

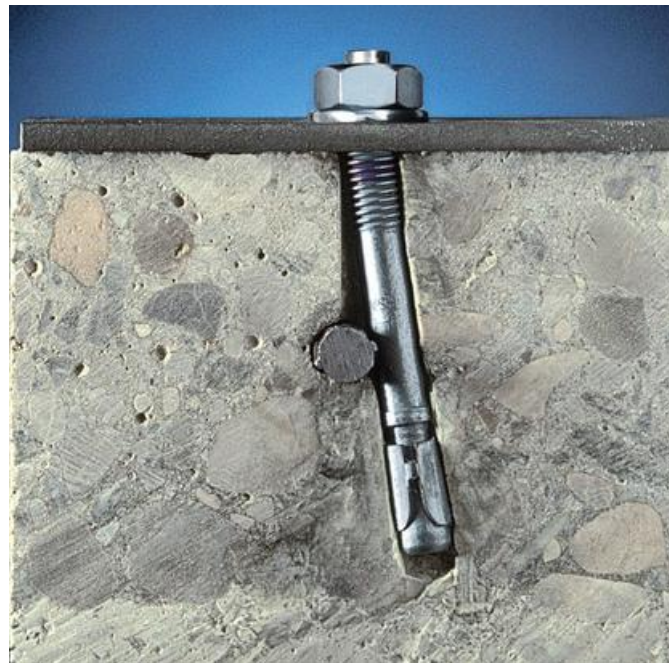
Ceiling structures

CEILBOT-PROJECT

FASTENING GUIDE LINES



TEKNILLINEN KORKEAKOULU
Rakenne- ja rakennustuotantotekniikan laitos
Talonrakennustekniikka



Base materials

- Different building materials provide different conditions for anchors
- Base material play a decisive role selecting a fastener
- Concrete -> cracking, low tensile strength
- Steel -> corrosion
- Timber -> orthotropy, moisture
- Masonry -> low strength, joints

Anchor holding principles, concrete

- Friction
- Keying
- Bonding
- Reduction for
 - Cracked concrete
 - Anchor spacing
 - Edge distance
 - Anchorage depth
- Anchors for permanent use must have test results for fire resistance or approved method for fire protection

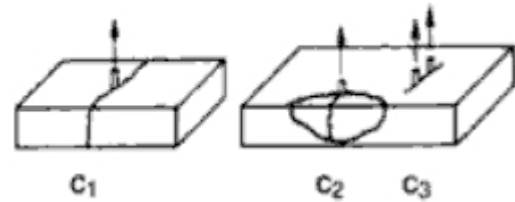
Safety concepts

- Partial safety factors for the applied loads
- Partial safety factors for the resistance of the fastening to these loads
- Global safety factor
- Design codes in different countries

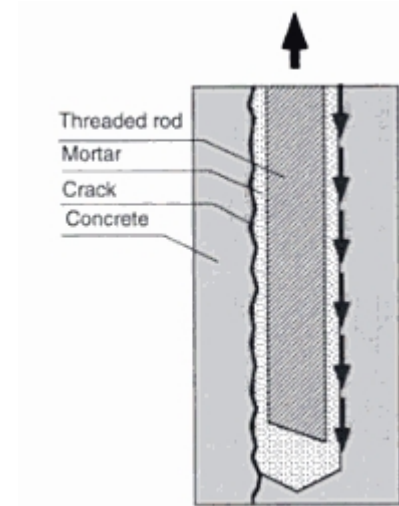
Fastening and concrete structures

- Resistance to tension loads
 - Steel failure
 - Pull-out failure
 - Concrete cone failure
 - Splitting failure

