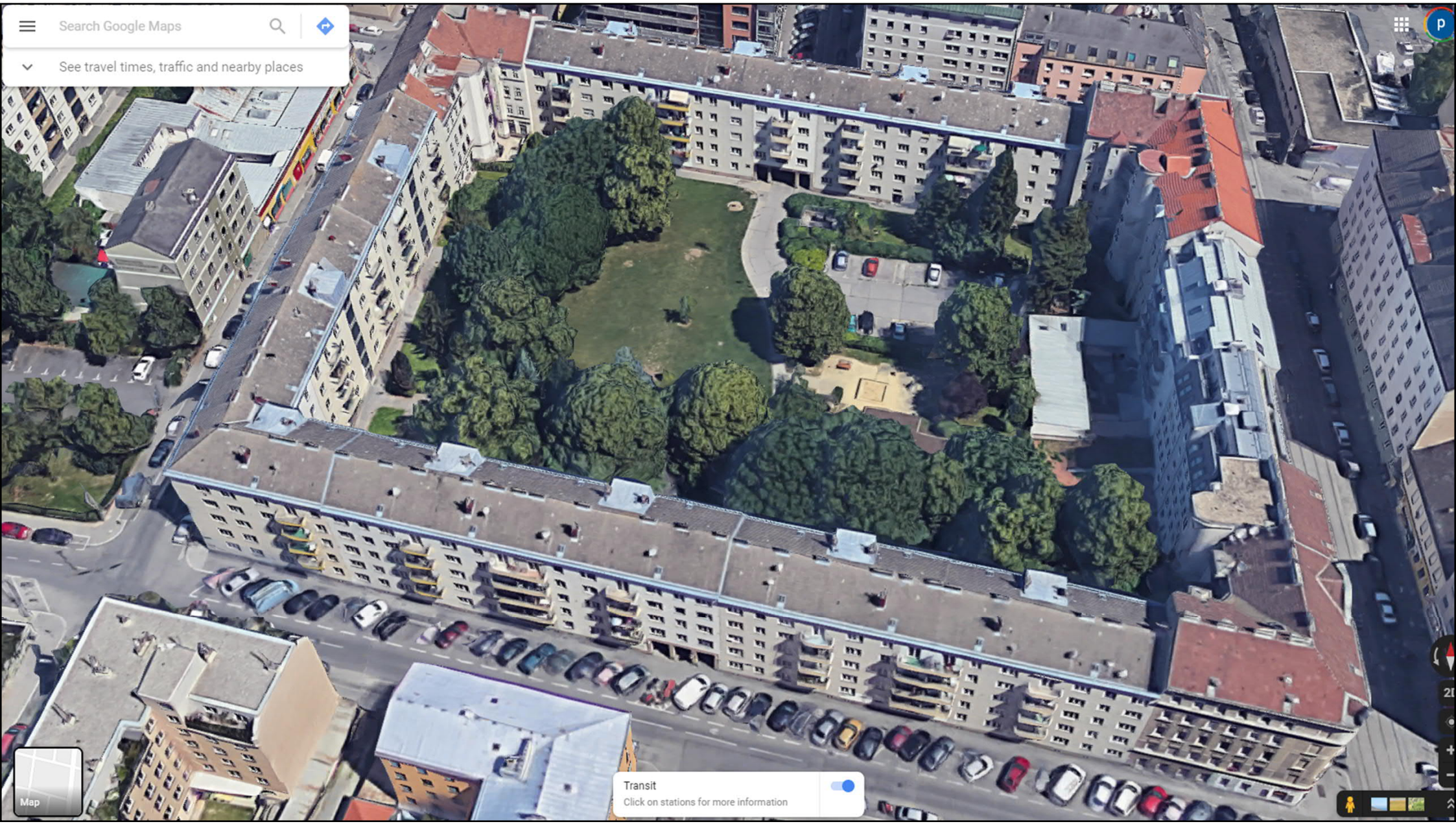
RaU Architekten – Penthouse WEG





☰ Search Google Maps 🔍

⌵ See travel times, traffic and nearby places

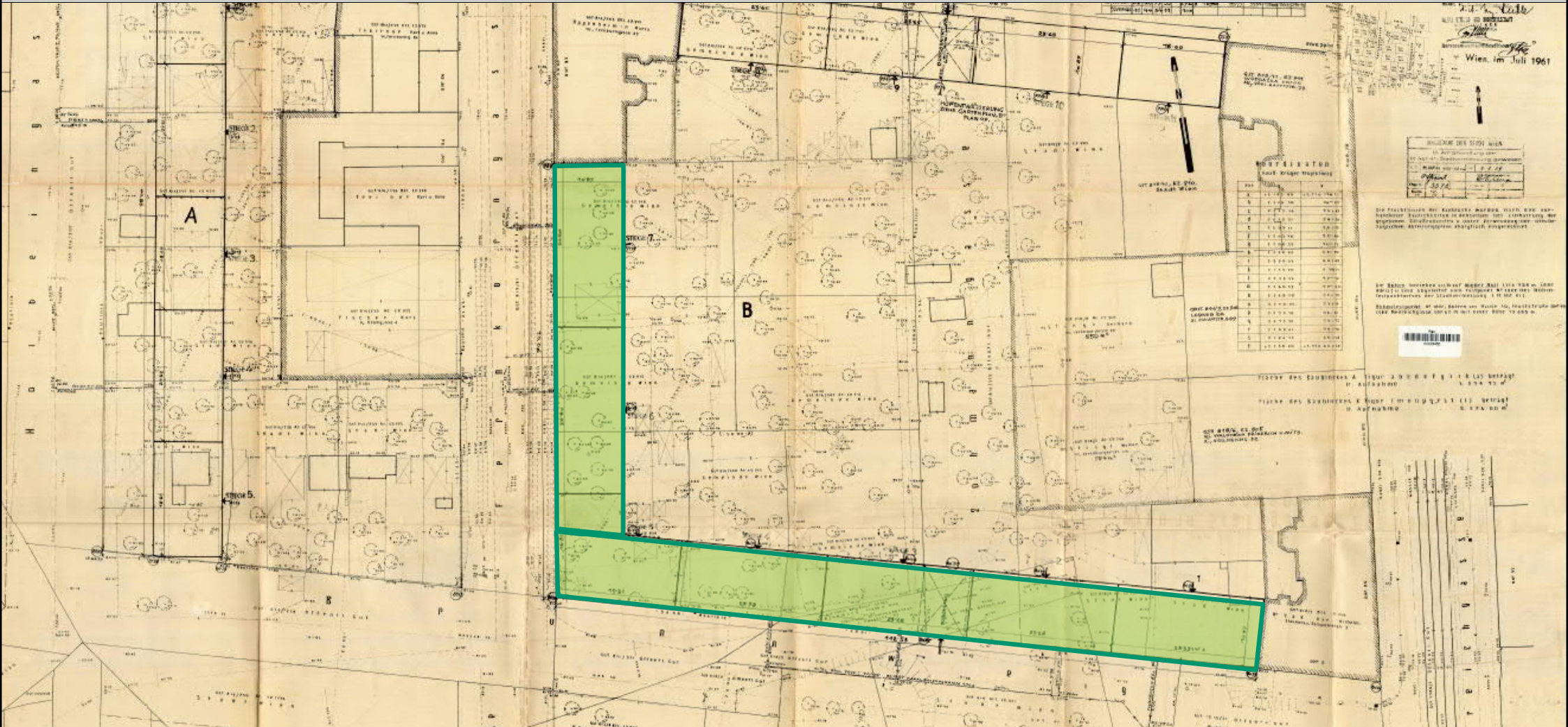


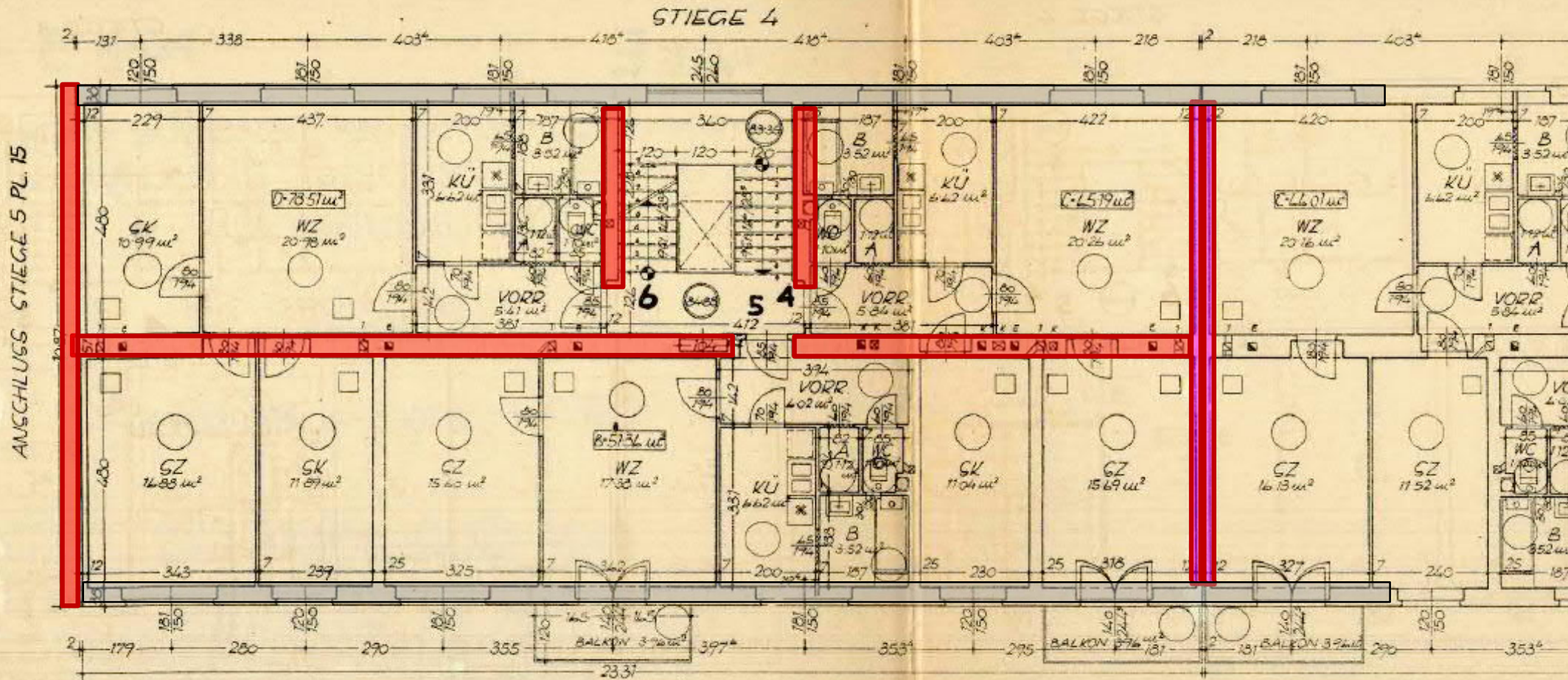
Transit

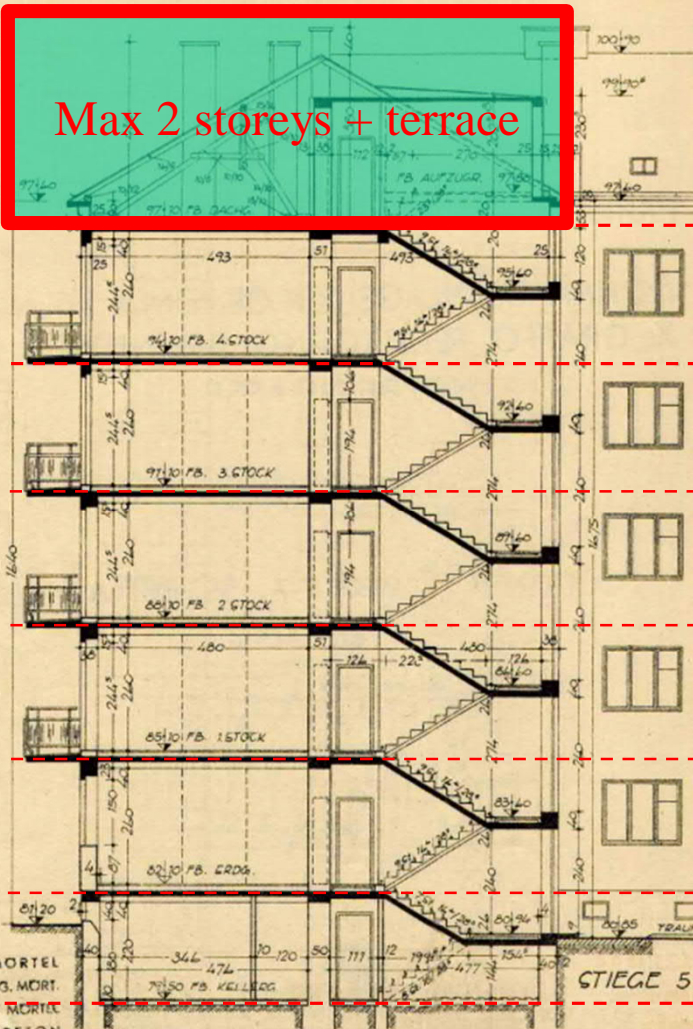
Click on stations for more information

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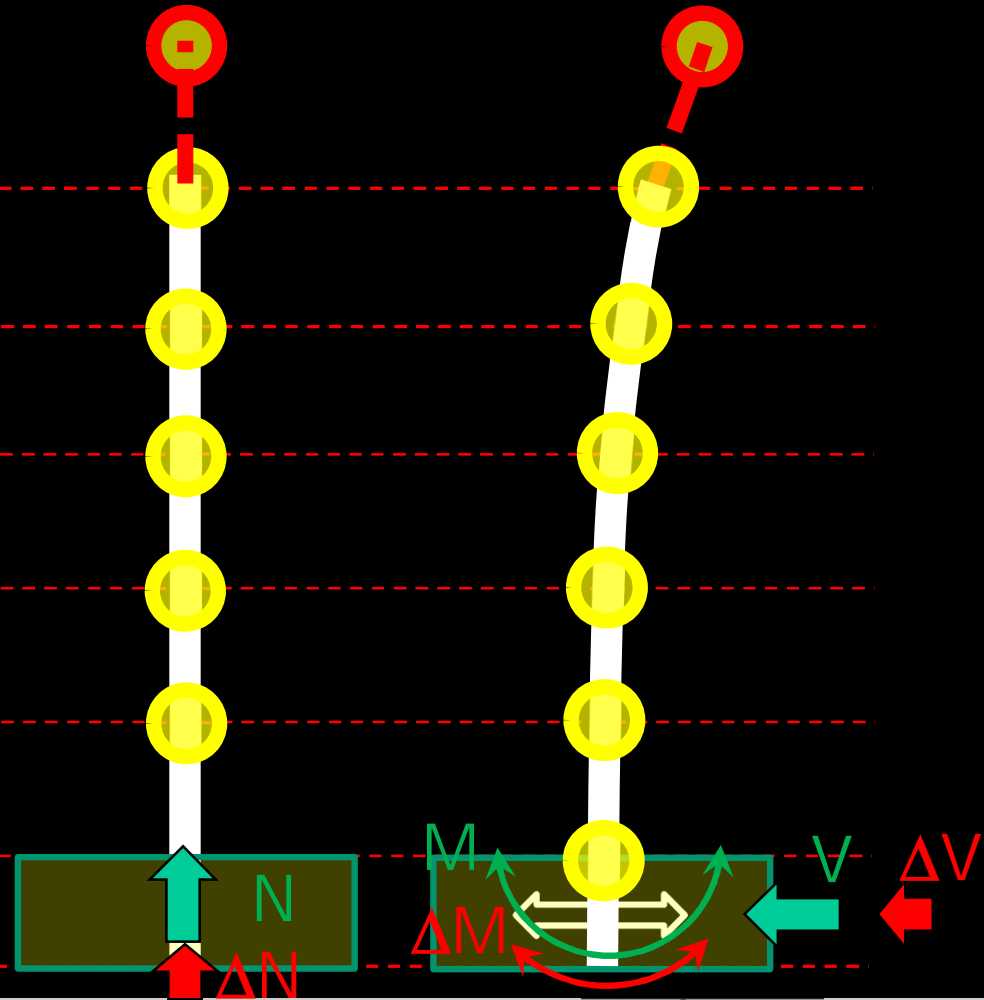
21

