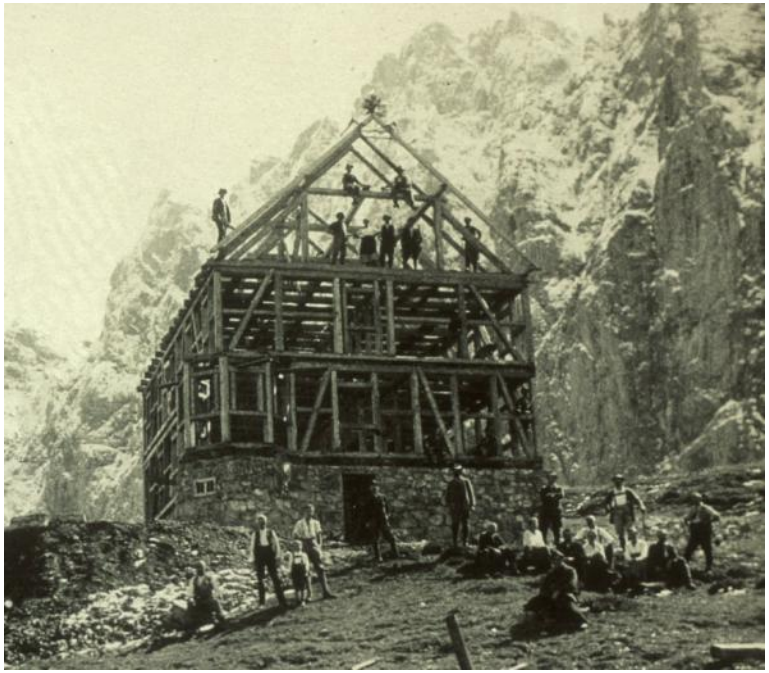
Prospects and challenges in future (10 – 20 years) timber engineering research

Ausblicke und Herausforderungen Holzforschung in den nächsten 10 bis 20 Jahren

COST Action E55 „Modeling the Performance of Timber Strutures
Zürich 26. Mai 2011

Heinrich Kreuzinger

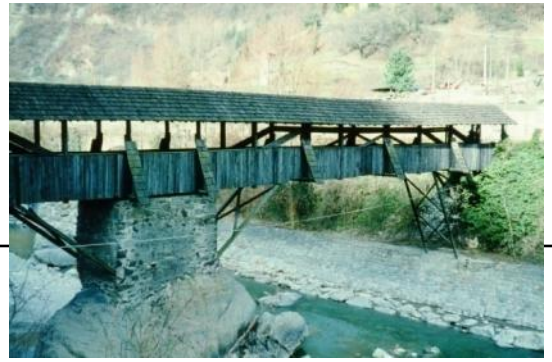
Erection now and in former times



Falkenhütte
1926

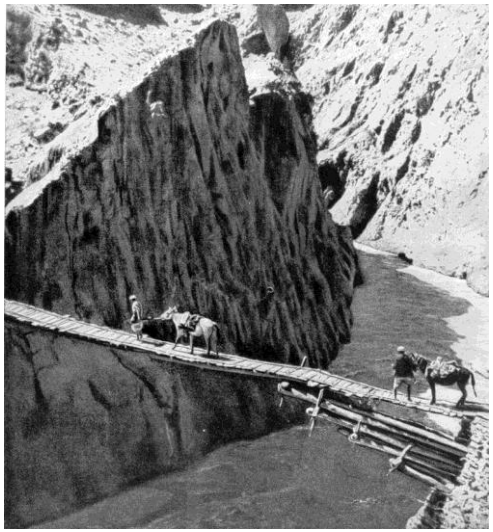
Olpererhütte
2005

Experience and calculation



State of the art

10 - 20 years



?

time

Large roofs

Eisstadion Inzell
(Grossmann)

State of the art

20 years

Sevilla
(Merk)

?

time

Development of gluing

State of the art

Hetzer, Adhesive

Welding?

20 years

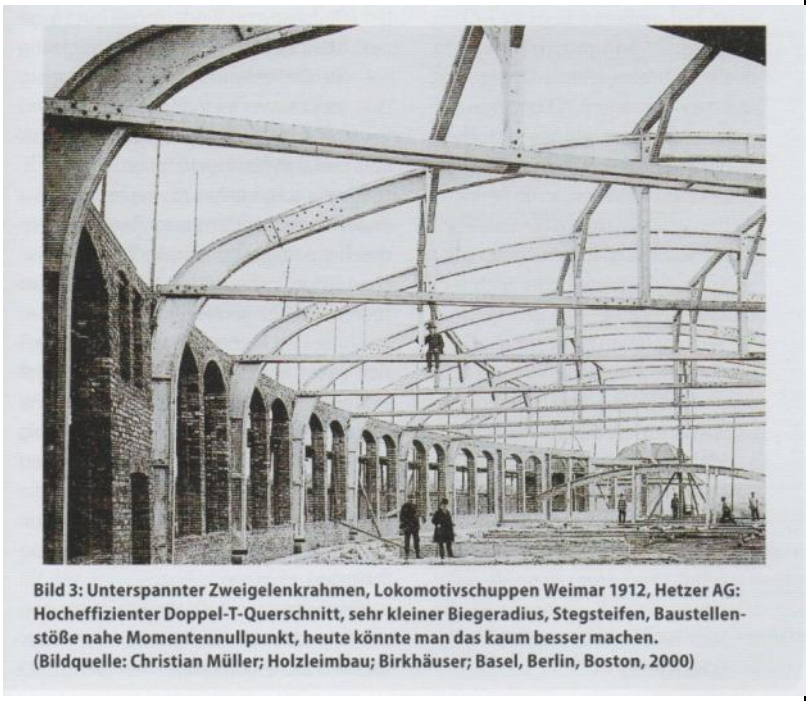
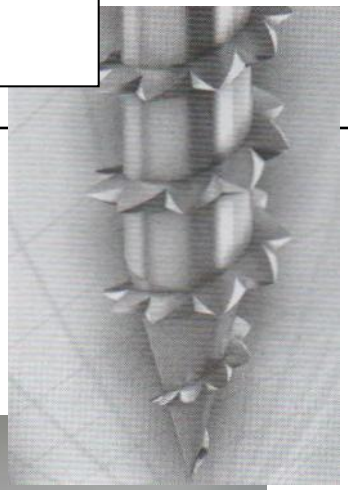


Bild 3: Unterspannter Zweigelenkrahmen, Lokomotivschuppen Weimar 1912, Hetzer AG: Hocheffizienter Doppel-T-Querschnitt, sehr kleiner Biegeradius, Stegsteifen, Baustellenstöße nahe Momentennullpunkt, heute könnte man das kaum besser machen.
(Bildquelle: Christian Müller; Holzleimbau; Birkhäuser; Basel, Berlin, Boston, 2000)

