ICC EVALUATION SERVICE

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TO: **PARTIES INTERESTED IN POST-INSTALLED ANCHORAGE TO CONCRETE COVERED IN ICC EVALUATION SERVICE REPORTS**

SUBJECT: Clarification on the Use of the Conversion Factor "α" to Convert Strength Design (SD) to Allowable Stress Design (ASD)

Dear Madam or Sir:

ICC-ES staff has been requested to clarify how the Conversion Factor, "α", is to be used in the allowable stress design (ASD) equations noted in ICC-ES evaluation reports on post-installed anchorage to concrete.

The ICC-ES Acceptance Criteria for Mechanical Anchors in Concrete Elements (AC193) and the ICC-ES Acceptance Criteria for Post-installed Adhesive Anchors in Concrete Elements (AC308) were revised in February 2008 to include an amended method for converting Strength Design (SD) capacities to Allowable Strength Design (ASD) capacities using "α".

In the acceptance criteria, the definition of "α" was revised to define the conversion requirements using the load factors in the 2006 IBC and ASCE 7-05. The more clearly defined "α" states, "the value is calculated as a weighted average of the load factors for the controlling load combination." This more clearly defined "α" has been included in all ICC-ES evaluation reports on post-installed mechanical and adhesive anchors published after March 1, 2008.

For all reports with a March 1, 2008, or later date, the amended method must be used by the structural design professional for the project anchor design whenever converting from SD to ASD.

For reports with an issue date earlier than March 1, 2008, a fixed "α" was provided based on a set of presumed application conditions and assumed controlling load combination. The table below shows the previously specified "α" in these reports.

REFERENCE FOR STRENGTH REDUCTION FACTORS USED IN CALCULATION, R_d	α	
	Including Seismic	**Excluding Seismic**
ACI 318 Section D.4.4	1.1	1.4
ACI 318 Section D.4.5	1.2	1.55

For some anchor applications, use of these fixed "α" values will result in ASD values, $R_{allow,\ ASD}$ ($T_{allow,\ ASD}$ and $V_{allow,\ ASD}$), that are unconservative when compared to the values calculated using the amended method.

Upon renewal of these reports, this table will be removed and replaced with the amended methodology for determining ASD resistance values. Prior to renewal of these reports, when converting SD to ASD, the amended ASD conversion procedure should be used by the structural design professional for the specific anchor application.

To assist in the proper application of "α", two design examples have been provided below. For further clarification when seismic (earthquake) loads are involved, one of the design examples is controlled by the Basic Load Combination, which includes Earthquake (*E*) Load.

EXAMPLE 1—Controlled by Basic Load Combination Which Includes Dead (*D*) and Live (*L*) Loads

Given:

- Loading: Tension Load Only—From project design—40 percent Dead Load (*D*) and 60 percent Live Load (*L*)
- Controlling Basic Load Combination: Refer to the 2006 IBC, Sections 1605.2.1, Eq. 16-2 and 1605.3.1 Eq. 16-9; or ASCE 7-05, Sections 2.3.2, Eq. 2 and 2.4.1, Eq. 2

Strength Design: → $1.2D + 1.6L \leq \phi N_n$

Allowable Stress Design: → $1.0D + 1.0L \leq \phi N_n/\alpha$
→ $\alpha\,[1.0D + 1.0L] \leq \phi N_n$

Therefore, for equivalent level of safety → $1.2D + 1.6L = \alpha\,[1.0D + 1.0L]$
→ $\alpha = [1.2D + 1.6L]/[1.0D + 1.0L]$

where:

ϕ = Strength reduction factor for controlling failure mode.
N_n = Nominal strength in tension for controlling failure mode.
α = Conversion factor to convert from SD Anchor Strength to ASD Anchor Resistance.

Determine: Conversion Factor, α

→ $\alpha = [1.2D + 1.6L]/[1.0D + 1.0L]$
→ $\alpha = [1.2(0.4) + 1.6(0.6)]/[1.0(0.4+0.6)]$
→ $\alpha = [1.44]/[\ 1.0]$
→ $\alpha = 1.44$

EXAMPLE 2—Controlled by Basic Load Combination Which Includes Dead (*D*) and Earthquake (*E*) Loads

Given:

- Loading: Tension Load Only—From project design—50 Percent Dead Load (D) and 50 Percent Earthquake (E)
- Seismic Design Category C
- Controlling Basic Load Combination: Refer to 2006 IBC, Sections 1605.2.1, Eq. 16-5 and 1605.3.1, Eq. 16-12; or ASCE 7-05, Sections 2.3.2, Eq. 5 and Section 2.4.1, Eq. 5.

Strength Design: $\rightarrow$ $1.2D + 1.0E \leq \phi_{duct.}\ \phi_{seis}\ \phi N_n$

Allowable Stress Design: $\rightarrow$ $1.0D + 0.7E \leq \phi_{duct.}\ \phi_{seis}\ \phi N_n/\alpha$
$\rightarrow$ $\alpha\,[1.0D + 0.7E] \leq \phi_{duct.}\ \phi_{seis}\ \phi N_n$

Therefore, for equivalent level of safety $\rightarrow$ $1.2D + 1.0E = \alpha\,[1.0D + 0.7E]$
$\rightarrow$ $\alpha = [1.2D + 1.0E]/[1.0D + 0.7E]$

where:

$\phi_{duct.}$	=	0.4 for nonductile failure mode, when applicable.
ϕ_{seis}	=	0.75 for seismic, when applicable.
ϕ	=	Strength reduction factor for controlling failure mode
N_n	=	Nominal strength in tension for controlling failure mode.
α	=	Conversion factor to convert from SD (Anchor Design Strength) to ASD (Anchor Design Resistance).

Determine: Conversion Factor, α

$$\alpha = [1.2D + 1.0E]/[1.0D + 0.7E]$$

$$\rightarrow \quad \alpha = [1.2(0.5) + 1.0(0.5)]/\ [1.0(0.5) + 0.7(0.5)]$$
$$\rightarrow \quad \alpha = [1.1]/[\ 0.85]$$
$$\rightarrow \quad \alpha = 1.294$$

If you have any questions, please contact Mahmut Ekenel, Ph.D., P.E., staff engineer, or the undersigned at (800) 423-6587, extension 3260. You may also reach us by e-mail at es@icc-es.org.

Yours very truly,

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