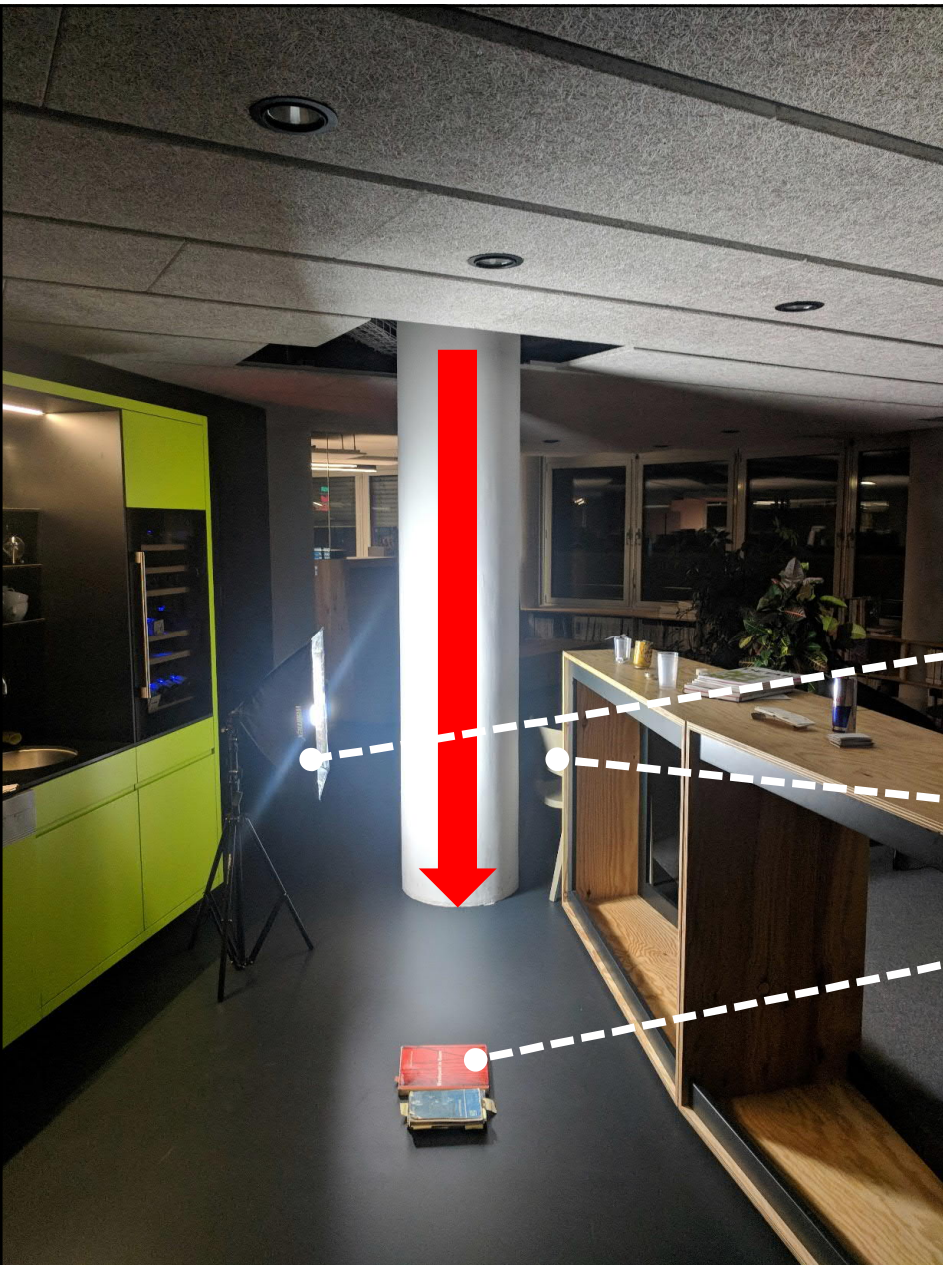






Max 2 storeys + terrace





Setup

Fall height: approx. 3.2 m

Spotlight

Chair

Camerafixing





Google Pixle – Slow Motion I





Google Pixle – Slow Motion II





Unverformter
Alukörper

Plastisch
verformter
Alukörper

Vorher

Nachher



Setup

Fall-height $h = 3.2 \text{ m}$

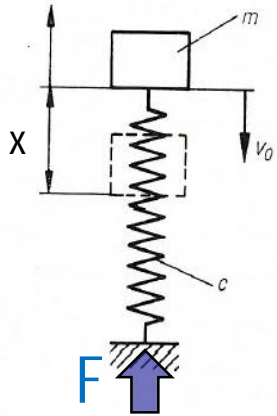
Weight light bulb + boxing $\sim m = 50 \text{ g}$

Free fall:

$$v(t) = g t \text{ and } s(t) = \frac{1}{2} g t^2$$

Therefore: $t(\text{s}) = (2 h/g)^{0.5} = 0.80 \text{ sec}$

And: $v = (2 g h)^{0.5} = 7.92 \text{ m/sec (= 28.5 km/h)}$



Energy in timestep t (s = collision):

Kinetic Energy = **Mechanic Energy**

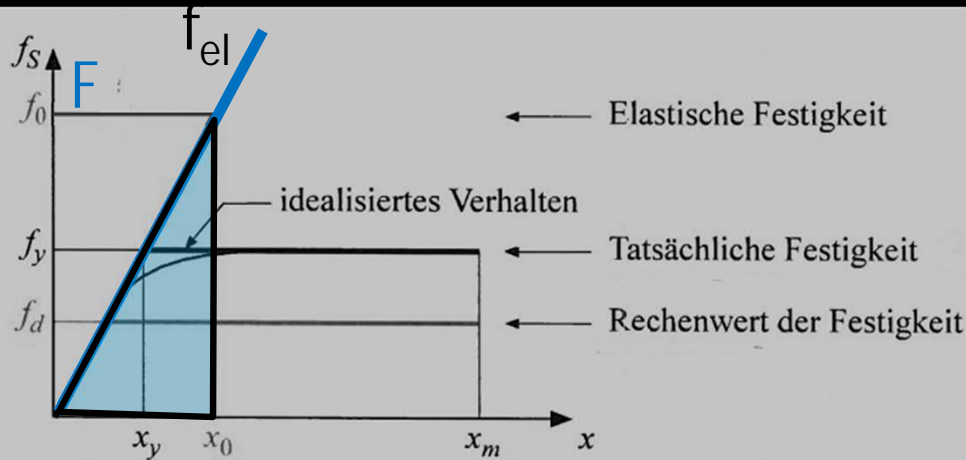
Elastic response:

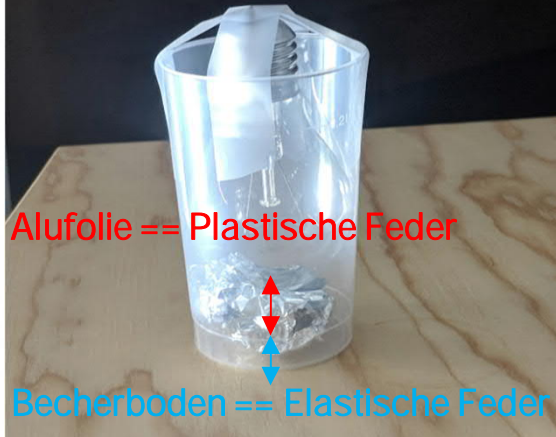
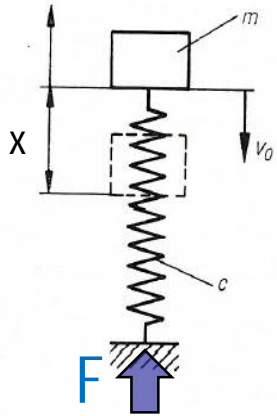
$$m v^2/2 = c x^2/2 = F x/2 \quad \text{because of: } F = c x$$

x ..deformation in t (s)

If $x == 1$ mm (asumption)

$$F = 0.05 * 7.92^2/0.001 = 3136 \text{ N } (== \text{„300 kg“})$$





Energy in timestep t ($s = \text{collision}$):

Kinetic Energy = **Mechanic Energy**

plastic response

$$m v^2/2 = F_{pl} x_{el}/2 + F_{pl} (x_{pl} - x_{el})$$

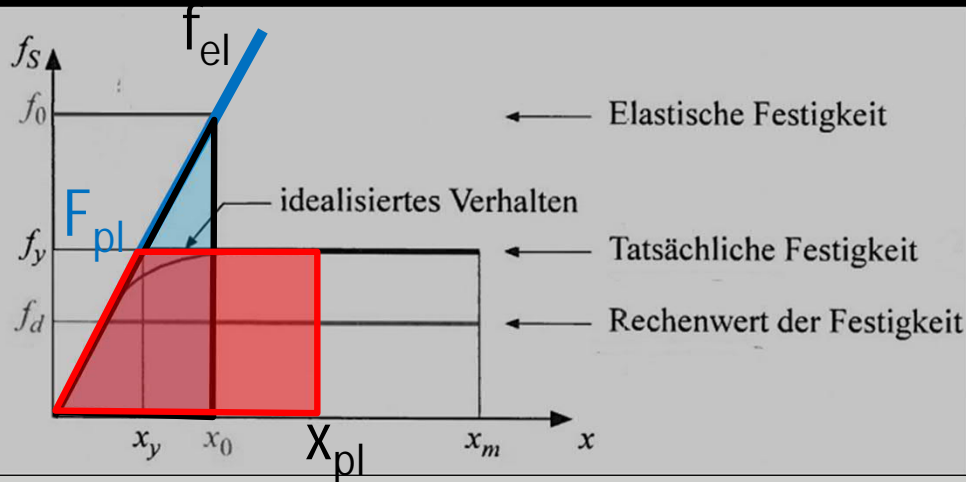
Note: F_{pl} can be chosen if $x_{pl} == \text{"enough"}$

If $x_{el} == 0.5 \text{ mm}$; $x_{pl} == 10 \text{ mm}$ (assumption, total height $\sim 12 \text{ mm}$)

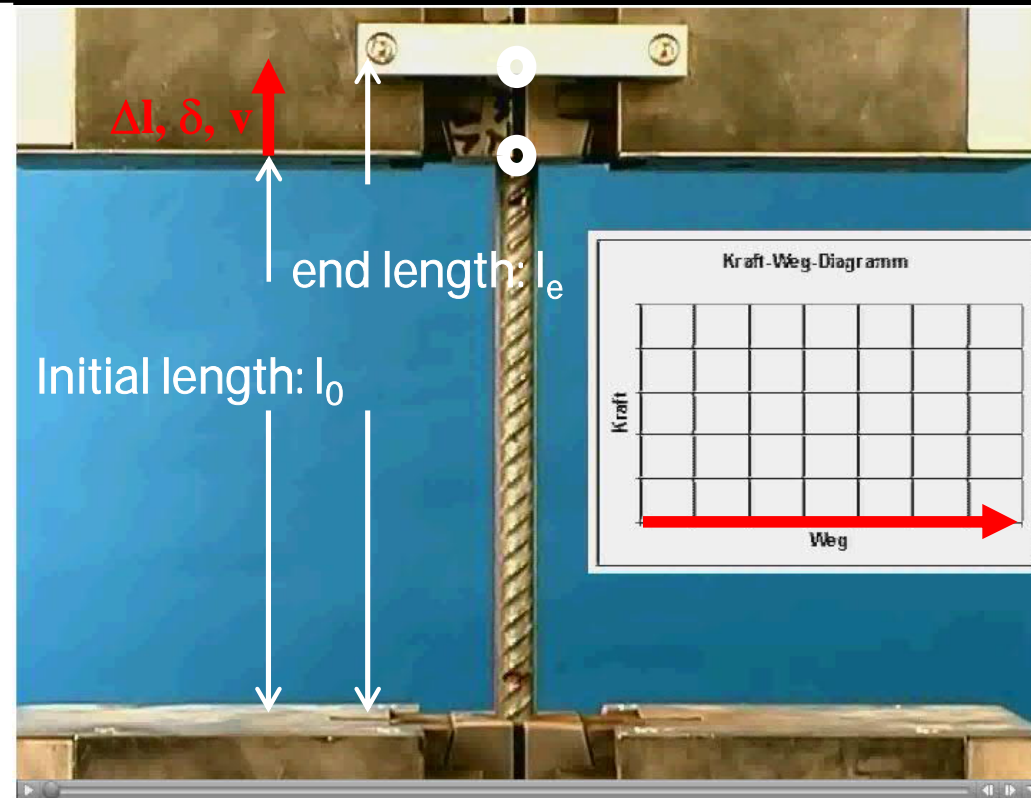
$$F = 0.05 * 7.92^2/2 * 1/(0.0005/2 + (0.01 - 0.0005)) = 160 \text{ N}$$

($== \text{"16 kg"}$)

Note: After test Alu-foil is crushed! (But lamp is safe)



28 Day Strength



Hochfester Werkstoff
Elastisches Verhalten - Sprödbbruch

Hochfester Werkstoff
Plastisches Verhalten – Duktiler Bruch



Chuetsuoki earthquake test



Kobe earthquake test



Pause (k)

CLT Lateral Design
Youtube: Think Wood

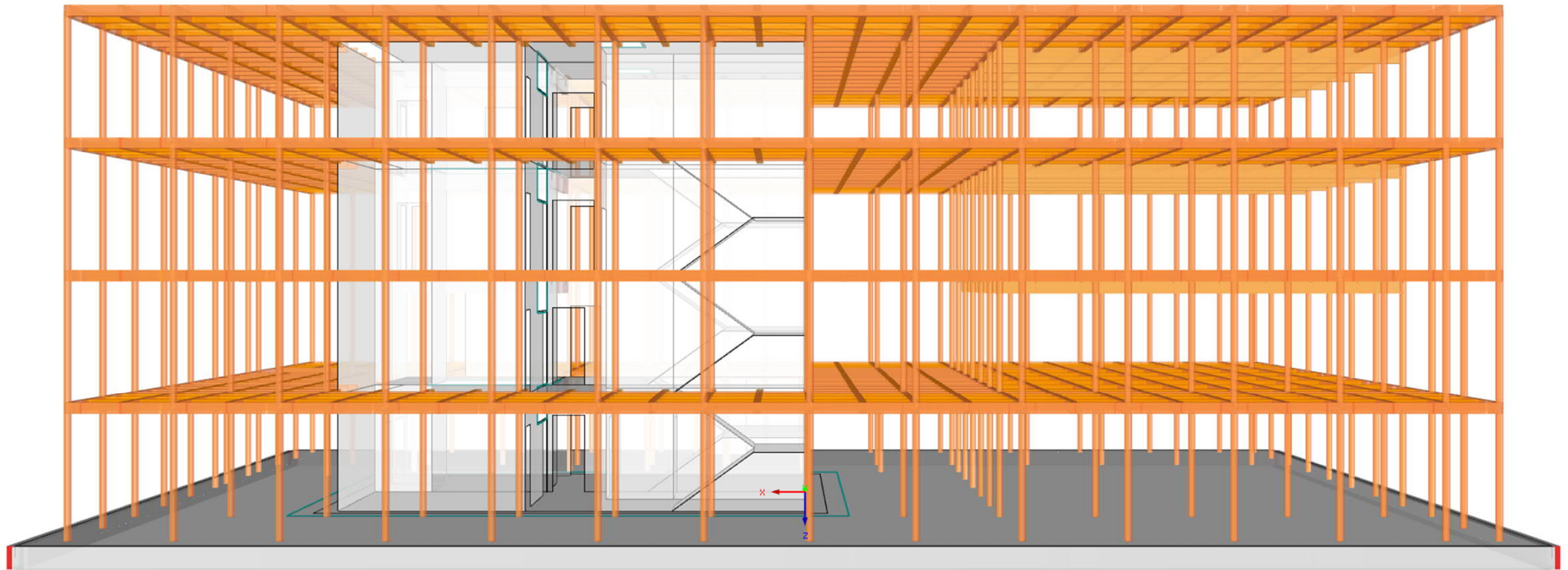
Japan's Hyogo
Earthquake Engineering
Research Center