time

Developement of screws

State of the art



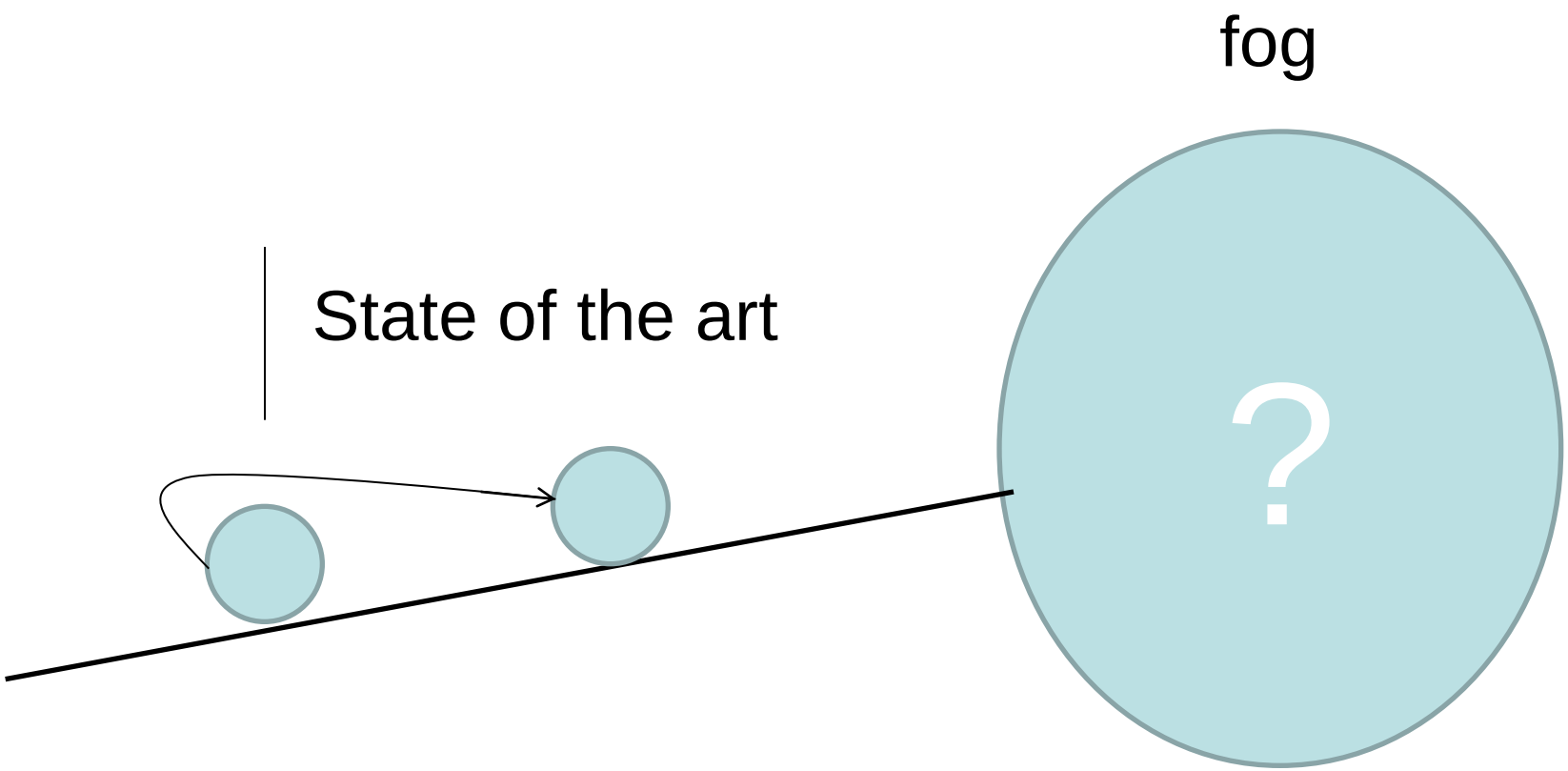
20 years

?