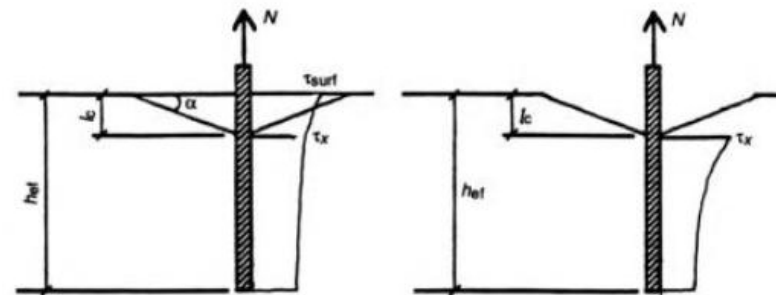
Typical tension failures, concrete



Splitting failure



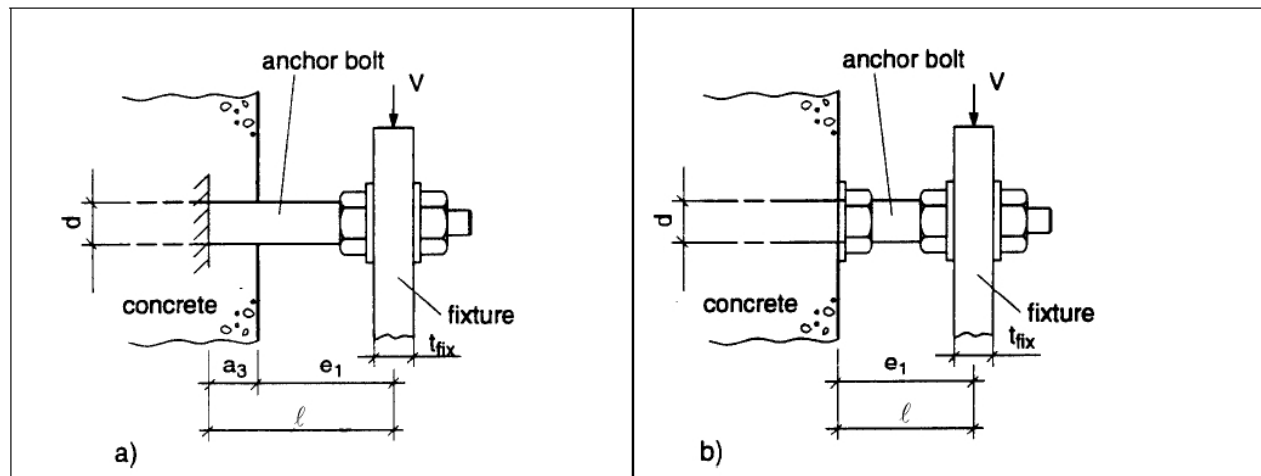
Pull-out failure



Concrete cone failure

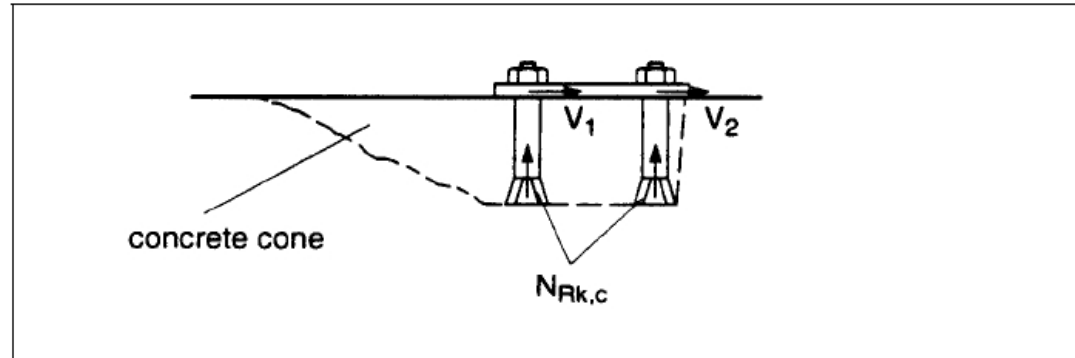
Fastening and concrete structures

- Resistance to shear loads
 - Steel failure, shear load without lever arm
 - Pull-out failure, shear load with lever arm
 - Concrete pryout failure
 - Concrete edge failure