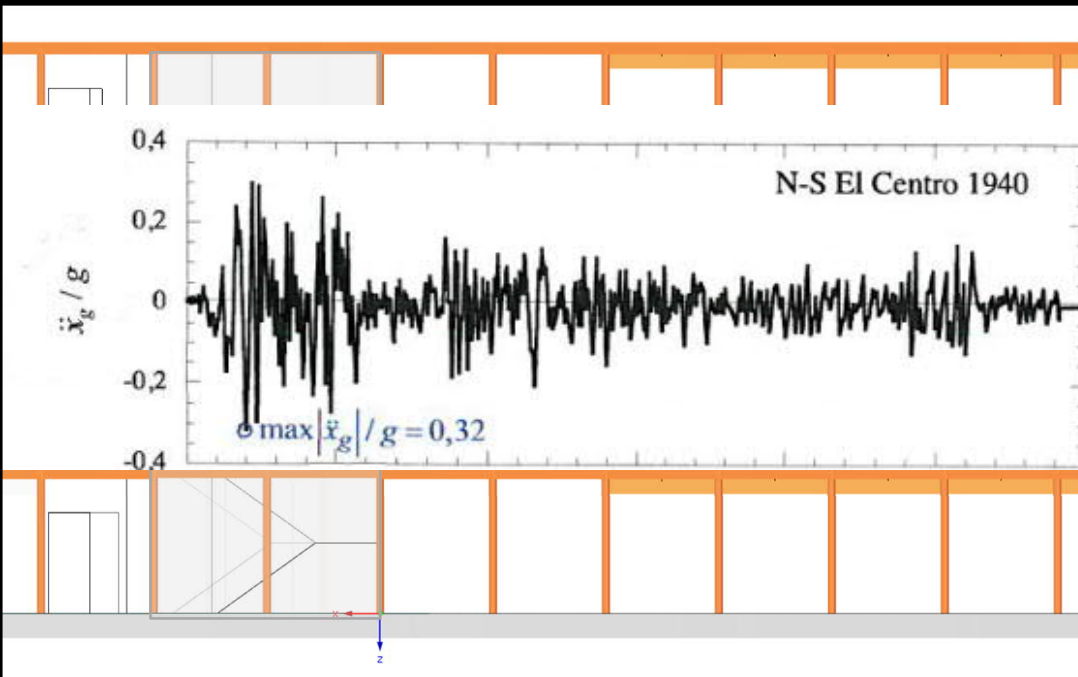


LukasLANG-System; Ersatzparlamentgebäude Heldenplatz Wien



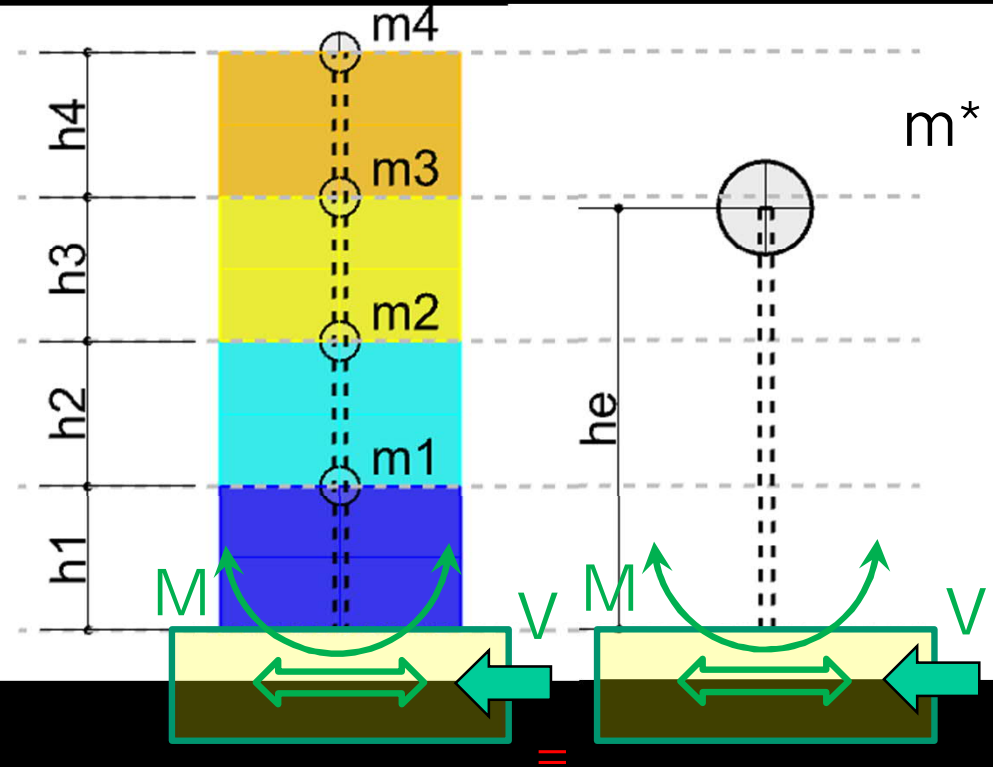
LukasLANG-System; Ersatzparlamentgebäude Heldenplatz Wien

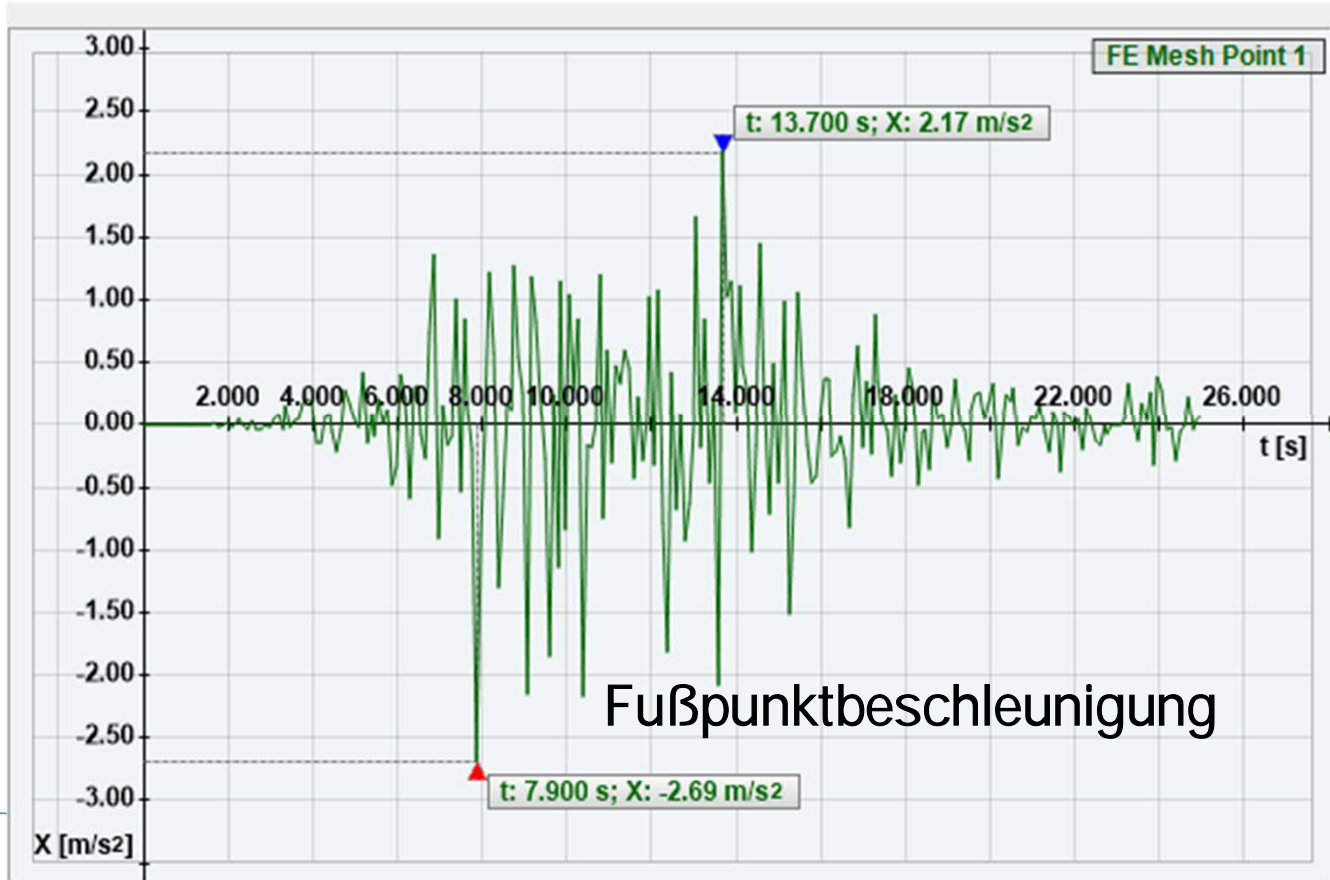
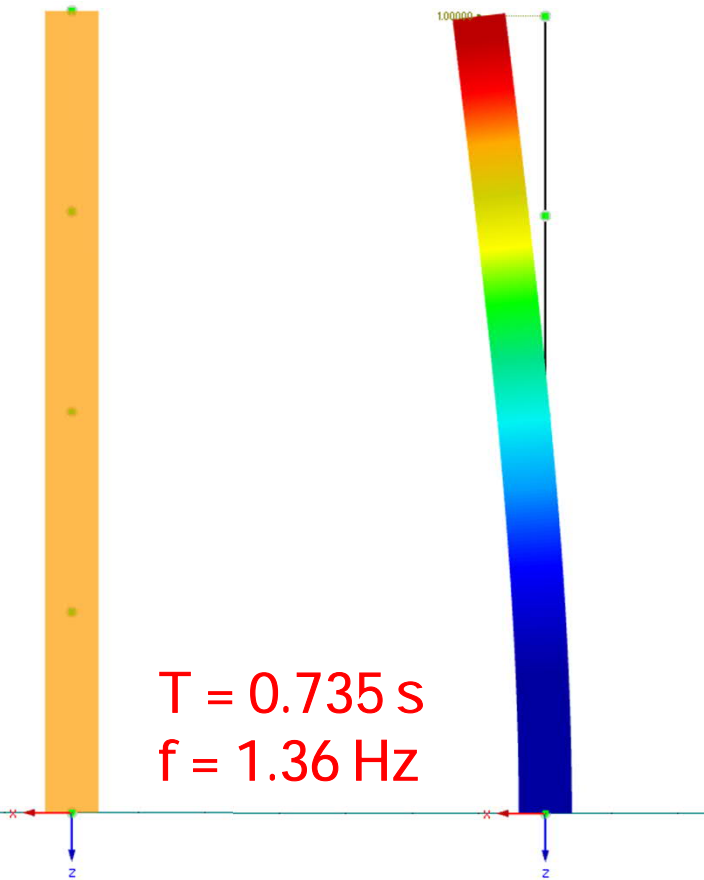


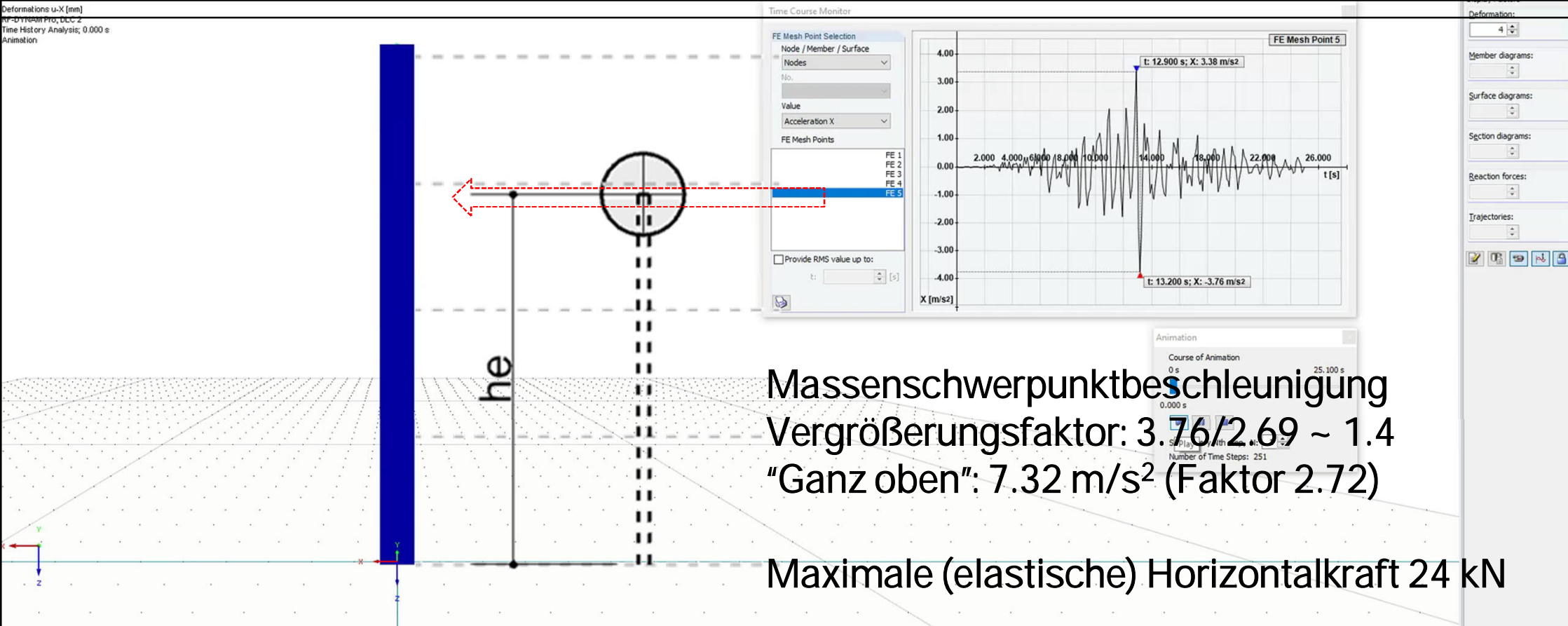


MDOF

SDOF







Massenschwerpunktbeschleunigung
 Vergrößerungsfaktor: $3.76/2.69 \sim 1.4$
 "Ganz oben": 7.32 m/s^2 (Faktor 2.72)