time

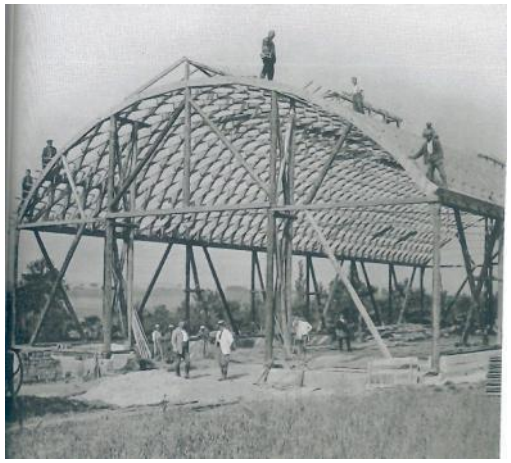
Look to the future

= review + beginning

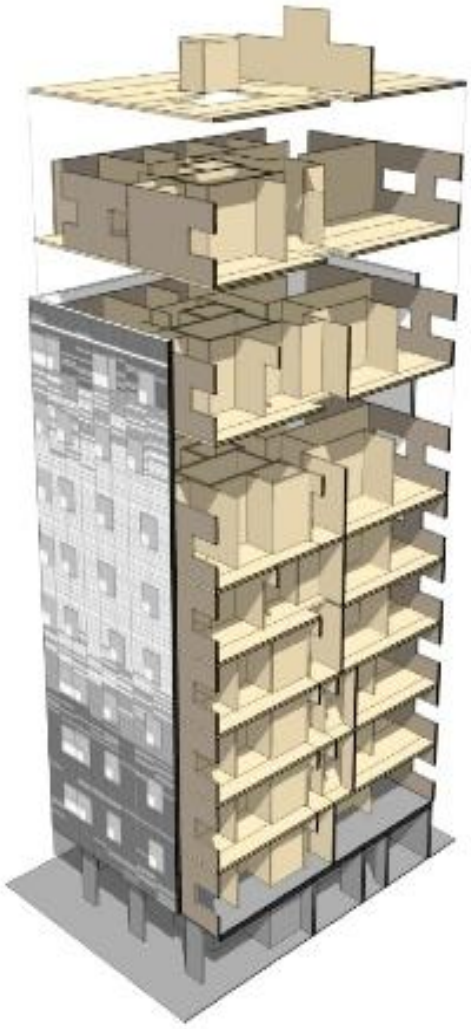


1. Introduction
2. State of the art
3. Potential for research
4. Research in future
5. Conclusion, banalities

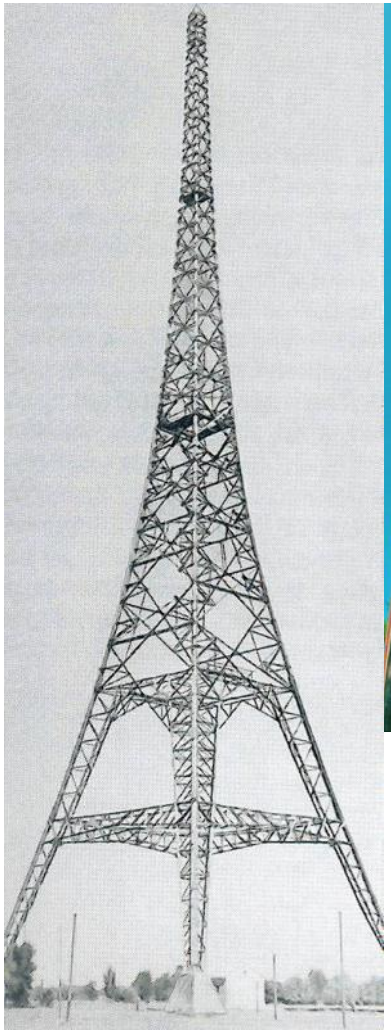
2. State of the art



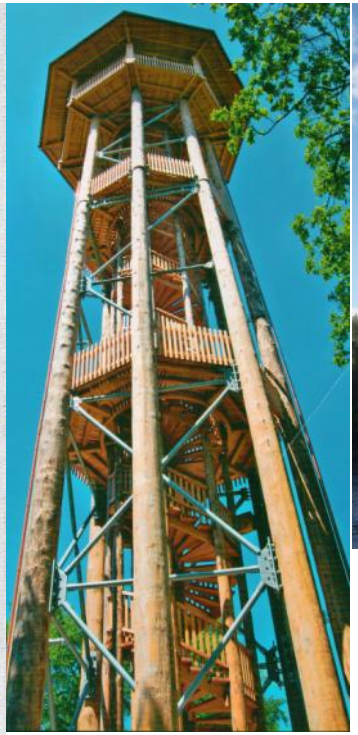
All kind of buildings



2. State of the art



Ismaning, 1934,
163 m,

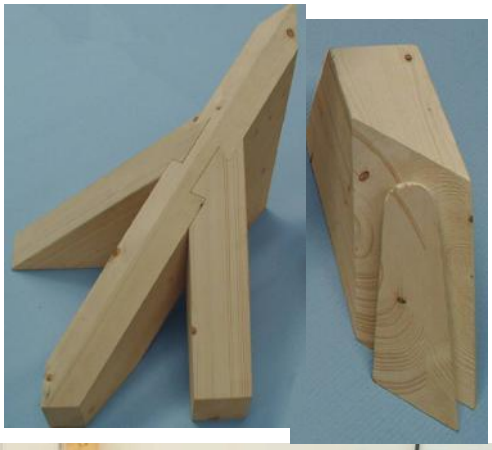


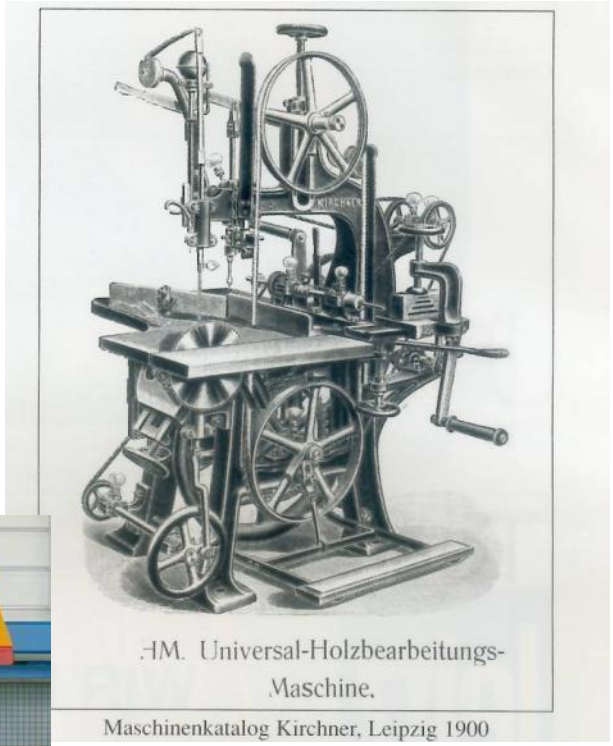
Switzerland

Flisabrücke Norway

2. State of the art

production
processing
handling

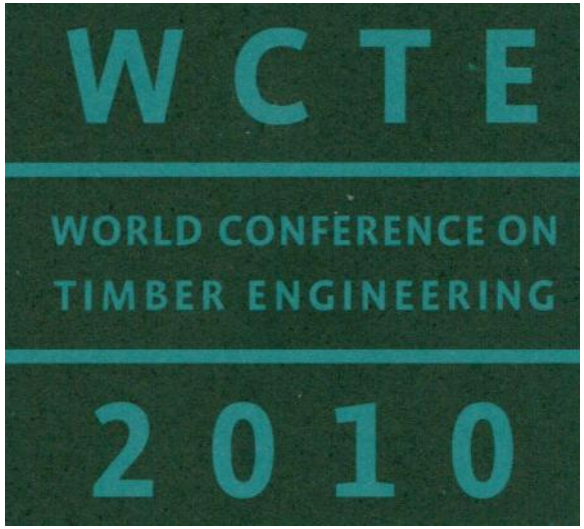




HM. Universal-Holzbearbeitungs-Maschine.