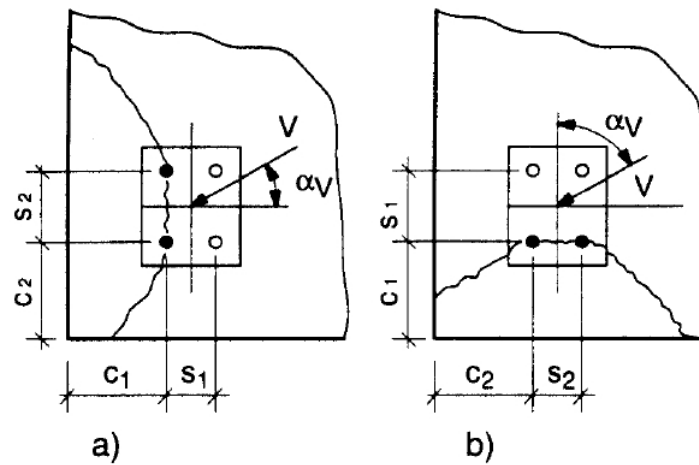


Definition of lever arm

Typical shear failures, concrete



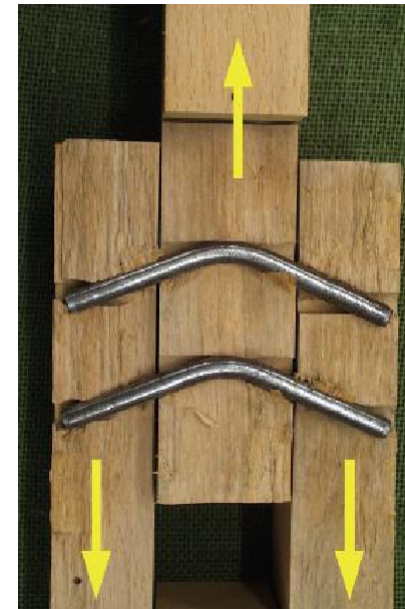
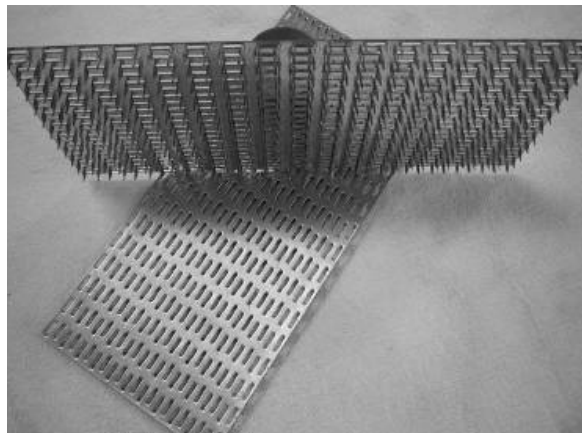
Concrete pryout failure



Concrete edge failures

Typical fasteners in timber

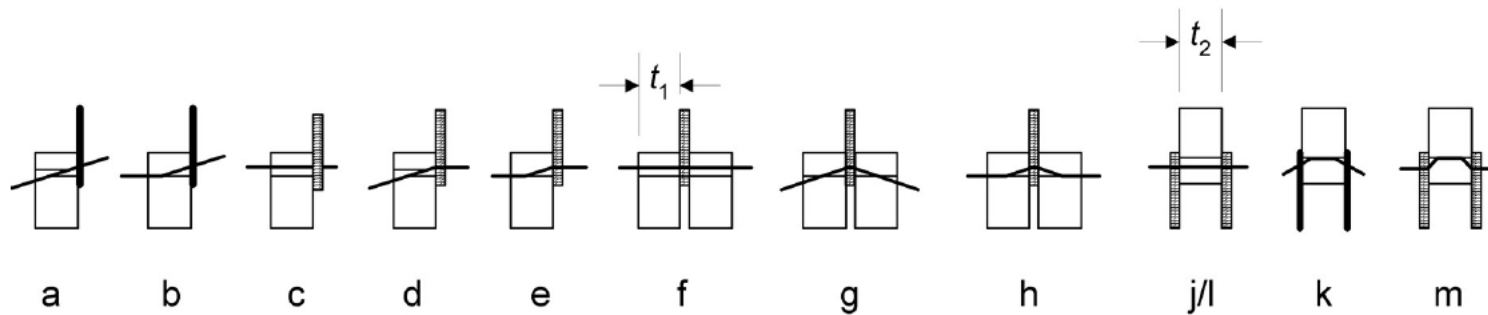
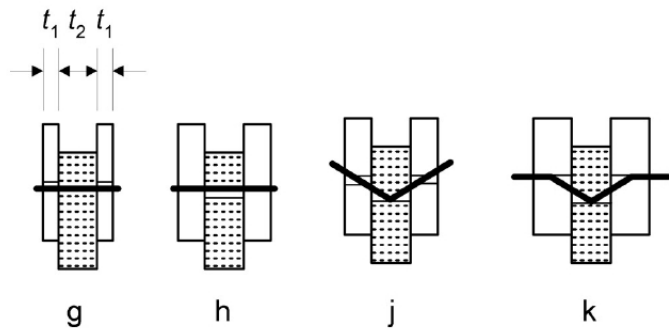
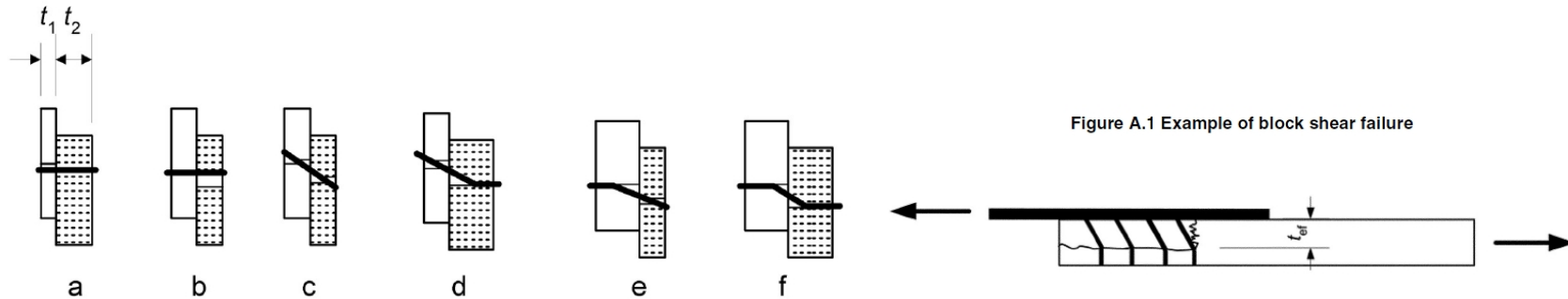
- Nails
- Screws
- Bolts
- Nail plates



