



Fall 2021
Virtual Convention

440-F FRP Repair & Strengthening
Sub-Committee Meeting
Monday October 18, 2021
12pm – 3pm EDT

Pre-read Material for Resolution of comments on Main
Ballot 4 (June 4, 2021)

ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

Pre-read Material for Resolution of comments on Main Ballot 4 (June 4, 2021)

The changes to Chapters 10, 13, 14 & References was balloted at MAIN.

Please review the following comment resolutions and the motions that will be made at MAIN on Tuesday, 10/19.

ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

6. Resolution of comments on Main Ballot 4 (June 4, 2021)

Item #	Affirmative	Affirmative with Comments	Negative	Abstain	Not Returned
1 – Revisions to 10.1.1, 14.1.1 and References	34	3	2	1	9
2 – Revision to Chapter 13 and References	31	6	2	1	9

- 1/2 rule is satisfied
- 2/3 rule is satisfied

ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (1/6)

18 incorporating an additional strength reduction factor for FRP, ψ_f , in addition to the strength reduction factor
19 ϕ per ACI 318 for structural concrete. Anchorage systems such as U-wraps ~~mechanical fasteners, and~~ fiber
20 anchors, ~~and U-anchors~~ (examples are shown schematically in Fig. ~~14.1.110.1.1b~~) have been proven
21 successful at delaying, and sometimes preventing, debonding failure of the longitudinal FRP. Providing
22 such anchorage can improve the flexural strength and deformability of the FRP-strengthened member
23 (Kalfat et al. ~~2013~~2018; Grelle and Sneed 2013; Lee and Lopez 2020). Providing anchorage does not
24 necessarily mitigate FRP debonding nor the brittle failure mode. However, the debonding failure may be
25 changed to a progressive and more controlled behavior that not only maintains the integrity of the FRP but
26 allows it to continue to resist force. Experimental studies have shown that these anchorage systems can
27 increase the effective strain in the flexural FRP to values up to tensile rupture (Lee et al. 2010; Orton et al.
28 2008).

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27 Anchorage systems, such as U-wraps, ~~mechanical fasteners,~~ fiber anchors, and near-surface-mounted
28 (NSM) anchors (~~examples are shown schematically in Fig. 14.1.1~~), have been proven successful at delaying,
29 and sometimes preventing, debonding failure of ~~the longitudinal~~ FRP (Eshwar et al. 2008; Kalfat et al. ~~2013~~
30 2018; Grelle and Sneed 2013; Lee and Lopez 2020). Numerical and experimental studies have shown that

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Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (2/6)

	Item	pg.	ln	N/AC	COMMENT	RESOLUTION
Gold	1	3	25	N	<p>The sentence starting “However...” on line 24 seems to contradict the earlier statement beginning “Anchorage systems...” on line 19. Anchorage is proven to delay and prevent debonding...but it does not mitigate debonding? I would recommend changing the sentence starting on line 19 to “Anchorage systems...have been proven successful at delaying, and sometimes preventing, <u>to control</u> debonding failure.” or rephrasing the sentence starting on line 24.</p> <p>This would also apply to Page 18, Line 28/29.</p>	<p>Persuasive. Anchorage does not prevent local <u>debonding</u> but it can control/mitigate complete debonding of the FRP. Revise as follows:</p> <p>Page 3, Lines 19-26: Anchorage systems such as U-wraps, mechanical fasteners, and fiber anchors, and U-anchors (examples are shown schematically in Fig. 14.1.1(a) 14.1.1(b)) have been proven successful at <u>successful at</u> delaying, and sometimes preventing, <u>to control</u> debonding failure of the longitudinal FRP. <u>Providing such anchorage can improve the flexural strength and deformability of the externally-bonded FRP-strengthened member</u> (Kalfat et al. 2013 2018; Grelle and Sneed 2013; <u>Lee and Lopez 2020</u>; <u>Smith et al 2013</u>). <u>Providing anchorage does not necessarily mitigate prevent local FRP debonding nor the associated brittle failure mode. However, FRP anchorage may mitigate sudden complete the debonding of the FRP, failure may be changed to a progressive and more controlled behavior to develop allowing the FRP to continue to resist force.</u></p> <p>Page 18, Lines 27-29: Anchorage systems, such as U-wraps, mechanical fasteners, fiber anchors, and near-surface-mounted (NSM) anchors (examples are shown schematically in Fig. 14.1.1), have been proven successful at delaying, <u>successful at</u> 28 and sometimes preventing, <u>to control</u> debonding failure of the longitudinal FRP (Eshwar et al. 2008; Kalfat et al. 2013 2018; Grelle and Sneed 2013; <u>Lee and Lopez 2020, Smith et al 2013</u>).</p> <p>Accepted proposed resolution per email on 7/14/21.</p>

ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (3/6)

Bouadi	1	3	23-26	N	<p>Remove the sentence “Providing anchorage... continue to resist force.”</p> <p>1. The statement lacks supporting reference <u>in regards to “progressive” and “controlled behavior”</u></p> <p>“Progressive” and “Controlled behavior” are not defined and are not terms that are used in member behavior. Is the text trying to imply “ductile”?</p>	<p>Persuasive. The intent is to acknowledge that anchorage of FRP may mitigate the sudden debonding of the FRP and allow a more progressive/controlled debonding wherein the anchors continue to provide the connection of the FRP to the member.</p> <p>See N from Gold above.</p> <p>Accepted proposed resolution per email on 7/15/21.</p>
Gold	1	18	28/29	AC	<p>Similar to previous comment, rephrase to “Anchorage systems...have been proven successful at delaying, and sometimes preventing, to control debonding failure.” or rephrasing the sentence starting on Page 3 / Line 24.</p>	<p>Persuasive. See N from Gold above.</p>
Shield	1	18	29	AC	<p>Suggest changing “FRP” to “surface applied <u>FRP</u>” This sentence needs some kind of modifier for FRP</p>	<p>Persuasive. If the intent is to differentiate between <u>surface-applied</u> and NSM FRP, it would cleaner to say “externally bonded FRP” since we use this in other places in the document. Revise as indicated in response to Gold N</p> <p>Accepted proposed resolution per email on 7/14/21.</p>
Tatar	1	3	23-26	AC	<p>The below statements should be supported by references.</p> <p>“Providing anchorage does not necessarily mitigate FRP debonding nor the brittle failure mode. However, the debonding failure may be changed to a progressive and more controlled behavior that not only maintains the integrity of the FRP but allows it to continue to resist force.”</p>	<p>Persuasive. Add the reference to Smith et al 2013, which was inadvertently left out.</p> <p>See N from Gold above.</p>

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Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (4/6)

Tatar	1	6	14-18	AC	<p>The below statement contradicts the statement from page 3 where it's stated that anchorage does not mitigate debonding. Additionally, it is stated on page 6 that anchorage will increase the debonding strain for which evidence is lacking in the literature. Moreover, it is assumed that strain compatibility is maintained with anchorage which may not always be the case—depending on the anchorage type and layout, there is a possibility of change in behavior from bonded to unbonded behavior which would have its implications on the curvature. Considering that the current version of 440.2R provides no guidance for flexural anchorage design, it may be appropriate to modify the language so that anchorage is not suggested as a solution to this problem.</p> <p>As a sidenote—the intent of the below guideline is not obvious. The ductility of lightly reinforced sections can be a problem but, based on what is stated below, it is not clear <u>whether or not</u> a designer should always ensure that $\epsilon_t + \epsilon_{cu} > 0.008$. A more elegant solution would be to modify the phi factors (Eq. 10.2.7) so they are specified as a function of curvature ($\epsilon_t + \epsilon_{cu}$).</p> <p>“The condition may arise in which the governing failure mode is FRP debonding; this occurs if the right term of the inequality in Eq. 10.2.5 controls. In these cases, although ϵ_t may be greater than 0.005, ϵ_c may be less than 0.003 at section capacity. This leads to section curvature less than that which defines tension controlled <u>behavior</u>; i.e., $\epsilon_t + \epsilon_{cu} < 0.008$. In these cases, anchorage of the FRP can be used to increase ϵ_{fd} and/or mitigate a debonding failure mode.”</p>	<p>Persuasive. The wording on page 3 has been revised to address the N from Gold & Bouadi.</p> <p>A TG is currently working on the issue of curvature and the modification of phi factors.</p> <p>The wording on which the comment focusses was balloted and approved in a previous Main ballot.</p> <p>Propose to revise as indicated in Gold N.</p>
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Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (5/6)

Tatar	1	5	17	AC	This is another place where anchorage is recommended as a means of mitigating debonding. I suggest replacing “mitigate” with “delay” or “control”.	Persuasive. Although this is not within the scope of this ballot, revise as indicated in response to N from Gold.
Tatar	1	18	17	AC	Same as above.	Same as above.