Maschinenkatalog Kirchner, Leipzig 1900

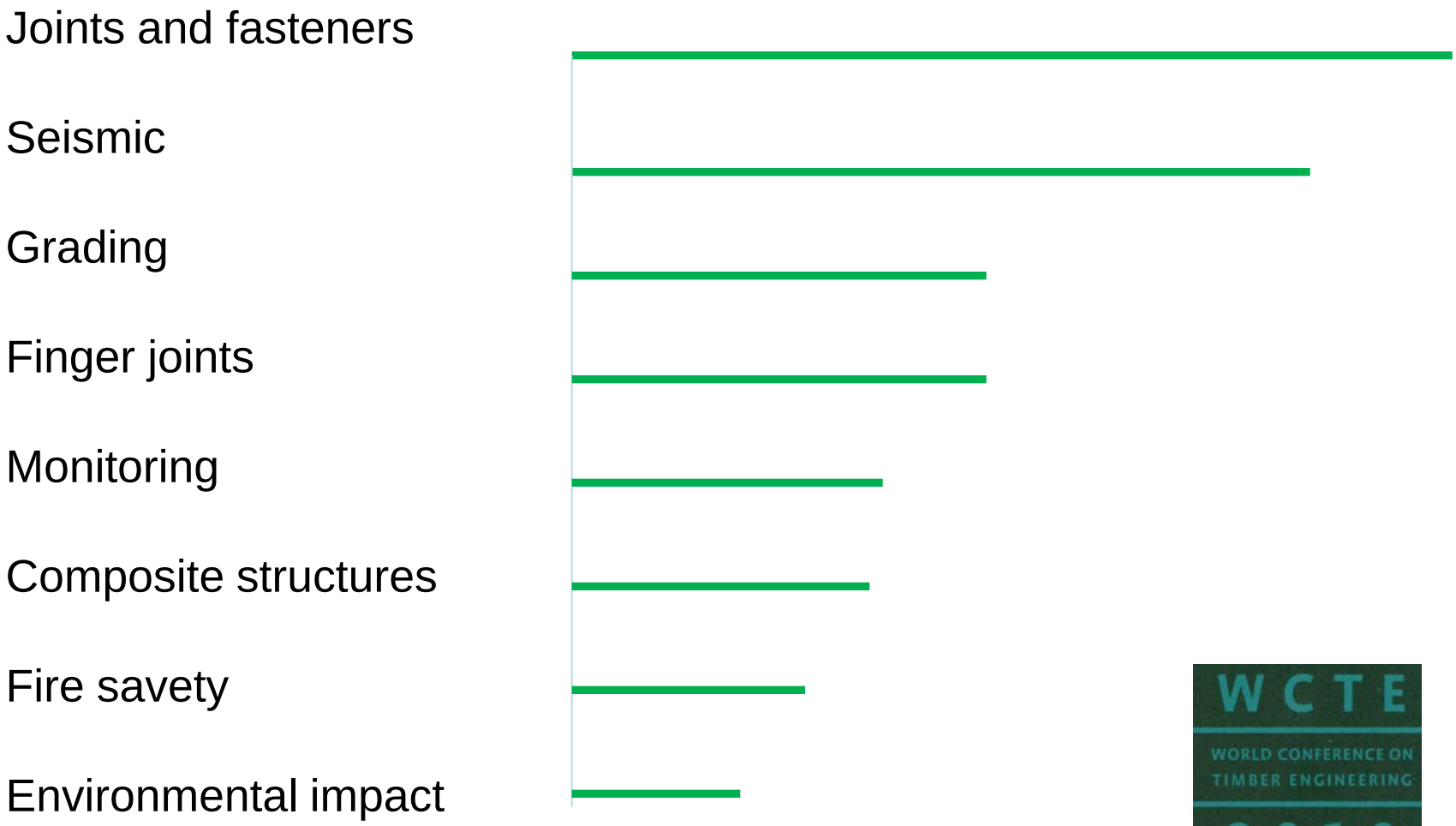
2. State of the art



about 320 papers

about 70 papers

2. State of the art



3. Potential for research

design and developement

leaving the expert knowledge

extrapolation instead of interpolation

new things

competition

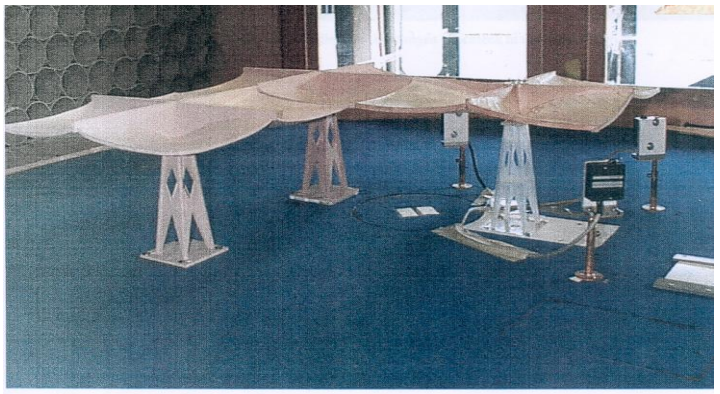
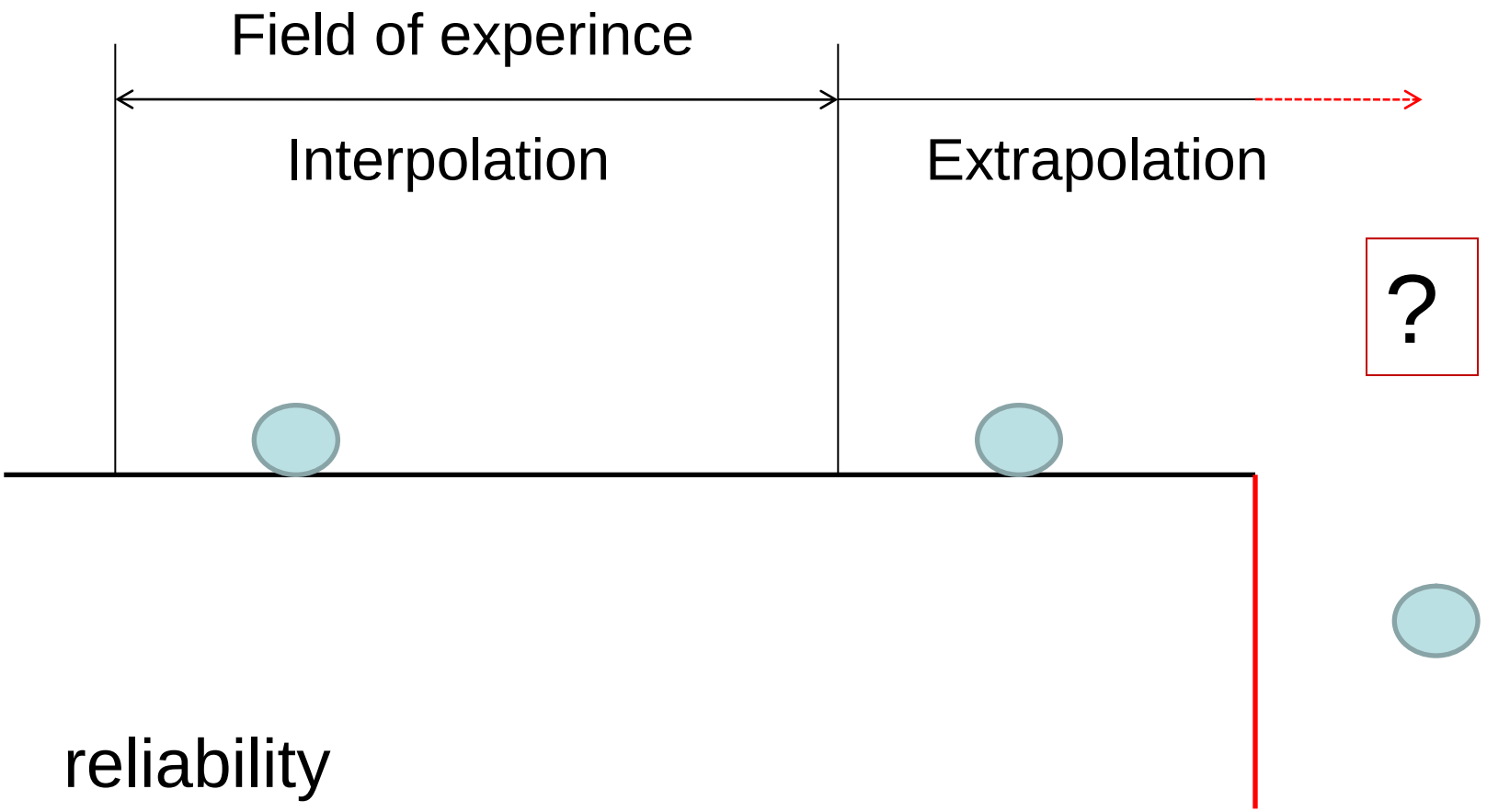


Fig. 2a Aeroeslastisches Modell des EXPO-Dach im Versuchsbereich des Grenzschichtwindkanales des LASEN.

new concept, ideas, innovation ?

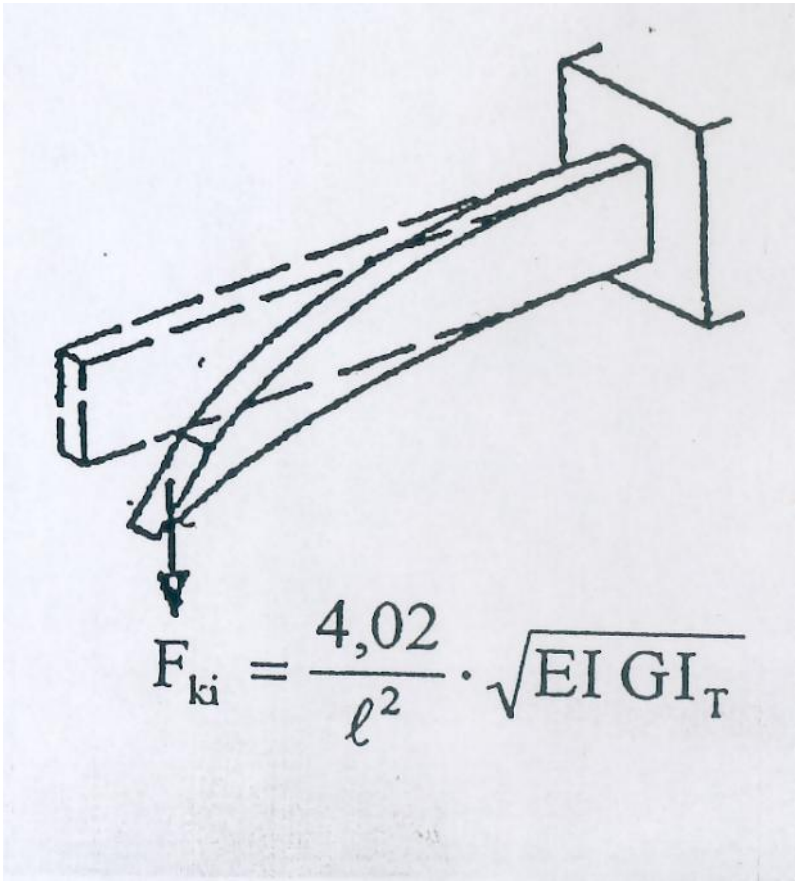
3. Potential for research



3. Potential for research

material strength

$$F_k = f_{k,m} \cdot W \cdot \ell$$



unknown effect: buckling

3. Potential for research

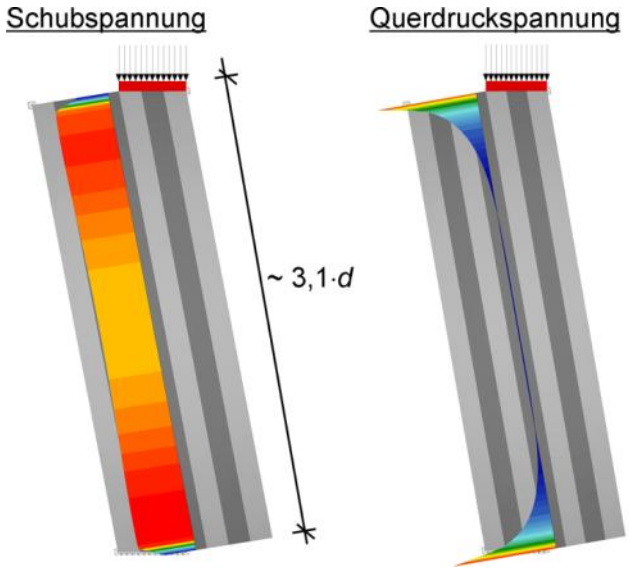
monitoring

ultrasound
non destructive

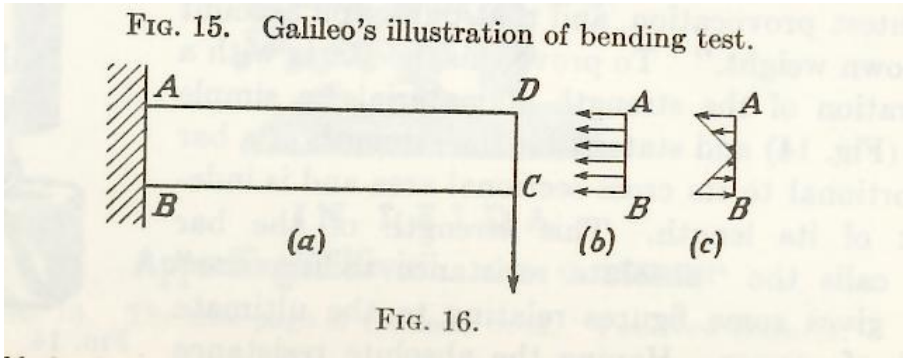
Compare with other disciplines
Widen your horizon

