

OIBA
ORDINE DEGLI INGEGNERI
della Provincia di Bari



POLITECNICO
MILANO 1863

Teoria dell'ancoraggio post-installato: comportamento di ancoraggi singoli sotto azioni assiali e taglianti
Meccanismi di rottura per ancoraggi meccanici e chimici, cenni al comportamento di gruppo

Giovanni Muciaccia



*European Committee for
Standardization*

Qualifica di prodotto

Product Standards
ENs XXXXX:YYYY

Metodo di progetto



**+ Factory Production
Control
CE**



*European Committee for
Standardization*

e.g.
Eurocodes



*European Organisation
for Technical Approval*

Qualifica di prodotto

*Metal Anchors for use in
concrete*
ETAG 001



*European Technical
Approval*
ETA

Metodo di progetto

*Design Method for
Anchorage*
Annex C

*Design for Bonded
Anchors*
TR029

*Design under
seismic action*
TR45



**+ Factory Production
Control
CE**



*European Committee for
Standardization*

*Design Method for
Anchorage*
CEN/TS 1992-4

Qualifica di prodotto

Metal Anchors for use in concrete

ETAG 001

Internal method

Annex C

Plastic Anchors for ETICS

ETAG 014

Internal method

Section 7.1

Plastic Anchors for multiple use for n.s. appl.

ETAG 020

Internal method

Annex C

Metal Injection Anchors for use in Masonry

ETAG 029

Internal method

Annex C

Metodo di progetto

Design for bonded anchors

TR029

Design under seismic action

TR45



*European Organisation
for Technical
Assessment*

Qualifica di prodotto

*European Assessment
Document*
EAD

Metodo di progetto

*European Technical
Assessment*
ETA



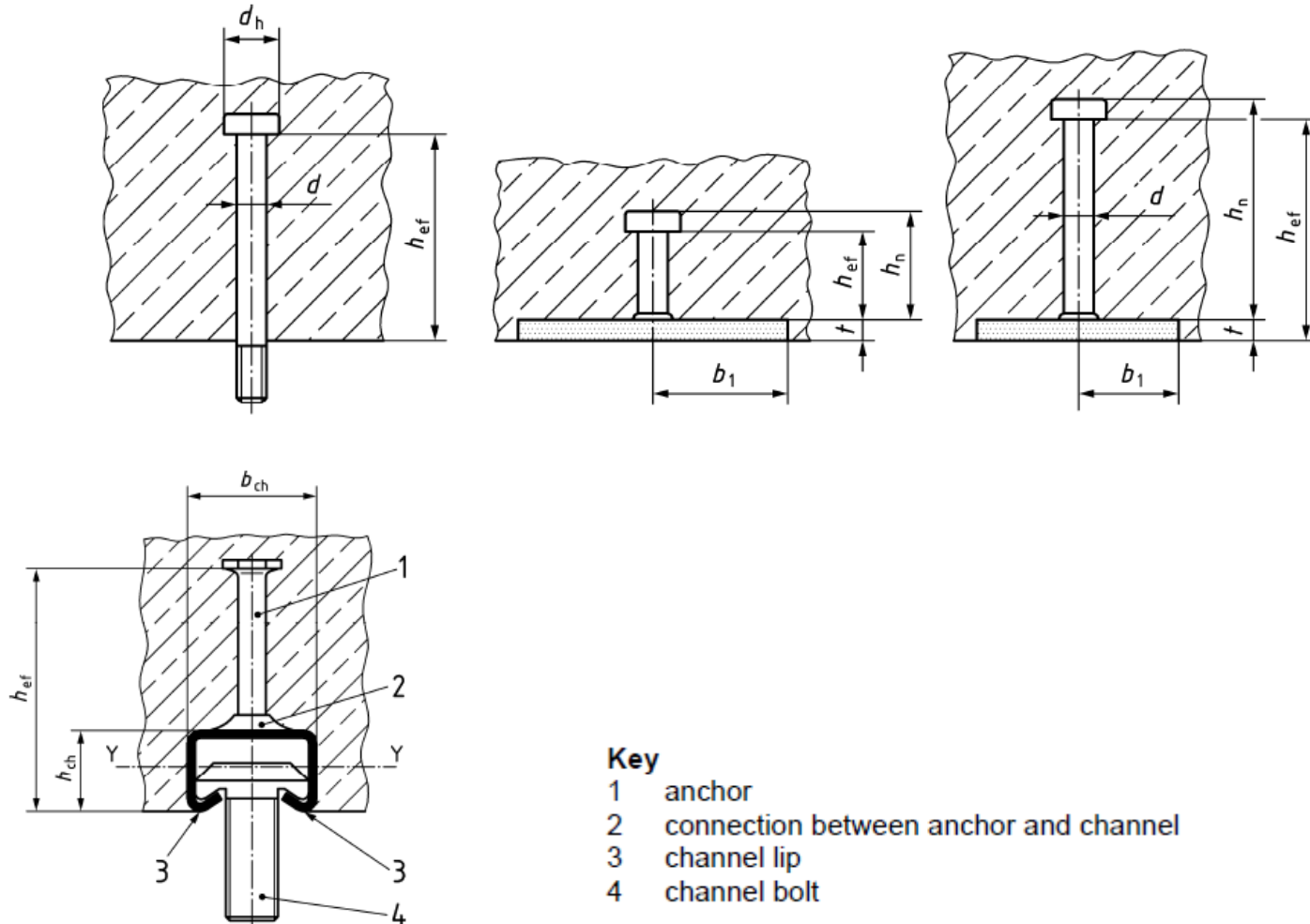
+ **Factory Production
Control**
CE



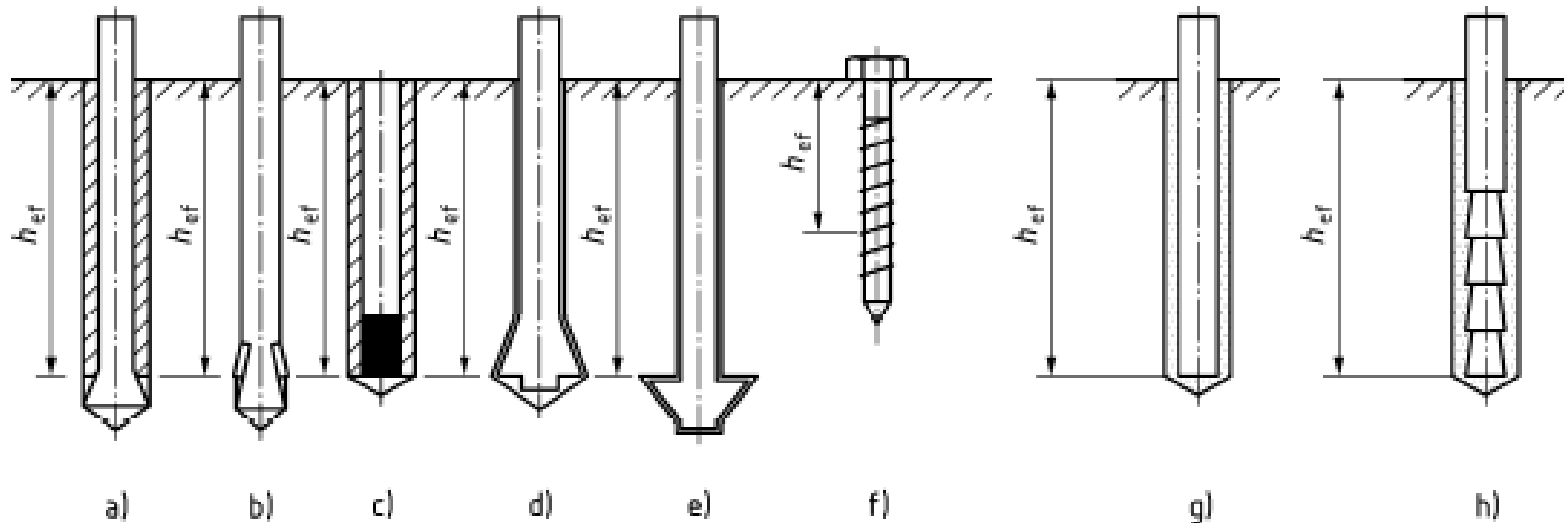
*European Committee for
Standardization*