Maximale (elastische) Horizontalkraft 24 kN

Common design strategy

$$F_{EI} = m a$$

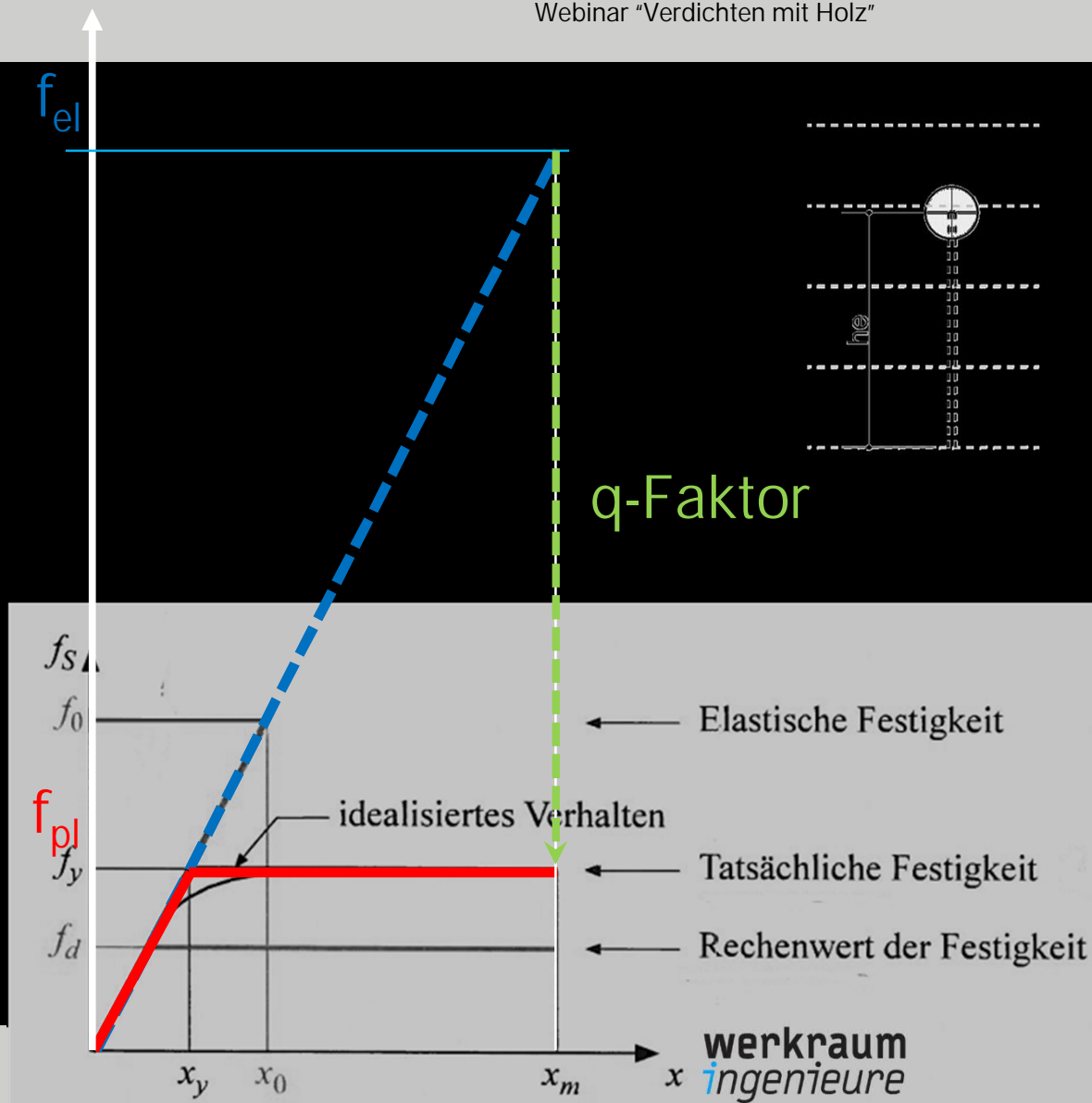
Updated design strategy

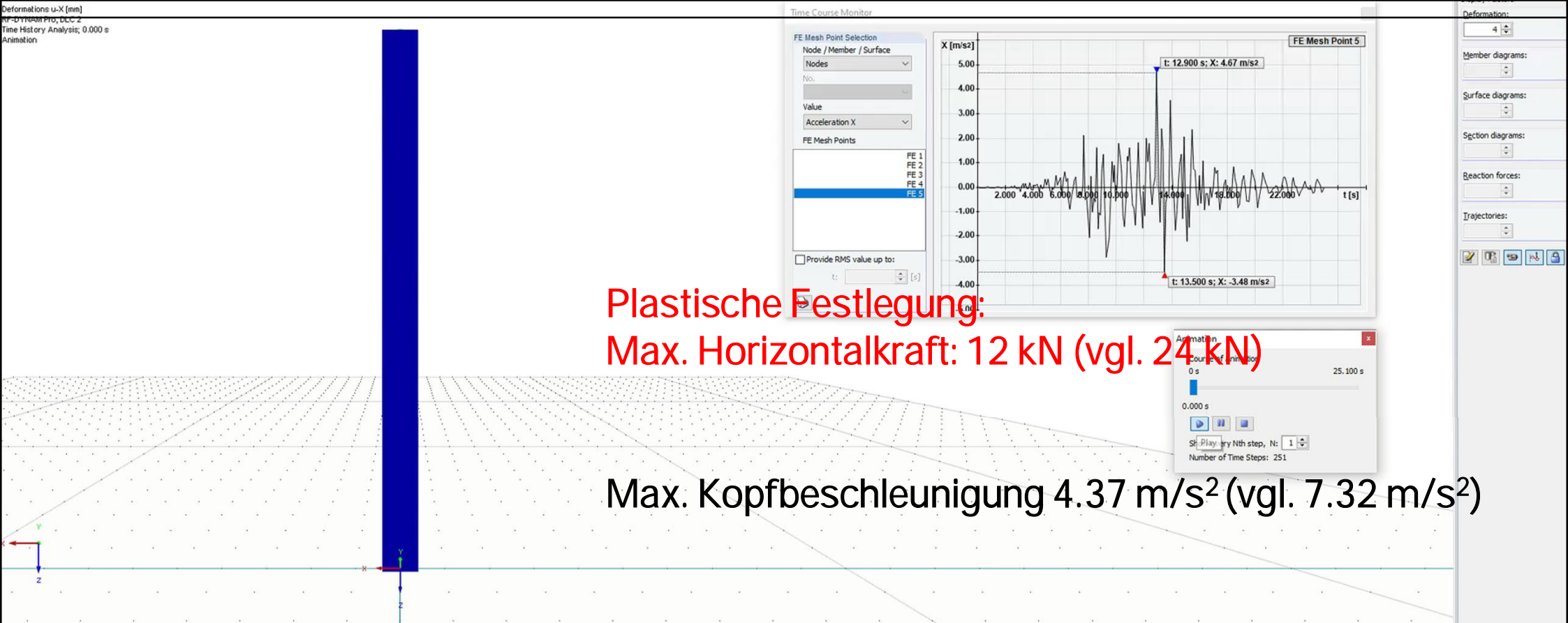
$$a_{E,max} = \frac{F_{PI}}{m}$$

Target:

$k = k(x)$ or $c ==$ „high“

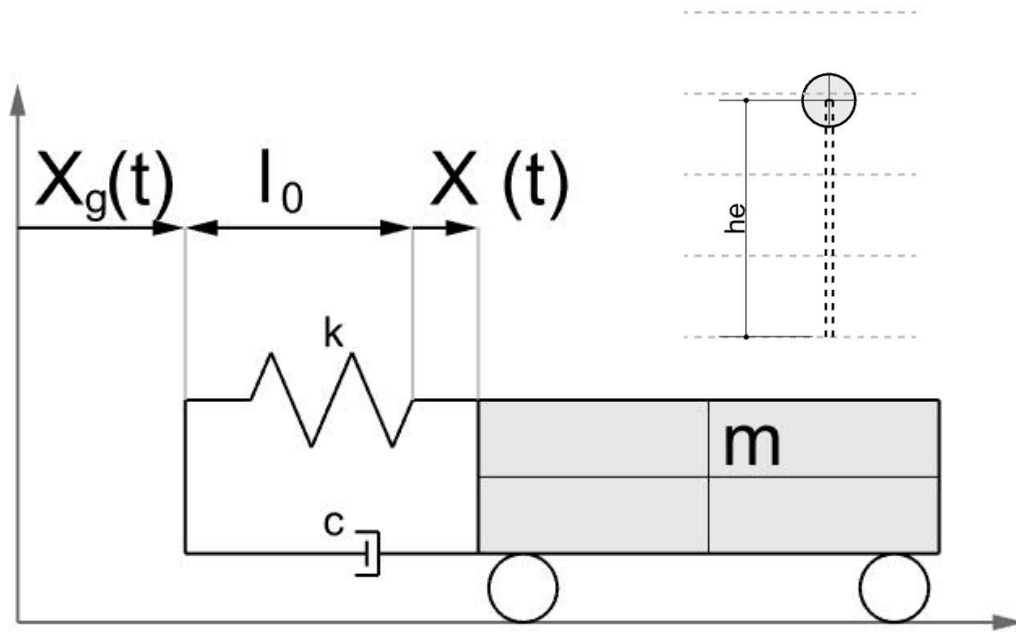
$f_y ==$ „low“ (Note: windforce)



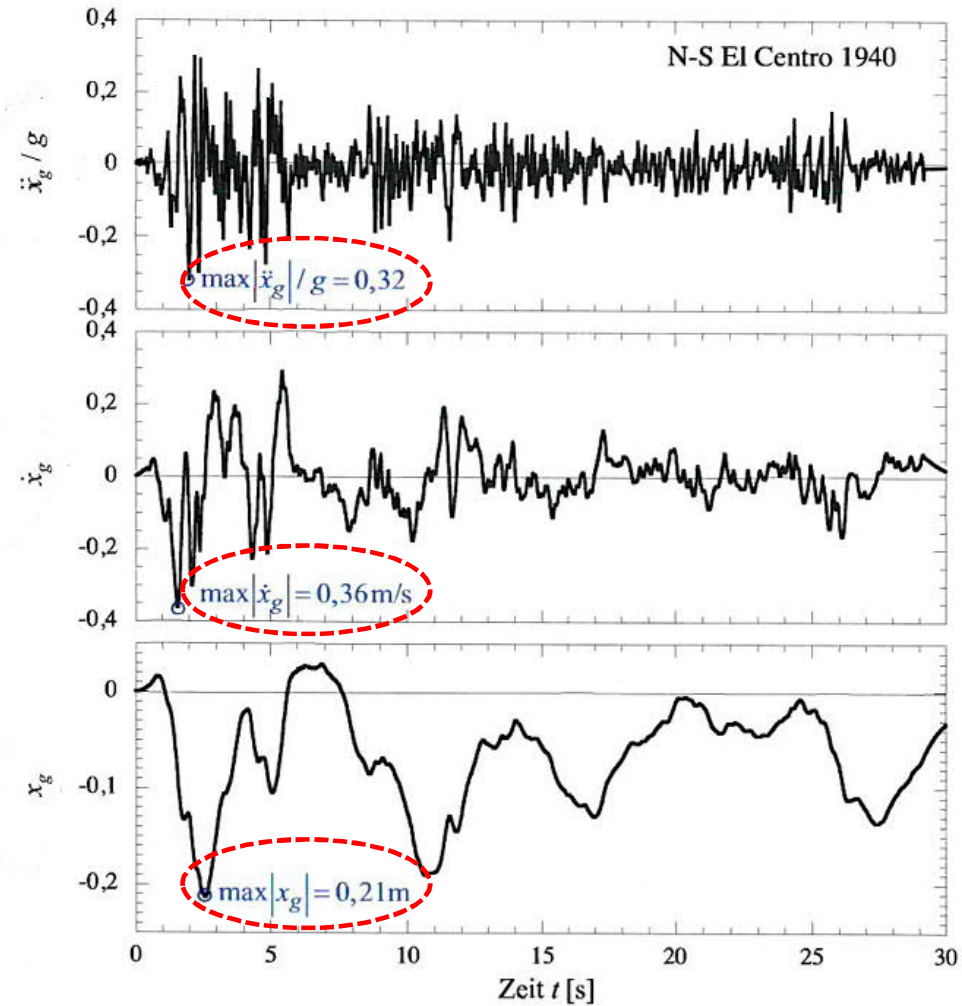


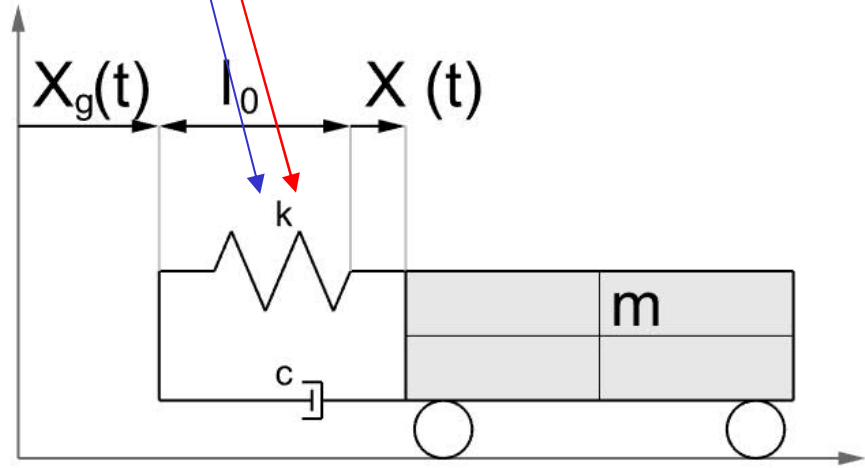
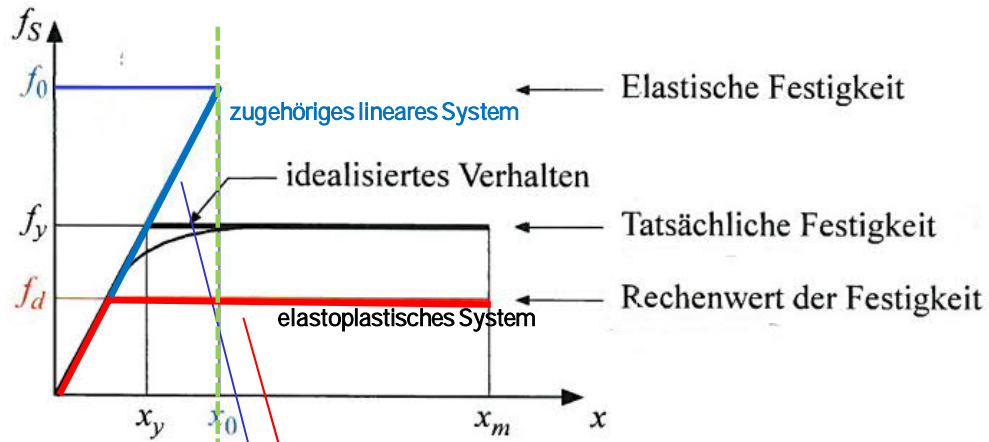
Plastische Festlegung:
Max. Horizontalkraft: 12 kN (vgl. 24 kN)

Max. Kopfbeschleunigung 4.37 m/s² (vgl. 7.32 m/s²)



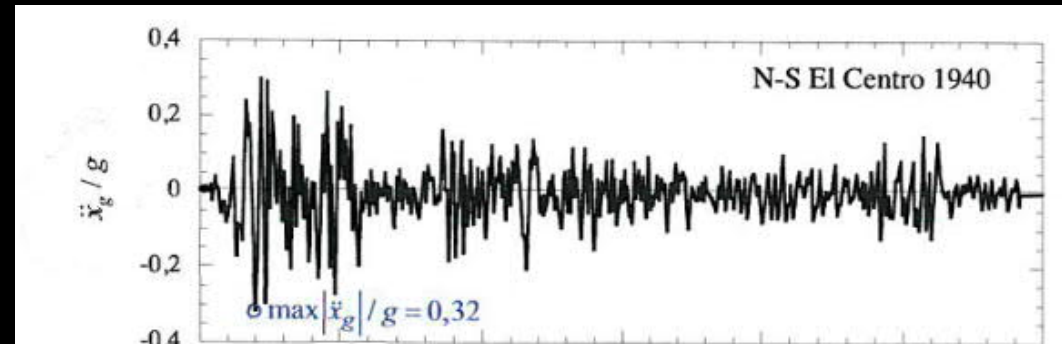
Erstellung von Codes:
Normierte Beben und Bebenantworten