3. Potential for research

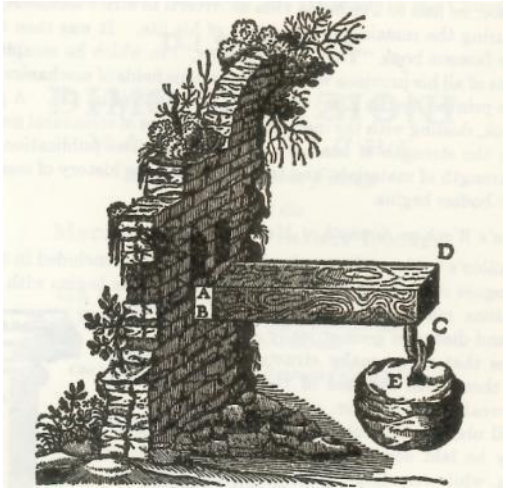
Calculation
also to calibrate testing



TUM, P. Mestek



$$\sigma = \frac{M}{I} \cdot z \leq f$$

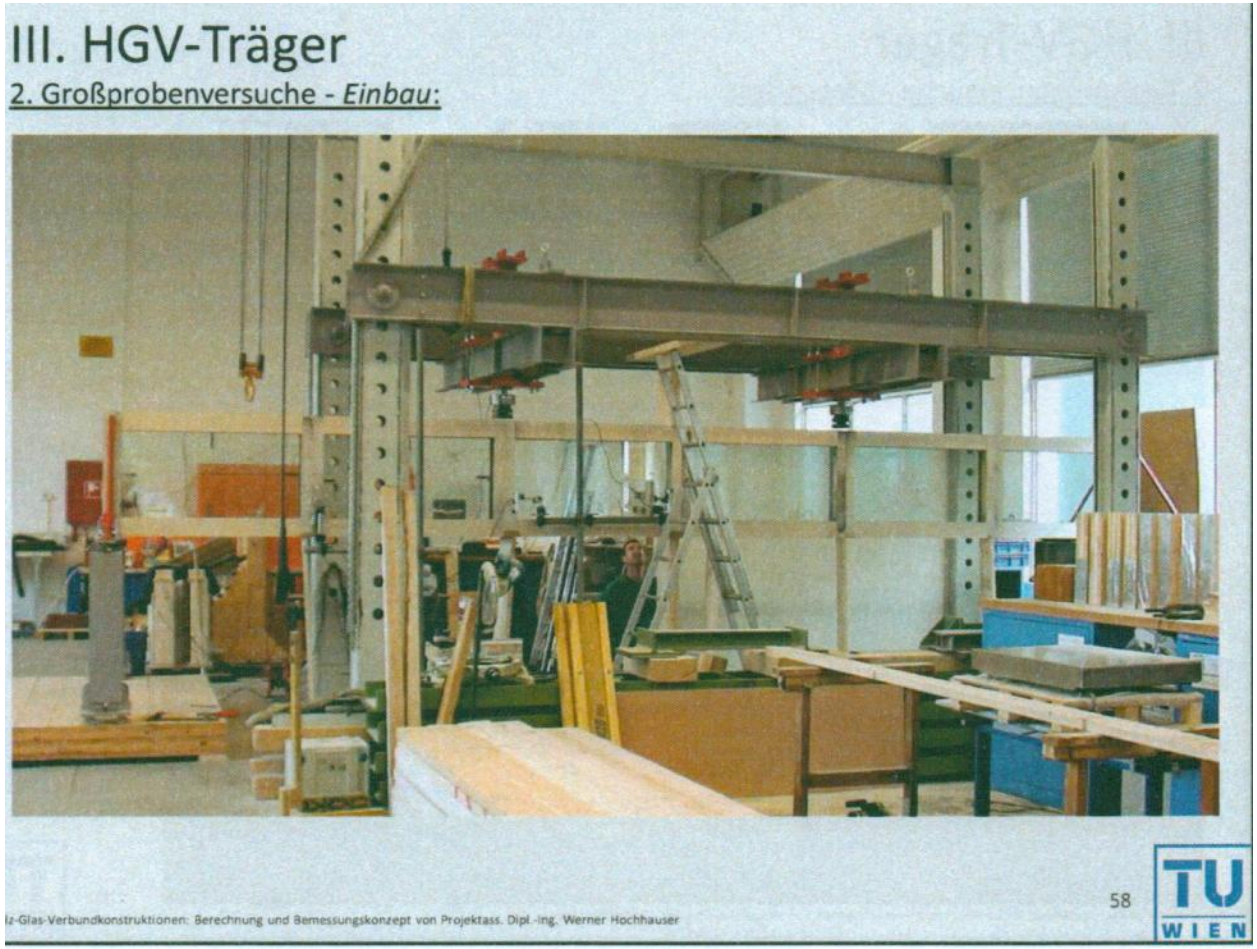


4. Research in future: material

New forms, materials, systems

4. Research in future: material

Composite e.g. timber glass



4. Research in future: material

Glued in FKV and aluminium

Neuheit im Fokus: Mit einer Aluminium-Stabilisierungs-Schicht (ASS) im Deckbereich, der Armierung aus Faser-Kunststoff-Verbund (FKV) und zwei Aluminium-Dampfsperrschichten im Rahmenholz reduziert Variotec zukünftig den Verzug, auch von großformatigen Türblättern – sowohl im Extremklima als auch bei besonderen Einsatzzwecken.