*Design Method for
Anchorage*
EN 1992-4

Pre-inserite



Post-inserite



Key

- | | | | |
|----|---|----|---------------------------|
| a) | torque controlled fastener, sleeve type | e) | undercut fastener, type 2 |
| b) | torque controlled fastener, wedge type | f) | concrete screw |
| c) | deformation controlled fastener | g) | bonded fastener |
| d) | undercut fastener, type 1 | h) | bonded expansion fastener |



Wedge type



Sleeve type



Drop-in

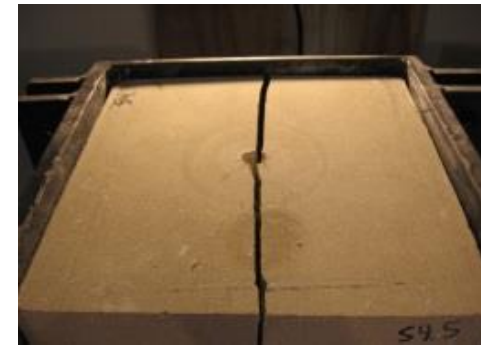
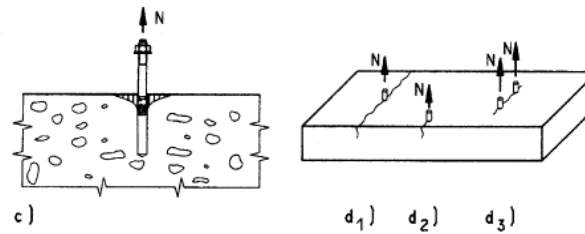
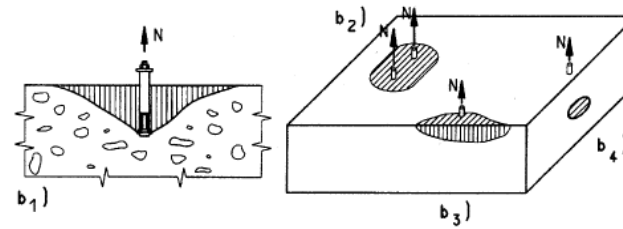
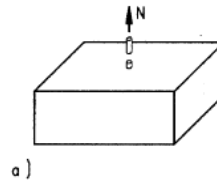


