

Erdbebensicherung von Bauwerken I – FS09

## V7: Bemessung und konstruktive Durchbildung von Hochbauten

- Fotografische Dokumentation -

Alessandro Dazio

**i|b|k** Erdbebeningenieurwesen und Baudynamik **ETH**

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### V 7.1: Querschnittsanalyse von Stahlbetonbauteilen

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### Erdbebenbeanspruchung eines Stahlbetongebäudes

**Wirklichkeit** **Versuch**

3-geschossiger Skelettbau ausgesteift durch Tragwände

Stockwerksmassen 3 x 12 t

Versuchskörper im Maßstab 1:3 h = 3 x 1.36 m

ETH-Erdbebensimulator mit Versuchskörper

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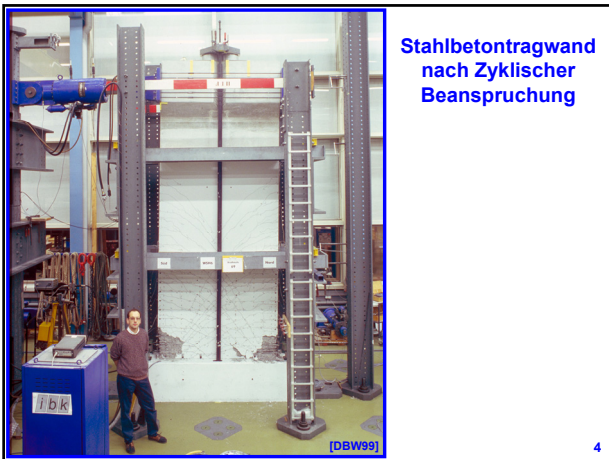
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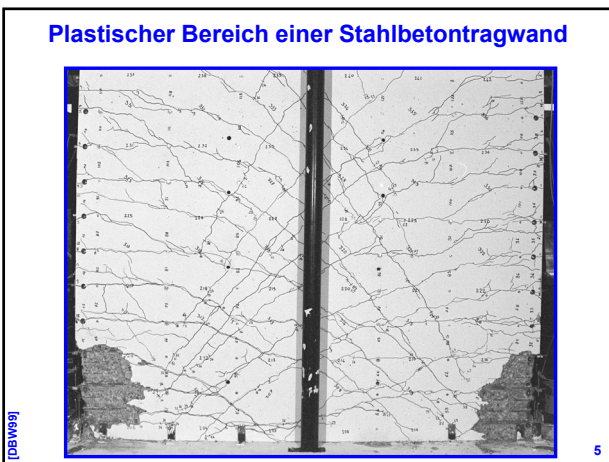
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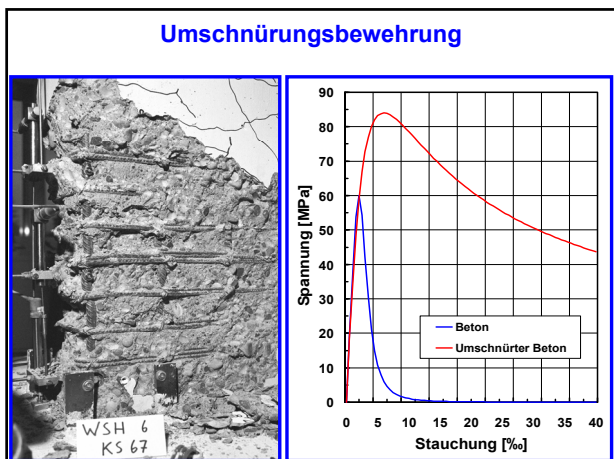
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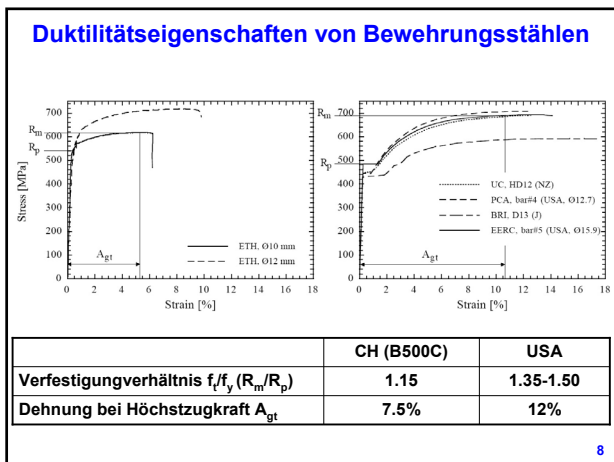
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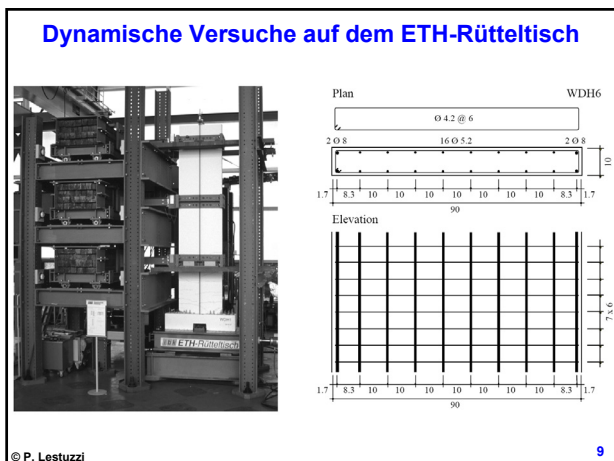
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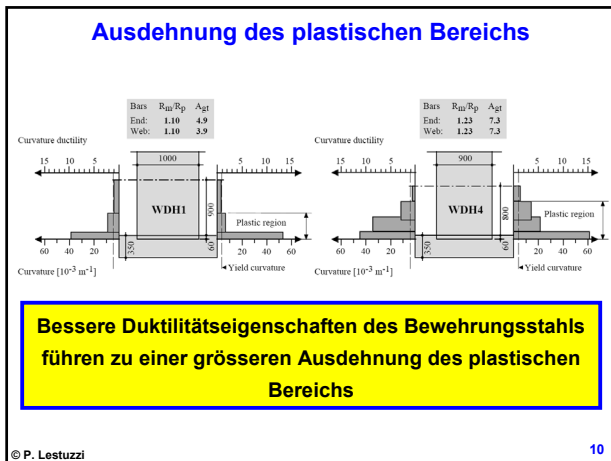
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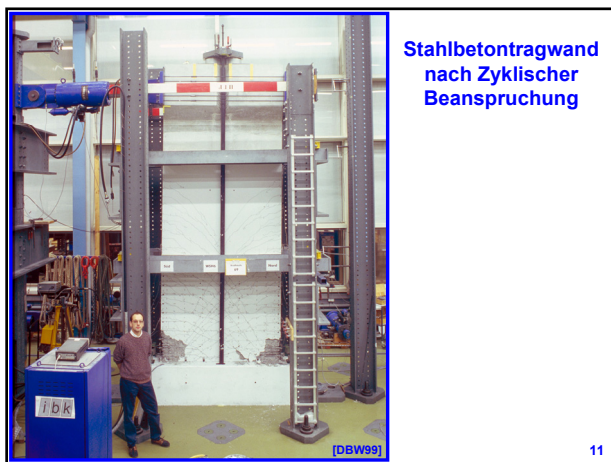