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Item 1: Revisions to 10.1.1, 14.1.1 and References

MOTION #1: Find the resolutions of the following N and AC comments persuasive and revise as indicated (6/6)

Bakis	1	31	29	AC	“Cruz-Noguez C. A. and Lau David, 2015” Missing a couple of authors (Carlos A. Cruz-Noguez; David T. Lau; Edward G. Sherwood; Stylianos Hiotakis; Joshua Lombard; Simon Foo; and Moe Cheung). Fix punctuation and first/second initials of authors. Missing the paper number, too; it is 04014023. No page nos. in JCC these days.	Persuasive. Revise as follows: Cruz-Noguez, C. A.; Lau, D. T.; Sherwood, E. G.; Hiotakis, S.; Lombard, J.; Foo, S.; and Cheung, M., 2015, “Seismic behavior of RC shear walls strengthened for in-plane bending using externally bonded FRP sheets”, Journal of Composites for Construction 19(1):04014023. Accepted proposed resolution per email on 7/14/21
Bakis	1	37	9	AC	“Layssi H., Cook W.D. and Mitchell D, 2012” Fix punctuation on author initials. Add the page nos.: 332-339.	Persuasive. Revise as follows: Layssi, H.; Cook, W.D.; and Mitchell, D., 2012, “Seismic response and CFRP retrofit of poorly detailed shear walls”, 31 Journal of Composites for Construction 16(3):332-339. Accepted proposed resolution per email on 7/14/21
Bakis	1	43	11	AC	The Woods ref is missing the article number. It is 04016052. This journal does not use page nos. <u>any more.</u>	Persuasive. Revise as follows: Woods, J.; Lau, D.T.; and Cruz-Noguez, C. A., 2016, “In-plane seismic strengthening of non-ductile reinforced concrete shear walls using externally bonded CFRP sheets”, Journal of Composites for Construction 20(6):04016052. Accepted proposed resolution per email on 7/14/21
Bakis	1	28	1	AC	Many of the listed ASTM standards are now into later versions with a more recent year than the one shown. I do not know if the reason they are listed depends on the particular year listed.	Persuasive. The year of the most recent version will be used. Accepted proposed resolution per email on 7/14/21
Bouadi	1	18	22	AC	Change “few” to “limited”	Persuasive. Revise as follows: A few studies have proposed analytical models to predict the behavior of specific anchor systems (Kim and Smith 2010); however, few limited published anchorage design guidelines are currently available.
Lee	1	3	5	AC	Change “Fig. 10.1.1a” to “Fig. 10.1.1” because deleting Fig. 10.1.1b at P3/L20 eliminates the need for “a” at the end. (Make similar edit at P4/L4.)	Persuasive. Revise as suggested.

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Item 2: Revision to Chapter 13 and References

MOTION #2: Find the resolutions of the following N comments persuasive and revise as indicated (1/4)

3 ~~For beams, the plastic hinge length L_p can be approximated as twice the beam height ($2h$). The~~ For beams,
4 ~~the plastic hinge length can also be determined using detailed analysis but should not be less than the beam~~
5 ~~height.~~ In FRP-jacketed columns, the plastic hinge length L_p can be computed using Eq. (13.3.2d) (Priestley
6 et al. 1996)

$$L_p = g + 0.0003f_y d_{be} \quad (\text{in.-lb})$$

(13.3.2d)

$$L_p = g + 0.044f_y d_{be} \quad (\text{SI})$$

10 where d_{be} and f_y are the diameter and yield stress of the flexural steel, respectively, and g is the clear gap
11 between the FRP jacket and adjacent members, as shown in Fig. 13.3.2. The gap g should not be greater
12 than 2 in. (50.8 mm).