Undercut

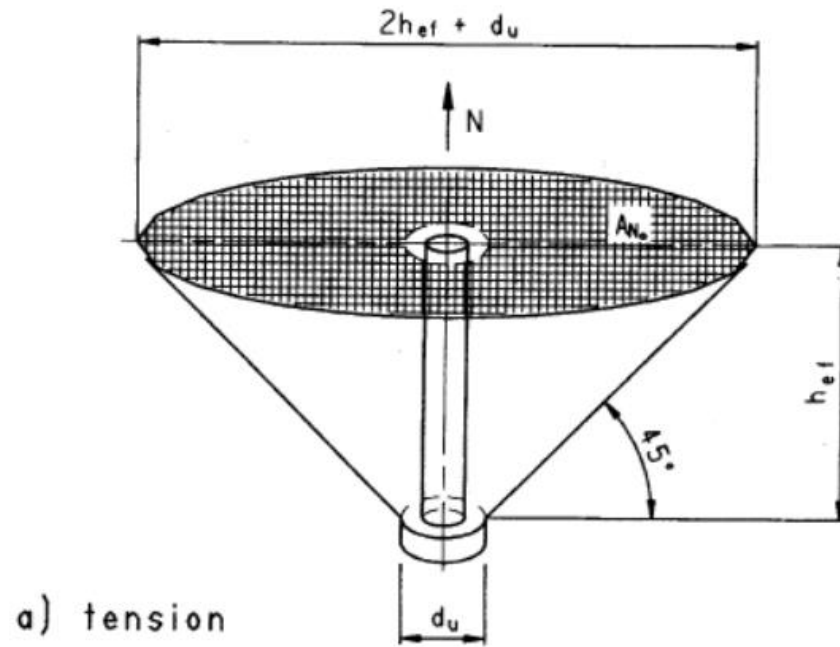


Screw

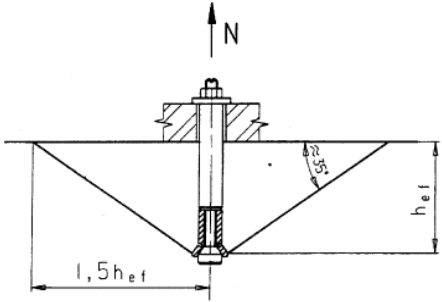
Modalità di rottura a trazione



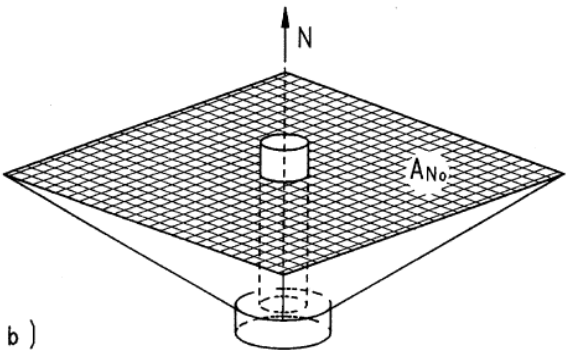
primi modelli: ACI 349-85



approccio CCD /1

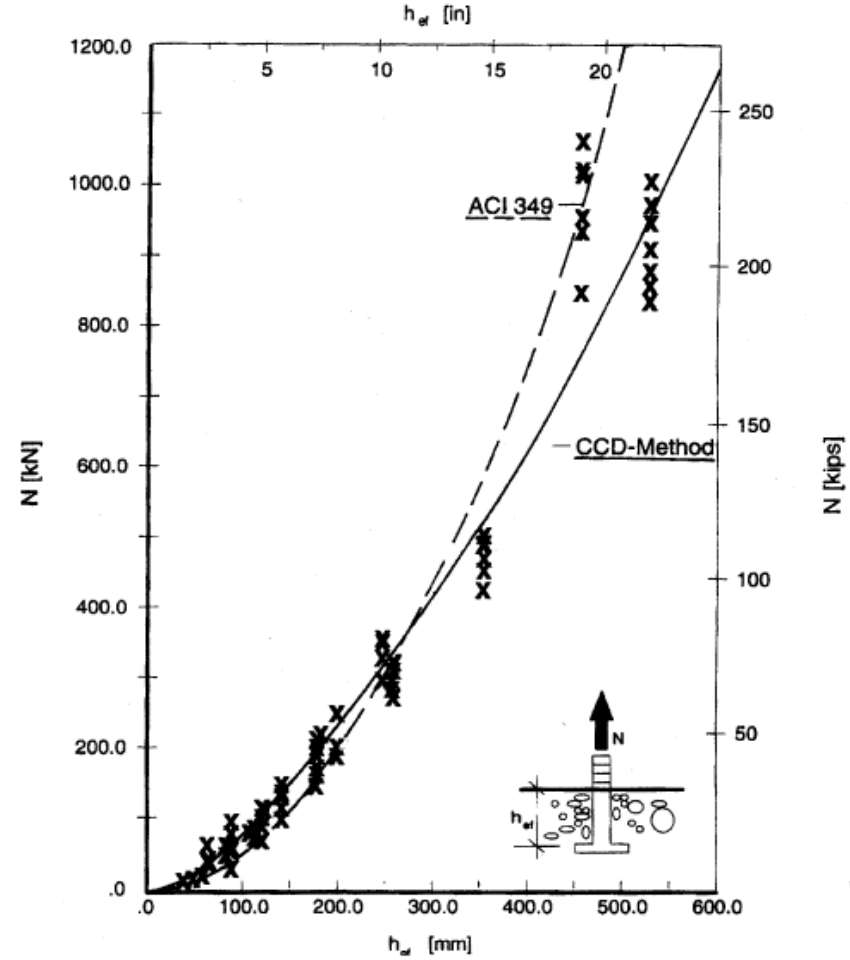
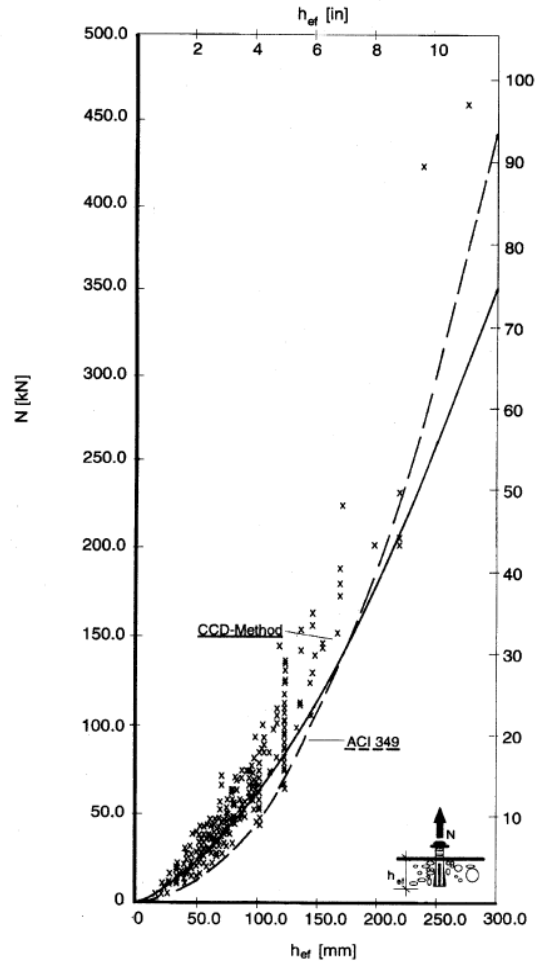


a)

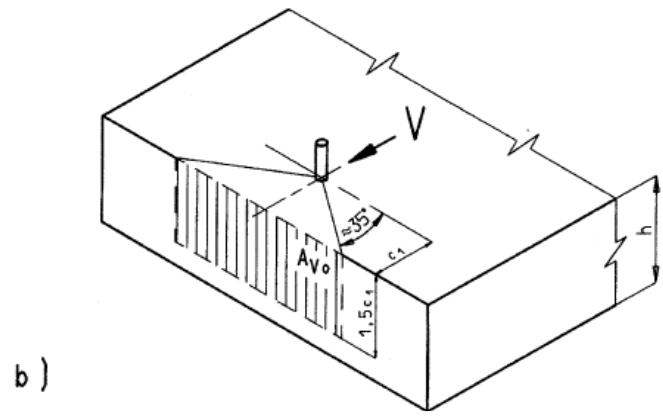
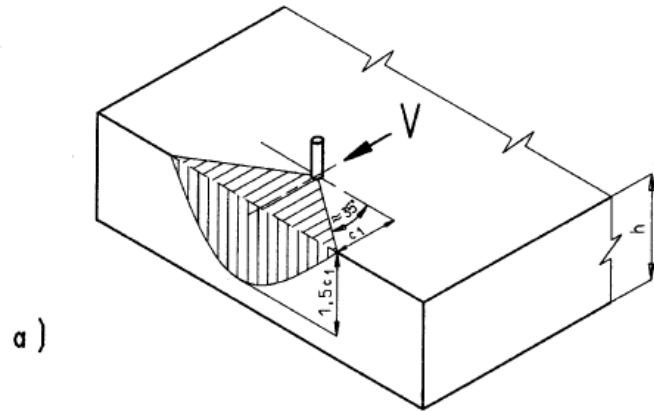



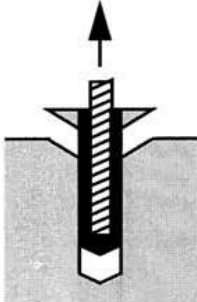
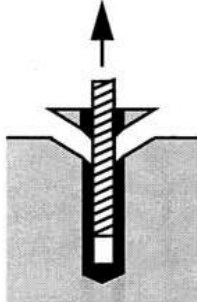
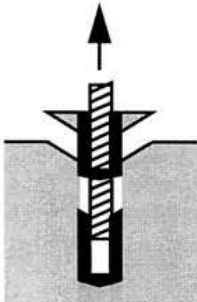
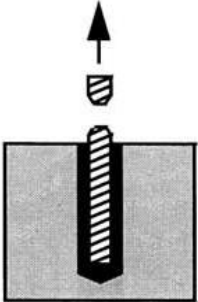
b)

