European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrément Technique

ETAG 001

Edition February 2003
Amended July 2008

GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL
OF
METAL ANCHORS
FOR USE IN CONCRETE

Part six: ANCHORS FOR MUTIPLE USE FOR NON-STRUCTURAL APPLICATIONS

EOTA, ©
Kunstlaan 40 Avenue des Arts,
B - 1040 Brussels

INTRODUCTORY NOTES

In this Part requirements, criteria and test information for metal anchors for multiple use in concrete for non-structural applications are given. The same numbering of paragraphs as in Part 1 is used. If a paragraph is not mentioned, then the text in Part 1 applies without modification.

TABLE OF CONTENTS

PART SIX:

ANCHORS FOR MULTIPLE USE FOR NON-STRUCTURAL APPLICATIONS

2 SCOPE

2.0 General

This Part of the Guideline covers the assessment of post-installed metal anchors for multiple use in normal weight concrete for non-structural applications.

For the use of these anchors, the requirements concerning safety in use as identified in Essential Requirement N°4 (ER 4) of the CPD shall be satisfied. Failure of the fixture represents an immediate risk to human life.

These anchors shall be used for multiple fixings, see 2.6..

2.1 Anchors

2.1.1 Types and operating principles

This Part of the Guideline applies to metal anchors placed into drilled holes with the following operating principles:

- torque-controlled expansion anchors
- deformation-controlled expansion anchors
- undercut anchors (including concrete screws)
- bonded anchors
- load-controlled expansion anchors
- other operating principles for hollow slabs

Examples of the different type of anchors are given in Part 1, Figure 2.2

2.1.2 Materials

Part 1, 2.1.2 applies. Additionally this Part of the Guideline applies to anchors made out of metals other than steel; however, for these anchors further assessments concerning durability, corrosion etc. are necessary.

2.1.3 Dimensions

This Part of the Guideline applies to anchors with a minimum thread size (M5) or minimum drill hole diameter of 5 mm.

The effective anchorage depth min h_{ef} should be at least 30 mm; in special cases (internal exposure conditions only) min h_{ef} can be reduced to 25 mm. In precast prestressed hollow core elements, anchors may be fastened in a wall with a minimum thickness of 17 mm (see Figure 2.3).

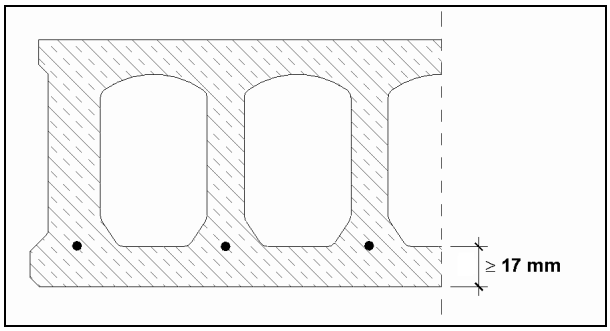


Figure 2.3: Example of precast prestressed hollow core slabs

2.2 Concrete

2.2.1 Materials

This Part of Guideline applies to the use of anchors in normal weight concrete between strength classes C12/15 and C50/60, inclusively according to EN 206-1:2000-12 (8).

This Part of Guideline does not cover anchorages made in screeds or toppings, which can be uncharacteristic of the concrete and/or excessively weak.

2.2.2 Concrete members

This Part of Guideline applies to applications where the minimum thickness of members in which anchors are installed is $h \geq 2\ h_{ef}$ and at least $h \geq 80$ mm. For bonded anchors, see Part 5. For precast, prestressed hollow core elements the wall thickness should be ≥ 17 mm.

2.3 Actions

Part 1, 2.3 applies. Additionally, the loads acting on the anchors shall originate from multiple systems.

2.4 Categories

This Part applies to anchorages in respect to:

a) Use category
   - use in cracked and non-cracked concrete (multiple use);

b) Durability categories
   - use in structures subject to dry, internal conditions,
   - use in structures subject to other environmental conditions.