13 In plastic hinge regions for beams, the FRP confinement should be provided over a length not less than
14 ~~the larger of the plastic hinge length and twice the beam height ($2h$).~~ In plastic hinge regions for columns,
15 ~~the FRP confinement should be provided over a length not less than the plastic hinge length and~~ ℓ_o , where
16 ℓ_o is the length, measured along the member axis from the face of the joint, over which special transverse

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Item 2: Revision to Chapter 13 and References

MOTION #2: Find the resolutions of the following N comments persuasive and revise as indicated (2/4)

Lee	2	6	15	N	<p>The following change is needed: "... should be provided over a length not less than the larger of the plastic hinge length and l_o, where ..."</p>	<p>Persuasive. Revise as suggested. <u>In plastic hinge regions for columns, the FRP confinement should be provided over a length not less than the larger of the plastic hinge length and l_o</u>, where $15 l_o$ is the length, measured along the member axis from the face of the joint, over which special transverse 16 reinforcement must be provided as defined in Chapter 18 of ACI 318. Accepted proposed resolution per email on 7/14/21.</p>
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ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

Item 2: Revision to Chapter 13 and References

MOTION #2: Find the resolutions of the following N comments persuasive and revise as indicated (3/4)

10 13.7.2.1 Concrete strain limits—For flexural strengthening, the concrete compressive strains ϵ_c should
11 be limited by Eq. (13.7.2.1)

$$12 \quad \epsilon_c = \epsilon_{fd} \left(\frac{1}{L_w/c-1} \right) \leq \epsilon_{cu} \leq 0.003 \quad (13.7.2.1)$$

13 where ϵ_{fd} corresponds to the strain at which debonding of the FRP may occur, per Eq. (10.1.1). The
14 condition may arise where FRP debonding occurs before compression failure of the section. In such cases,
15 anchorage of the longitudinal FRP can be used to mitigate a debonding failure.

16 13.7.2.2 Anchorage, confinement and continuity of longitudinal FRP—In walls strengthened for flexure,
17 the longitudinal FRP should be continuous through existing slabs and be anchored to the foundations to
18 ensure load path continuity. Any anchorage method should be evaluated experimentally prior to field
19 implementation.

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Item 2: Revision to Chapter 13 and References

MOTION #2: Find the resolutions of the following N comments persuasive and revise as indicated (4/4)

Gold	2	15	12	N	<p>I am confused by this equation. It seems like the ϵ_{cu} term is irrelevant here because ϵ_{cu} will always be less than or equal to 0.003 and so ϵ_{cu} should be removed from this expression.</p> <p>But I think the intent is to allow ϵ_{cu} to be higher than 0.003 if confinement of the boundary elements is provided? In which case the 0.003 portion of the equation should go away (or be changed to 0.010). Whichever way it is, either the ϵ_{cu} should be removed or the 0.003 should be removed/changed. If we are allowing this to go up to the confined compressive strain, it is probably a good idea to also add a statement like: "The concrete ultimate compressive strain, ϵ_{cu}, can be increased by confinement of boundary elements as discussed in Section 13.7.3."</p>	<p>Persuasive. Revise Eq. 13.7.2.1 to delete ϵ_{cu}.</p> <p>The intent of 13.7.2 and 13.7.2.1 is to allow flexural strengthening only in locations where there will not be inelastic deformations (as clarified by Page 14, Line 33 and Page 14, Lines 1-2). Thus, by extension, $\epsilon_{cu} \leq 0.003$.</p> <p>Higher strains are only permitted for confinement per 13.7.3. However, at this point, flexural strengthening of confined sections is not permitted since the effect of the extensive concrete damage on the flexural FRP is not understood.</p> <p>Accepted proposed resolution per email on 7/14/21.</p>
Gold	2	15	14-15	N	<p>This statement seems to imply that we should not allow FRP debonding to occur before a compression failure, but Equation 13.7.2.1 is essentially determining this. And again we are contradicting what we now state in Chapter 10 where we state that anchors do not necessarily mitigate debonding. I would rephrase these two sentences to: "Where FRP debonding controls failure, anchorage of the longitudinal FRP can be used to enhance flexural performance as discussed in Section 10.1.1."</p>	<p>Persuasive. Revise as suggested.</p> <p>The condition may arise where FRP debonding occurs before compression failure of the section. In such cases, anchorage of the longitudinal FRP can be used to mitigate a debonding failure. Where FRP debonding controls failure, anchorage of the longitudinal FRP can be used to enhance flexural performance as discussed in Section 10.1.1.</p> <p>Accepted proposed resolution per email on 7/14/21.</p>

