Annex 12

Recommendation on Compiled comments received on the working draft on Design of post installed anchorage to concrete CED 2 (0126)

Sl No.	Name of the commentator/organization	Abbreviation used
1	Engineers India Limited, Gurgaon	EIL
2	Tata Consulting Engineers Limited, Mumbai	TCE

Sl. No.	Clause/Sub-clause/Para No.	Abbreviation of the commentator	Comments/Suggestions	Modified Wordings	Reasons/ Justifications for the Proposed Changes	Remarks from WG
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	1.1	EIL	Base material for the connection shall be of minimum M25 grade & a maximum of M60 grade	Base material for the connection shall be of minimum M20 grade & a maximum of M60 grade	Minimum concrete grade as per IS 456 is M20. Further, technical requirement for minimum grade as M25 is not understood.	Clause to be reframed as follows – "The concrete that forms the base material for the connection shall be of in conformity with IS 456 as may be applicable for reinforced concrete".
2.	5.2.1	EIL	For mechanical anchors, the embedment depth of the anchor shall generally be at least 6 times the anchor diameter.	For mechanical anchors, the embedment depth of the anchor shall be at least 6 times the anchor diameter.	Minimum embedment depth shall be firmed up by removing the word: "generally"	Accepted.
3.	5.2.2	EIL	For adhesive anchors, the maximum embedment depth for design of the anchor shall be 20 times the anchor element diameter.	For adhesive anchors, the maximum embedment depth for design of the anchor shall be 20 times the anchor element diameter. The maximum permissible diameter of adhesive anchor shall be .....mm.	The maximum permissible diameter of adhesive anchor shall be specified. For mechanical anchor, it is already specified in Clause 5.2.1	WG agreed to remove the upper limit for mechanical anchors and be flexible to the evolving assessment document & testing regimes.
4.	5.2.2	EIL	For adhesive anchors, the maximum embedment depth for design of the anchor shall be 20 times the anchor element diameter.	-	Requirement for maximum embedment depth of adhesive anchor is not understood	WG added the clause – "Any embedment depth in excess of 20 times diameter shall be ignored in design calculation" **Reason** - For deeper embedment, constant distribution of bond stress over the entire embedment depth cannot be assumed. (refer EAD 330449 cl. 1.1)
5.	Figure 3A,3B & 3C: Edge distance < max (10hef, 60do)	EIL	This distance is practically too high to be avaialble e.g. For 30mm diameter adhesive anchor with embedment depth = 20*30=600, it comes out to be : max(6000, 1800) i.e. 6000mm	This distance may be valid for unreinforced concrete. Can this requirement of minimum edge distance be reduced for reinforced concrete?	Various required anchor configurations may not be feasible with clearance holes with this high requirement of edge distance.	WG agreed to remove the requirement. Fig. 3°, 3B & 3C have been merged into Fig 3 which includes all details. **Recommendation** – The standard recommends 2 scenarios. 1. The principal recommendation as per the standard is to ensure there is no annular gap between the plate and the anchor. In such cases, equal

						distribution of shear force can be considered. 2. In exceptional cases, where the hole filling cannot be ensured, the entire shear load transfer will happen through the first row of anchor.
x	5.4	EIL	The concrete thickness required for post-installed mechanical anchors shall be atleast 2hef, but not less than 120mm)	-	Considering any structural element i.e. beams, columns, slabs, walls etc., this value is too high to be practically available. e.g. for 30mm diameter anchor with embedment depth = 10do = 300mm, required concrete thickness = 600mm.	The WG agreed to retain the clause. **Reason** - The use of anchor depends on the type of application. Generally heavy duty fixing (e.g., 30 mm diameter anchor) is not done on thin concrete members, since the concrete may itself not have the adequate strength to withstand such load. Hence, it is capped as a minimum value & accepted globally (including India). If the thickness of concrete member is smaller, aspects such as beniding of the concrete member under loading may affect the performance to an extent currently not accounted for in the assessment provisions.
7.	Figure 7A & 7B	EIL	When gap between the anchor & the fixture is not filled up	When the gap between the anchor & the fixture exceeds the clerance hole limit as per clause 5.3.1; & the fixture is not filled up	Clerance holes in fixture are minimal to ensure transfer of shear forces uniformly among all anchors.	WG agreed to retain the clause. **Reason** - Any gap between the fixture & the anchor will not ensure equal load transfer in case of edge failure. Restriction on clearance limit mentioned in Cl 5.3.1 since no performance assessment guideline is available globally beyond a maximum limiting value.
8.	6.2.1	EIL	Fig. 1 Fig. 2 Fig. 3 Fig. 4	Fig. 6 Fig. 7 Fig. 8 Fig. 9	-	Already revised.
9.	6.2.2	EIL	Fig.5 Fig.6 Fig. 7	Fig. 10 Fig. 11 Fig. 12	-	Already revised
10.	7.1.3	EIL	It shall be ensured that the displacements of anchors occuring under the design loads are not larger than the admissible displacement as may be decided by the structural engineer.	-	Significance of dispacement under limit state of serviceability for elastic design is not understood. Further, in our analysis, anchor fasteners are considered as either pinned/fixed (i.e. zero dispacement)	WG agreed to retain the clause **Explanation** - Absolute fixity cannot be achieved for post installed anchor in practical scenario. The performance of an anchor is always determined based on a load versus displacement behavior & is published in the assessment document & assessment report corresponding to each type and diameter of anchor. We also do not rely in pretension during the lifetime of the anchor.
11.	7.2.2.2	EIL	Determination of concrete cone strength	-	Concrete cone strength dependent on embedment depth of anchor . Concrete cone failure mode depending on embedment depth for adhesive anchors not understood.	Concrete cone determination is applicable for both mechanical & chemical anchors. Refer strength check in Table 1.

