WYMIAROWANIE W ŻELBECIE
na właściwe momenty zginające

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CONTENT

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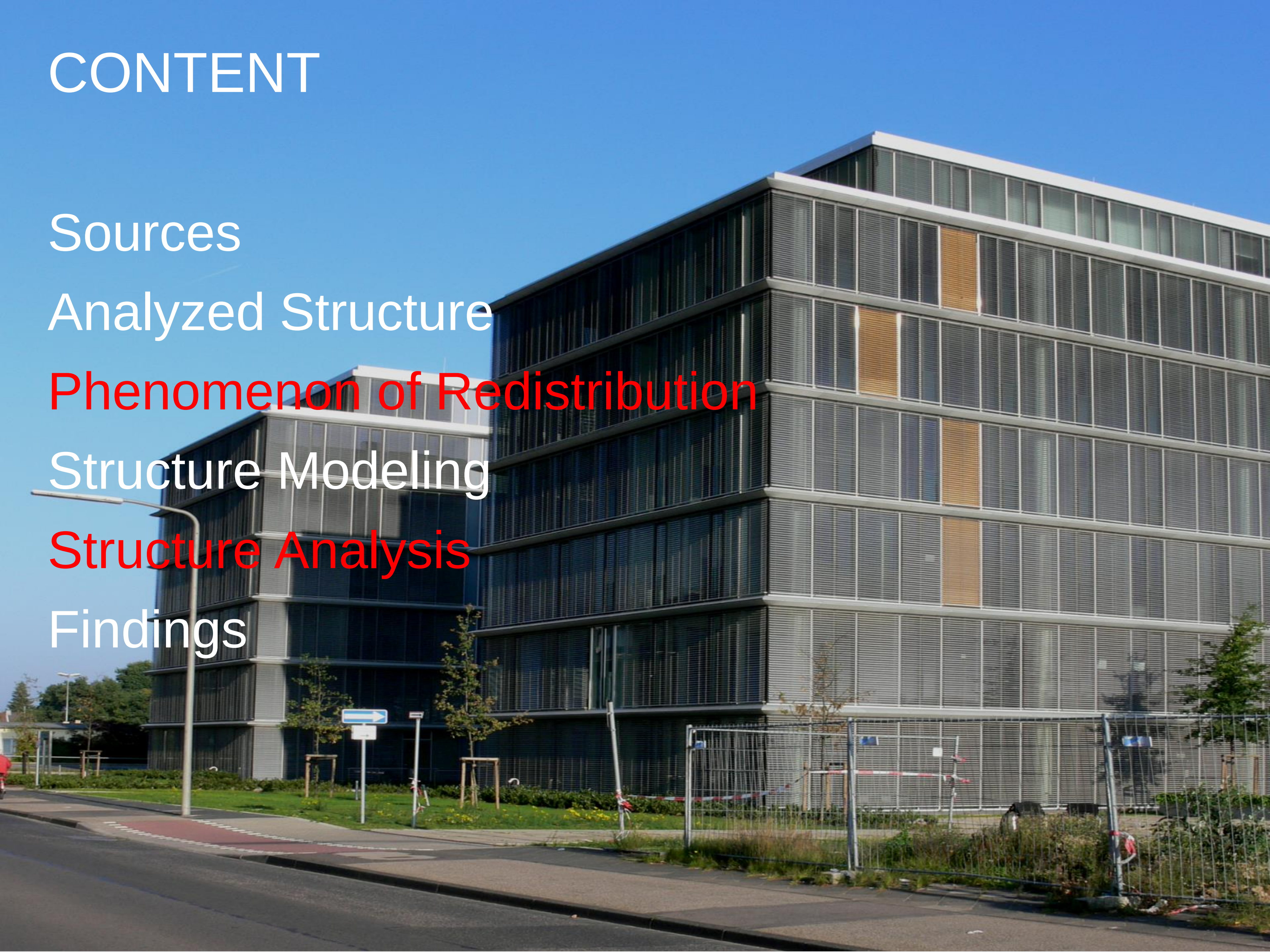
Structure Modeling