approccio CCD /2

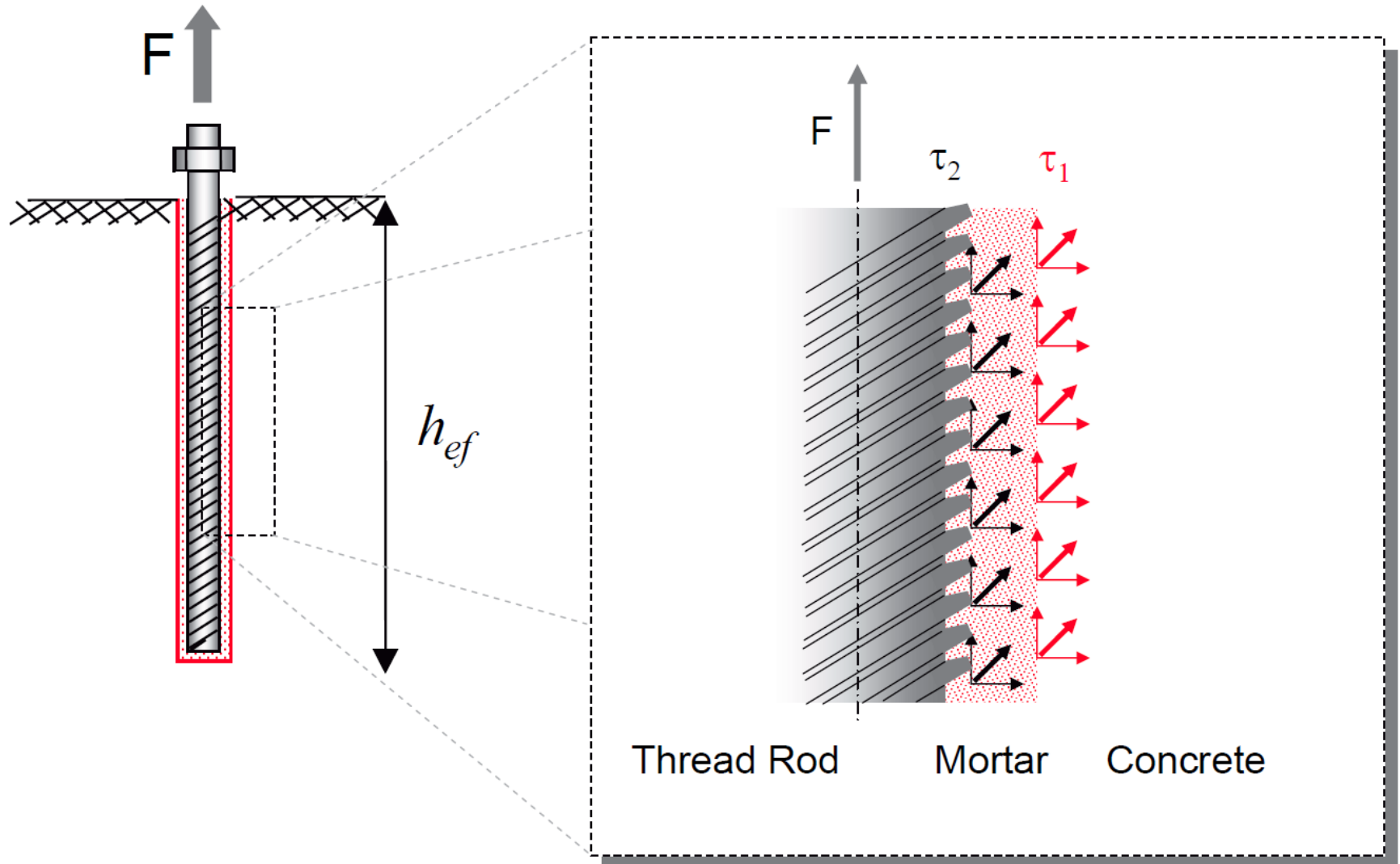


approccio CCD /3

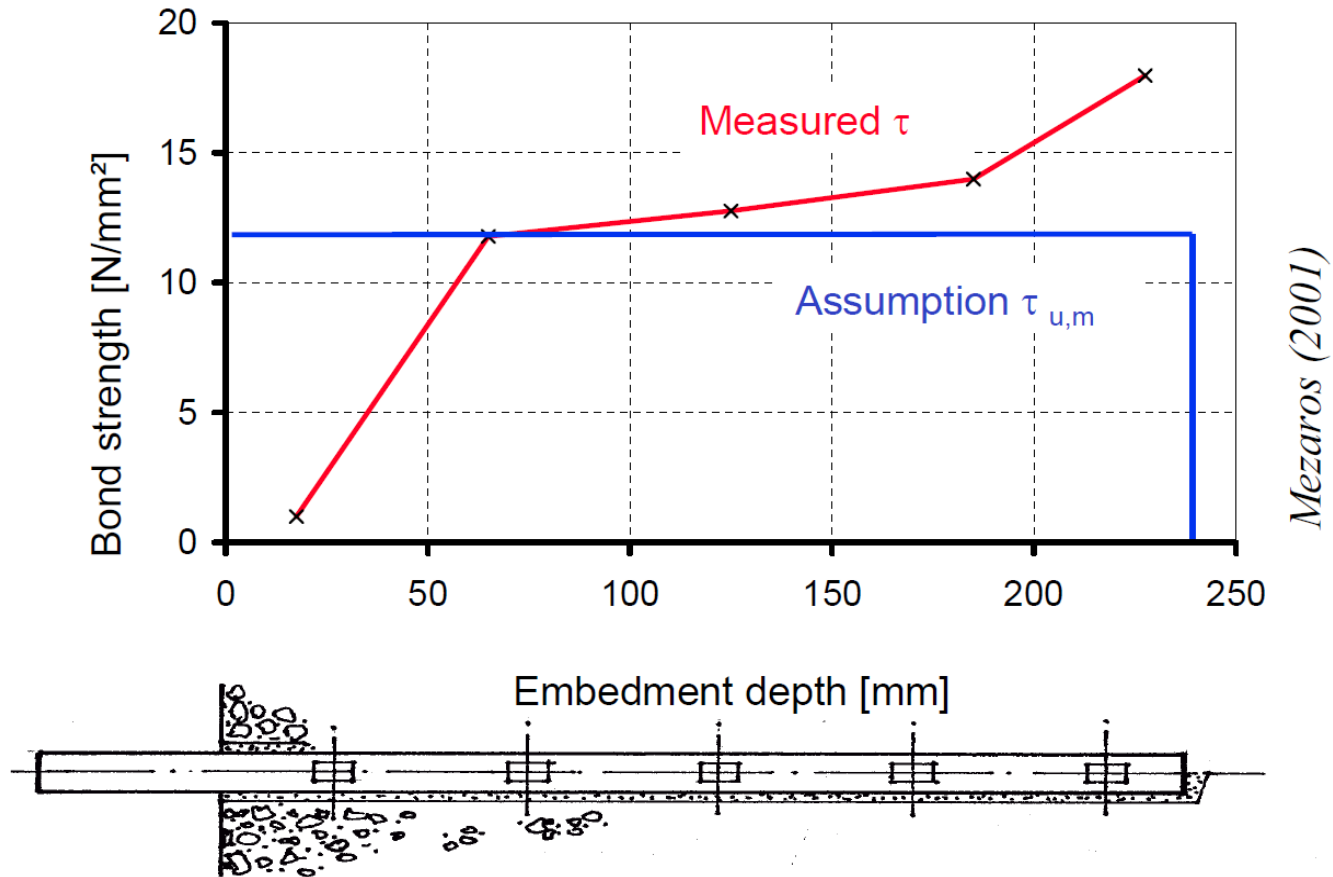


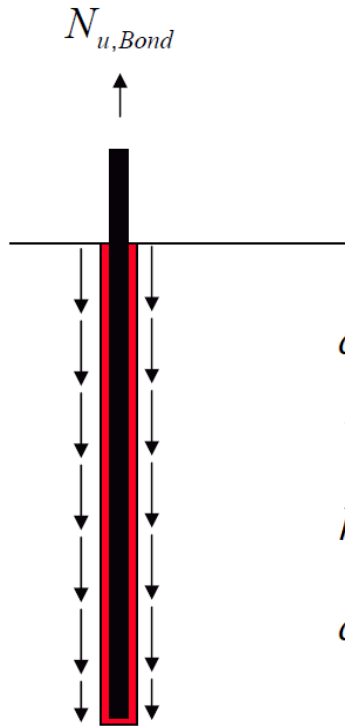
				
<p>a) Concrete cone failure</p>	<p>Pull-out failure</p>			<p>e) Steel failure</p>
<p>b) Failure mortar / concrete</p>		<p>c) Failure threaded rod / mortar</p>	<p>d) Mixed failure</p>	

(Cook, Kunz, Fuchs, Konz (1998))



[Eligehausen and Appl 2006]





$$N_{u,Bond} = \pi \cdot d \cdot h_{ef} \cdot \tau_{u,m} \quad [\text{N}] \quad d_0 / d \leq 1,5$$

d = diameter of the anchor rod [mm]