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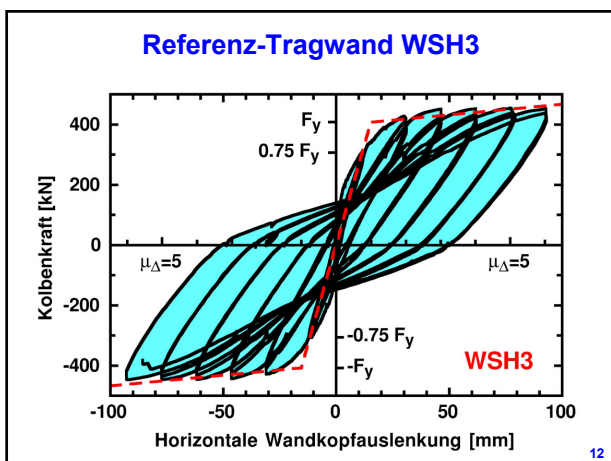
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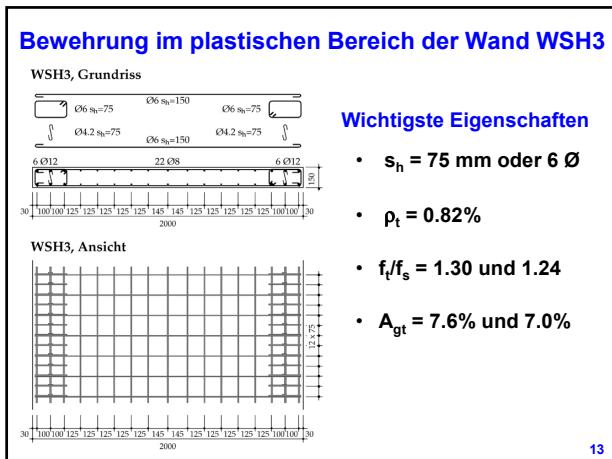
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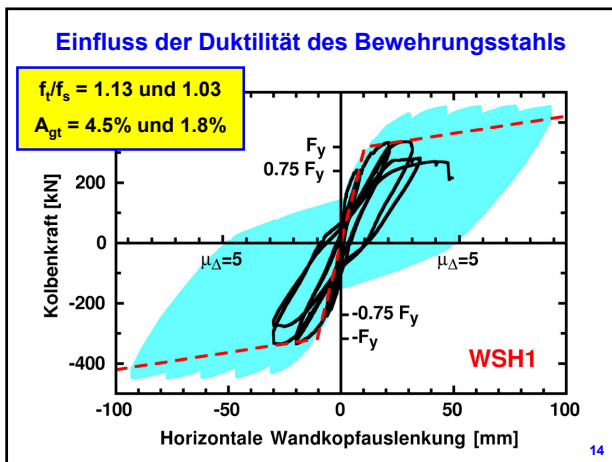
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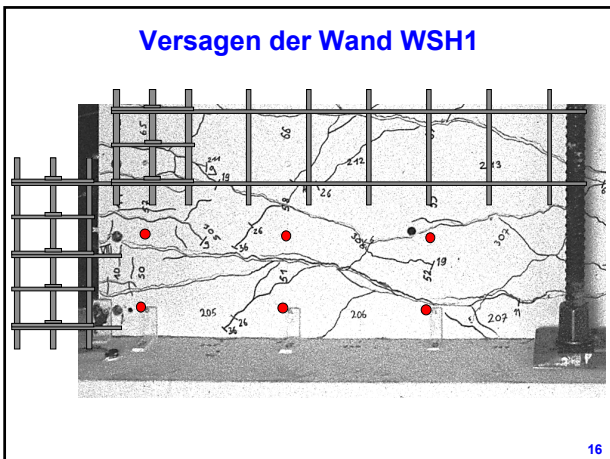
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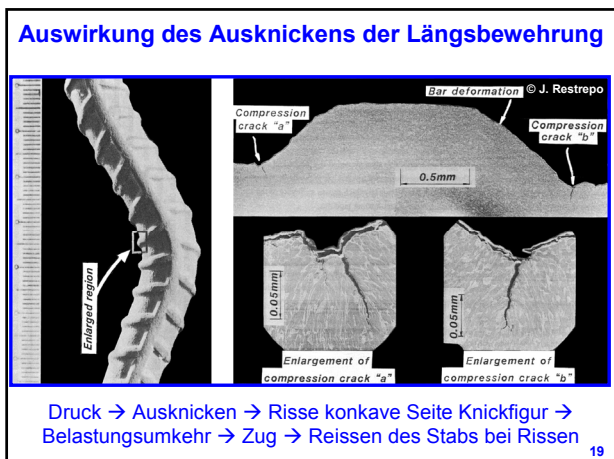
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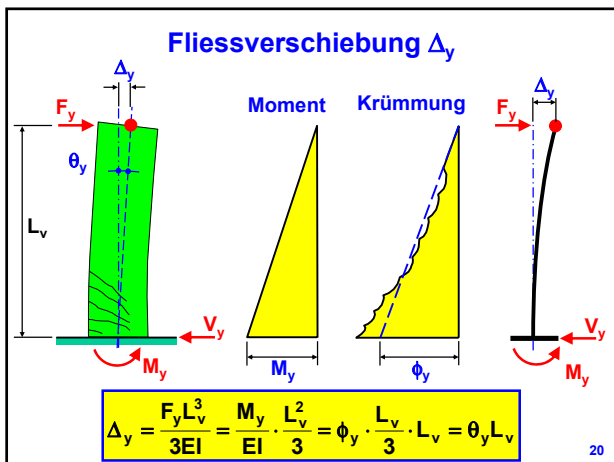
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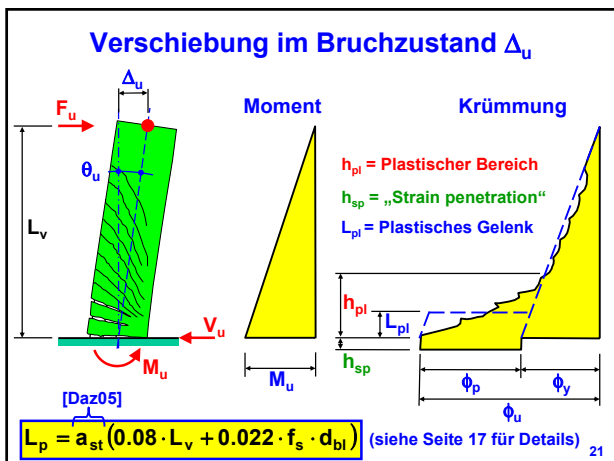