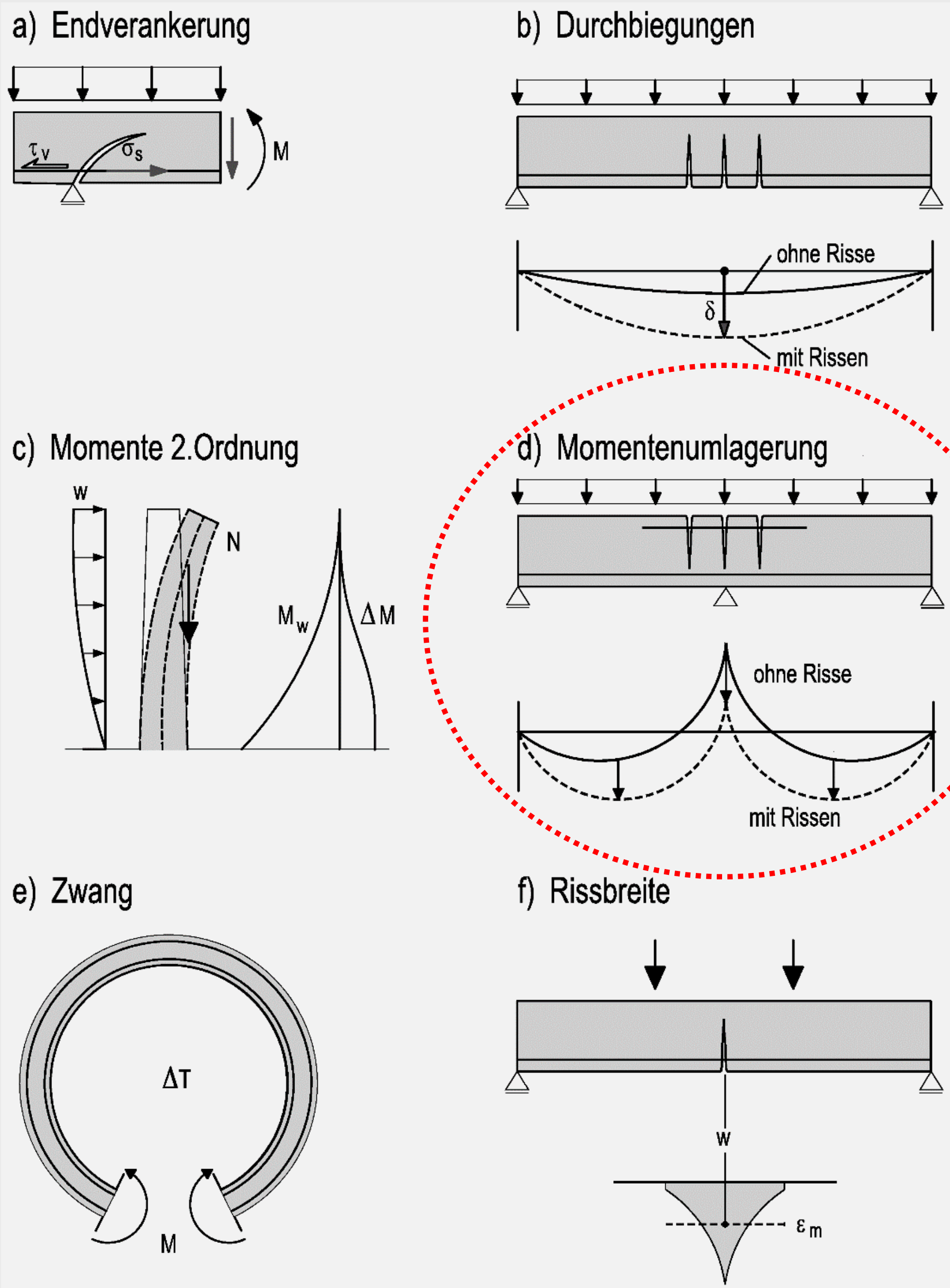
Structure Analysis

Findings

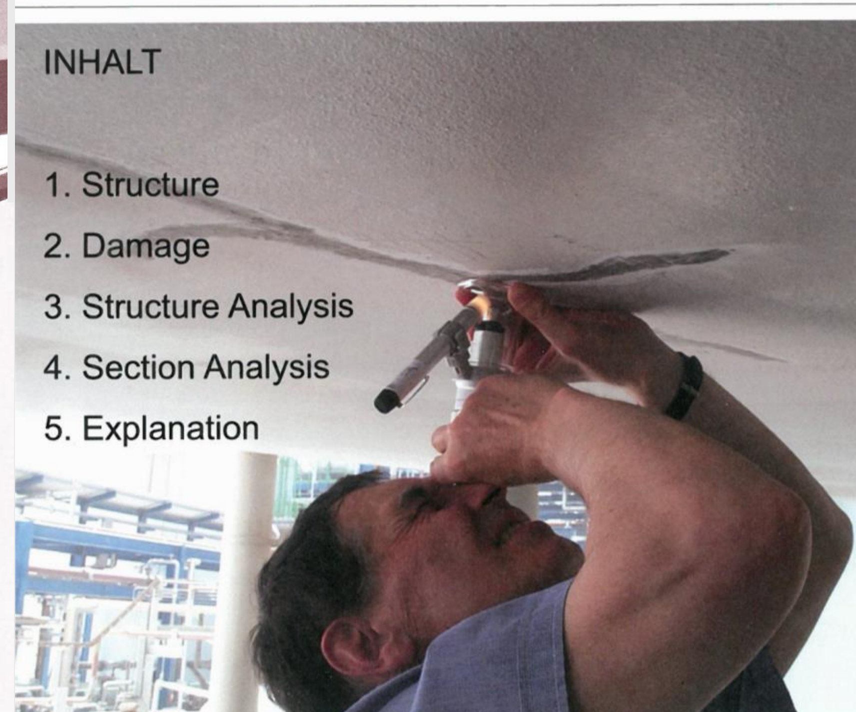


SOURCES, Lectures

Statics of reinforced Concrete



SOURCES, Trainings



SOURCES, Standards

DIN EN 13084-2

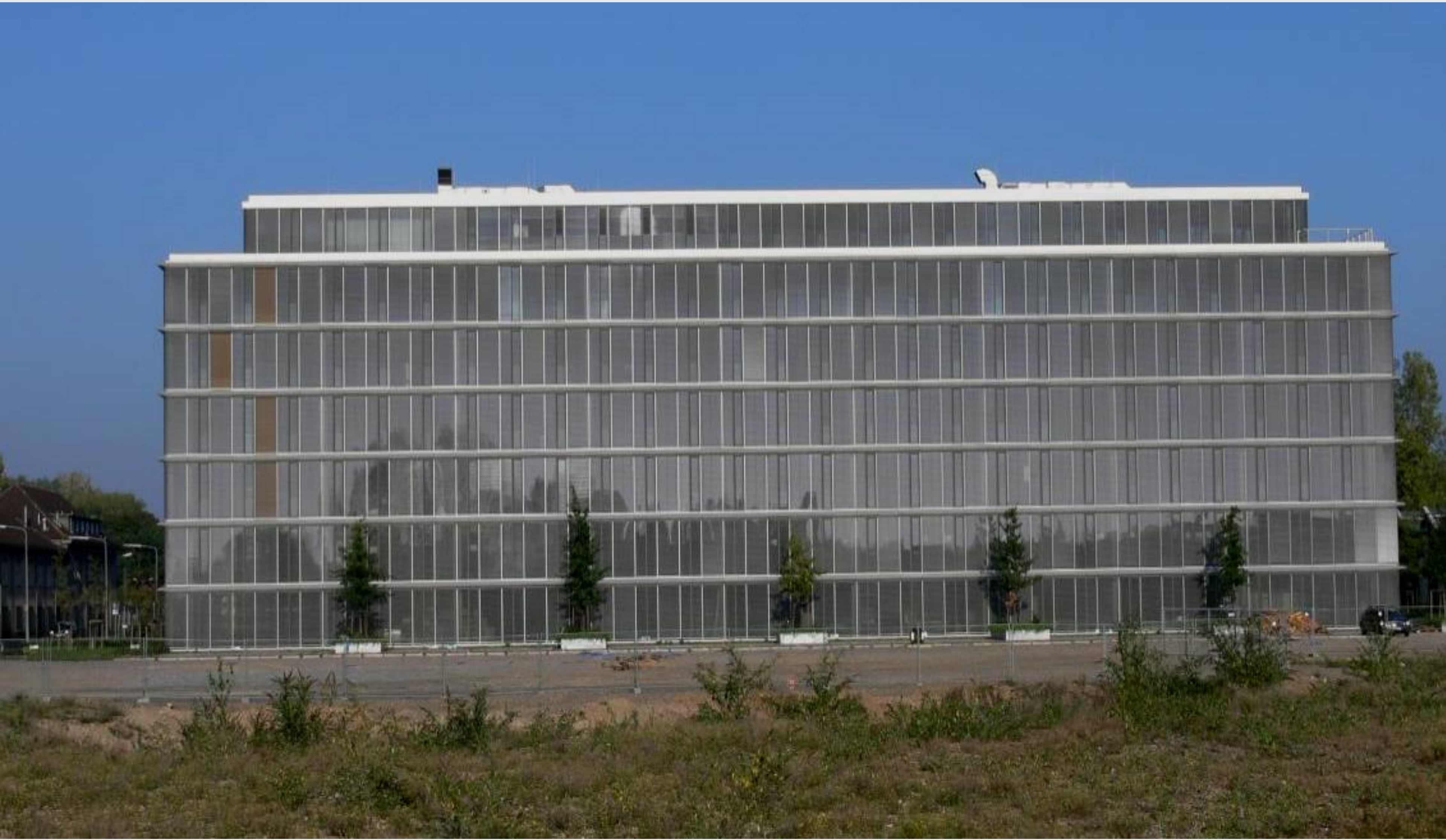
ICS 91.060.40

Supersedes
DIN EN 13084-2:2002-04

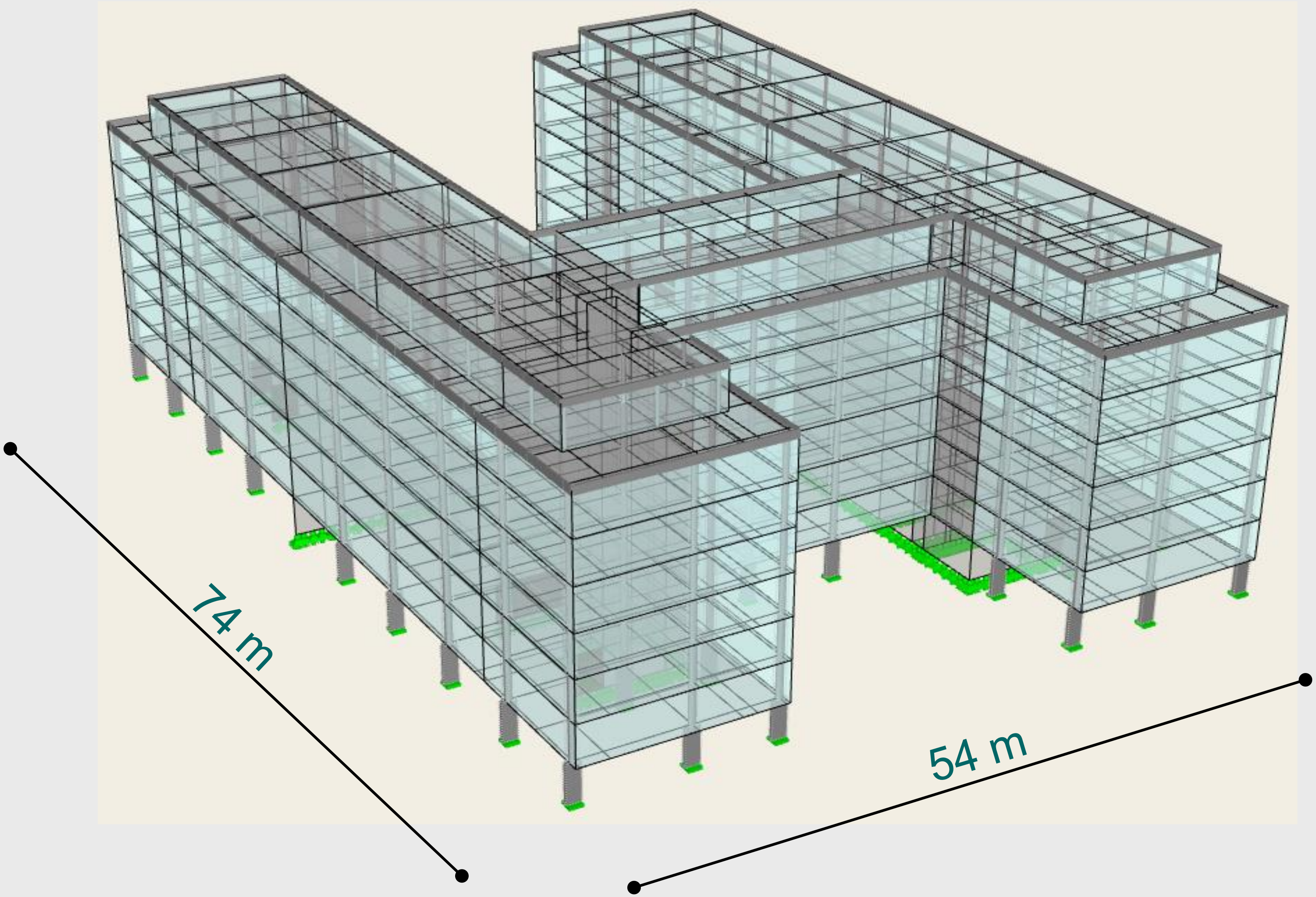
$$w_k = 3{,}5\left(\frac{\sigma_{sr}^{0{,}88} \times d_s}{f_{cm}^{\frac{2}{3}}}\right)^{0{,}89} \times \frac{\sigma_s - 0{,}4 \times \sigma_{sr}}{E_s}$$

w_k	Characteristic crack width [mm]
$\sigma_{cr}(M_{cr}, N_{cr})$	Crack stress [MN/m²]
$\sigma_s(M, N)$	Real steel stress [MN/m²]
f_{cm}	Tensile strength of concrete [N/m²]
E_s	E-Modulus for reinforcement [MN/m²]
d_s	Bar diameter [mm]