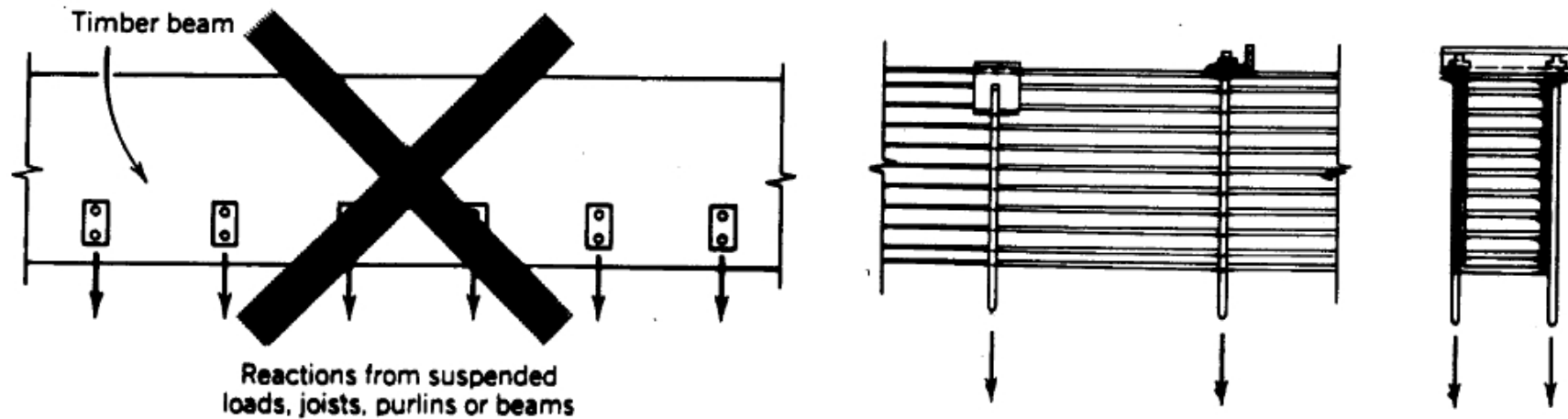
Anchor holding principles, timber

- Shear
- Tension
- Compression (saddle-type connection)
- Reduction for timber
 - Moisture
 - Load duration
 - Edge distance
 - Anchor spacing
- Unless rules are given in design codes, characteristic values for anchors capacity, stiffness and fire properties must be determined by testing

Typical shear failures, timber



Fastening to timber



Safety ranking for fasteners:

- 1) Saddle
- 2) Shear connection (nails, screws, nail plates),
 - avoid fasteners in bottom area of the beam
- 3) Tension joint (should be avoid)

Sources

- ETAG 001
 - Metal Anchors for Use in Concrete, Parts 1 to 6
- <http://www.eota.be>
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- Analyses of anchor pull-out in concrete, A.Vervuurt, J.G.M.Van Mier, E.Schlangen, Delft University of technology
- Failure analysis of anchoring systems in concrete, Y.Li, B.Winkler, A.Eckstein
- Fastenings to concrete and masonry structures, CEB.
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- SFS-EN 1995-1-1
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- Timber Engineering. STEP1 and STEP2. H.J.Blass, P.Aune, B.S.hoo, R.Görlacher, D.R.Griffiths, B.O.Hilson, P.Racher, G.Steck