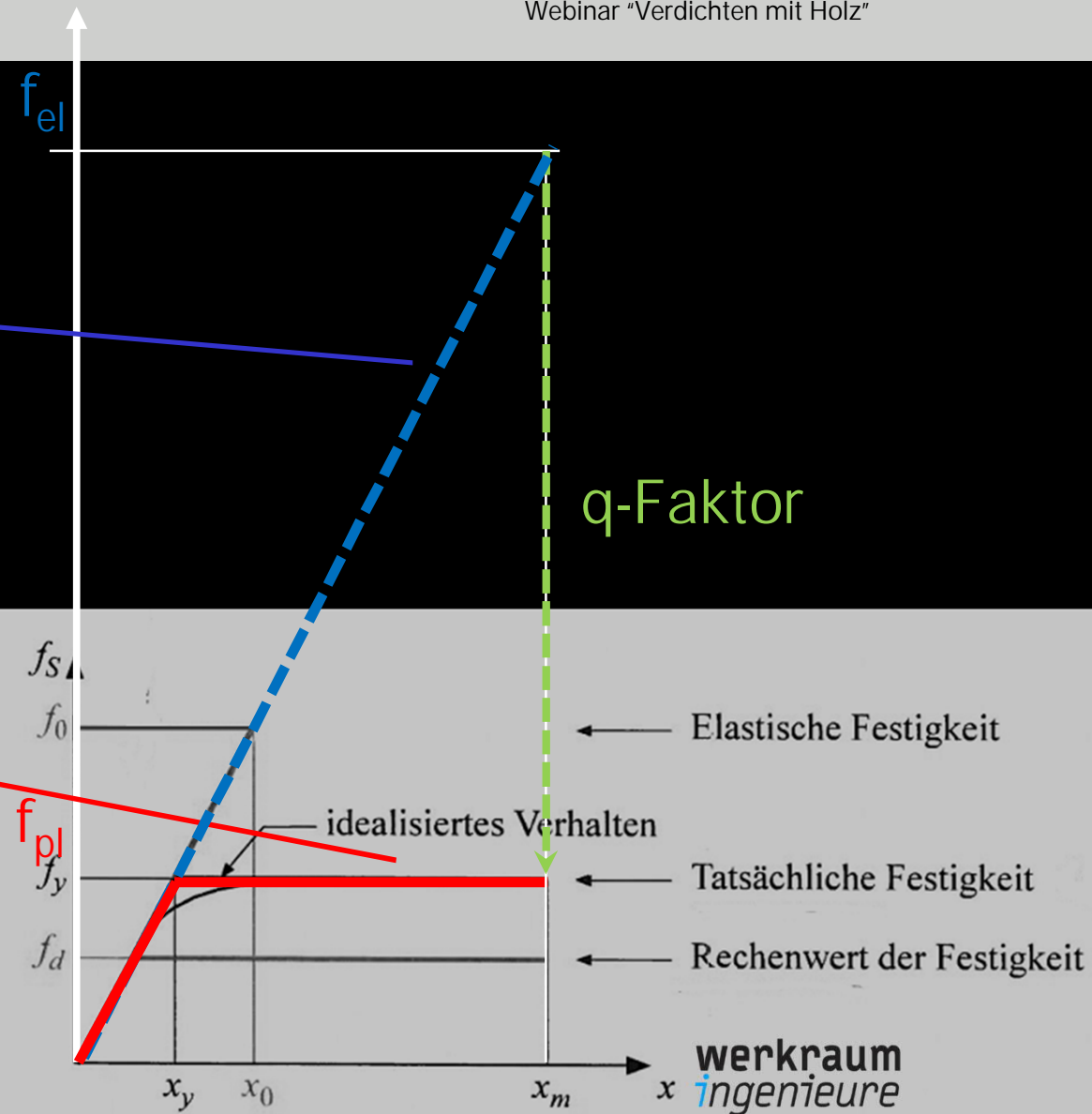
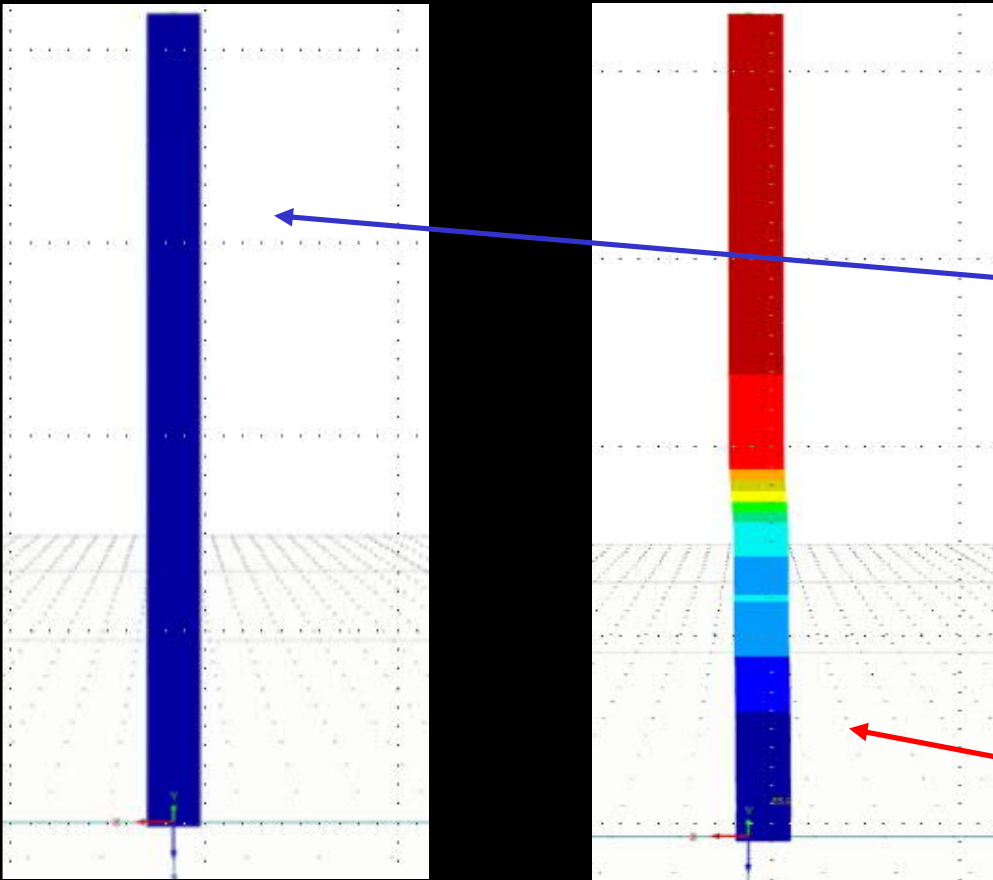




Überfestigkeit $\Omega_d = f_y/f_d$
Festigkeitsreduktionsfaktor $R_\mu = f_0/f_y = x_0/x_y$
 (stellt den Zusammenhang von einem „realen“ elastoplastischen System mit dem zugehörigem linearen System her)

Achtung!
 Bei nichtlinearen Verfahren liegt der Ansatz $f_d < f_y$ nicht immer auf der sicheren Seite (wenn z.B. daraus die max. auftretenden Beschleunigungen für Bewohner oder Geräte abgeschätzt werden)

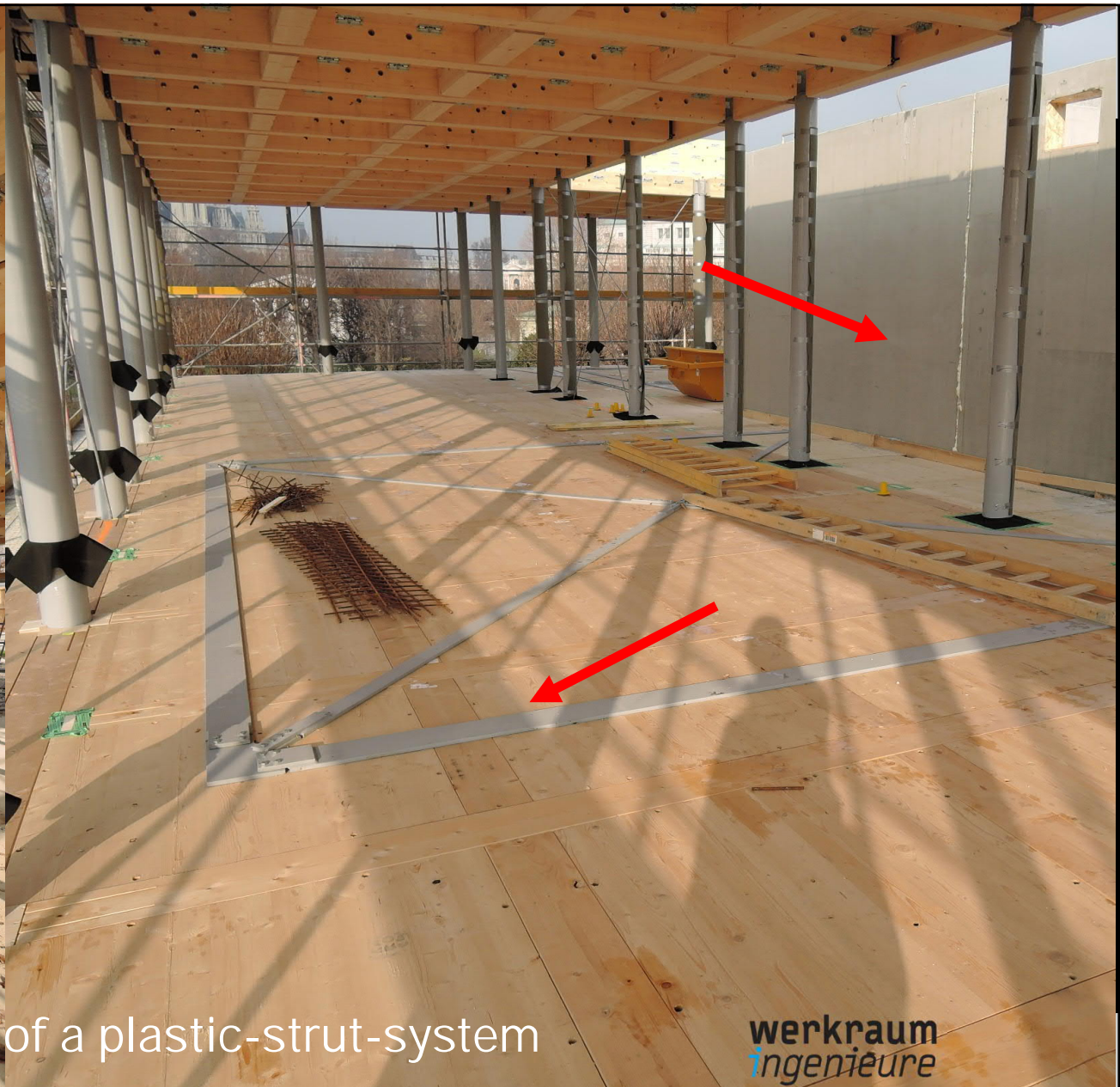




Verformung nach dem $x_m - x_0 \sim 2.5 \text{ cm}$
Bemessungsbeben $H \sim 12 \text{ m}$



LukasLANG-System; Ersatzparlamentgebäude Heldenplatz Wien



LukasLANG-System; Development of a plastic-strut-system

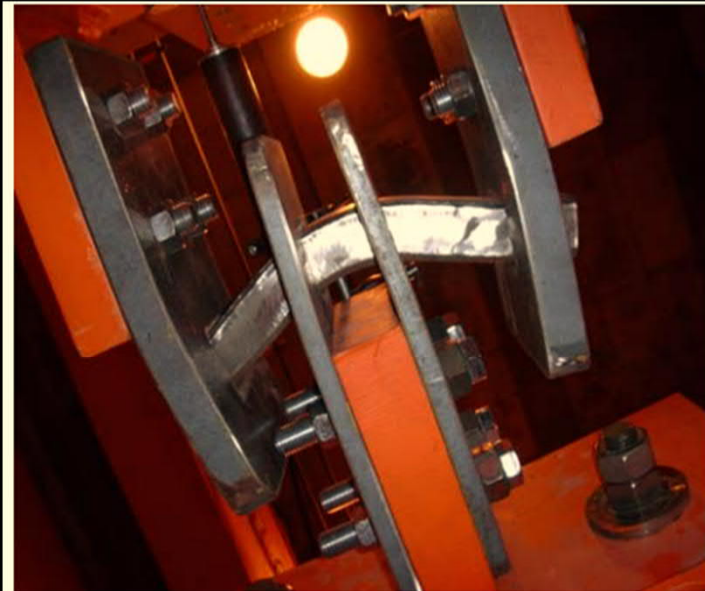


Fig. 1: Detail of the pin connection during loading

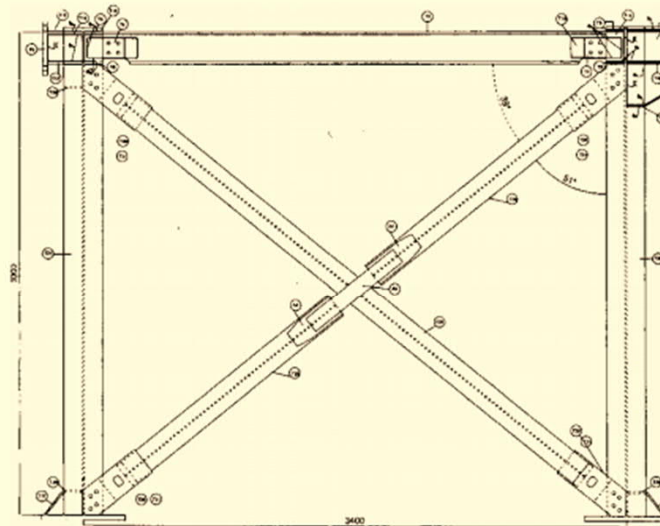
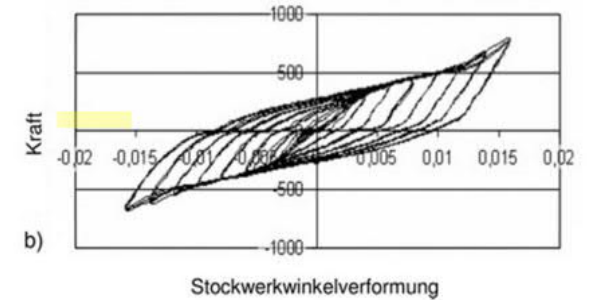


Fig. 2: Pin connections within a frame

Bild 54. a) Bolzenverformungen der INERD-Verbindungen, b) Hysteresisschleifen von ausgesteiften Rahmen mit INERD-Verbindungen



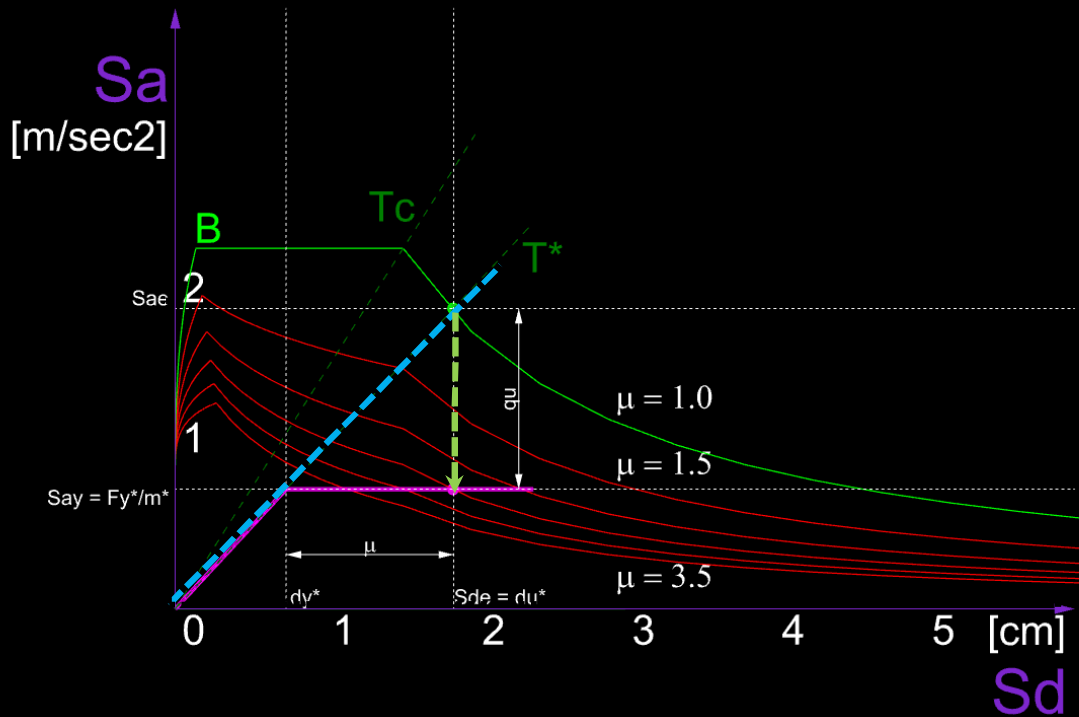
a)