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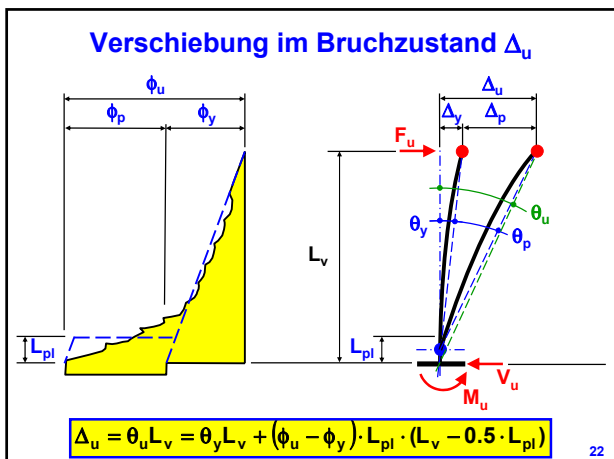
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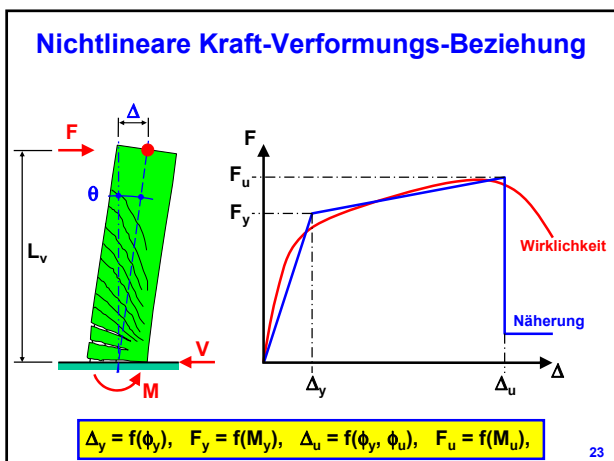
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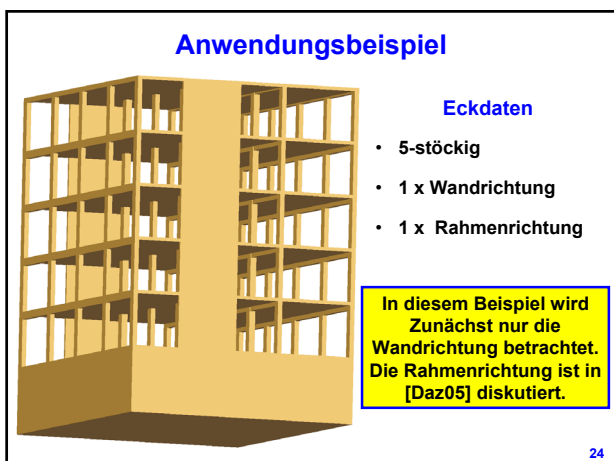
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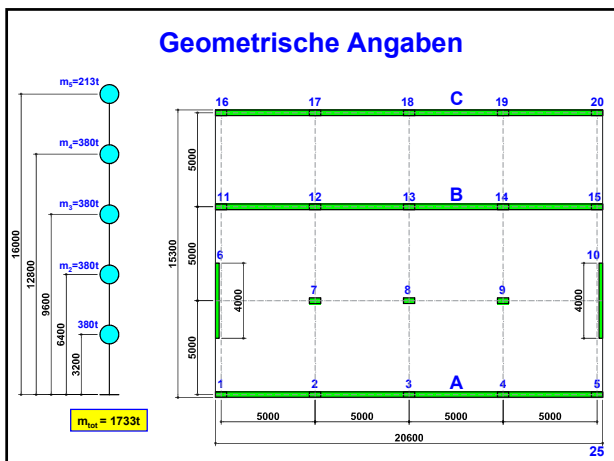
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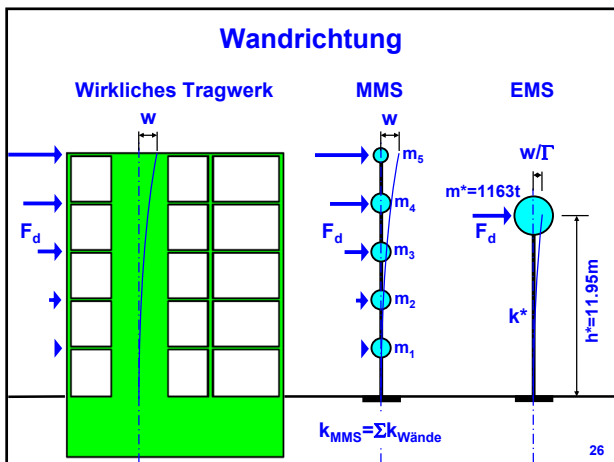
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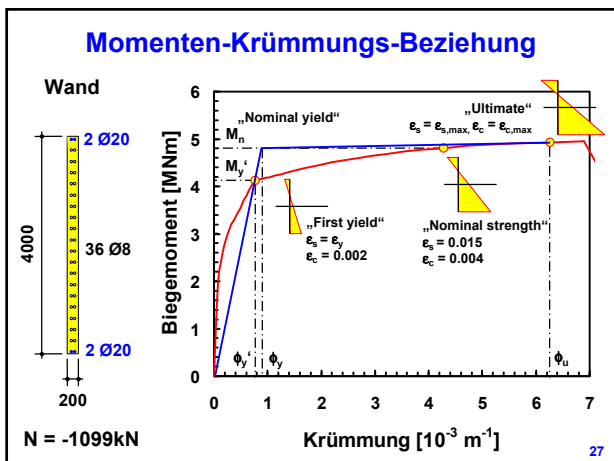
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### Berechnung der Kraft-Verformungs-Beziehung