Bildnachweis: Variotec

4. Research in future: calculation

Equations for the anisotropic material
Stiffness matrix

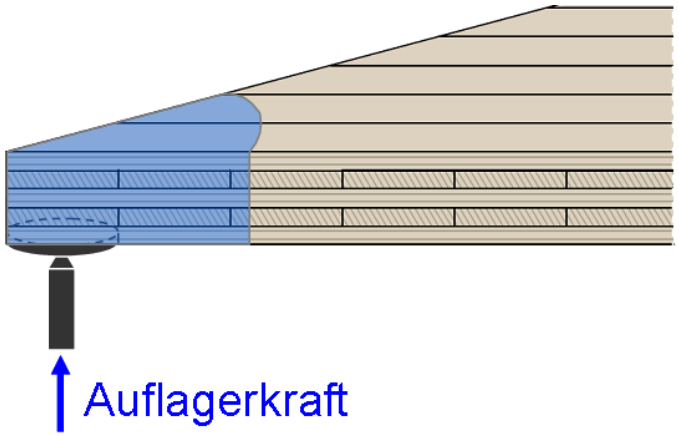
Model for cracking

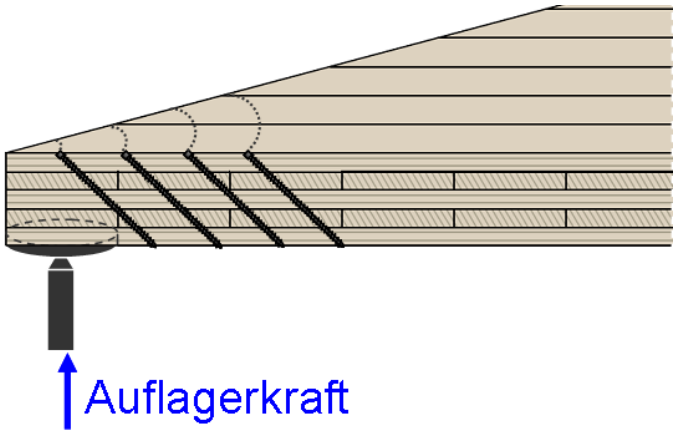
Phenomenons: k_{mod}, k_{def}, k_{fat}

Size factor

4. Research in future: calculation

Simplified methods for design

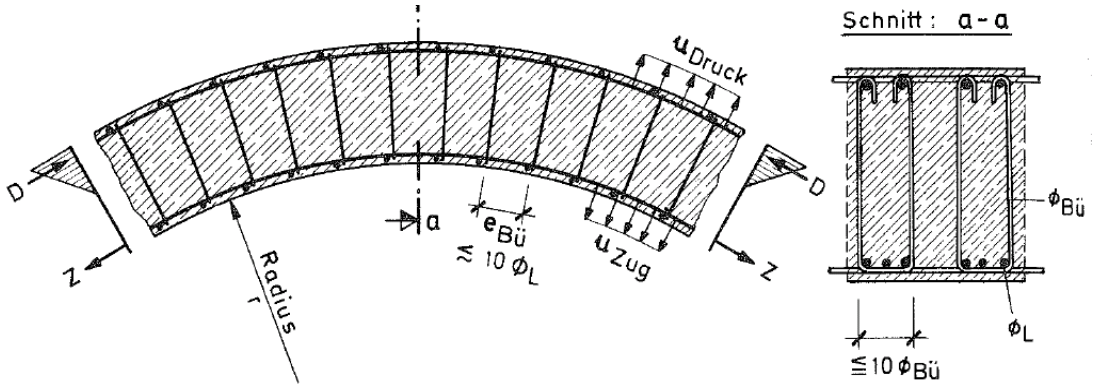




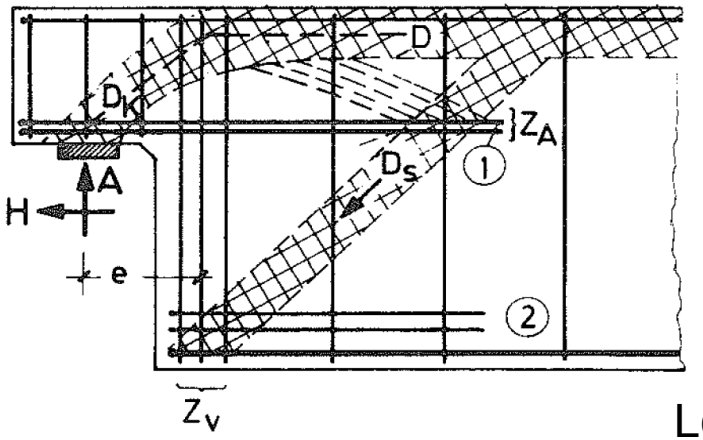
Current research project TU München, Mestek

4. Research in future: calculation

Look around

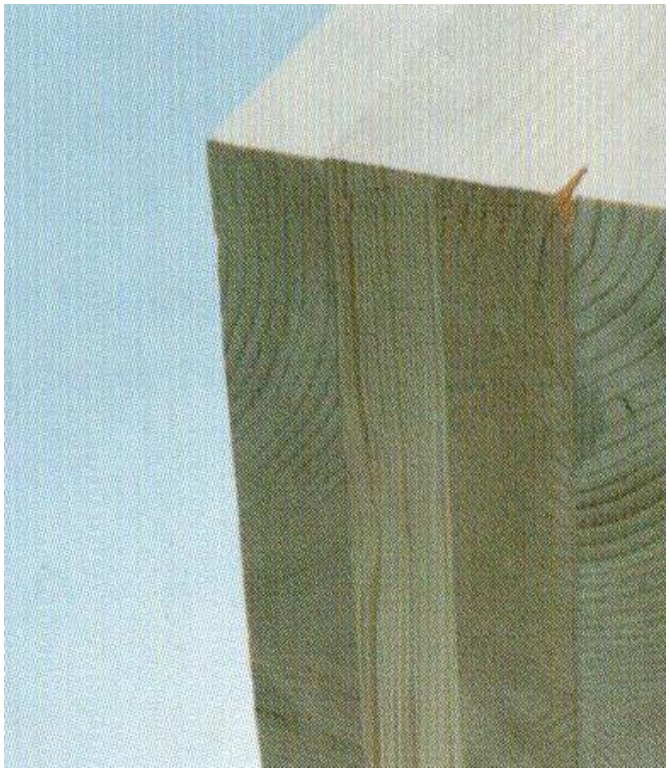


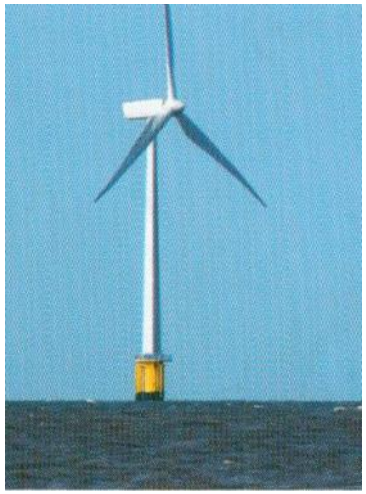
(Kirchanschöring, MPA BAU)



Leonhardt; Vorlesungen über Massivbau

4. Research in future: fatigue





Timber Tower

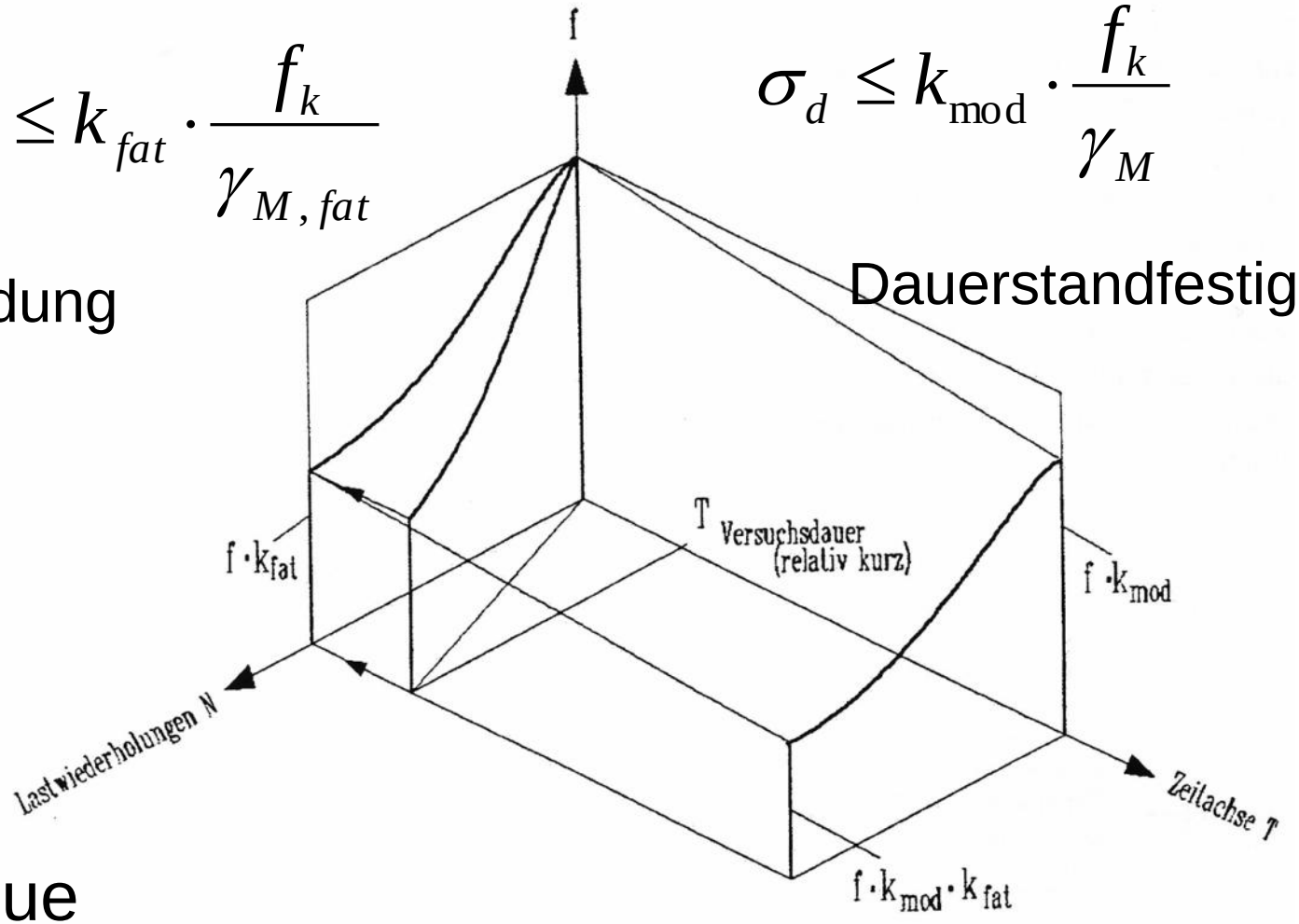
4. Research in future: fatigue, kfat and kmod