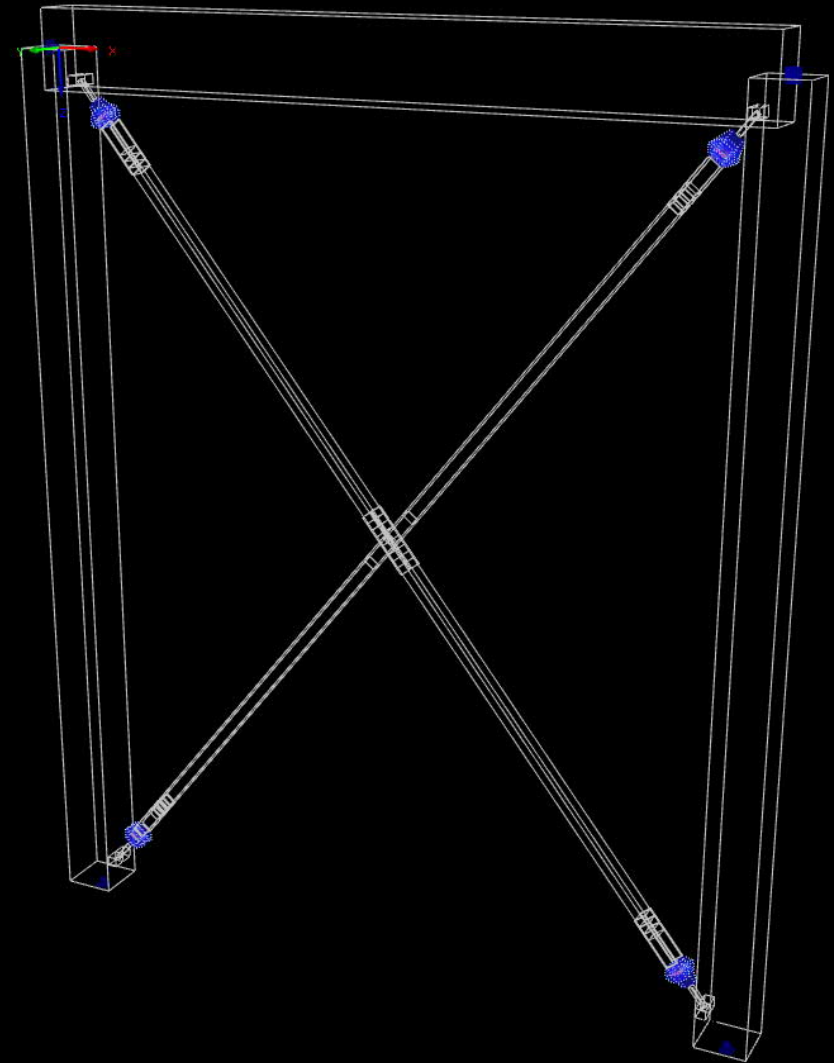
b)

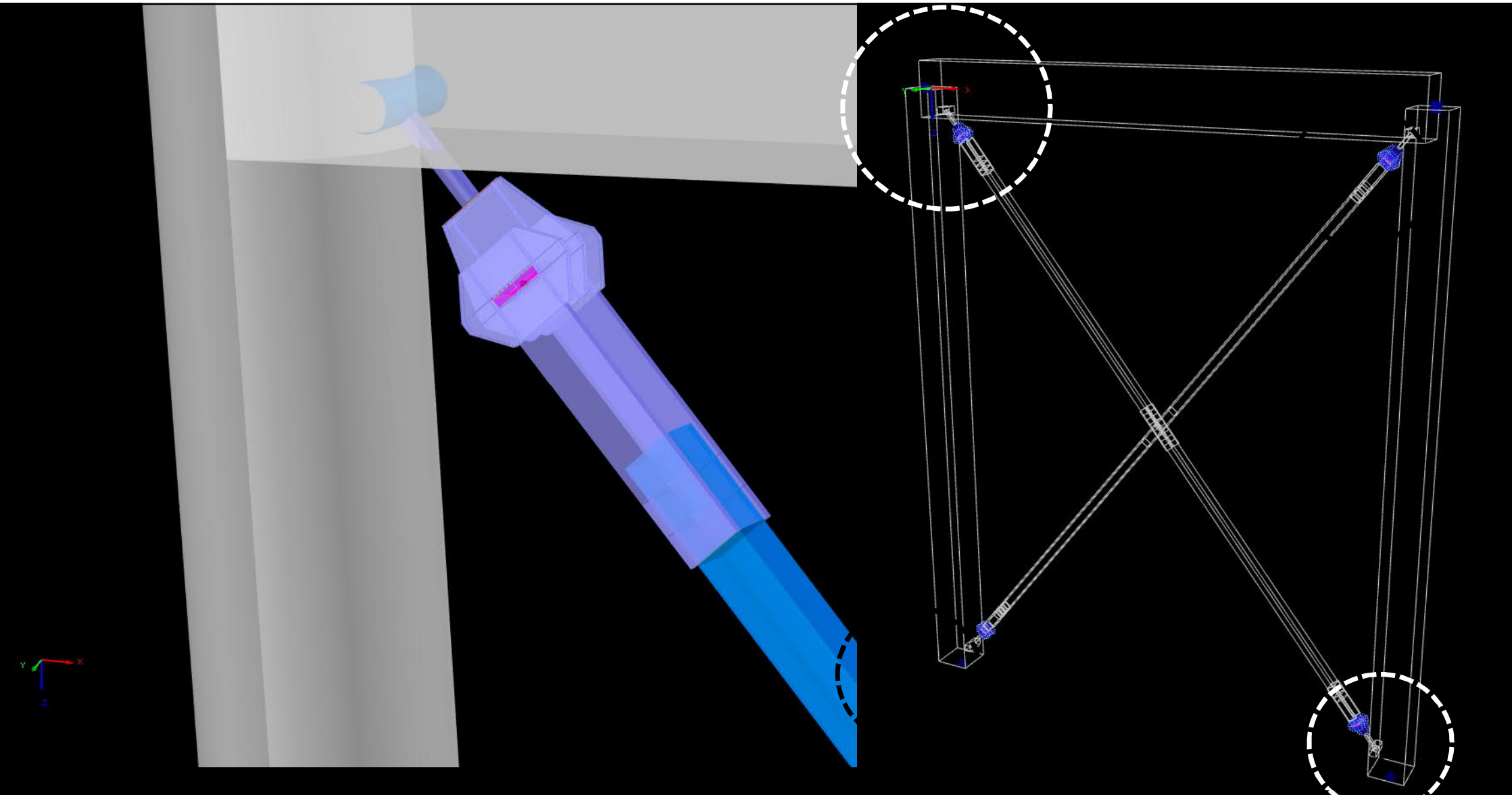
$$F_{\max} = m S a_{\max} \quad S a_{\max} = \frac{F_{\max}}{m}$$

LukasLANG-System; Development of a plastic-strut-system – INERD-System

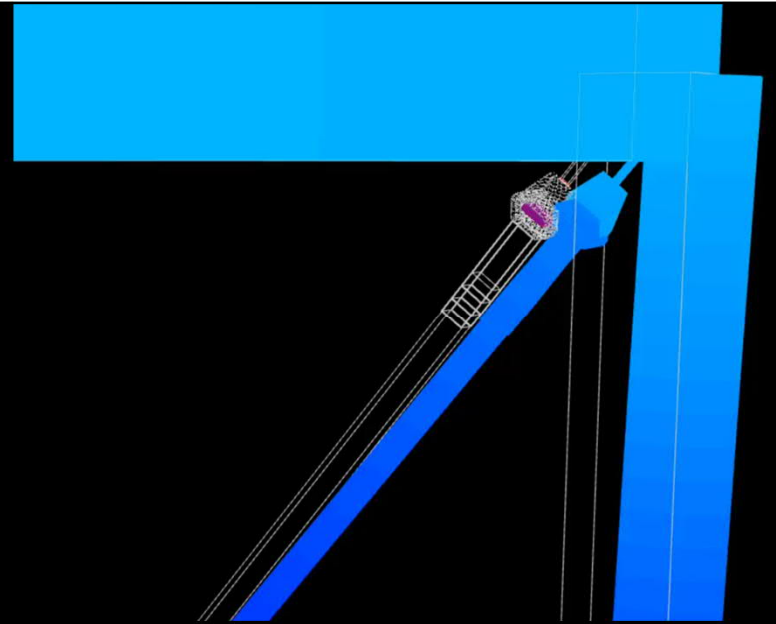
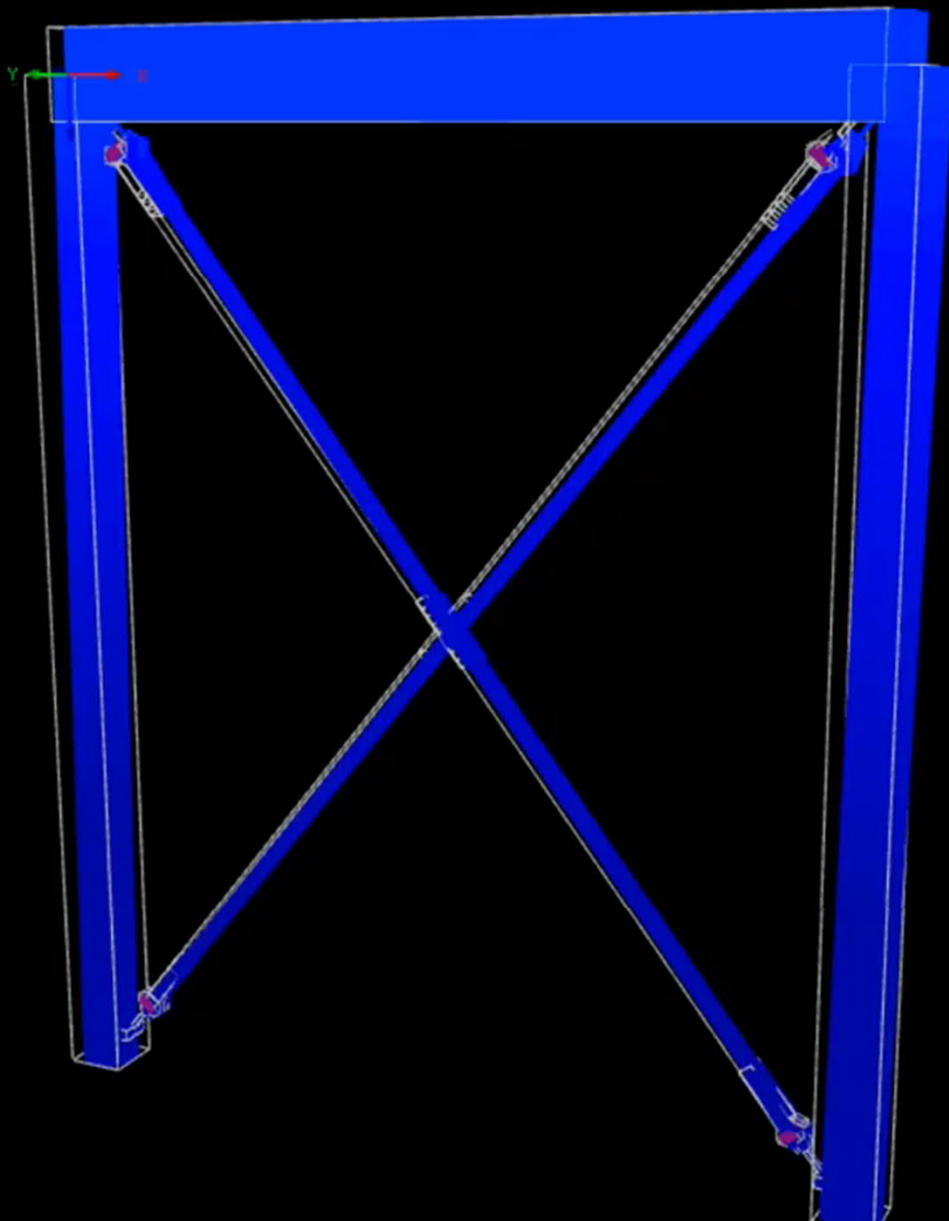


Goal: $q == 4!$
 Elastic: wind, minor earthquakes
 Plastic: major earthquakes









[kN]

Plastic strut

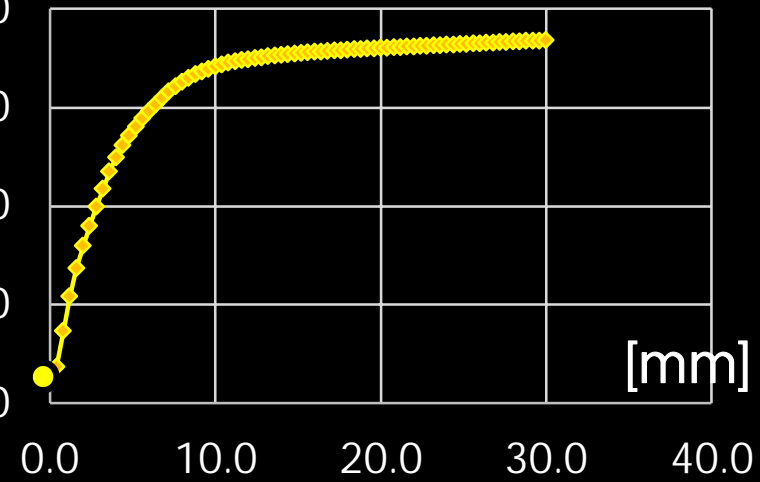
80.00

60.00

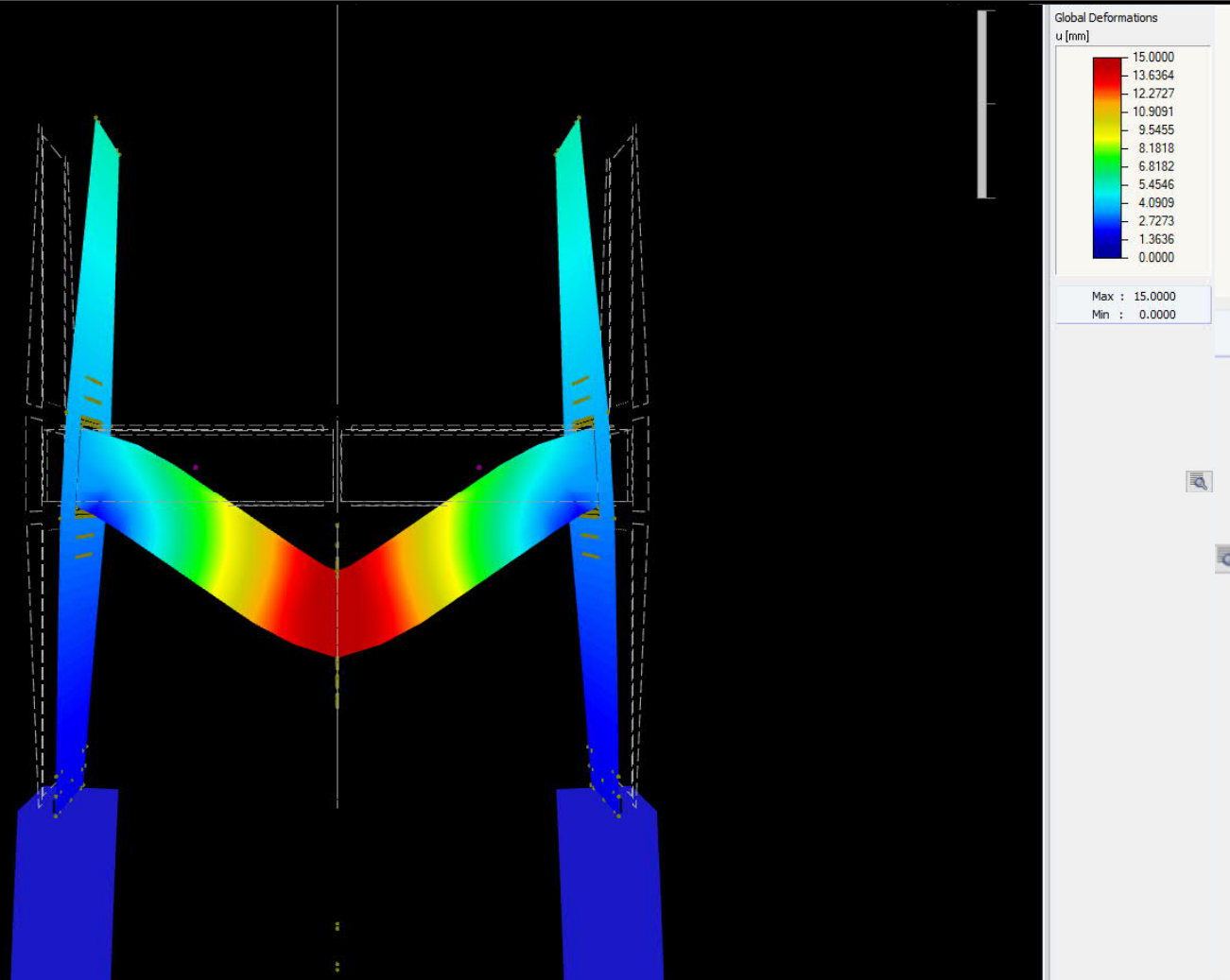
40.00

20.00

0.00



[mm]