ANALYZED STRUCTURE
Front View

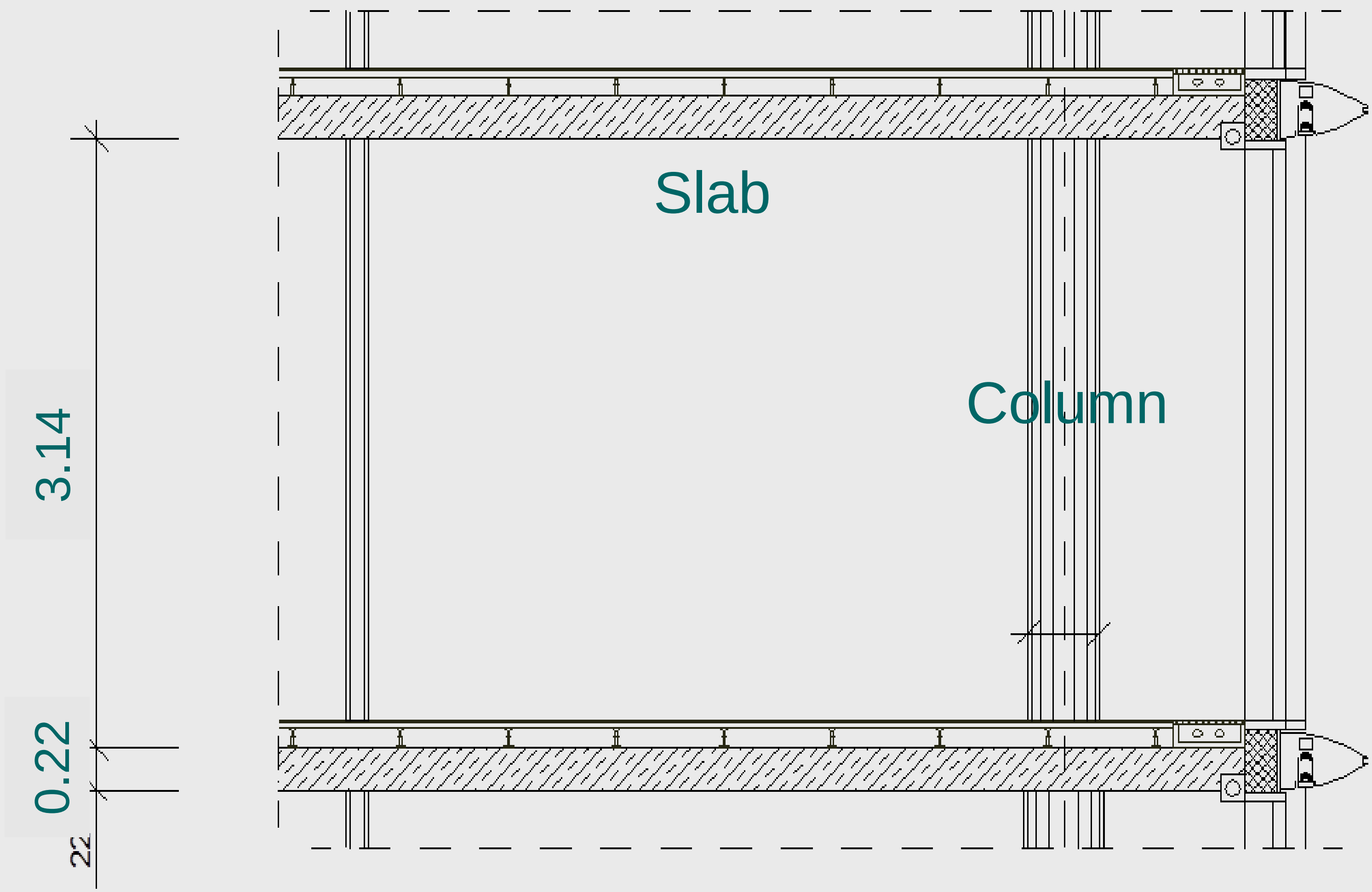


ANALYZED STRUCTURE
Building body



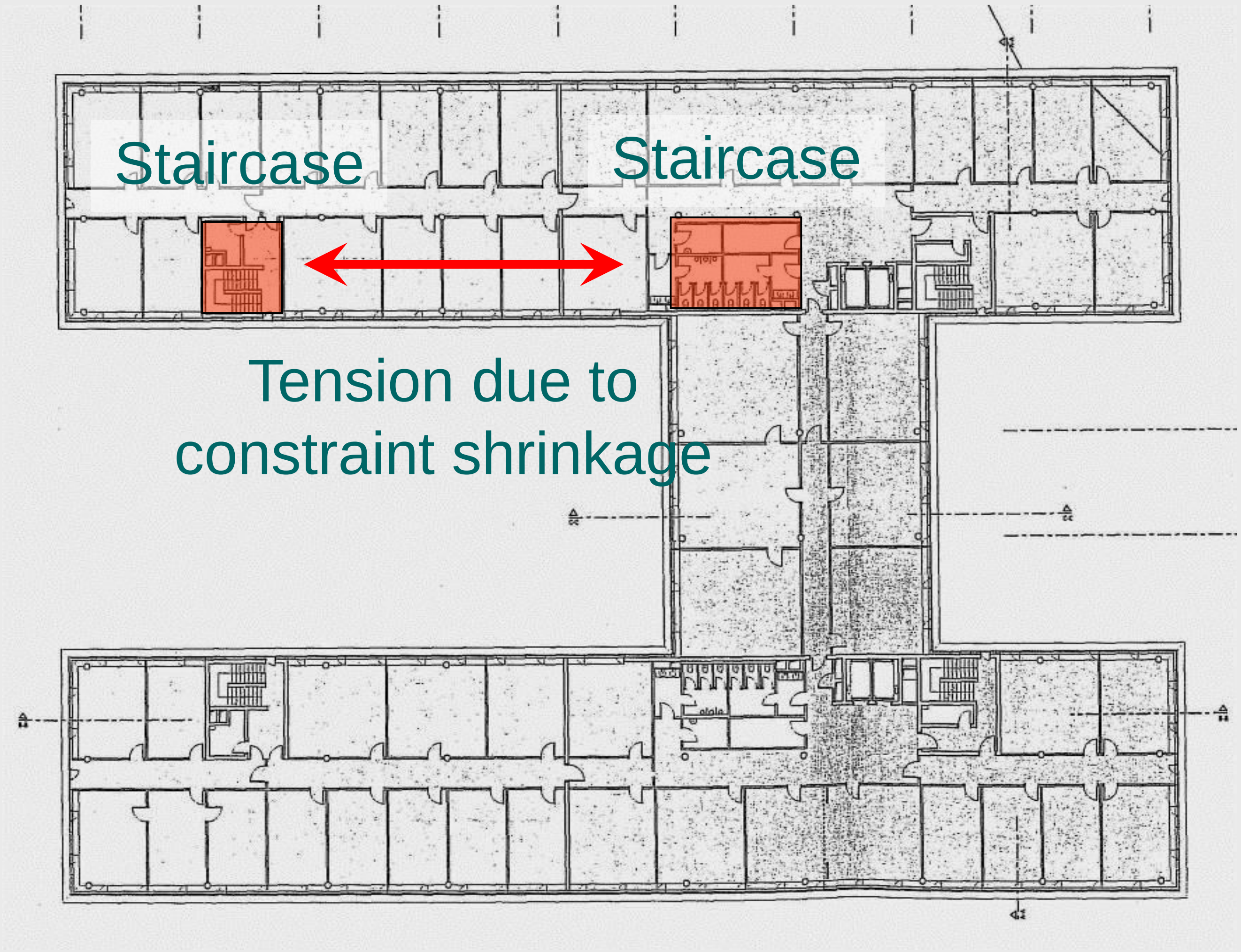
ANALYZED STRUCTURE

Slab-Column System



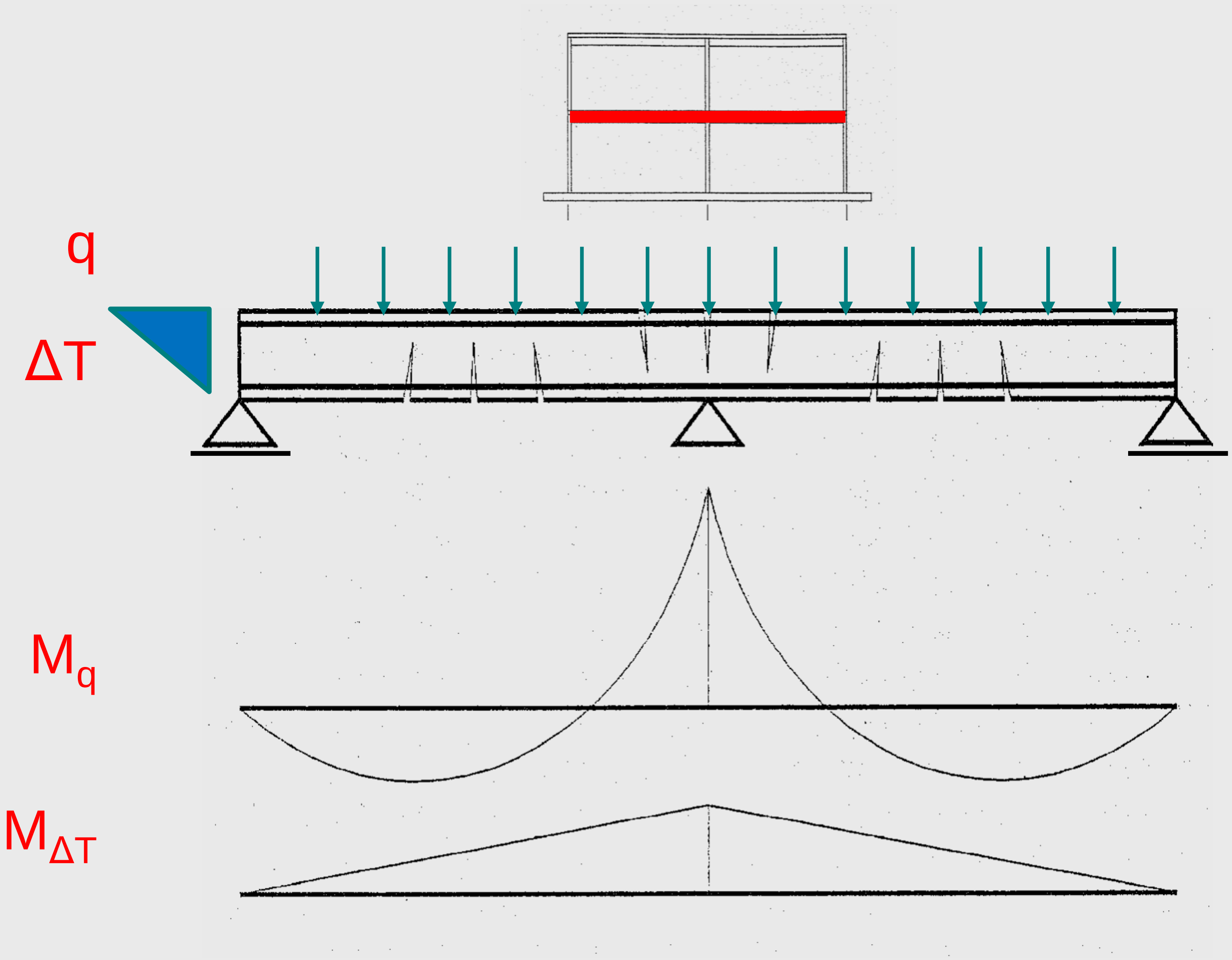
ANALYZED STRUCTURE

Bending Moments + Tension Forces



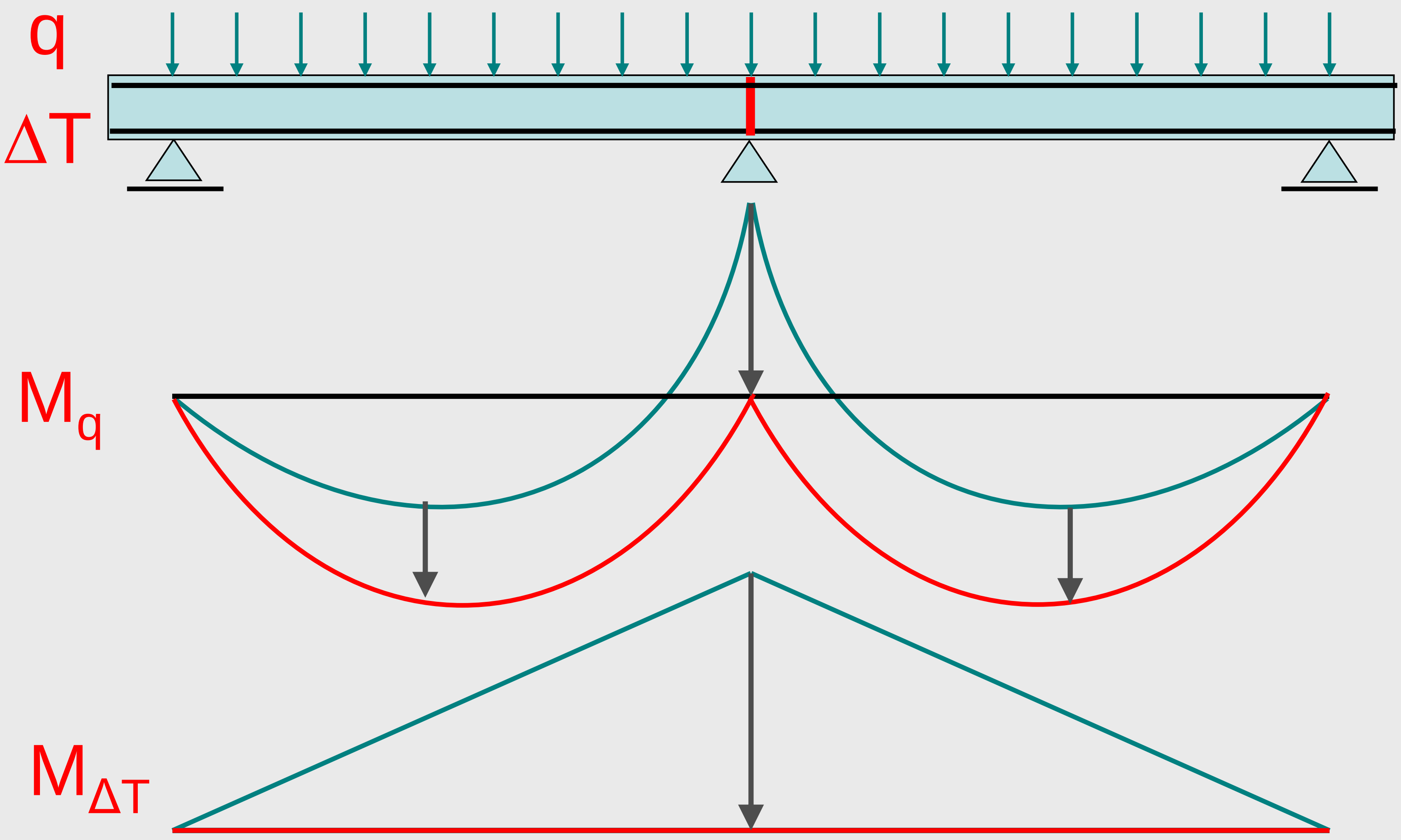
PHENOMENON of REDISTRIBUTION

Beam loaded by q and ΔT



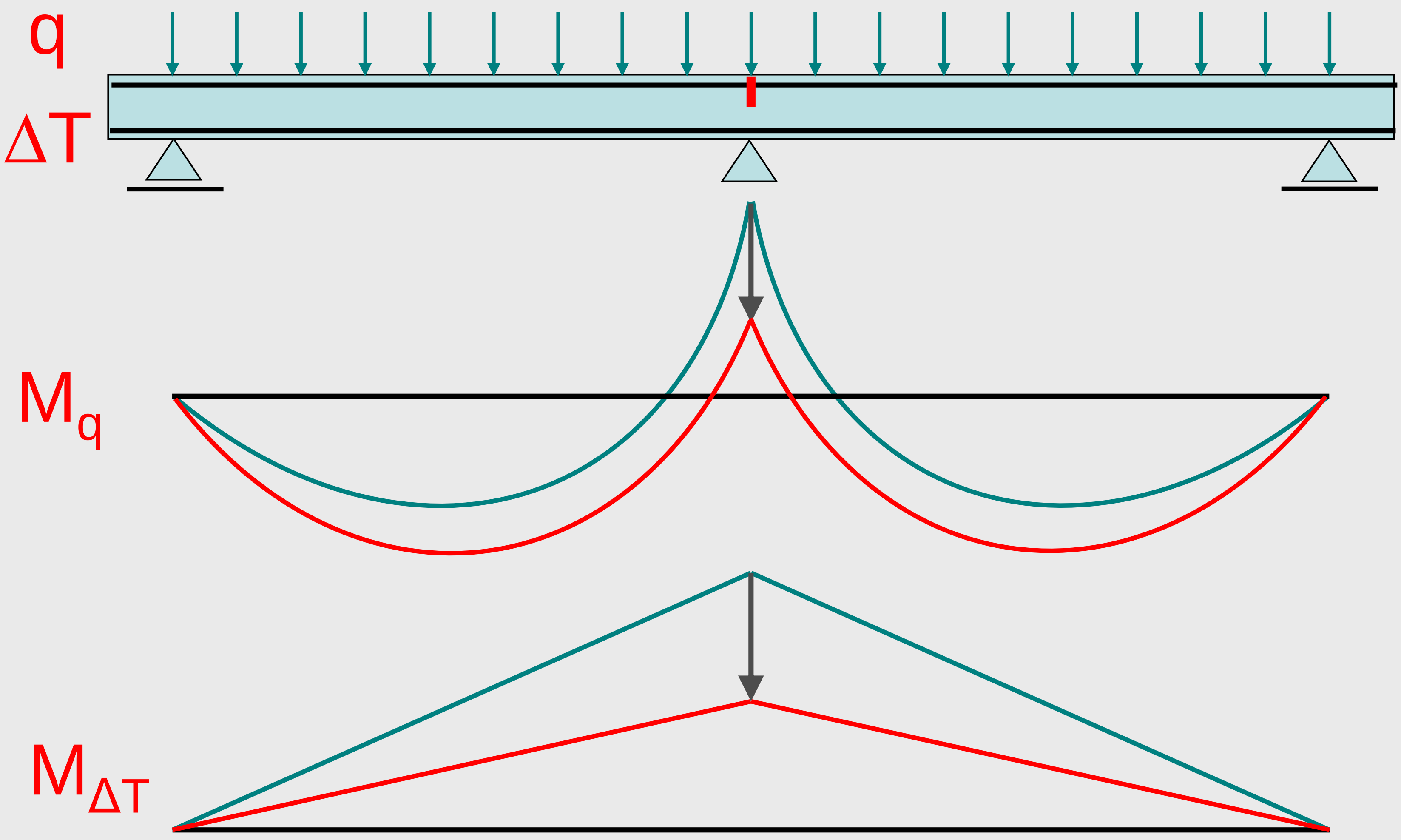
PHENOMENON of REDISTRIBUTION

Moment drop caused by a total cut