a) Länge des plastischen Gelenks

$$L_{pl} = 0.08 \cdot 11950 + 0.022 \cdot 450 \cdot 20 = 1154 \text{ mm}$$

b) Nominelles Fließen

$$\Delta_y = \phi_y \cdot \frac{h^2}{3} = 0.814 \times 10^{-3} \cdot \frac{11.95^2}{3} = 0.039 \text{ m}$$

$$F_y = \frac{M_n}{h} = \frac{4450}{11.95} = 372 \text{ kN}$$

c) Versagen

$$\Delta_u = 0.039 + (6.896 - 0.814) \times 10^{-3} \cdot 1.154 \cdot \left( 11.95 - \frac{1.154}{2} \right) = 0.119 \text{ m}$$

$$F_u = \frac{M_u}{h} = \frac{4950}{11.95} = 414 \text{ kN}$$

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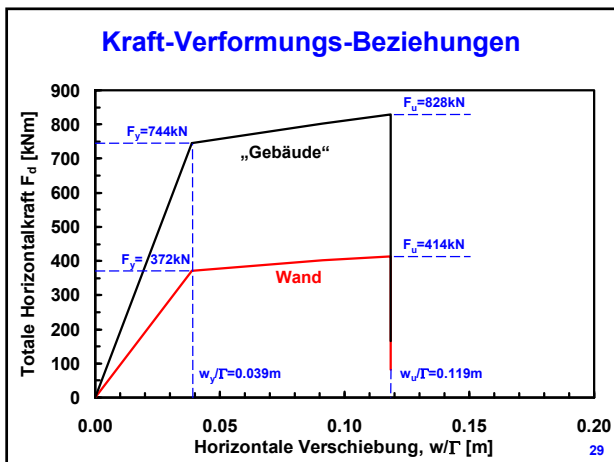
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### Überfestigkeit $\epsilon$ nach Norm SIA 262

