Acceptance Criteria for Moment Frames Based on Structural Testing (ACI 374.1-05) and Commentary

An ACI Standard

Reported by ACI Committee 374

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This document defines the minimum experimental evidence deemed adequate to validate the use, in regions of high seismic risk or in structures assigned to satisfy high seismic performance or design categories, of weak beam/strong column moment frames not in conformance with Chapter 18 of ACI 318-14. This document consists of both a Standard and a Commentary that is not part of the ACI 318-14 Standard and Commentary. The document

ACI Committee 374 adopted ACI T1.1/T1.1R-01 as ACI 374.1-05 on October 12, 2005. ACI T1.1/T1.1R-01 superseded ACI ITG/T1.1-99 and became effective March 9, 2001.

has been written in such a form that its various parts can be adopted directly into Sections 2, 3, 18.1, and 18.2 of ACI 318-14 and the corresponding sections of the Commentary of ACI 318-14. Among the subjects covered are requirements for: procedures that shall be used to design test modules; configurations for those modules; test methods; test reports; and determination of satisfactory performance.

The Commentary describes some of the considerations of the Innovation Task Group (1) in developing this Standard. The section numbering for the Commentary is the same as that for the Standard, with numbers preceded by an "R" and the text in italics to distinguish them from the corresponding section numbers of the Standard.

The Commentary references documentary evidence, additional to the references of Chapter 18 of the ACI 318-14 Commentary, that supports this Standard. Consistent with the approach of ACI 318-14, no comparison is made between research results for test modules conforming to ACI 318-14 with those for modules that, although not conforming to ACI 318-14, do conform to this Standard. Such comparisons, both experimental and analytical, are available in the references of the Commentary.

Keywords: acceptance criteria; drift ratio; energy dissipation; lateral resistance; moment frame; post-tensioning; precast concrete; prestressed concrete; seismic design; test module; toughness.

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INTRODUCTION

For seismic design, 18.2.1.7 in ACI 318-14 specifies 18.2.1.7 that "a reinforced concrete structural system not satisfying this chapter shall be permitted if it is demonstrated by experimental evidence and analysis that the proposed system will have strength and toughness equal to or exceeding those provided by a comparable reinforced concrete structure satisfying this chapter." This Standard defines the minimum experimental evidence that shall be provided in order to validate the use, in regions of high seismic risk or for structures assigned to satisfy high seismic performance or design categories, of a special beam/strong column moment frame not conforming to the requirements of Chapter 18 of ACI 318-14.

Consistent with the ACI 318-14 requirement for analysis, this Standard specifies that, before the testing mandated by the Standard, a design procedure shall have been developed for prototype frames having the generic form for which acceptance is sought and that design procedure shall be used to proportion the test modules. Further, the Standard assumes that the prototype frames have forms that are essentially regular, having no significant physical discontinuities in plan or in vertical configuration or in their lateral-force-resisting systems, and that the frames conform to some, but not all, of the requirements of ACI 318-14, Chapter 18. Such frames might, for example, involve use of precast elements, precast-prestressed elements, post-tensioned reinforcement, or combinations of those elements and reinforcement. Prescriptive requirements for moment frames constructed with such elements are not included in ACI 318-14. Such frames might also, for example, use alternate methods, other than those specified in Chapter 18, for force transfer through beam-column joints.

The provisions of this Standard are intended to supplement the provisions of Chapter 18 of ACI 318-14 and not to supplant them.

1.0—Notation

Only notation additional to that in ACI 318-14 is defined.

E_{max} = maximum lateral resistance of test module determined from test results (forces or moments)

E_n = nominal lateral resistance of test module determined using specified geometric properties of test members, specified yield strength of reinforcement, specified compressive strength of concrete, a strain compatibility analysis for flexural moment strength, and a strength reduction factor ϕ of 1.0

E_{pr} = probable lateral resistance of test module determined using actual geometric and material properties of test members, an analysis for probable flexural moment strength of beams based on strain compatibility and including strain-hardening effects in the reinforcement, and a strength reduction factor ϕ of 1.0

λ = column overstrength factor used for test module

θ = drift ratio

β = relative energy dissipation ratio

R1.0—Notation

Only symbols used in this Commentary that are additional to those in Section 2.1 of ACI 318-11 and ACI T1.1-01 are defined in the following:

A_h = *area of hysteresis loop*

E_1, E_2 = *peak lateral resistance for positive, negative, loading for third cycle of loading sequence*

f_1 = *factor on live load defined in R2.6*

h = *height of column of test module, in. or mm*

K,K′ = *initial stiffness for positive, negative, loading for first cycle*

θ_1, θ_2 = *drift ratios at peak lateral resistance for positive, negative, loading for third cycle of loading sequence*

θ_1', θ_2' = *drift ratios for zero lateral load for unloading at stiffnesses* K,K′ *from peak positive, negative, lateral resistance for third cycle of loading sequence (Fig. R2.4)*

Δ = *lateral displacement, in. or mm. See Fig. R2.1*