ACI 440-F: FRP Repair & Strengthening – 440.2R Main Ballot 4

Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (1/8)

3 ~~For beams, the plastic hinge length L_p can be approximated as twice the beam height ($2h$). The~~ For beams,
4 ~~the plastic hinge length can also be determined using detailed analysis but should not be less than the beam~~
5 ~~height.~~ In FRP-jacketed columns, the plastic hinge length L_p can be computed using Eq. (13.3.2d) (Priestley
6 et al. 1996)

$$7 \quad L_p = g + 0.0003f_y d_{bt} \quad (\text{in.-lb})$$

13 In plastic hinge regions for beams, the FRP confinement should be provided over a length not less than
14 ~~the larger of the plastic hinge length and twice the beam height ($2h$).~~ In plastic hinge regions for columns,
15 ~~the FRP confinement should be provided over a length not less than the plastic hinge length and~~ ℓ_o , where
16 ℓ_o is the length, measured along the member axis from the face of the joint, over which special transverse
17 reinforcement must be provided as defined in Chapter 18 of ACI 318. ~~It should be noted that plastic~~ Plastic
18 hinges may occur at locations other than the ends of the member. Complete wrapping around the perimeter
19 of the member should be used for plastic hinge confinement. Continuous (full) coverage of the plastic hinge
20 length with an FRP jacket is recommended. When a continuous jacket is not possible, discrete transverse
21 FRP strips around the perimeter of the section can be used.

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (2/8)

Lee	2	6	4	AC	<p>Insert "L_r" after "plastic hinge length"</p> <p>Additional comments on 9/27/21: Line 4: Change "can" to "should" since alternative is not provided. Line 5: Start a new paragraph with "In FRP-Jacketed columns..." Lines 18-20: For beams confinement extends beyond plastic hinge length. Removing "plastic hinge" in sentence starting on line 18 and "of the plastic hinge" in sentence starting on line 19 would make this better.</p>	<p>Comment withdrawn. After further discussion, other comments were entertained from Lee to make the document clearer</p> <p>Revise as follows: Lines 3 – 6: For beams, the plastic hinge length <u>should</u> can also be determined using detailed analysis. In FRP-jacketed columns, the plastic hinge...</p> <p>Lines 18 - 20: Complete wrapping around the perimeter 18 of the member should be used for plastic hinge confinement. Continuous (full) coverage <u>of the plastic hinge length</u> with an FRP jacket is recommended.</p> <p>Accepted proposed resolution in email on 9/27/21</p>
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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (3/8)

25 It is good practice to ensure that the shear strength of walls strengthened in shear using FRP is greater
26 than the shear corresponding to the expected flexural strength of the wall including shear amplification due
27 to higher modes as provided in ACI 318-19. When this section is used in conjunction with ASCE/SEI 41,
28 shear should be considered a force-controlled action. If the shear strength of the strengthened wall is greater
29 than the shear corresponding to the expected flexural strength of the wall, flexure may be considered a
30 deformation-controlled action.

31 **13.7.2 Flexural strengthening**—In-plane flexural strengthening can be achieved by applying longitudinal
32 (i.e., vertical) FRP at the ends of the shear wall, on one or both sides of the wall, to resist tensile stresses.
33 The flexural strength of shear walls in regions where plastic hinging is expected can be enhanced with FRP

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (4/8)