PHENOMENON of REDISTRIBUTION

Moment drop caused by a partial cut

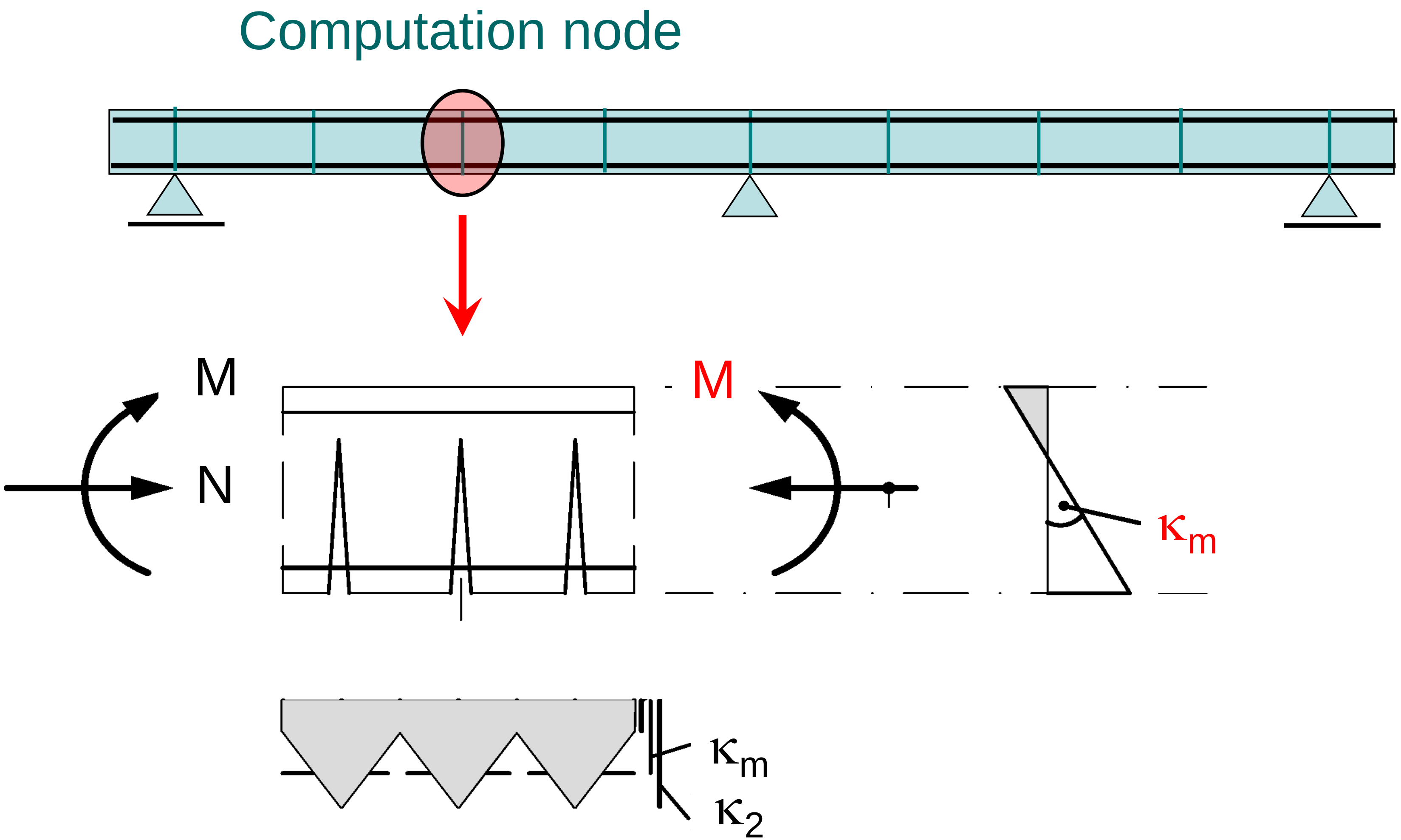


PHENOMENON of REDISTRIBUTION

Cracks causing moment redistribution

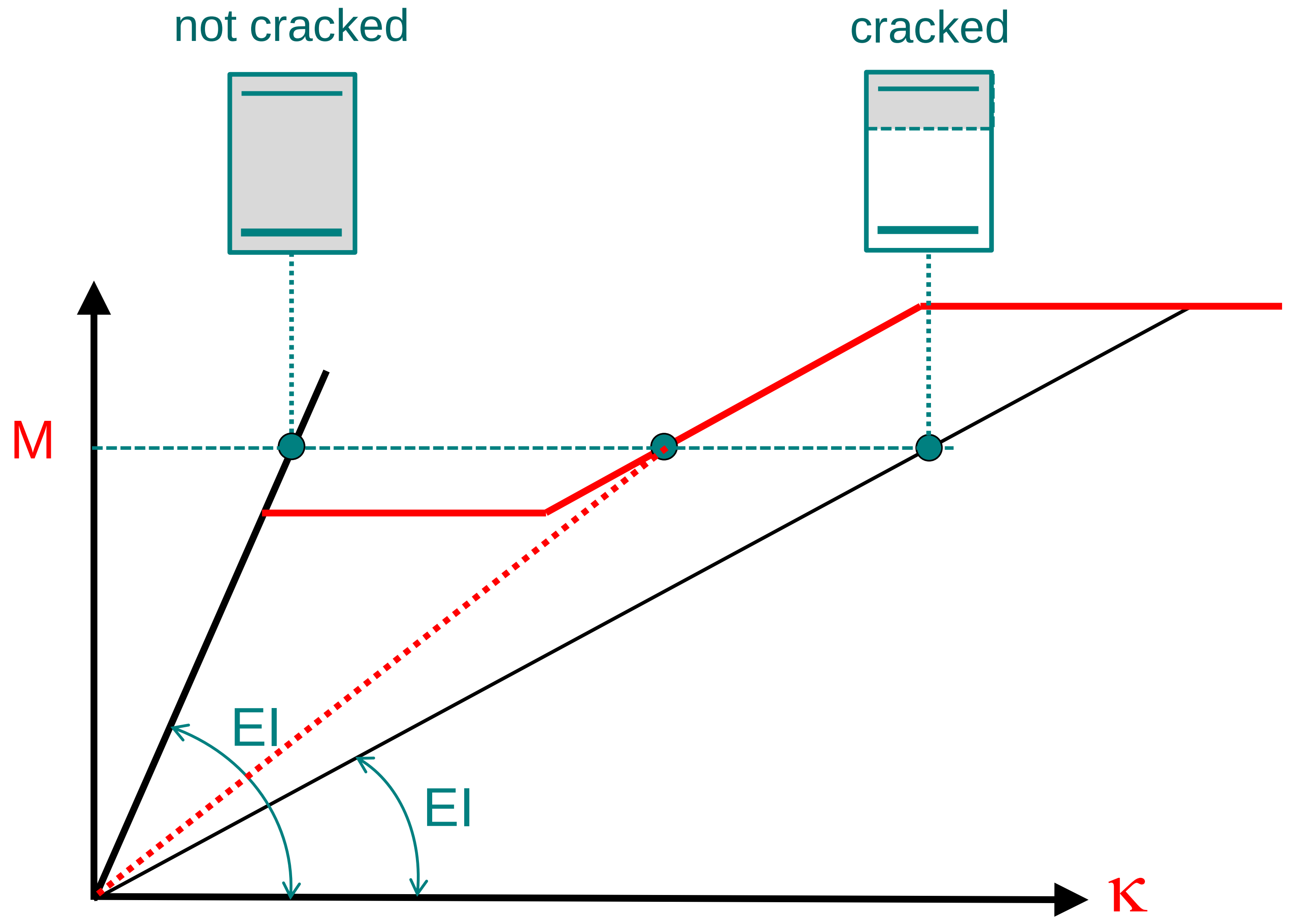
STRUCTURE MODELING

Computation node

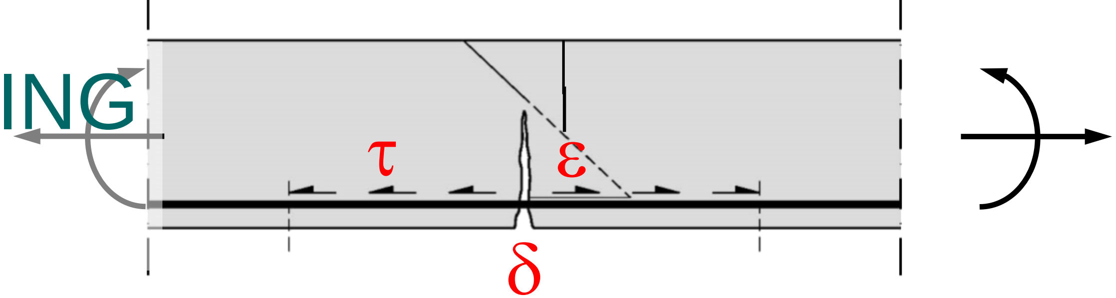


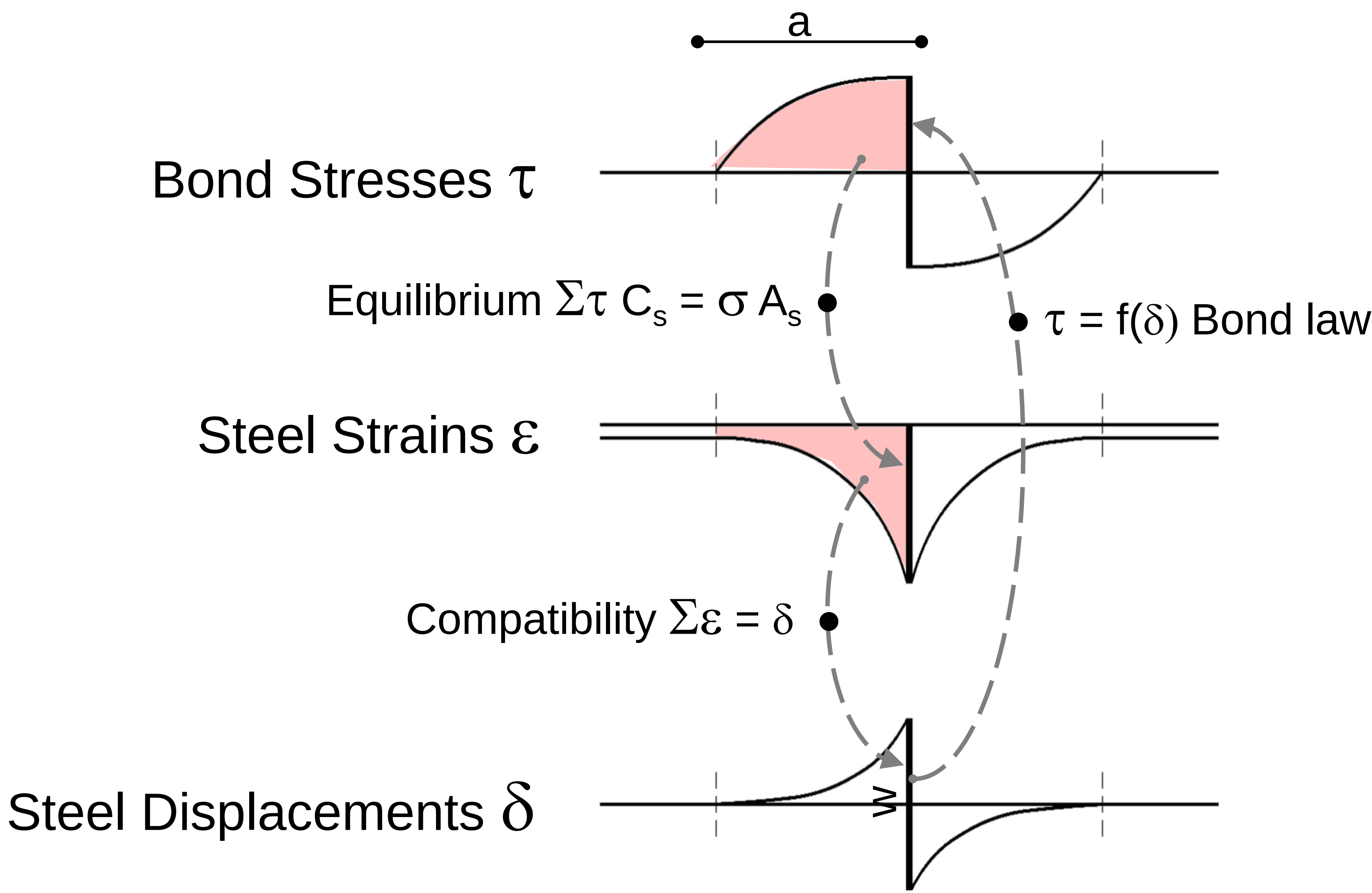
STRUCTURE MODELING

Deformation Low M - κ



STRUCTURE MODELING
General relations





STRUCTURE MODELING
Bond Stress Distribution