Bemessung einer Wand für  $M_d = 20.0 \text{ MNm}$ ,  $N_d = 3.60 \text{ MN}$ ,  $V_d = 1.37 \text{ MN}$

	Querschnitt	Bewehrung	Beton	Widerstand
Bemessungswert des Biegewiderstands		$f_{td} = 435 \text{ MPa}$ $\epsilon_{td} = 0.065$	$f_{cd} = 26 \text{ MPa}$ $\epsilon_{cd} = 0.003$	
Biegewiderstand bei Überfestigkeit		$1.27 f_{sk} = 633 \text{ MPa}$ $1.1 f_{sk} = 550 \text{ MPa}$ $\epsilon_{uk} = 0.075$	$f_{cm} = 53 \text{ MPa}$ $\epsilon_{cd} = 0.003$	
	Topar 500C C 45/55			

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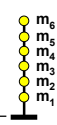
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### Ermittlung der effektiven Steifigkeit

Gebäude

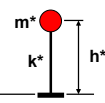


MMS



$k_{MMS} = \sum k_{Wände}$

Äquivalenter Modaler EMS



Die effektive Steifigkeit eines Gebäudes ist die Steifigkeit  $k^*$ , die ein äquivalenter modaler EMS haben muss, um ein ähnlich dynamisches Verhalten wie das Gebäude zu haben.

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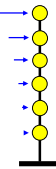
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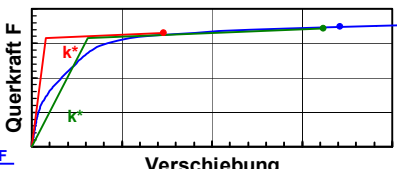
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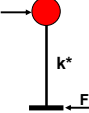
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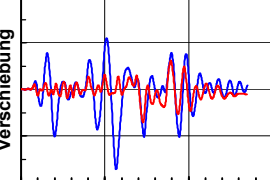
### Ermittlung der effektiven Steifigkeit





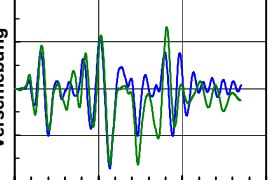


Verschiebung



Zeit

Verschiebung



Zeit

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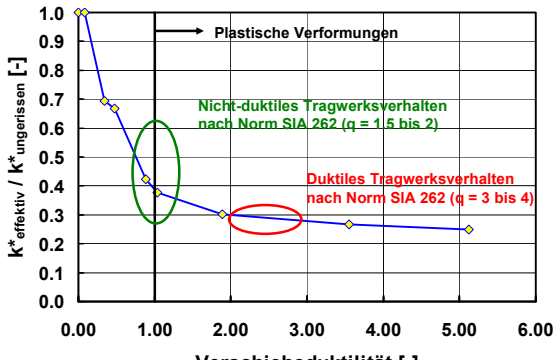
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### Ermittlung der effektiven Steifigkeit



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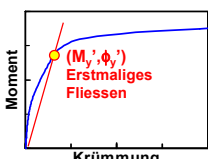
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### Ermittlung der effektiven Steifigkeit

1) Berechneter Wert

$$EI_{\text{eff}} = \frac{M'_y}{\phi'_y}$$


2) Geschätzter Wert für Vorbemessung

Balken	Stützen	Wände
Rechteckiger QS → 0.40 I <sub>g</sub>	N/(f <sub>cd</sub> A <sub>c</sub> ) > 0.5 → I = 0.80 I <sub>g</sub>	N/(f <sub>cd</sub> A <sub>c</sub> ) = 0.2 → I = 0.45 I <sub>g</sub>
T- oder L-QS → 0.35 I <sub>g</sub>	N/(f <sub>cd</sub> A <sub>c</sub> ) = 0.2 → I = 0.60 I <sub>g</sub>	N/(f <sub>cd</sub> A <sub>c</sub> ) = 0.0 → I = 0.25 I <sub>g</sub>
	N/(f <sub>cd</sub> A <sub>c</sub> ) = -0.05 → I = 0.40 I <sub>g</sub>	N/(f <sub>cd</sub> A <sub>c</sub> ) = -0.1 → I = 0.15 I <sub>g</sub>