					Is concrete cone failure applicable for mechanical anchors only?	
12.	7.2.2.2 & 7.2.3.4	EIL	Basic/characteristic concrete strength		This shall be specified separately for reinforced & un-reinforced concrete	WG agreed to retain the clause, in line with the philosophy adopted for concrete design. WG recommended to remove the word basic characteristic resistance as applicable. The terminology to be replaced by "The characteristic strength of a single anchor placed in concrete and not influenced by adjacent fasteners or edges of the concrete member.."
13.	7.2.2.2	EIL	Factor to account for negative effect of orthogonal reinforcement		Is basic charectistic concrete strength computed based on some presumed orthogonal reinforcement; that is being reduced for further increase in orthogonal reinforcement spacing or decrease in orthogonal reinforcement diameter.Please clarify.	This factor is to take into consideration effect of dense reinforcement. The clause may be rephrased as follows - "Factor to account for the effect of dense reinforcement between which the fastener is installed." **Reason** - When the effective depth of the anchor is less than 100, there may be a reduction in concrete cone pull-out capacity since the strength of the reinforcement will not be fully mobilized. Surface reinforcement cannot be activated when the fastener is loaded in tension. With shallow embedment the reinforcement may even disturb the concrete cone and end up with lower ultimate capacity.
14.	7.2.2	EIL	Computation of concrete side face blow out strength shall be specified	-	-	WG agreed to retain the provision. **Reason** - This is applicable for cast-in anchors & post installed undercut Anchors with edge distance < 0.5 heff. May refer to EC2 cl 7.2.1.8 7.2.1.8 Concrete blow-out failure (1) Verification of concrete blow-out failure is required in case of headed fasteners and for post-installed mechanical undercut fasteners acting as headed fasteners if the edge distance $c < 0.5 h_{ef}$. Each edge shall be considered in turn. The characteristic resistance in case of concrete blow-out failure is calculated as
15.	7.2.4	EIL	α= 2 & 1.5 for steel & other failure modes respectively	**s-**	In case, tension is governed by steel failure & shear is governed by concrete failure; shall α value be different for the same equation of combined check. Please clarify.	No. The checks have to be separately performed for steel & concrete, both in tension & in shear. 7.2.4 *Check for Combined Tension and Shear* The following equations shall be satisfied for combined tension and shear loads (see Figure 2.1). $\beta_N \leq 1$ $\beta_V \leq 1$ $(\beta_N) + (\beta_V) \leq 1.2$ (for failure mode other than steel) Or $(\beta_N)^\alpha + (\beta_V)^\alpha \leq 1$ where, $\alpha = 2.0$, if N_{Rd} and V_{Rd} are governed by steel failure, and $\alpha = 1.5$, for all other failure modes β_N and β_V = Ratio between design load and design strength for tension and shear loading, respectively. The largest value of β_N and β_V for the different failure modes shall be taken.
16.	8.3.2.1	EIL	αgap = 0.5; in case of connections with hole clearance as given in 5.3.1	αgap = 0.5; in case of connections with hole clearance greater than as given in 5.3.1	Hole clearance as per 5.3.1 is least value required for fixing of anchors. Further for αgap = 0.5, seismic characteristic strength gets siginificantly reduced compared to static characteristic strength of concrete (approx.	The WG agreed to retain the clause. **Reason** - Hole clearance values mentioned in cl 5.3.1 is maximum. Any gap between the fixture & the plate will call for a reduction in the capacity This is because the forces on the anchors are amplified in

					reduced to 40%).	presence an annular gap under shear loading due to a hammer effect on the anchor.
17.	Fig. 25, second figure on *Load on each anchor*	TCE	Loads neglected because sum of components is directed away from the edge.	-	This will depend on magnitude of the applied lateral load and shear generated from torsion. in case net load is towards edge, it cannot be neglected, statement may be clarified.	Noted. Arrow marking is wrong. Will be corrected.