



American Concrete Institute®
Advancing concrete knowledge

**What About Adhesive Anchors?
 Part 1(A)**


**ACI Spring 2010 Xtreme Concrete Convention
 March 21 - 25, Chicago, IL**

ACI WEB SESSIONS

ACI Web Sessions

ACI is bringing you this Web Session in keeping with its motto of “Advancing Concrete Knowledge.” The ideas expressed, however, are those of the speakers and do not necessarily reflect the views of ACI or its committees.

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ACI Web Sessions

ACI Web Sessions are recorded at ACI Conventions and other concrete industry events. At regular intervals, a new set of presentations can be viewed on ACI’s website free of charge.

After one week, the presentations will be temporarily archived on the ACI website or made part of ACI’s Online CEU Program, depending on their content.



ACI WEB SESSIONS

ACI Fall 2010 Convention

Pittsburgh

The Westin Convention Center Hotel & David L. Lawrence Convention Center
 October 24-28, 2010 • Pittsburgh, PA



ACI Conventions are dedicated to improving the design, construction, maintenance, and repair of concrete structures by offering 200+ committee meetings, 30+ technical and educational sessions, a number of networking events, and the opportunity to visit with exhibitors.

To coincide with the growing focus on “green” building practices, ACI has tailored numerous aspects of this fall’s convention to place emphasis on sustainability. Learn about the methods for reducing environmental impact and increasing the efficiency of concrete during committee meetings, sessions, and other events at the ACI Fall 2010 Convention. For more information and to register, visit www.aciconvention.org.




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ACI Web Sessions

This ACI Web Session includes three speakers presenting at the ACI Xtreme Concrete convention held in Chicago, IL, March 21st through 25th, 2010.

Additional presentations will be made available in future ACI Web Sessions.

Please enjoy the presentations.




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**What About Adhesive Anchors?
 Part 1(A)**

**ACI Spring 2010 Xtreme Concrete Convention
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Werner Fuchs is Director of Fastening Technology Research at the University of Stuttgart, Germany. He graduated in Structural Engineering from the University of Karlsruhe, and received his Ph.D. from the University of Stuttgart. He is an active member of ACI Committees 349 and 355, as well as a variety of European committees responsible for developing code provisions in the field of fastening technology.

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IWB

ACI Spring 2010 Convention
March 21-25, 2010
Chicago, IL, USA

Adhesive Anchors
Requirements for their reliable use
in concrete construction

by
Werner Fuchs, Rolf Elgehausen

Institute of Construction Materials
University of Stuttgart

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Adhesive anchors - their reliable use in concrete

→ Applications:



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Adhesive anchors - their reliable use in concrete

→ Applications:



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Adhesive anchors - their reliable use in concrete

→ Adhesive anchors – Requirements for their reliable use in concrete construction

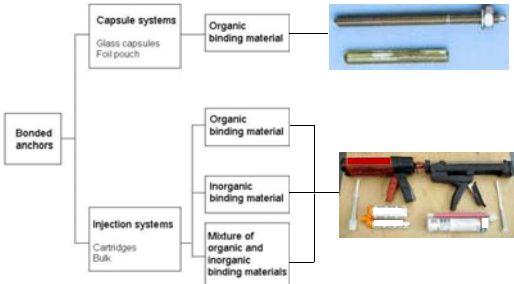
Detailed information:
'What about adhesive anchors?'