(1) Bond equation

$$[\tau(y)/(A\ f_{cm}^{2/3})]^{1/N} = 4/(d_s\ E_s) \iint \tau(y)\ dy\ dy$$

(2) Bond distribution

$$\tau(y) = k\ y^p$$

(3) Integration

$$[k\ y^p/(A\ f_{cm}^{2/3})]^{1/N} = 4/(d_s\ E_s)\ k/[(p+1)\ (p+2)]\ y^{(p+2)}$$

(4) Solving for p

$$p/N = p+2 \ \Rightarrow\ p = 2\ N/(1-N)$$

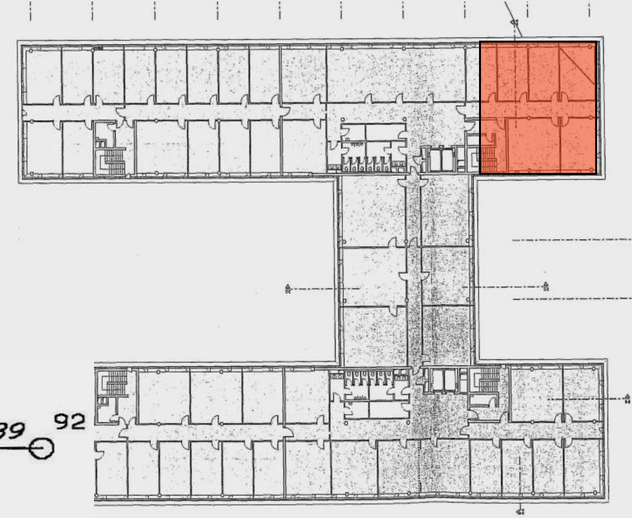
(5) Solving for k

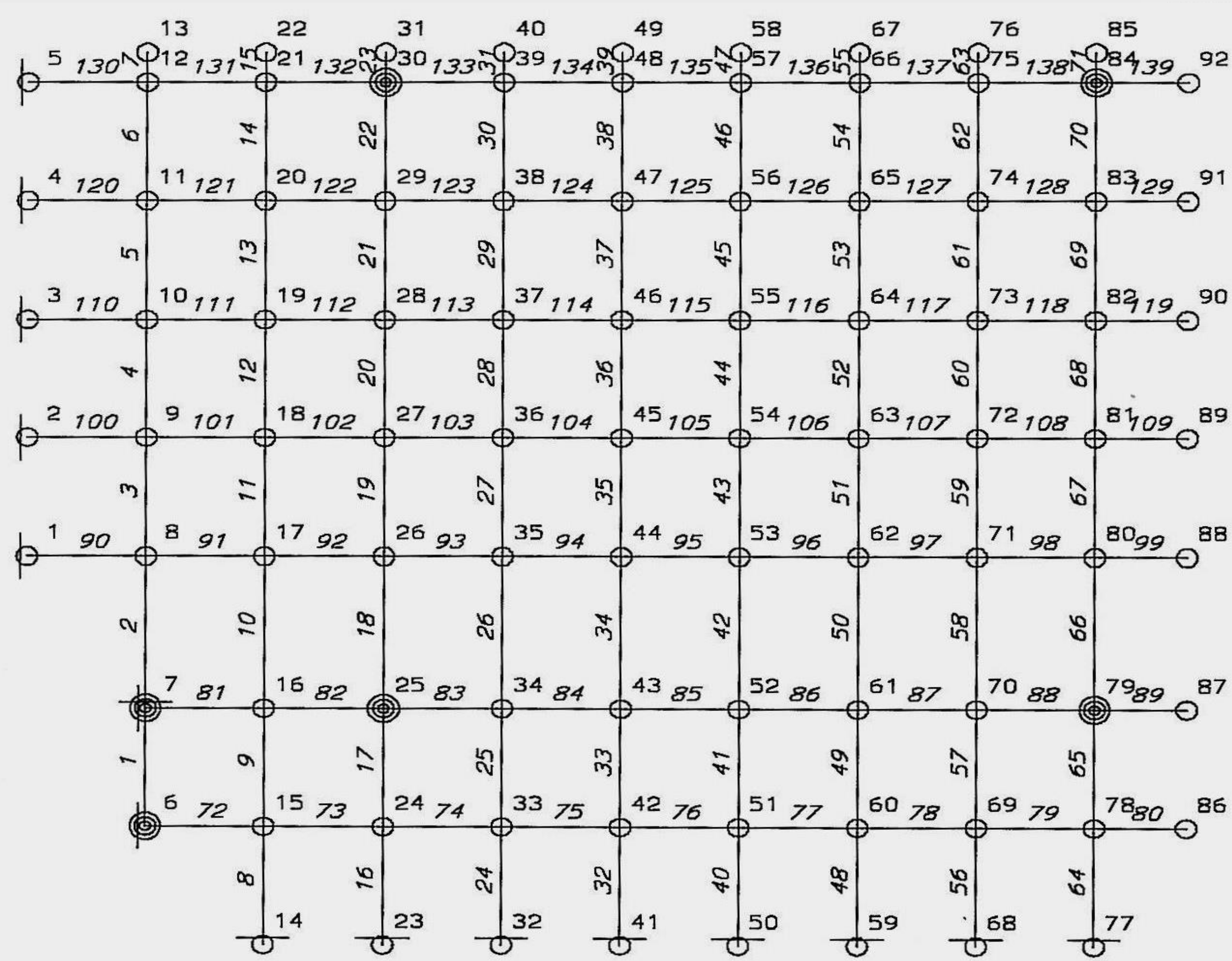
$$[k/(A\ f_{cm}^{2/3})]^{1/N} = 4/(d_s\ E_s)\ k/[(p+1)\ (p+2)]$$