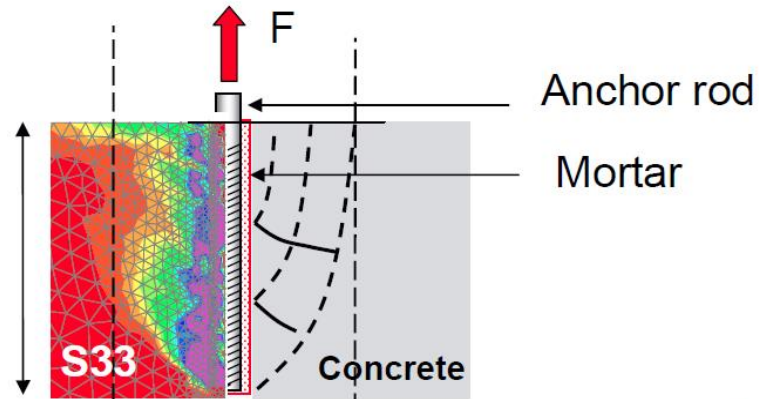
$\tau_{u,m}$ = average bond resistance [N/mm²]

h_{ef} = embedment depth [mm]

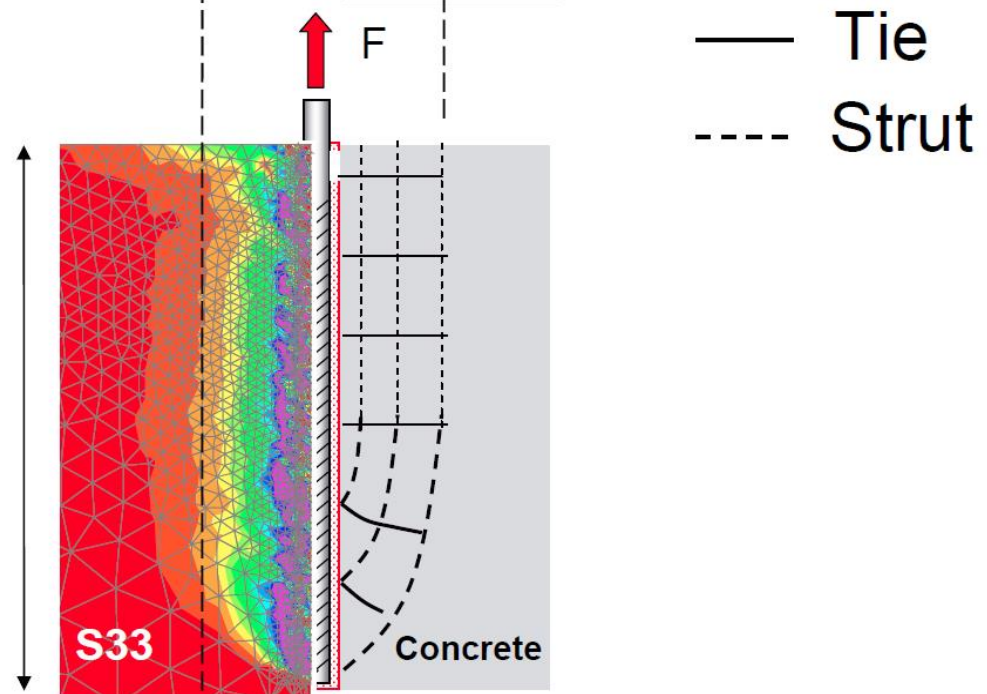
d_0 = diameter of of borehole [mm]

[Eligehausen and Appl 2006]

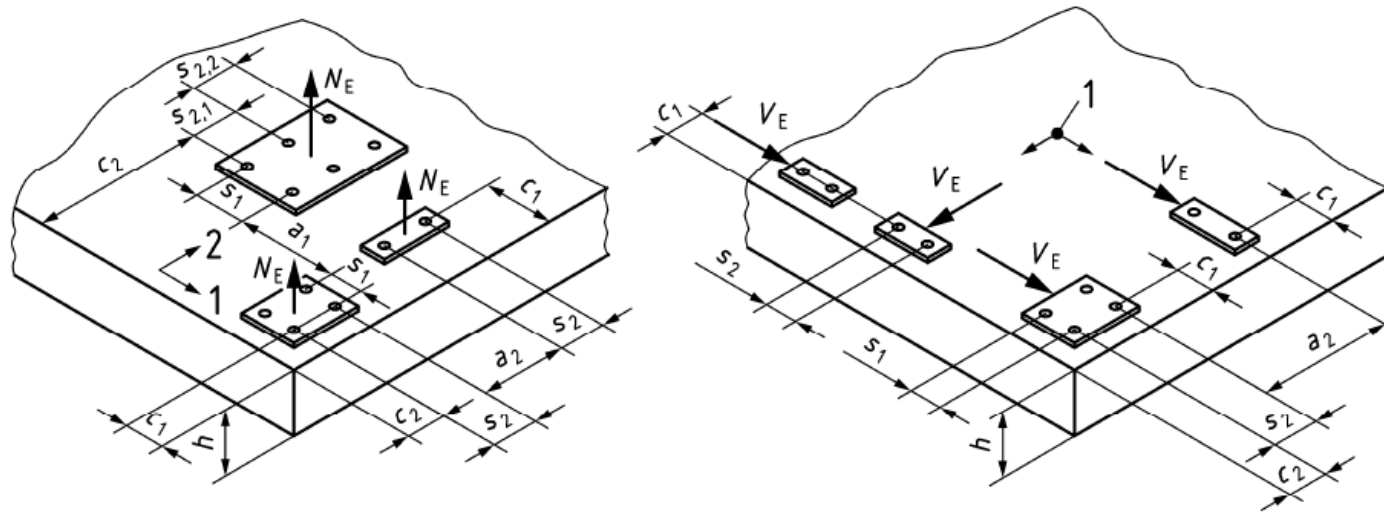
M12, $h_{ef}/d=10$, $\tau_u \sim 8\text{N/mm}^2$
Compression stress field



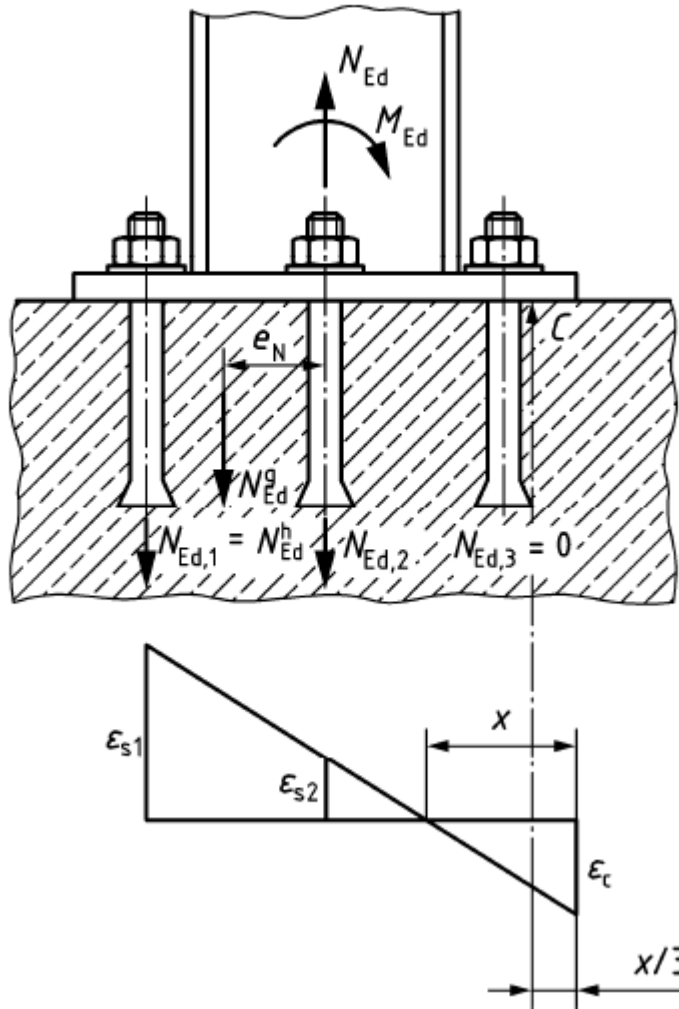
M12, $h_{ef}/d=20$, $\tau_u \sim 8\text{N/mm}^2$
Compression stress field