$$\sigma_{d,\max} \le k_{fat} \cdot \frac{f_k}{\gamma_{M,fat}}$$

Ermüdung

$$\sigma_d \le k_{\mathrm{mod}} \cdot \frac{f_k}{\gamma_M}$$

Dauerstandfestigkeit



Fatigue

Bild 4- 2: Verknüpfung der Einflüsse aus Dauerstandfestigkeit und Dauerfestigkeit (Bild 80 aus /Kre4/)

4. Research in future: kmod and kdef

Assumption for timber

$$\varepsilon_{t=0} = \frac{f_k}{E} \qquad \varepsilon_{t=\infty} = \frac{f_k \cdot k_{\mathrm{mod}}}{E} \cdot \left(1 + k_{def}\right)$$

$$k_{\mathrm{mod}} \cdot \left(1 + k_{def}\right) = 1 \quad ?$$

4. Research in future: earthquake

Earthquake

Factor q

Ceccotti

4. Research in future: joints

connections

joint

adhesive

welding

Fischer Kunststoff-Schweißtechnik GmbH

4. Research in future: adhesive

new adhesive!

no problem with humidity or temperature
simple to work
rapidly fixed

Rainstorm without protection!

None destructive test to verify the result

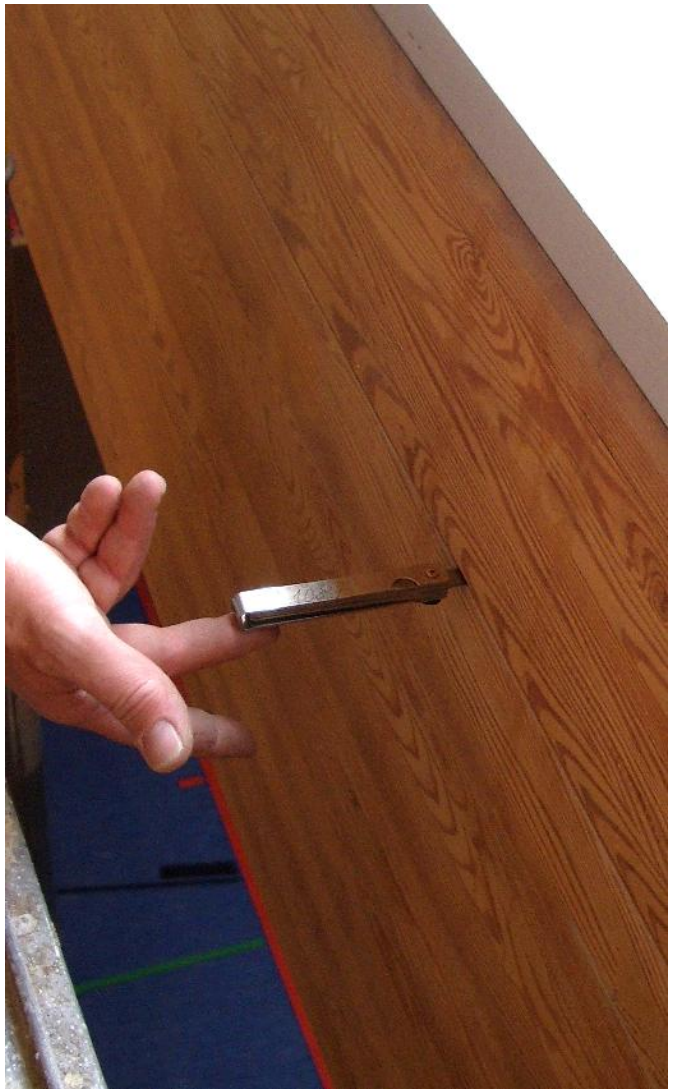
4. Research in future: durability

for buildings

4. Research in future: monitoring

Mesurement of cracks

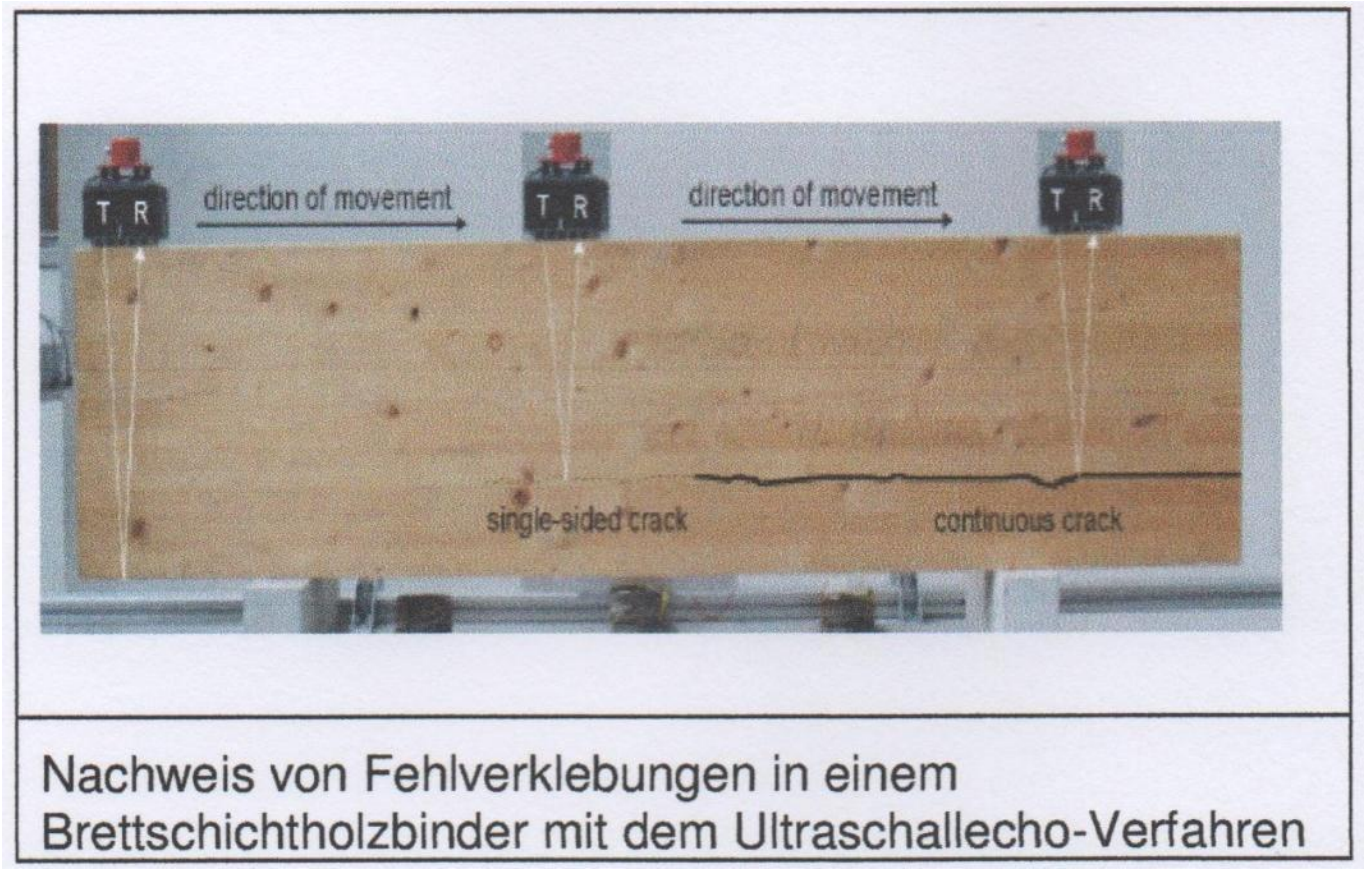
How to repair cracks?