Derzeit gültiger Erdbebencode „Holz“ EN 1998-1

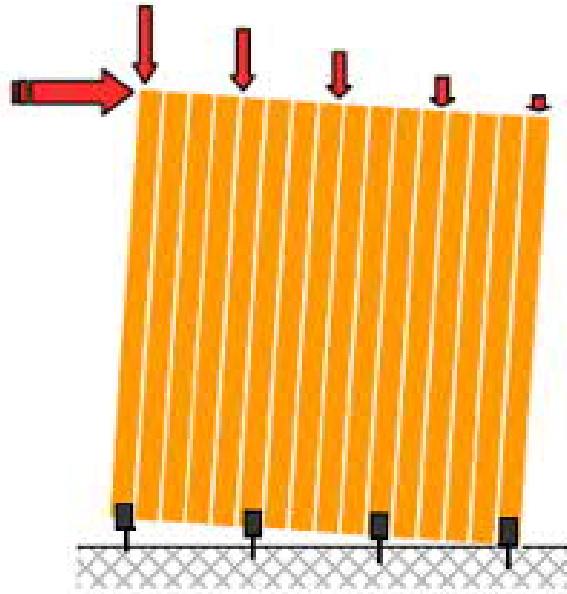
(4)P Die dissipativen Bereiche sind in den Verbindungen und mechanischen Verbindungsmitteln anzuordnen, **während für die Holzbauteile selbst elastisches Verhalten anzunehmen ist.**

(5) **Die Eigenschaften der dissipativen Bereiche sind nach prEN 12512 durch Versuche entweder an einzelnen Verbindungen, an ganzen Tragwerken oder anderen Teilen zu bestimmen.**

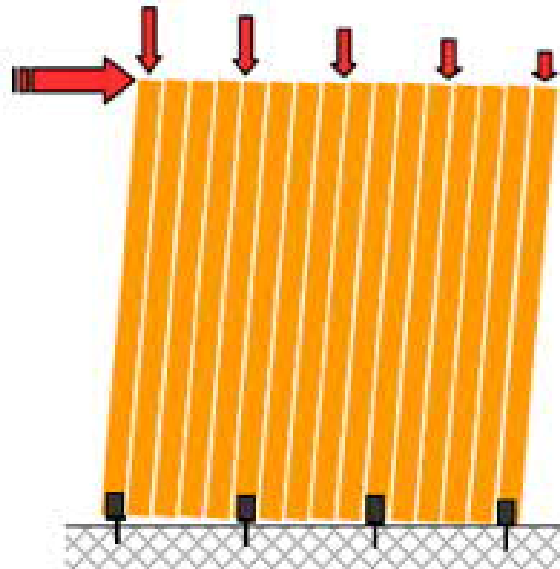
(6) Im Konzept b) werden die Schnittgrößen auf der Grundlage einer elastischen Tragwerksberechnung, ohne Berücksichtigung nichtlinearen Baustoffverhaltens, ermittelt. Wenn man das in 3.2.2.5 definierte Bemessungsspektrum verwendet, sollte der Verhaltensbeiwert q nicht größer als 1,5 angenommen werden.

Die Tragfähigkeit aller Tragwerksteile und Verbindungen sollte nach EN 1995-1-1:2004 ohne Zusatzerfordernungen ermittelt werden. Diese Konzept wird als Duktilitätsklasse L (niedrig) bezeichnet und ist nur für bestimmte Tragwerkstypen geeignet.

Rocking response of walls



Combined shear - rocking response of wall



Shear response of walls

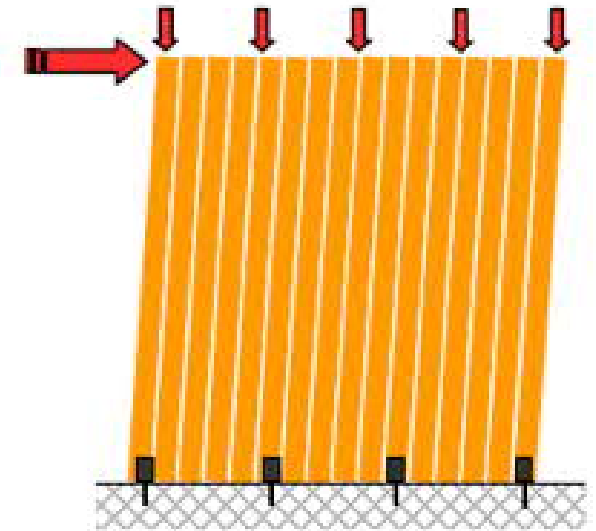
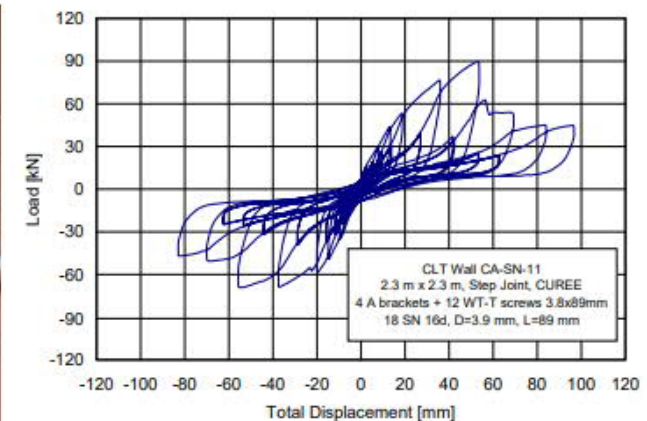


Fig.5: Typical responses of wooden wall panels exposed to combined vertical and horizontal load.

Taken from: Study of lateral resistance of massive X-Lam wooden wall system; Bruno Dujic, Roko Zarnic

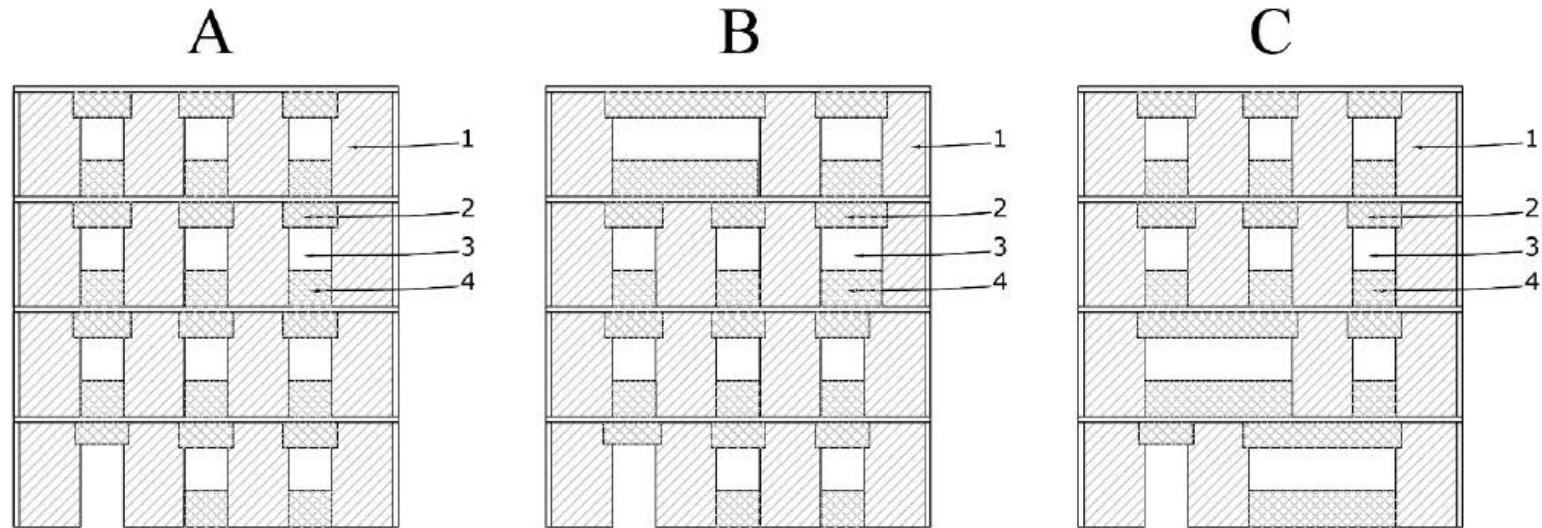
Ausblick: Entwicklung „plastischer“ Wände

proHolz Austria | zt:akademie



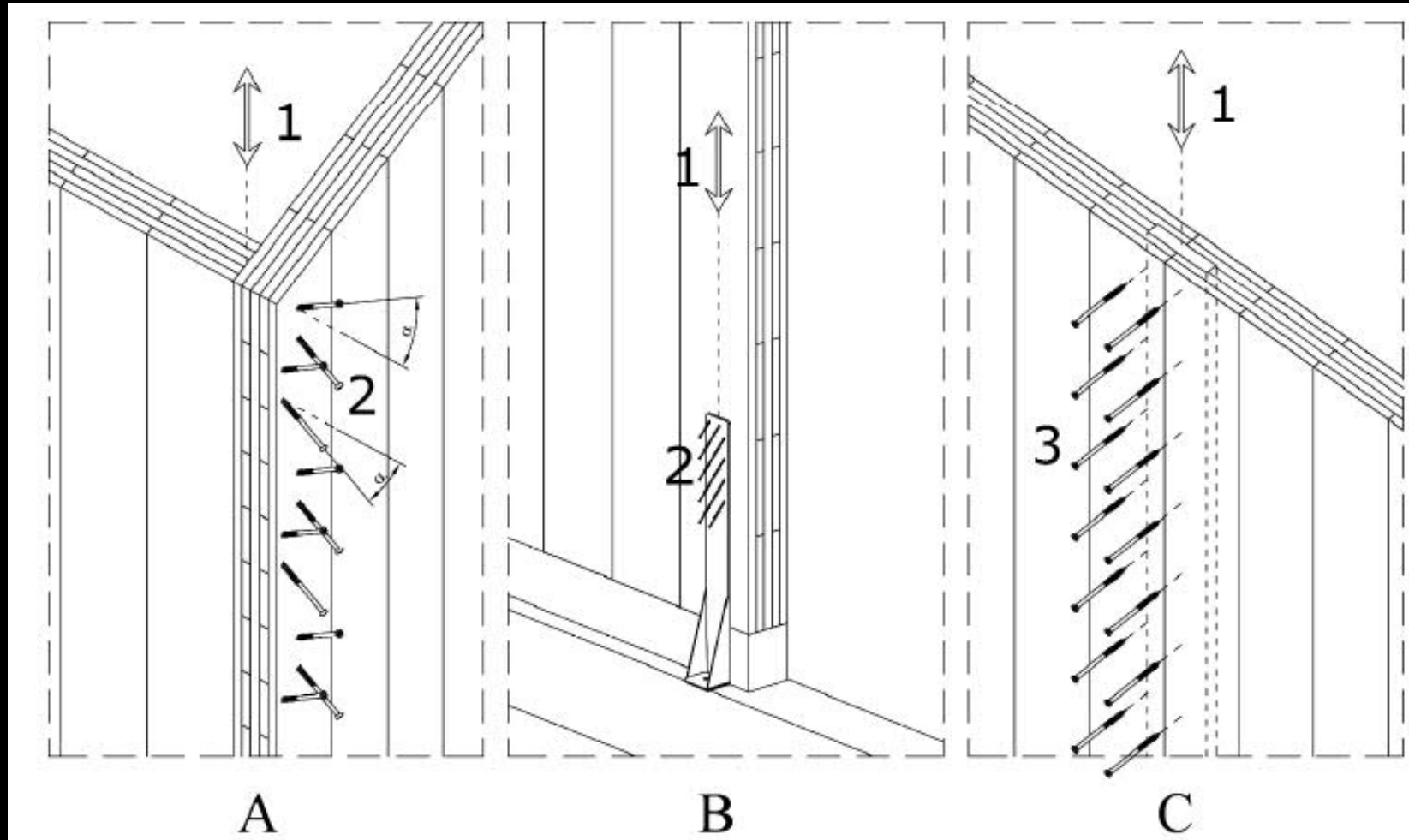
Auszug Draft
EN 1998 – Holz NEU

CLT - Konstruktion
q ... 1.5.. 3



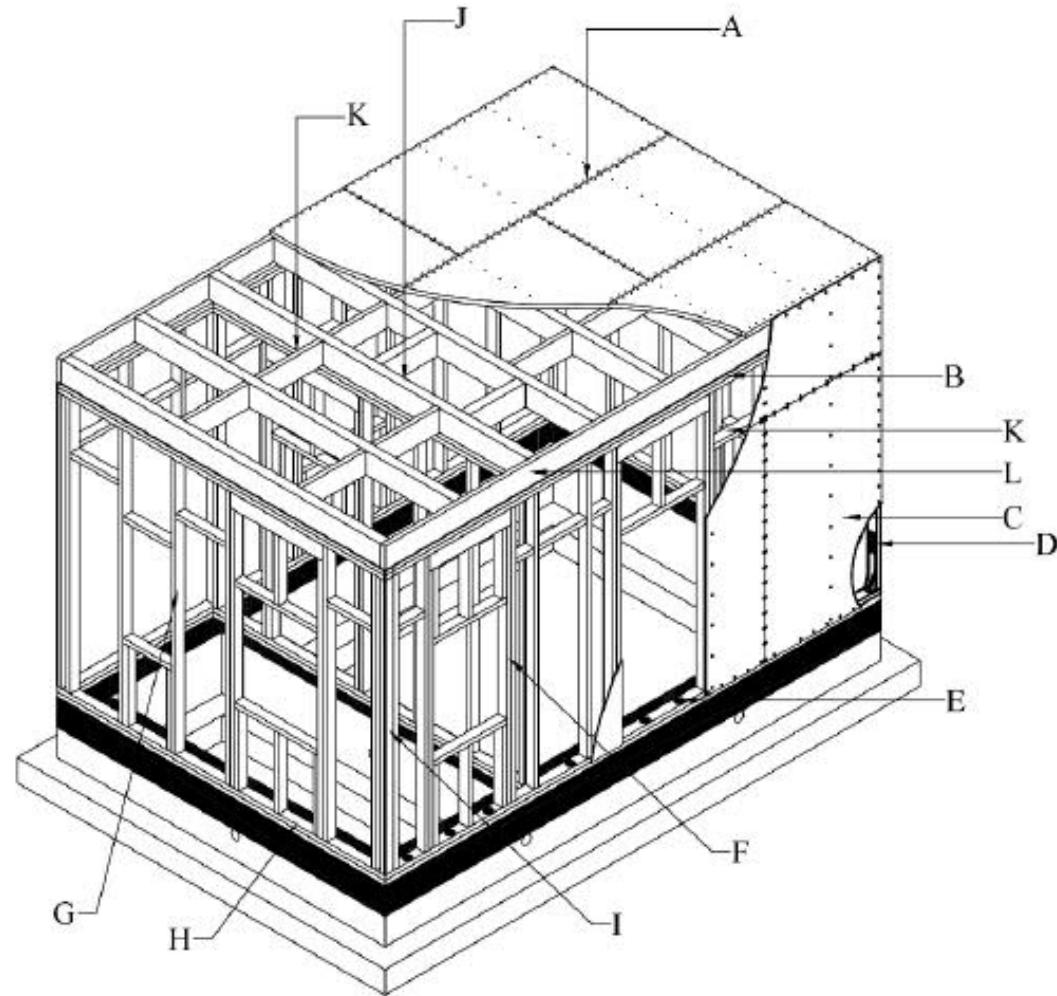
Key

- A Primary structure with all shear walls structurally continuous from the foundation to the roof.
- B Primary structure with part of the shear walls structurally continuous from the foundation to the roof and part of the shear walls interrupted at the top storey.
- C Primary structure with part of the shear walls interrupted below the second and third storey.
- 1 Structural wall
- 2 Lintel
- 3 Opening
- 4 Parapet