Shield	2	14	25	AC	You've got an indefinite it at the start of this line. Why not just make it "When possible, the shear strength of walls strengthened in shear using FRP should be greater than"	<p>Persuasive: Revise as below: It is good practice to ensure Ensuring that the shear strength of walls, strengthened in shear using FRP, is greater than the shear corresponding to the development of the expected flexural strength of the wall, including any amplification required by ACI 318, is considered good practice. including shear amplification due to higher modes as provided in ACI 318-19.</p> <p>Accepted proposed resolution in email on 9/27/21</p>
Brown	2	14	26	AC	Shear amplification due to higher modes of what? Please elaborate.	<p>Persuasive. Shear amplification due to higher modes can occur for cantilever walls, especially once inelasticity occurs. However, this is not pertinent to 440.2R. See response to Shield comment above.</p> <p>Accepted proposed resolution in email on 9/25/21</p>
Busel	2	14	25	AC	Suggest deleting "It is good practice" from the beginning of the sentence and just make the statement instead of suggesting.	<p>Partially-persuasive. Strengthening to shear corresponding to expected flexural capacity is not always required in seismic retrofit standards. Propose to revise as indicated below for Shield's comment.</p> <p>Accepted proposed resolution in email exchange on 9/26/21</p>

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (5/8)

Busel	2	3	18	AC	According to the TCM, section 9.6.12, the use of “and/or” is discouraged in ACI documents. This sentence needs to be revised.	Persuasive. Revise as follows: These guidelines are also not meant <u>intended</u> to address post-seismic conditions or residual strength of <u>either</u> the structure and/or the FRP retrofit system.
Krishna	2	4	7	AC	Delete- ‘ <u>In</u> such cases” .Replace with “ <i>In FRP retrofitted structures</i> an investigation of the stability, ductility, and residual strength of the structure should be performed after the seismic event to assess.....	Persuasive. Revise to delete “In such cases”. After a seismic event, a structure that has been retrofitted with FRP composites could develop large displacements and excessive cracking, resulting in residual stresses or damage to the FRP system. In such cases, an <u>An</u> investigation of the stability, ductility, and residual strength of the structure should be performed after the seismic event to assess...
<u>Bakis</u>	2	5	24	AC	This is not on the ballot, but we shouldn’t start a sentence with “ <u>Where</u> ”. Need to reconstruct the sentence to not start with <u>symbols</u> , if this is fixed. I’ll leave it up to you. I think this area has another problem, which is that eq. 13.3.2 should be placed immediately after eq. 13.3.1 based on where it is called out in the text.	Persuasive. Propose revising with lowercase “w” as we do elsewhere in the document. <u>Where <u>where</u> <u>ε_y</u> and <u>ε_{y,frp}</u> are the steel strain and depth of the neutral axis...</u> The second part of the comment intended to refer to the position of Eq. 13.3.2d. 2nd Part of comment withdrawn per email on 7/14/21

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (6/8)

Shield	2	5	4-5	AC	I'm not sure how to interpret "extend through the <u>section</u> " what does the word "through" mean here?	Persuasive. The wording is a little unclear. These anchors are intended to work like crossties and need to go completely through the member and to be splayed on the opposite faces. Revise as follows: <u>Such anchors should extend through the width or depth of the section and be splayed on the opposite faces. The anchors should and be spaced longitudinally and transversely in accordance with requirements for hoops and cross ties for columns in special moment frames given in ACI 318.</u> Accepted proposed resolution in email on 9/28/21
<u>Bakis</u>	2	6	14	AC	italicize the symbol "h".	Persuasive. Revise as suggested
Busel	2	14	31	AC	Suggest changing "can be" to "is"	Persuasive. Revise as suggested.
Busel	2	15	5	AC	Change "equation 13.7.2" to "Eq. (13.7.2)"	Persuasive. Revise as suggested.
<u>Okeil</u>	2	15	7	AC	In Fig. 13.7.2, the position of the compression force in concrete, C_c , should be at the center of the compression block.	Persuasive. Revise as suggested.
Bouadi	2	15	15	AC	Change "to mitigate debonding failure" to "to reach compression failure prior to debonding"	Persuasive. See change to wording per N by Gold.