Topic	No. of presentations
Provisions, Qualification, Design	2
Installation	3
Design	4
Sustained load	4
Environmental conditions	2
Other	2

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Adhesive anchors - their reliable use in concrete

→ Adhesive anchor systems



```

    graph LR
      BA[Bonded anchors] --> CS[Capsule systems]
      BA --> IS[Injection systems]
      CS --> G[Glass capsules]
      CS --> F[Foil pouch]
      CS --> OM1[Organic binding material]
      IS --> OM2[Organic binding material]
      IS --> IM[Inorganic binding material]
      IS --> M[Mixture of organic and inorganic binding materials]
  
```

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Adhesive anchors - their reliable use in concrete

➔ **Reliable connections with adhesive anchor systems**

Reliability depends on the amount of human errors and their effect on the structural behavior of adhesive anchors

↳ Requirement:
Reduction of erroneous contributions of humans to the adhesive anchor application process

- Error-tolerant products
- User-centered design
- Safe installations
- Qualified supervision, inspection

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Adhesive anchors - their reliable use in concrete

➔ **Requirements to ensure reliable fastenings**

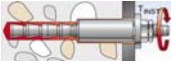

Producer
efficient fastening system

Engineer
accurate design

User
correct installation

↓ ↓ ↓

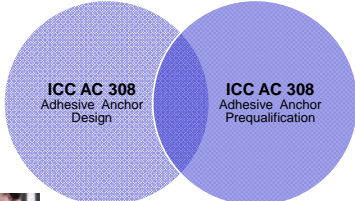
RELIABLE FASTENING






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Adhesive anchors - their reliable use in concrete

➔ **Actual situation**

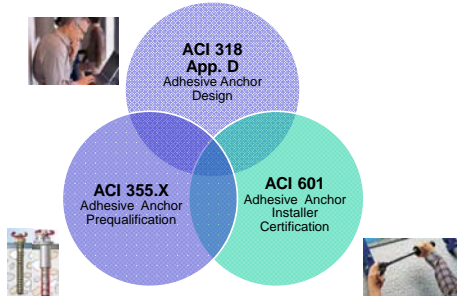


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Adhesive anchors - their reliable use in concrete

➔ **ACI 2011 - Approach for reliable fastenings**



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Adhesive anchors - their reliable use in concrete

➔ **Adhesive anchor prequalification**

Types of tests

- Identification test
compliance with fabrication requirements, establish baseline for quality assurance
- Reference tests
yield values to be compared with the results of the reliability tests
- Reliability tests
establish anchor categories used in ACI 318, App. D, demonstrate sensitivity to effects from possible deviations from the MPII likely to occur on-site and deviations occurring in service
- Service condition tests
establish characteristic resistance to be used in design

↳ Reliability tests do not cover gross installation errors. They shall be prevented by appropriate installer training and qualified site inspection **!**

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Adhesive anchors - their reliable use in concrete

➔ **Characteristics influencing the bond strength of adhesive anchors - mandatory in prequalification**

- Product
- Freeze/thaw
- Drilling method
- Sustained loading
- Concrete
low strength, high strength, regional variation
- Chemicals
resistance to alkalinity
- Hole cleaning, installation
dry and water saturated concrete
- Curing time
standard temperature, 73° F
- Mixing
- Cracked concrete
only for intended use in cracked concrete
- Temperature
longterm ≥ 110° F, short term ≥ 176° F



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Adhesive anchors - their reliable use in concrete

➔ **Parameters influencing the bond strength of adhesive anchors - optional in prequalification**

- Hole cleaning, installation
water filled hole, submerged concrete
- Installation
decreased installation temperature, < 50° F
- Chemicals
resistance to sulfur
- Installation direction
overhead
- Seismic loading

➤ Designer's task:
Compare exactly the requirements resulting from design for service life and installation with the field of application given in the ESRs of products from different manufacturers



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Adhesive anchors - their reliable use in concrete

➔ **Adhesive anchor selection - designer**

Anchor selection is governed by

- Loading conditions
static, seismic, sustained, load direction ...
- Location of fastening
edge distance, spacing, member depth ...
- Concrete, characteristics, condition
strength, cracked, uncracked ...
- Environmental conditions
elevated temperatures, freeze/thaw conditions, humidity ...
- Location of adhesive anchor
installation conditions, detailing ...
- Installation direction
vertical down, horizontal, overhead
- Environmental conditions
concrete temperature, submerged hole ...