[Eligehausen and Appl 2006]

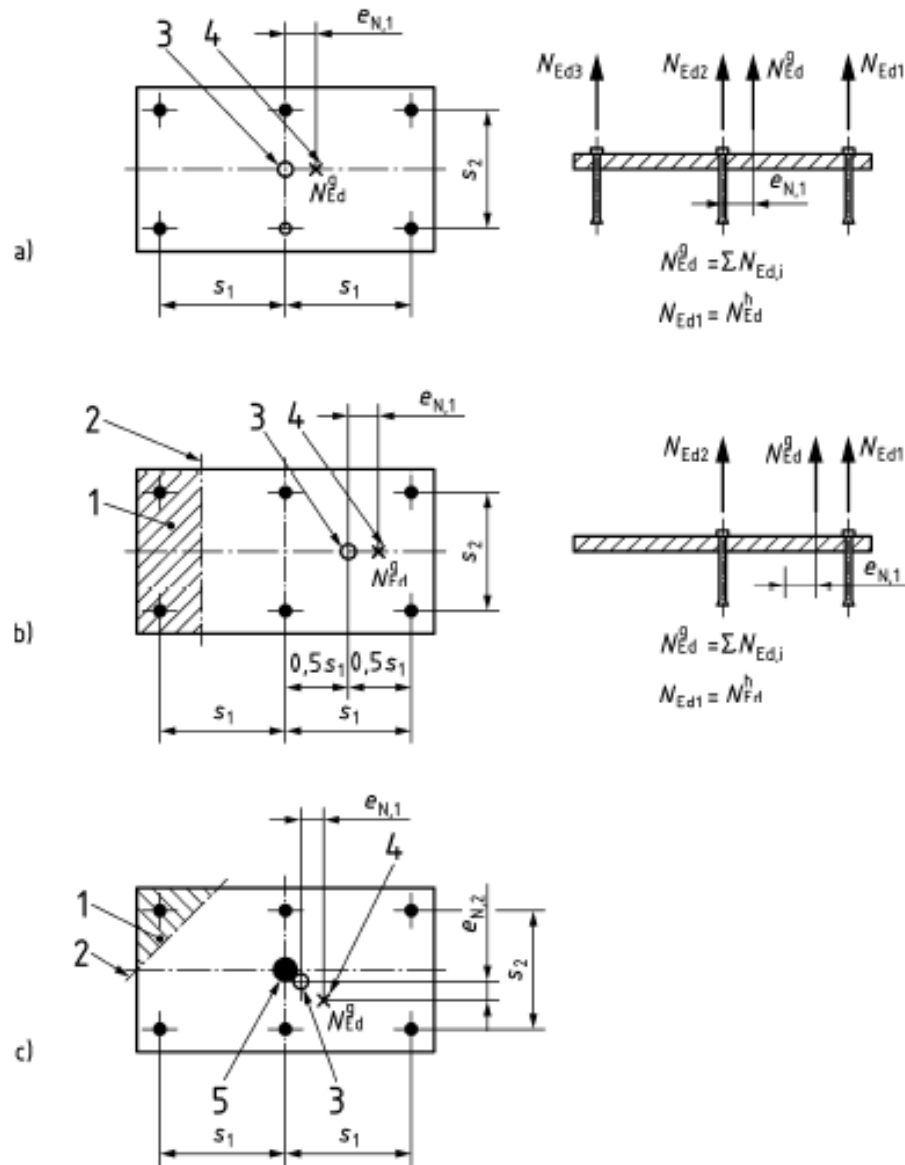


1	external diameter of fastener d^a or d_{nom}^b	6	8	10	12	14	16	18	20	22	24	27	30	> 30
2	diameter d_f of clearance hole in the fixture	7	9	12	14	16	18	20	22	24	26	30	33	$d + 3$ or $d_{nom} + 3$
* if bolt bears against the fixture.														
b if sleeve bears against the fixture.														

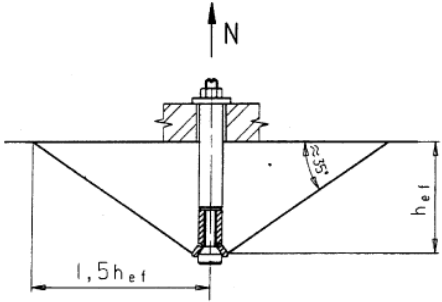


$$N_{Ed,1} = \epsilon_c E_c A_s$$

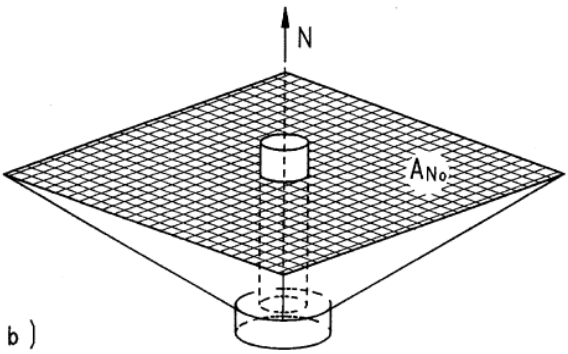
$$C_{Ed} = 0,5 b_{fix} \times \epsilon_c E_c$$



Approccio CCD /1



a)



b)

Approccio CCD /2

$$N_n = \frac{A_N}{A_{No}} \cdot \psi_1 \cdot \psi_2 \cdot N_{no}$$

ψ_1 = factor taking into account the eccentricity of the resultant tensile force on tensioned fasteners. In the case where eccentric loading exists about two axes (Fig. 11), the modification factor ψ_1 shall be computed for each axis individually and the product of the factors used as ψ_1 in Eq. (11a)

$$= \frac{1}{1 + 2e_N' / (3h_{ef})} \leq 1$$

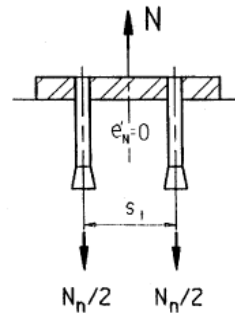
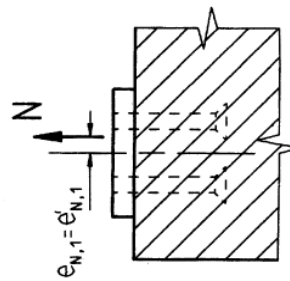
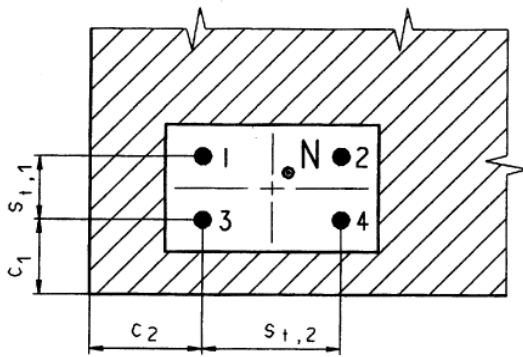
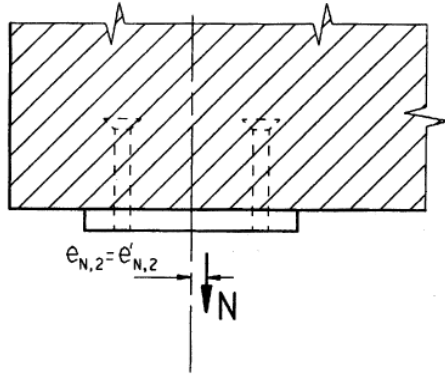
e_N' = distance between the resultant tensile force of tensioned fasteners of a group and centroid of tensioned fasteners