4. Research in future: monitoring

ultrasonic

Non-destructive



Nachweis von Fehlverklebungen in einem Brettschichtholzbinder mit dem Ultraschallecho-Verfahren

Dr. Krause
BAM

4. Research in future: monitoring

Vision !

Wartung, Überprüfung

43

Wunschtraum !

Holzart:	Fichte C24	
E-Modul:	15 322	MN/m²
Festigkeit:	38,5	MN/m²
Spannung:	0,3	MN/m²
Restnutzungsdauer:	121	Jahre

Heinrich Kreuzinger

4. Research in future: sustainability

wood =
sustainability

4. Research in future

best possibilities of research

best young researchers

best education

5. Conclusion, banalities

some keywords

Timber = sustainability = enviroment protection

To burn timber for heating is a pity

Sustainability is no trend, it is a necessity

Optimization of energy-efficiency is
not always sustainable

Is Evolution sustainable?

Era of timber?

Life cycle

Bring together material and ideas

5. Conclusion, banalities

greater spans
smaller cross sections

?

Challenge:
sustainability

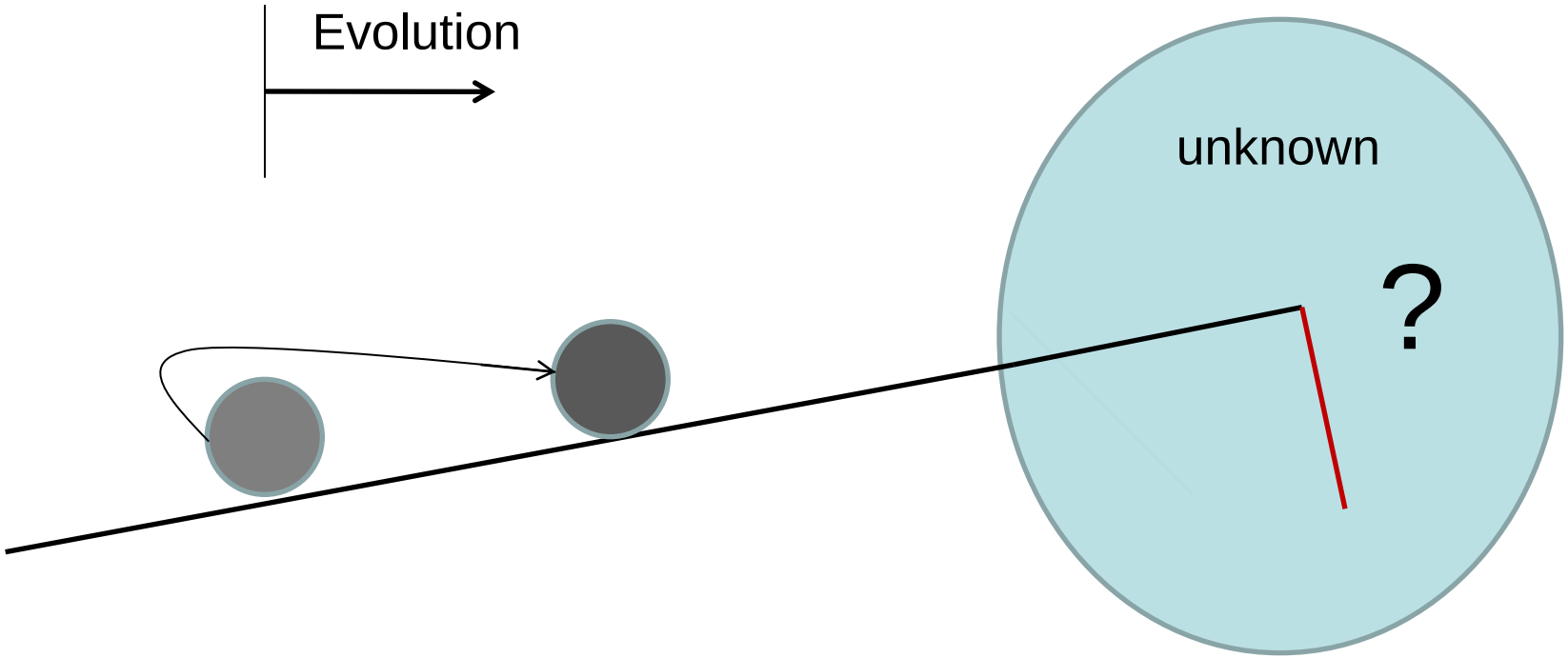
timber = future

5. Conclusion, banalities

View to the future

= review + beginning

Buckling
Size Effect
Galloping

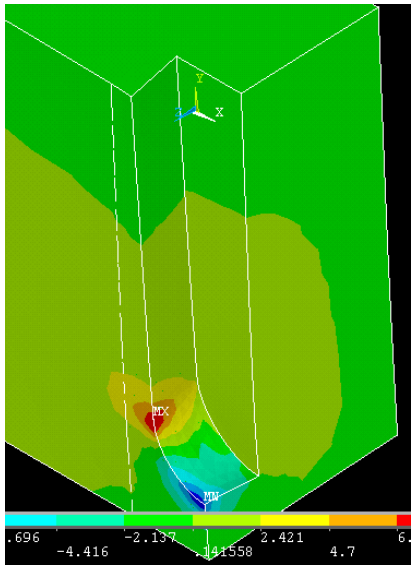


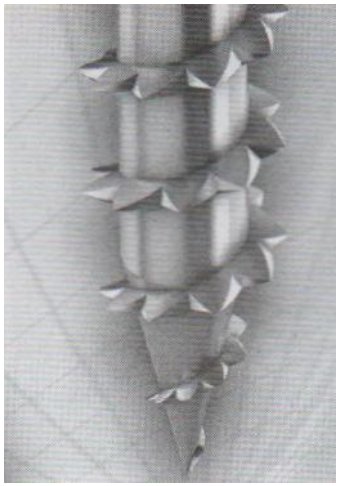
5. Conclusion, banalities

Big buildings

Project Austria, 80m

or details





for enthusiasm?

Answer:
both !

5. Conclusion, banalities

At the end of the actual knowledge

all the following things are very fascinating!!

Challenge:
to provocate enthusiasm for
enviroment, energy, social aspects

5. Conclusion, banalities

Research is necesary for the world!

Timber is not the most important

but the ideas behind timber
(wood, buildings, sustainability)

may help other fields

4. Research in Future

my favorites: help to increase the use of timber!

Calculation of details and structures

Robust adhesives

Cracks: avoid, measure, repair

Economy: material and energy, durability

Combination of all: materials and ideas

4. Research in Future

to work with timber

help to understand the world

and help to save the creation

5. Conclusion, banalities

Wood and timber for all!

Prospect and challenge:
Using timber from the beginning to the end in an economic and resposible way

For this, research is necesary!

decompose

fire

beginning → end

thank
You
for
Your
attention