$$\Rightarrow\ k = [2\ (1-N)^2/(1+N)\ (A\ f_{cm}^{2/3})^{1/N}/(d_s\ E_s)]^{N/(1-N)}$$

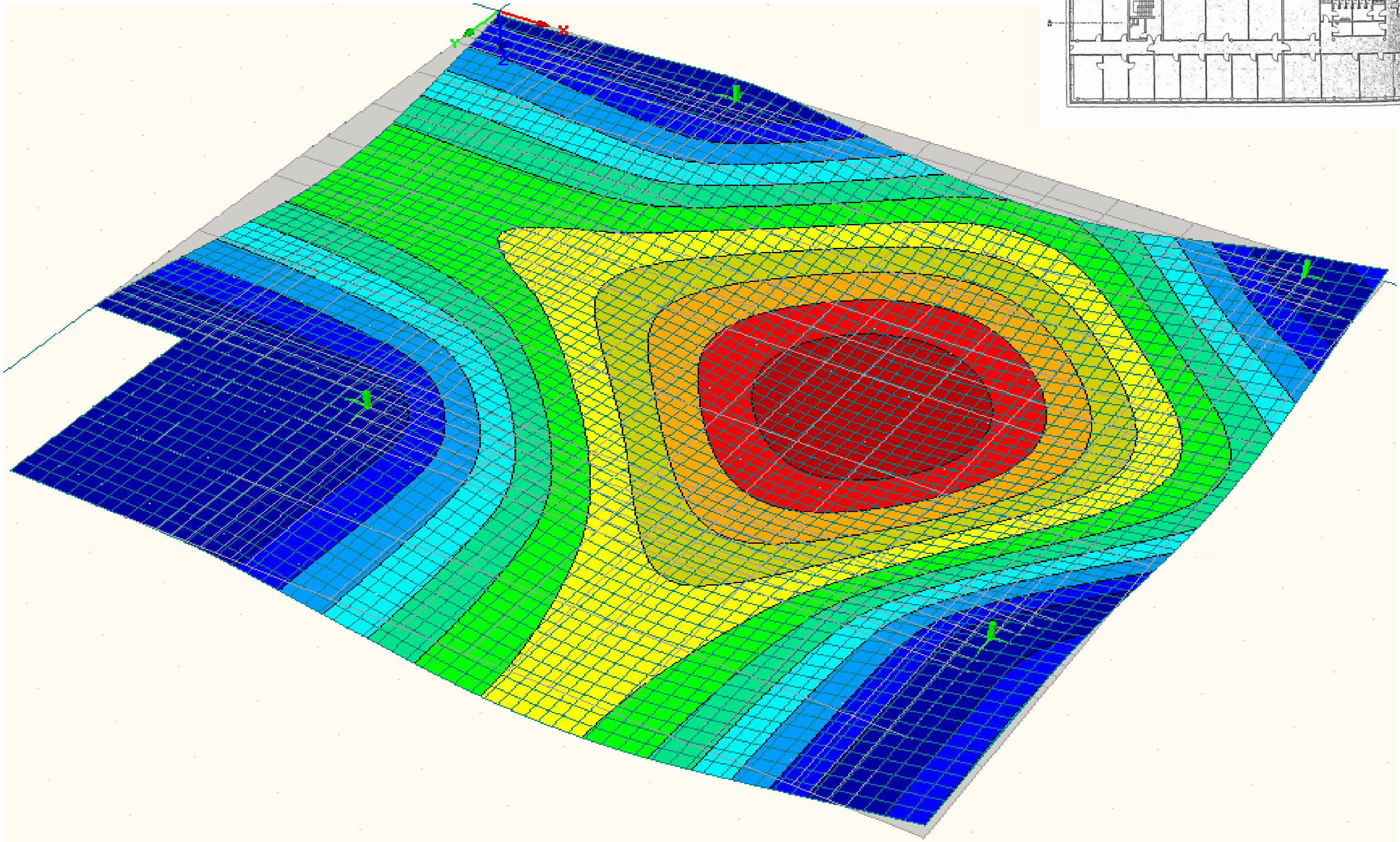
STRUCTURE MODELING

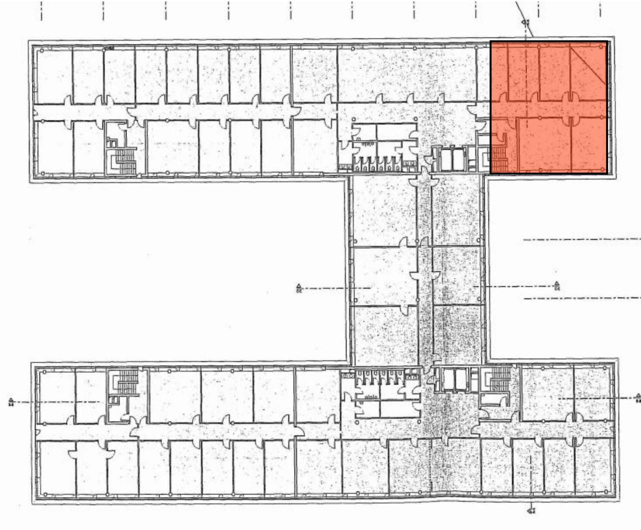
Grid System, 92 nods, 139 bars





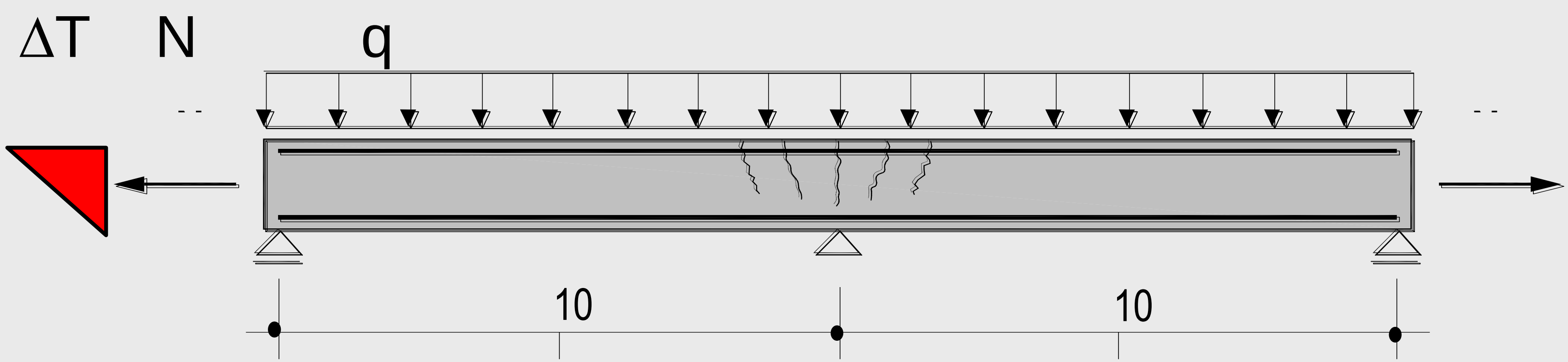
STRUCTURE MODELING
Slab System, 633 elements

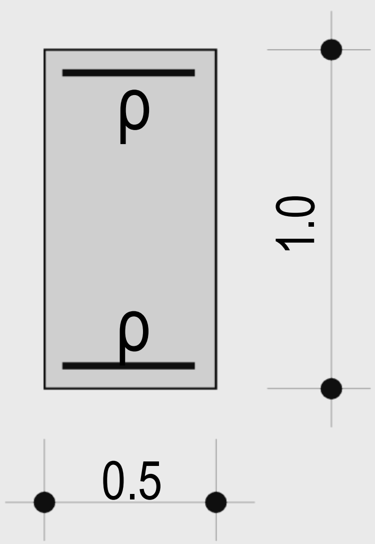




STRUCTURE ANALYSIS

Behavior of a beam loaded by DT, q and N





Case	1	2	3	4
ΔT [K]	15	15	15	15
q [kN/m]	20	40	20	20
N [kN]	0	0	600	0
ρ [%]	0.4	0.4	0.4	1.2