ψ_2 = tuning factor to consider disturbance of the radial symmetric stress distribution caused by an edge, valid for anchors located away from edges

$$\psi_2 = 1 \text{ if } c_1 \geq 1.5h_{ef}$$

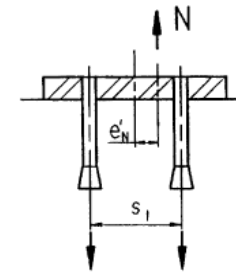
$$\psi_2 = 0.7 + 0.3 \frac{c_1}{1.5h_{ef}} \text{ if } c_1 \leq 1.5h_{ef}$$

Approccio CCD /3



$$N_n = \frac{A_n}{A_{n_0}} \cdot N_{n_0}$$

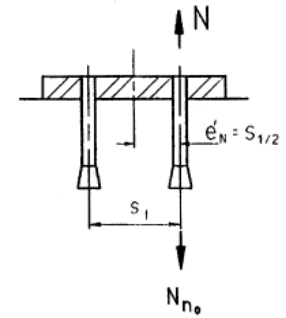
a)



$$N_n = \frac{A_n}{A_{n_0}} \cdot \psi_1 \cdot N_{n_0}$$

$$\psi_1 = \frac{1}{1 + 2e'_N / (3h_{ef})}$$

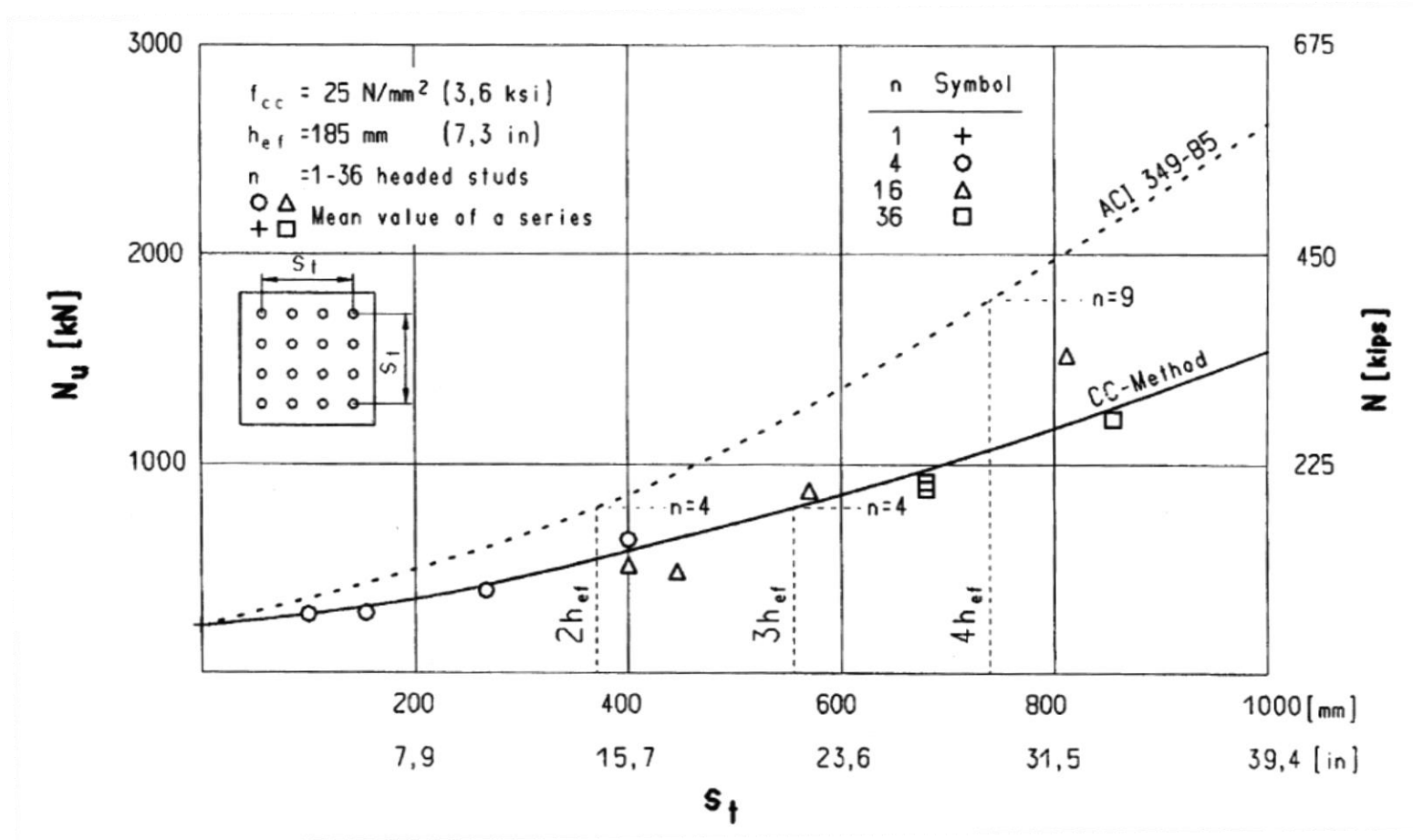
b)