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (7/8)

Shield	2	5	4-5	AC	I'm not sure how to interpret "extend through the <u>section</u> " what does the word "through" mean here?	<p>Persuasive. The wording is a little unclear. These anchors are intended to work like crossties and need to go completely through the member and to be splayed on the opposite faces.</p> <p>Revise as follows:</p> <p style="color: green;"><u>Such anchors should extend through the width or depth of the section and be splayed on the opposite faces. The anchors should and be spaced longitudinally and transversely in accordance with requirements for hoops and cross ties for columns in special moment frames given in ACI 318.</u></p> <p>Accepted proposed resolution in email on 9/28/21</p>
<u>Bakis</u>	2	6	14	AC	italicize the symbol "h".	Persuasive. Revise as suggested
Busel	2	14	31	AC	Suggest changing "can be" to "is"	Persuasive. Revise as suggested.
Busel	2	15	5	AC	Change "equation 13.7.2" to "Eq. (13.7.2)"	Persuasive. Revise as suggested.
<u>Okeil</u>	2	15	7	AC	In Fig. 13.7.2, the position of the compression force in concrete, C_c , should be at the center of the compression block.	Persuasive. Revise as suggested.
Bouadi	2	15	15	AC	Change "to mitigate debonding failure" to "to reach compression failure prior to debonding"	Persuasive. See change to wording per N by Gold.

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Item 2: Revision to Chapter 13 and References

MOTION #3: Find the resolutions of the following AC comments persuasive and revise as indicated (8/8)

Gold	2	15	22	AC	Here is another instance where we now say that FRP does mitigate debonding which contradicts what we are saying in Chapter 10. Consider changing "mitigate" to "control".	Persuasive. Revise as suggested. <u>Other anchorage methods, such as fiber anchors, may be provided to mitigate control debonding of the longitudinal FRP.</u>
<u>Bakis</u>	2	16	2	AC	Use italics and subscripts for ϵ_{cu} .	Persuasive. Revise as suggested
Brown	2	16	2	AC	Please correct formatting of e_{cu}	
Gold	2	16	2	AC	The "cu" in ϵ_{cu} should be subscript.	
Shield	2	16	2	AC	$\epsilon_{cu} \rightarrow \epsilon_{cu}$ (i.e. subscripts are currently not subscripted)	
Gold	2	17	7	AC	Here is another instance where we now say that FRP does mitigate debonding which contradicts what we are saying in Chapter 10. Consider changing "mitigate" to "control".	Persuasive. Revise as suggested. <u>Anchoring the FRP will help to mitigate control the FRP debonding failure mode, thereby maintaining the integrity of the shear mechanism to larger wall deformations.</u>
Shield	2	17	5	AC	Would it read better with a comma after 'not expected' ?	Persuasive. Revise as suggested.
<u>Bakis</u>	2	18	26	AC	Many of the listed ASTM standards are now into later versions with a more recent year than the one shown. I do not know if the reason they are listed depends on the particular year listed.	Persuasive. The year of the most recent version will be used.
<u>Bakis</u>	2	27	31	AC	Include page nos. on <u>Layssi</u> paper: 332-339	Persuasive. See response to <u>Bakis</u> comment on Item 1.
<u>Bakis</u>	2	27	34	AC	Lee/Lopez paper. Incomplete reference. Looks like volume 14, article no. 1, year 2020. No page nos. in this journal.	Persuasive. Revise as follows: <u>Lee, J. and Lopez, M. D., 2020, "Application of Frictional Bond-Slip Model to Large-Scale FRP-Strengthened T-Beams with U-wraps". International Journal of Concrete Structures and Materials, Volume 14, Article No. 1.</u>

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Item 2: Revision to Chapter 13 and References

Informational: The following comments were withdrawn

Krishna	2	4	5	AC	Section 13-Introduction –First para is <u>clear .Therefore,</u> delete “After a seismic event, a structure that has been retrofitted with FRP composites could develop large displacements and excessive cracking, resulting in residual stresses or damage to the FRP system”-This is a subjective statement and depends on the FRP material /strength of FRP bars in the case of NSM/number of layers of wraps etc.	Non-persuasive. The intent is to call attention to potential damage to the FRP due to the seismic event and to emphasize that a post-event assessment may be required. Comment withdrawn per email on 10/6/21
Bouadi	2	14	33	AC	Delete “is expected” (this is a typo)	Non-Persuasive. The intent is to allow flexural strengthening of regions where plastic hinge “is expected” only if the hinge is moved to another location in the structure. Comment withdrawn per email on 9/6/21
Bouadi	2	15	5	AC	Change “standard” to “code”	Non-persuasive. “Standard” is used consistently throughout the document. Comment withdrawn