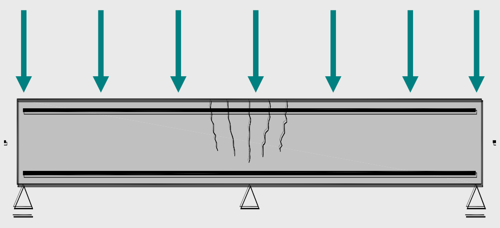
STRUCTURE ANALYSIS
Case 1: Standard

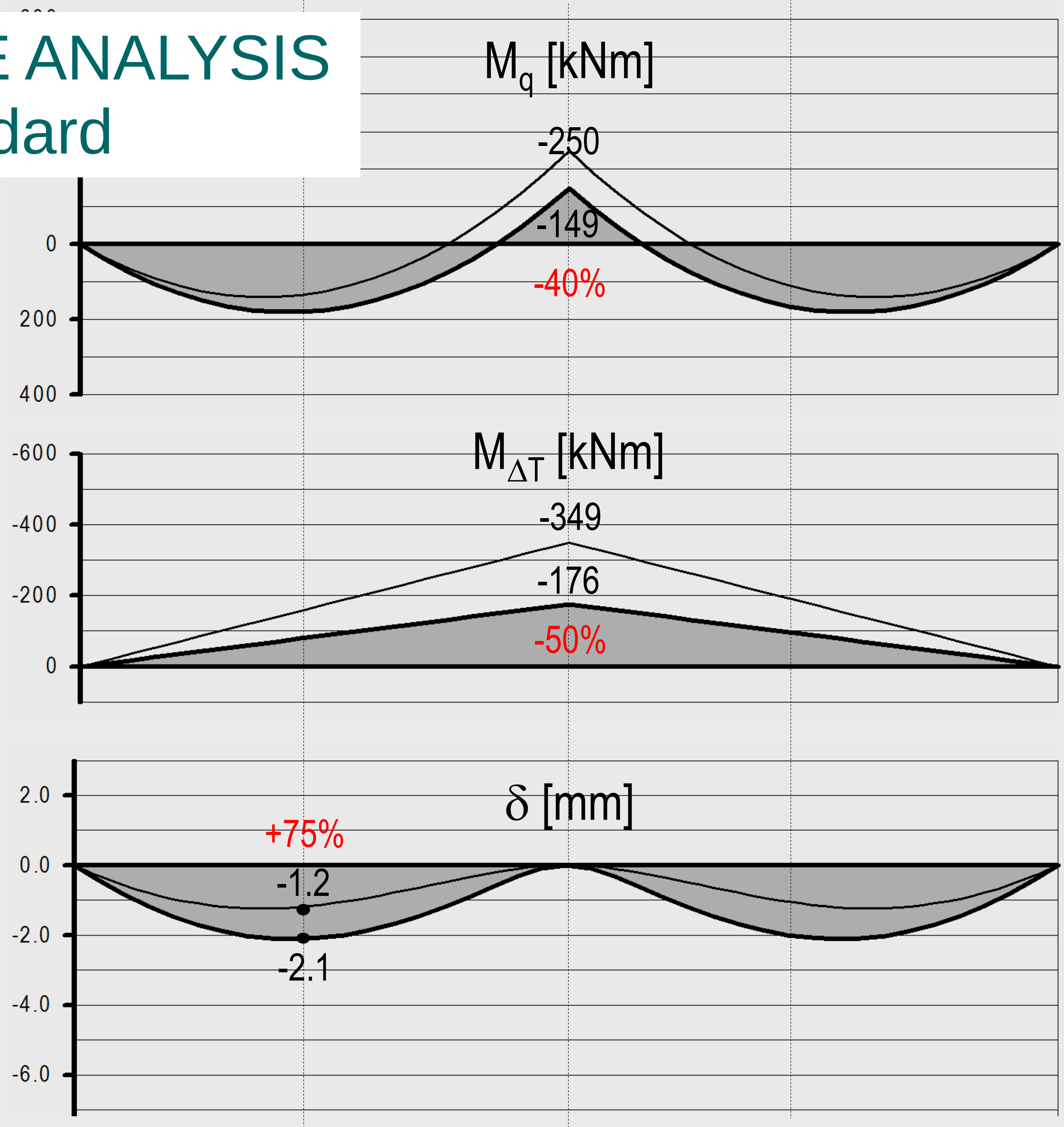
ΔT = 15 K

q = 20 kN/m

N = 0

ρ = 0.4 %





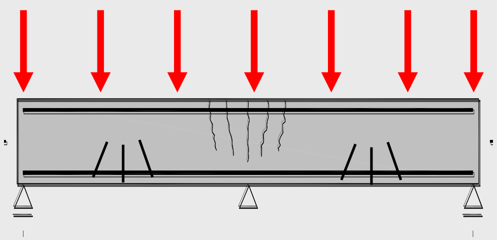
STRUCTURE ANALYSIS
Case 2: Load

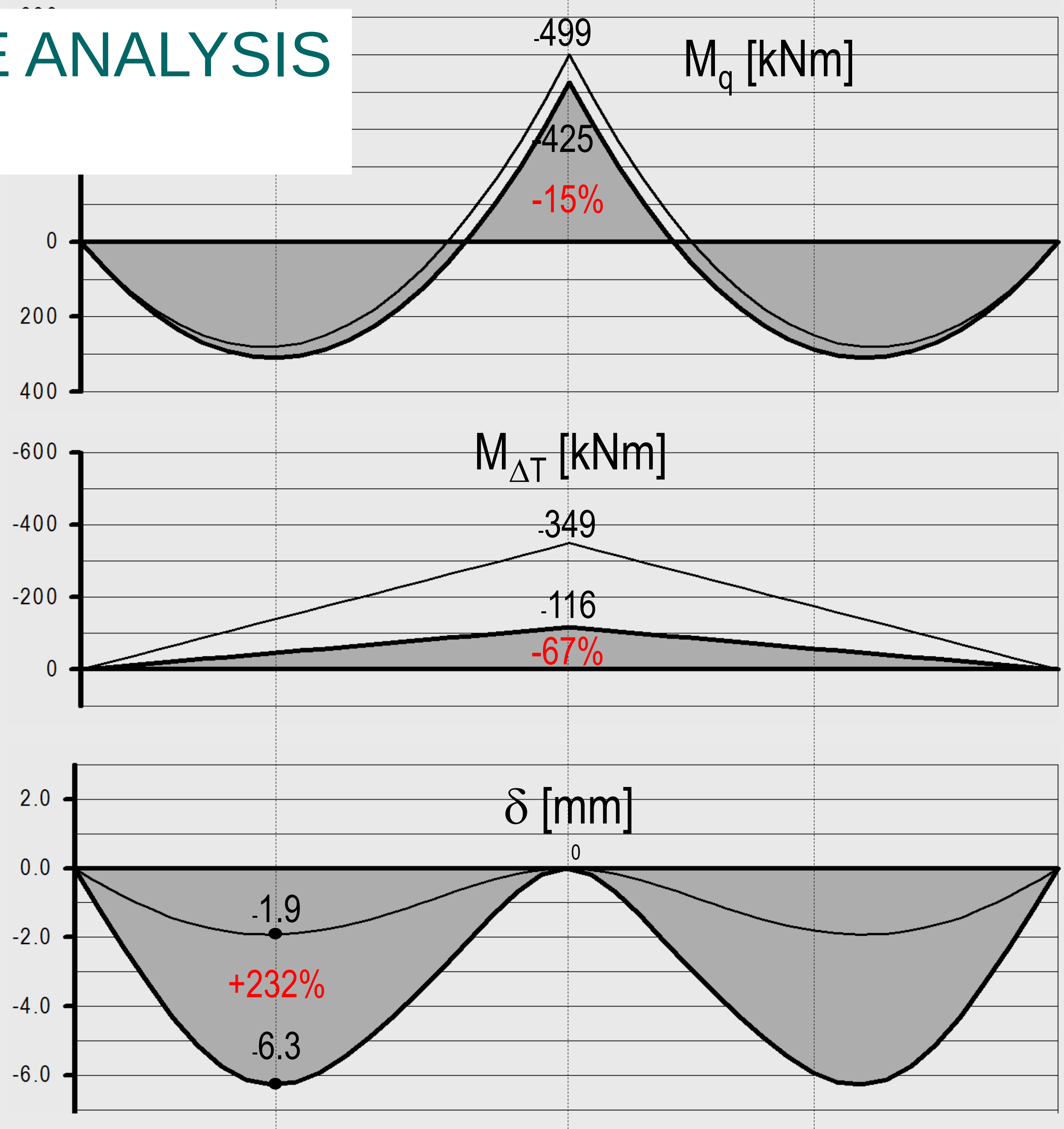
ΔT = 15 K

q = 40 kN/m

N = 0

ρ = 0.4 %





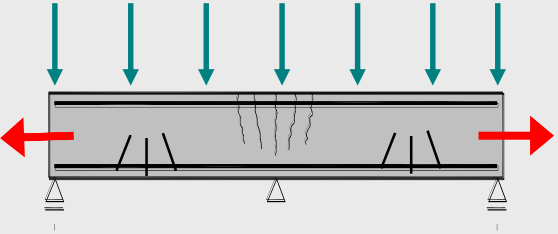
STRUCTURE ANALYSIS
Case 3: Tension

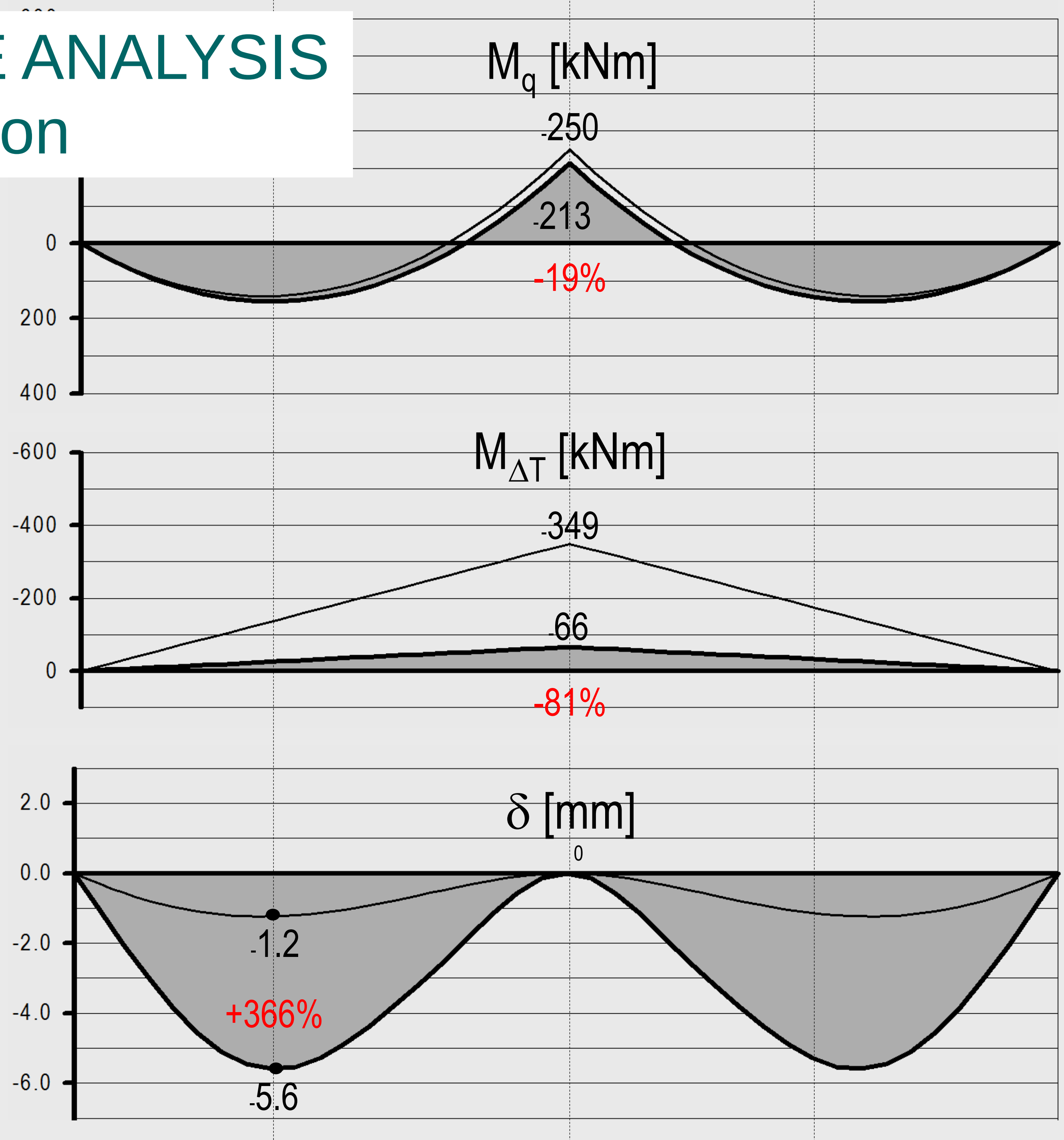
ΔT = 15 K

q = 20 kN/m

N = 600 kN

ρ = 0.4 %





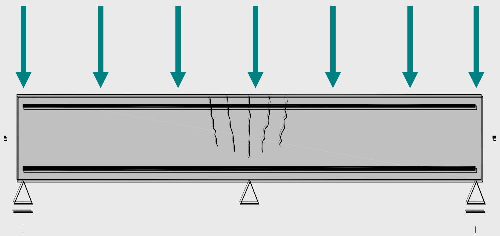
STRUCTURE ANALYSIS
Case 4: Reinforcement

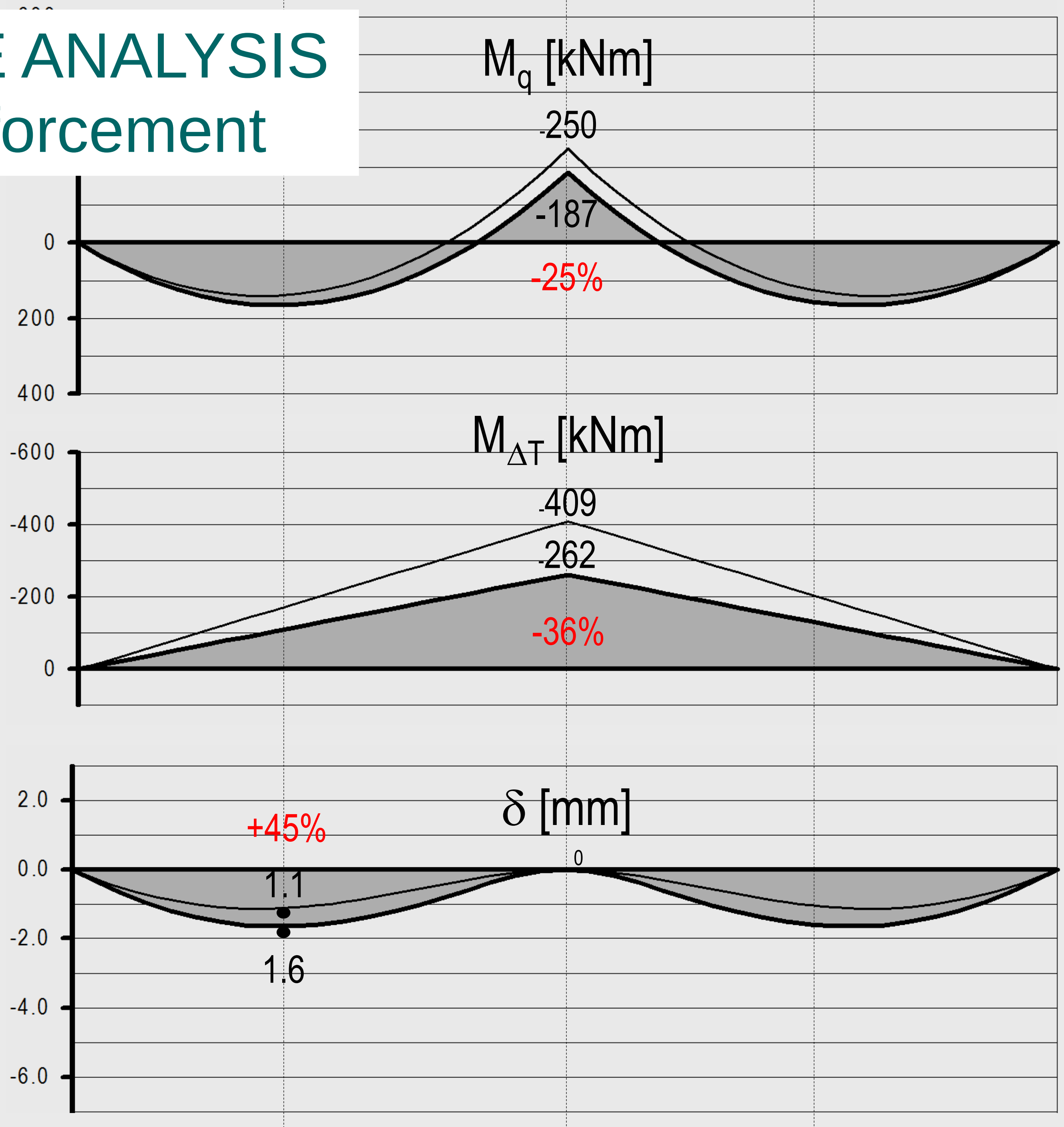
ΔT = 15 K

q = 20 kN/m

N = 0

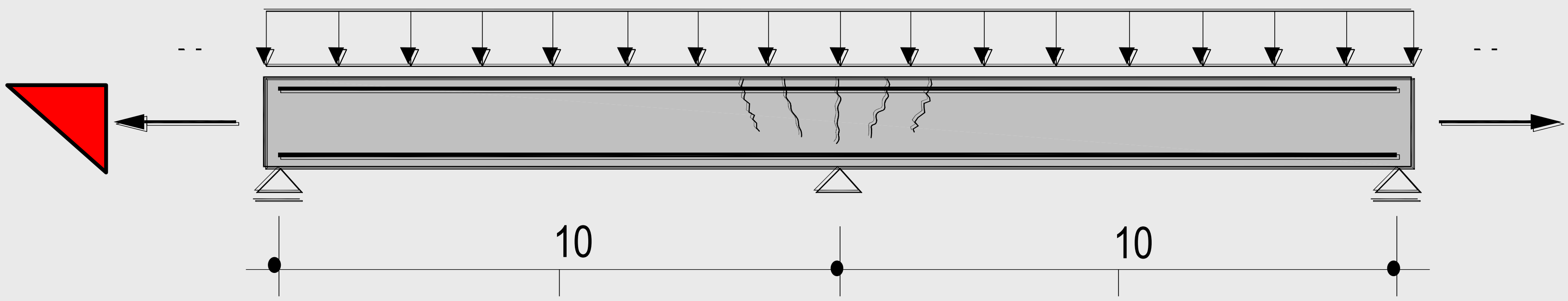
ρ = 1.2%