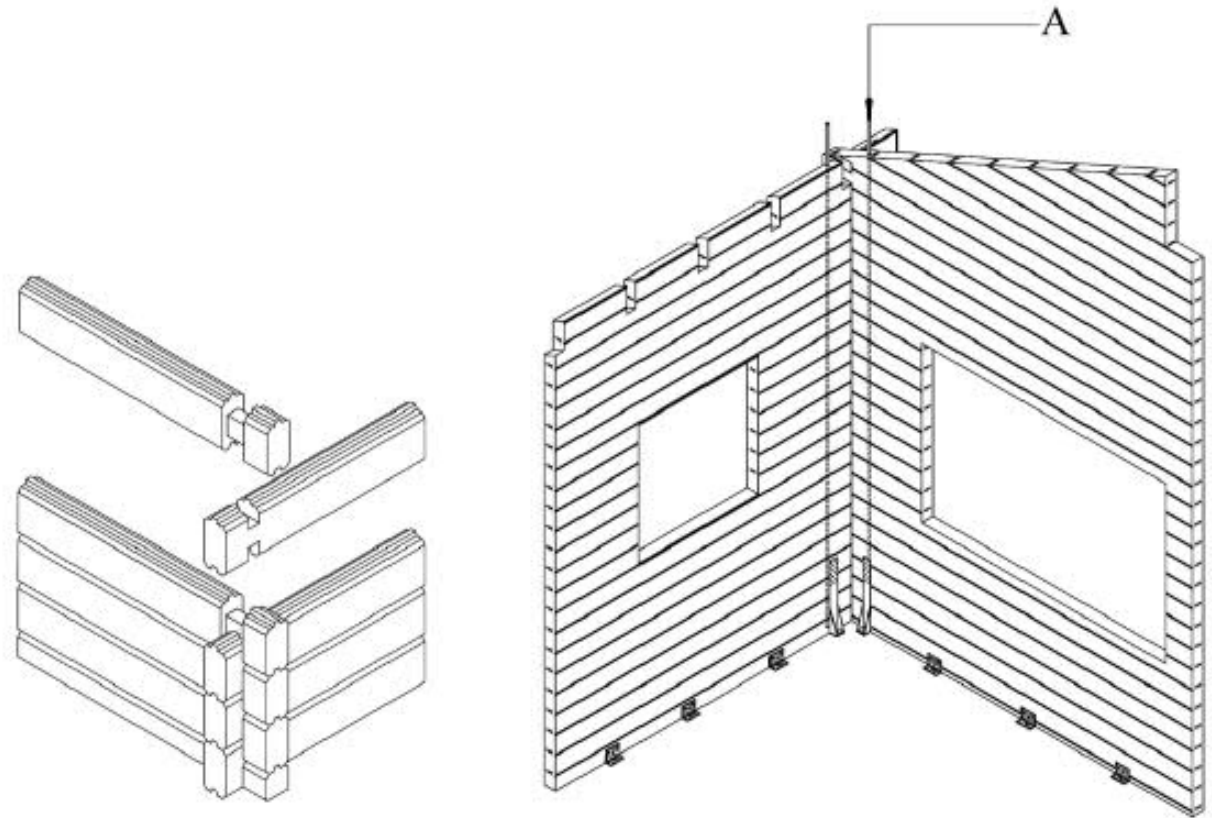
Auszug Draft
EN 1998 – Holz NEU

Pfosten – Riegel -
Struktur
q ...1.5.. 4



Auszug Draft
EN 1998 – Holz NEU

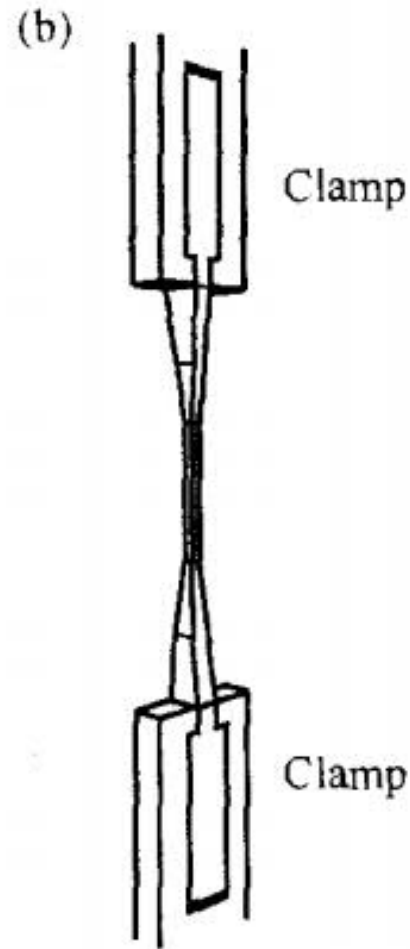
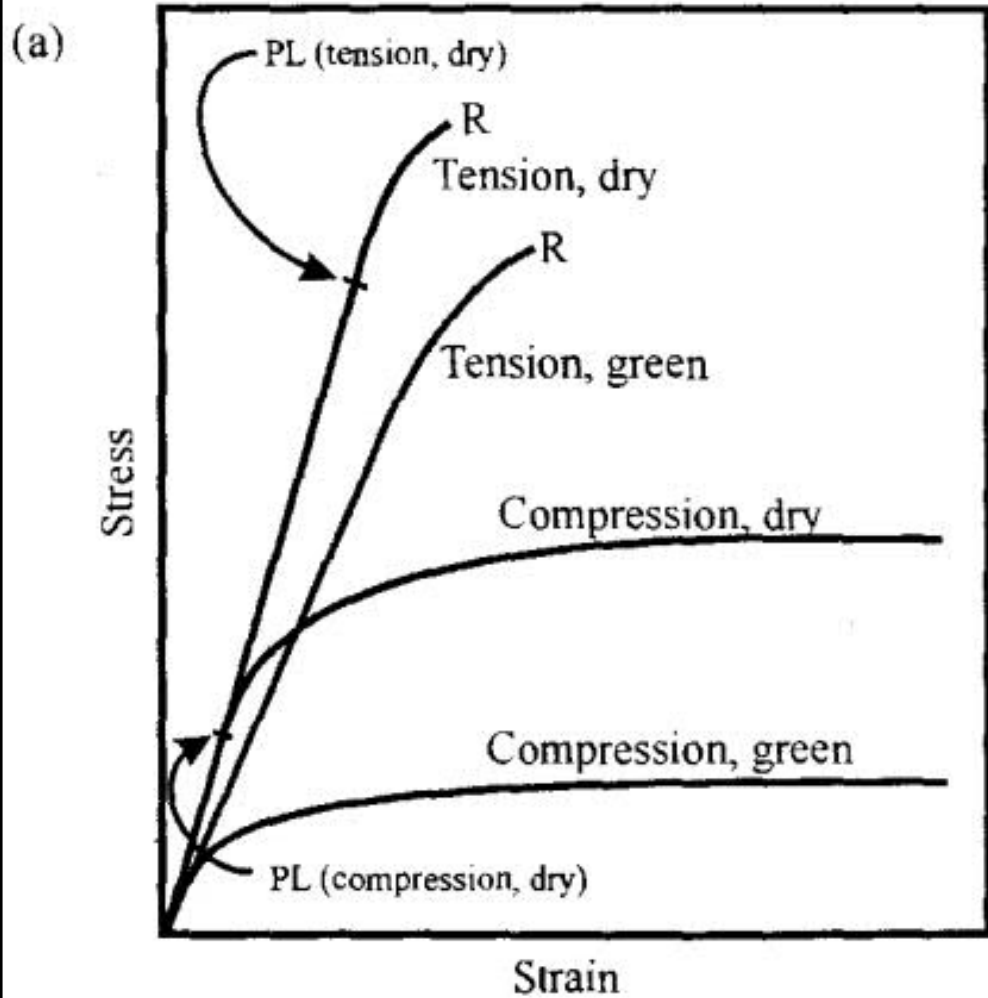
Bohlenstruktur
q ...1.5.. 2



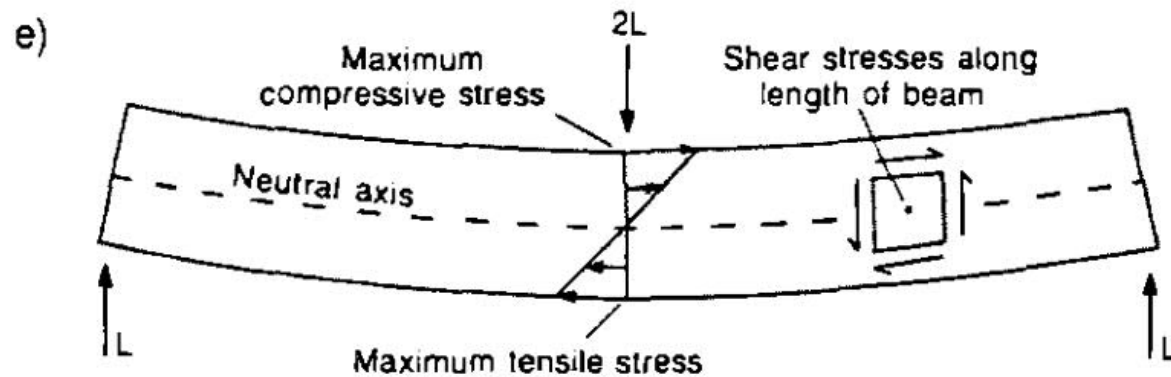
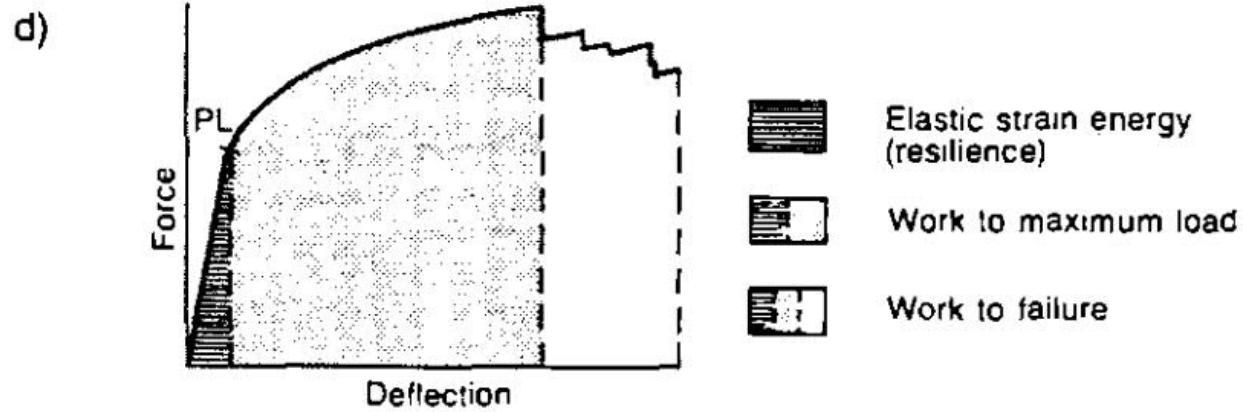
Key

A Possible steel rods as uplift restraint for timber logs.

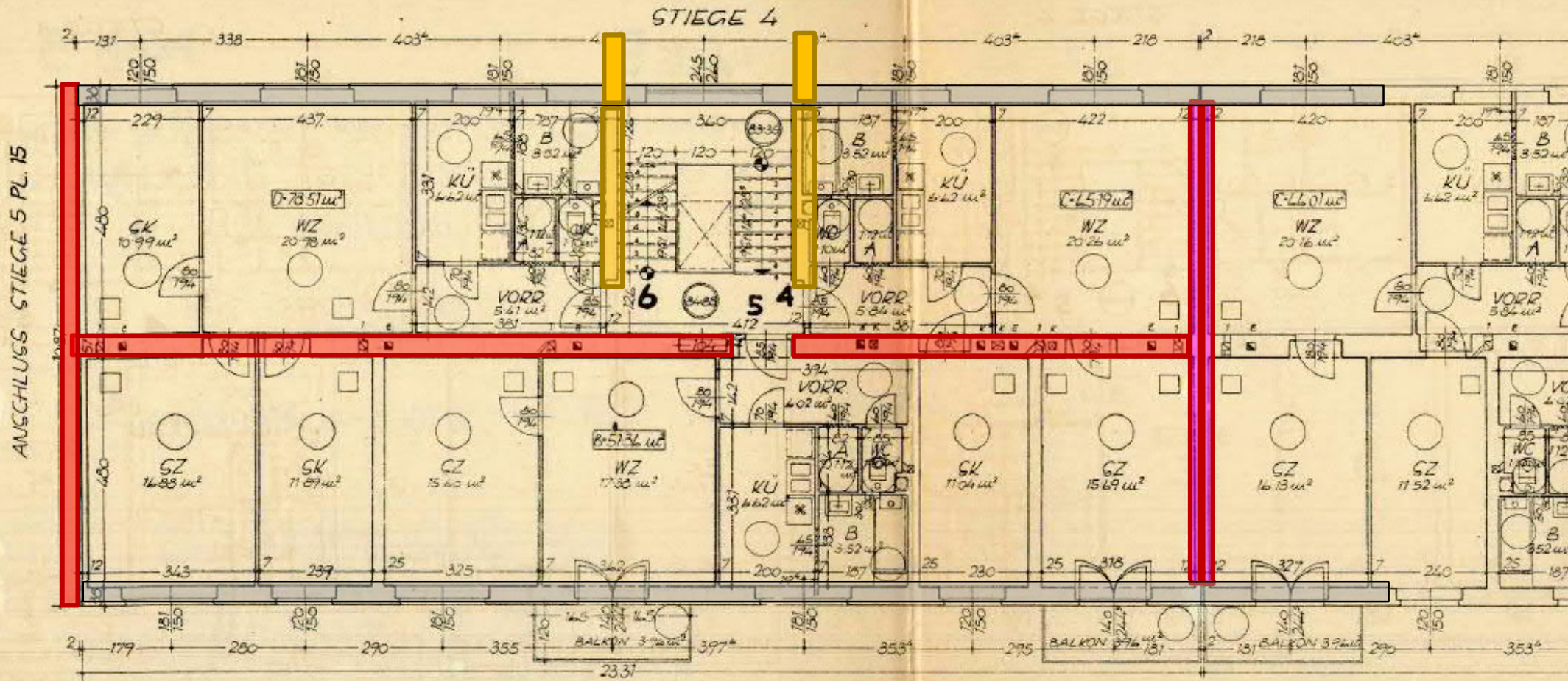
Figure 13.8 – Typical corner joint and connection details in log structures



Taken from:
Grading timber and
glued structural
members; David E.
Kretschmann; US
Forest Service



Taken from:
Grading timber and
glued structural
members; David E.
Kretschmann; US
Forest Service



Abfrage: 16.09.2020:

Weltbevölkerung	7 831 126 332
Geburten 2020	110 966 657
Tote 2020	43 236 516

Bevölkerungswachstum pro
Sekunde: 2.6

Baustoffbedarf pro Sekunde in t

1.300 | 870 | 300

*) Deutschland	490 t per capita
Industrieländer	335 t per capita
Weltdurchschnitt	115 t per capita

Folienidee: Werner Sobek

Quellen: <https://countrysimeters.info/de/> und
Sobek Stahlbautag 2019 Graz

Danke für Ihre Aufmerksamkeit