 Service life
 +
 Installation


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Adhesive anchors - their reliable use in concrete


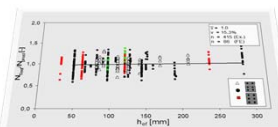
➔ **Adhesive anchor design - designer**

Adhesive anchor design is based on ACI 318-08, App. D (mechanical anchors)

Modifications:

- Verification of the sustained load
AC 308: reduction factor $\psi_{sust} = 0.75$
ACI 318, App. D: reduction factor $\psi_{sust} = 0.55$
- Prediction of the pull-out capacity by equations

➤ Design provisions of AC 308 and ACI 318 represent the state-of-art in adhesive anchor design

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Adhesive anchors - their reliable use in concrete

➔ **Adhesive anchor installation**

Actual situation:

- Qualification of the installer is not required
- Special inspection is required to take care of
 - + storage conditions of the adhesive
 - + application of the correct installation equipment
 - + sufficient hole cleaning
 - + correct insertion of the steel element
 - + adherence with the cure time

➤ Special inspector must be aware of the negative impact of deviations from the Manufacturer's Product Installation Instruction (MPII) on the adhesive anchor performance


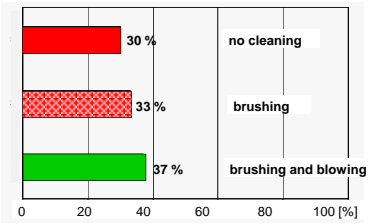


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Adhesive anchors - their reliable use in concrete

➔ **Adhesive anchor installation**

Example: Borehole cleaning in Germany
Injection system, required borehole cleaning: blowing and brushing
Requirement by the approval (ETA):
Installation performed by an appropriately qualified person

➔ Note: Gross errors are not covered by prequalification tests !!!


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Adhesive anchors - their reliable use in concrete

➔ **Adhesive anchor installation - installer**

The ACI 601 adhesive anchor installer training and certification program will consider


- the experience, limitations and capabilities of the installers
- the adhesive anchor relevant jobsite conditions
- the knowledge and understanding of the MPIIs
- the impact of deviations from the MPII
- the proper selection and use of the installation equipment and include
- a written and a performance exam



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Adhesive anchors - their reliable use in concrete

➔ **Conclusion**



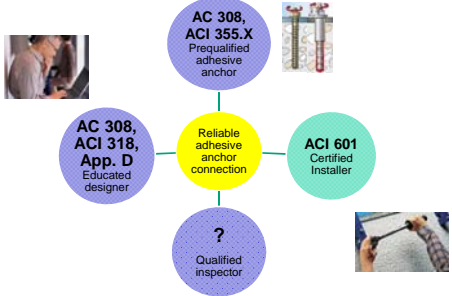
- The prequalification test conditions and evaluation criteria of adhesive anchors according to AC308 and ACI 355.X represent installation and in service conditions in practice
- The design of adhesive anchors according to AC 308 and ACI 318, App. D agrees with test results and considers the effect of sustained load with a reduction factor α_{sust}
- The adhesive anchor installer training and certification program according to ACI 601 takes care of proper installation

↳ The provisions for adhesive anchors based on extensive research represent the state-of-art of fastening technique and yield reliable connections

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Adhesive anchors - their reliable use in concrete

➔ **Reliable connections with adhesive anchor systems!**



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Related Documents

Anchorage to Concrete

- 355.2-07: Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary
- 349.2R-07: Guide to the Concrete Capacity Design (CCD) Method - Embedment Design Examples
- 503.5R-92: Guide for the Selection of Polymer Adhesives in Concrete (Reapproved 2003)
- SP-103: Anchorage to Concrete
- SP-130: Anchors in Concrete--Design and Behavior
- 318-08: Building Code Requirements for Structural Concrete and Commentary

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