[SIA D0171] s.155 nach [NZS 3101] 34

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### V7.2: Die Methode der Kapazitätsbemessung

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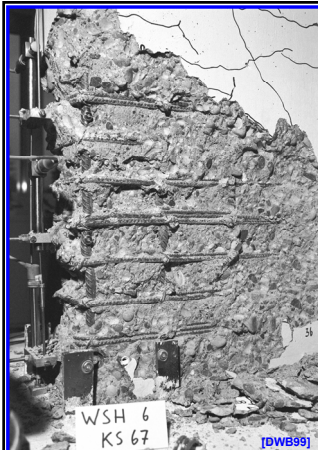
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**Biegedruckzone  
einer  
Stahlbetontragwand**

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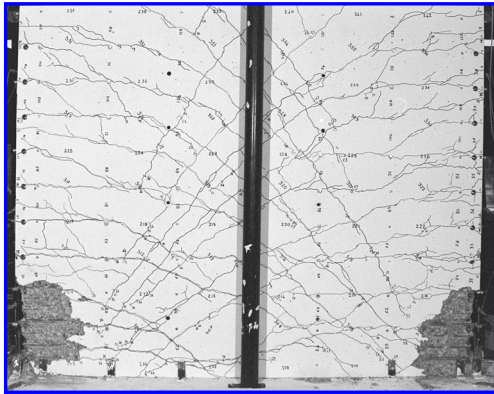
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Plastischer Bereich einer Stahlbetontragwand



[DBW99]

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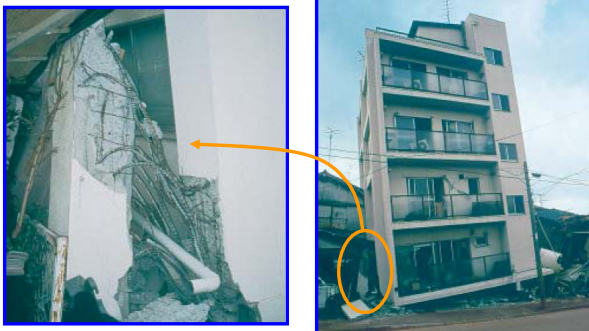
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Soft storey  
(Kobe Erdbeben, 1995)



© T. Wenk

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Soft-Storey  
(Kocaeli Erdbeben, 1999)



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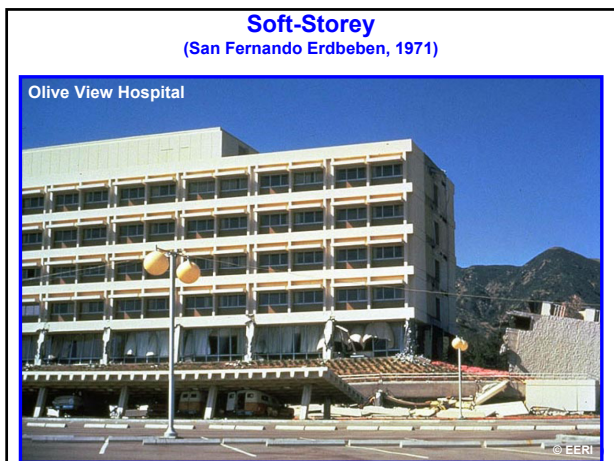
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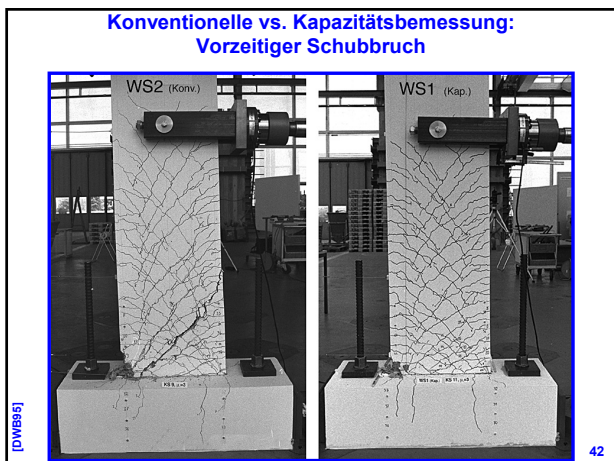
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