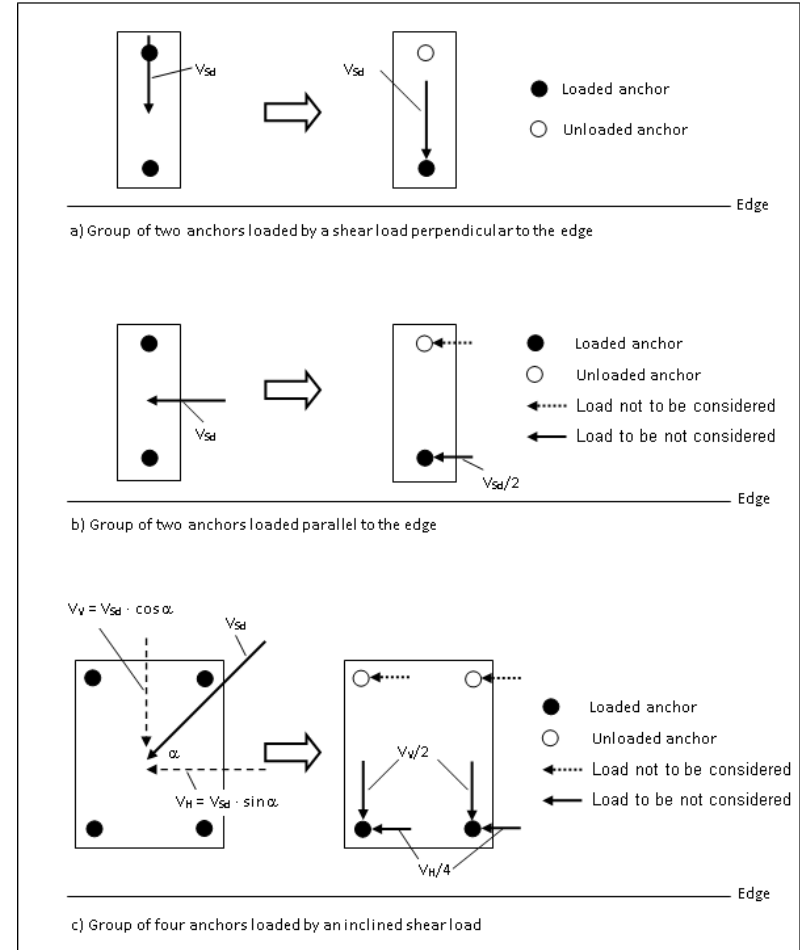
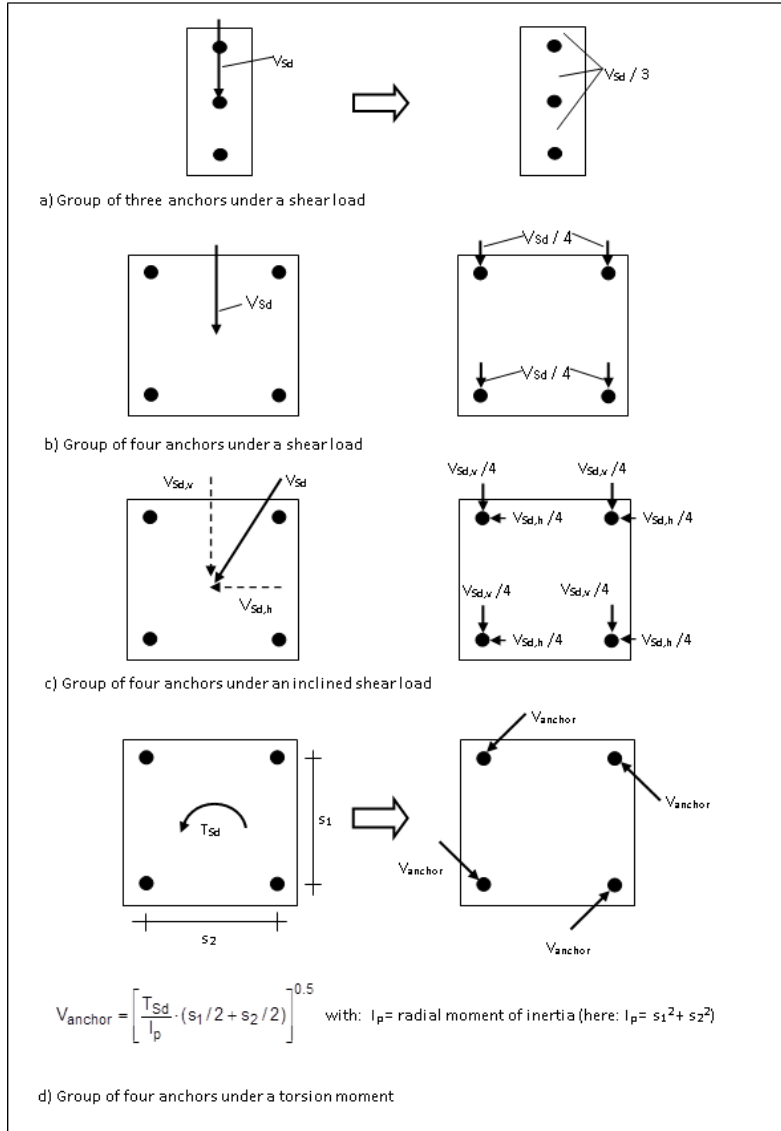


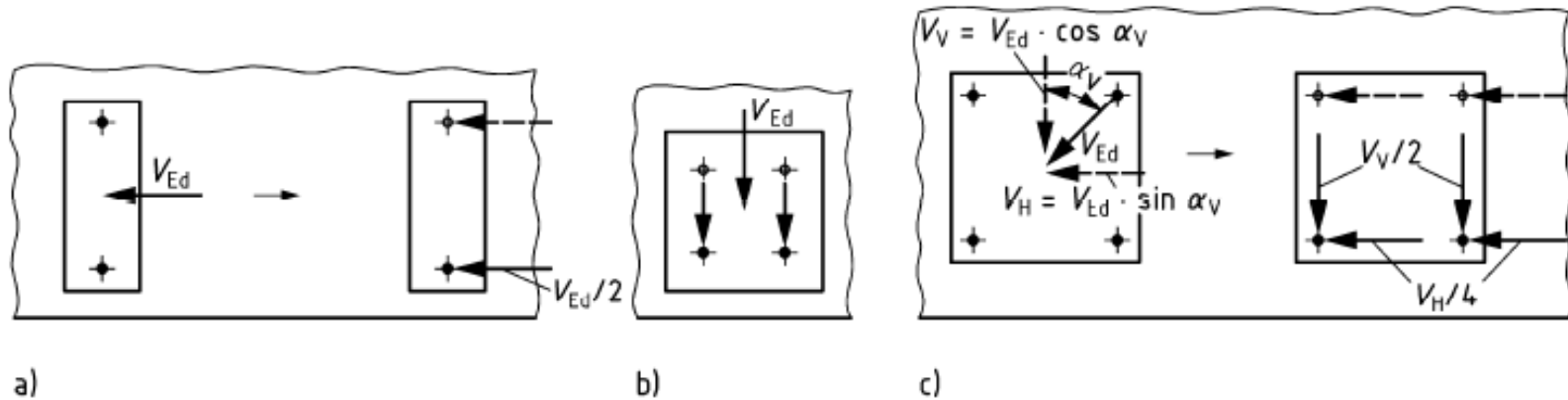
$$N_n = N_{n_0}$$

c)

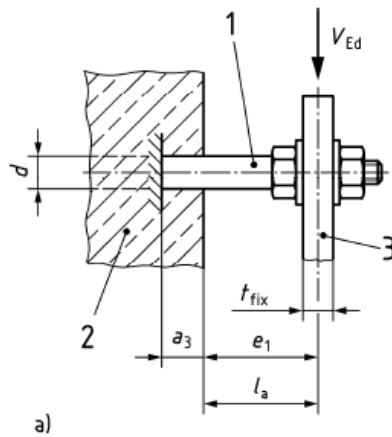
Approccio CCD /4



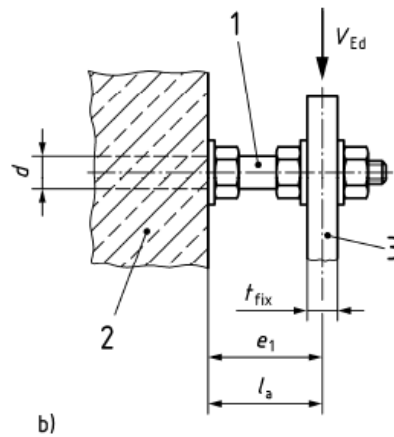




- a) group with two fasteners close to an edge loaded parallel to the edge;
- b) group with four fasteners close to an edge loaded perpendicular to the edge
- c) quadruple fastening close to an edge loaded by an inclined shear load



a) stand-off installation



b) stand-off installation with nut and washer to prevent local concrete spalling

Key

- 1 fastener
- 2 concrete element
- 3 attachment



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**Grazie per la vostra
attenzione**

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