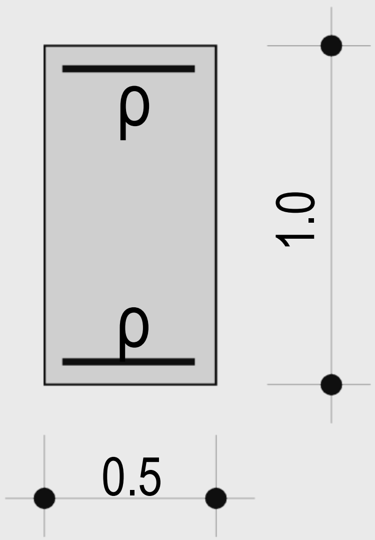




STRUCTURE ANALYSIS

Behavior of a beam loaded by DT, q and N





Case	1	2	3	4
ΔT [K]	15	15	15	15
q [kN/m]	20	40	20	20
N [kN]	0	0	600	0
ρ [%]	0.4	0.4	0.4	1.2
$\Delta M_q/M_{q1}$ [%]	-40	-15	-19	-25
$\Delta M_T/M_{T1}$ [%]	-50	-67	-36	-36
$\Delta\delta/\delta_1$ [%]	+75	+232	+366	+45

FINDINGS

Zarysowanie betonu jest ważne, bo sprawia, że
..momenty M znakomicie maleją a
..ugięcia δ znakomicie rosną.

Zarysowanie betonu jest „tajemnicze”, bo
..spadek momentów ΔM zależy od q, N i ρ a
..przyrost ugięć δ nie zależy od E_c a od N i ρ

Zarysowania betonu musi być uwzględniane gwoli
..właściwych momentów M i
..właściwych ugięć δ.


Dziękuję bardzo
Düsseldorf