2.6 Definition of multiple anchor use

By multiple anchor use it is assumed that in the case of excessive slip or failure of one anchor the load can be transmitted to neighbouring anchors without significantly violating the requirements on the fixture in the serviceability and ultimate limit state, see 7.1.

The definition of multiple anchor use is given by the Member States in Annex 1.

4 REQUIREMENTS FOR WORKS

4.1.1.2 Temperature

Part 1, 4.1.1.2 applies and for bonded anchors Part 5, 4.1.1.2 applies.

4.1.2.1 Correct installation

Part 1, 4.1.2.1 applies and for bonded anchors Part 5, 4.1.2.1 applies.

4.3 Hygiene, health and the environment

For bonded anchors Part 5, 4.3 applies.

5 METHODS OF VERIFICATION

5.1.2 Tests for suitability

The types of tests, test conditions, the number of required tests and the criteria applied to the results are given in Tables 5.1a to 5.1e for the different types of anchors. In general, all the tests shall be performed with single anchors without edge and spacing effects under tension loading.

Table 5.1a Suitability tests for torque-controlled expansion anchors for multiple use

	1	2	3	4	5					6	7	8	9
	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
					s	i	m	i	l	load/dis-placement behaviour	ultimate load req.α(2)		
1	Installation safety – anchorage intensity	C50/60	0.2	$d_{cut,m}$	5	5	5	5	5	6.1.1.1	$\geq$ 0.8 (3)	(4)	5.2.1
3	Functioning in low strength concrete	C20/25(5)	0.35	$d_{cut,max}$	5	5	5	5	5		$\geq$ 0.75		5.2.1
4	Functioning in high strength concrete	C50/60	0,35	$d_{cut,min}$	5	5	5	5	5		$\geq$ 0.75		5.2.1
6	Functioning under repeated loads	C20/25(5)	0	$d_{cut,m}$	-	-	3	-	-	6.1.1.1 and Part 1 6.1.1.2(b)	$\geq$ 1.0	(6)	5.6

Notes to Table 5.1a

(1) Anchor size: s = smallest i = intermediate m = medium l = largest

(2) For α, see Part 1, Equation (6.2).

(3) Valid for $\gamma_2 = 1.2$, for other values of γ_2, see Part 1, 6.1.2.2.2.

(4) Installation of anchor with torque moment T_{inst} = 0,5 req. T_{inst} in accordance with Part 2, Table 5.1.

(5) If there is an application for anchorage in C 12/15; tests are required in concrete with a compressive strength $f_{cm} \leq 20$ MPa (measured on cylinders) or $f_{cm} \leq 25$ MPa (measured on cubes).

(6) If anchors are not similar in respect of geometry, friction between cone and sleeve and friction between sleeve and concrete, then other sizes shall also be tested.

Table 5.1b Suitability tests for deformation-controlled expansion anchors for multiple use

	1	2	3	4	5					6	7	8	9
	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
					s	i	m	i	l	load/dis-placement behaviour	ultimate load req.α(2)		
0	Setting test	C50/60	0	$d_{cut,m}$	5	5	5	5	5			(3)	
1	Installation safety – anchorage intensity	C20/25 (4)	0.2	$d_{cut,m}$	5	5	5	5	5	6.1.1.1	$\geq$ 0.8 (5)	(6)	5.2.1
3	Functioning in low strength concrete	C20/25 (4)	0.35	$d_{cut,max}$	5	5	5	5	5		$\geq$ 0.75	(7)	5.2.1
4	Functioning in high strength concrete	C50/60	0.35	$d_{cut,min}$	5	5	5	5	5		$\geq$ 0.75	(7)	5.2.1
6	Functioning under repeated loads	C20/25 (4)	0	$d_{cut,m}$	-	-	3	-	-	6.1.1.1 and Part 1 6.1.1.2(b)	$\geq$ 1.0	(7), (8)	5.6

Notes to Table 5.1b

(1) Anchor size: s = smallest i = intermediate m = medium l = largest

(2) For α, see Part 1, Equation (6.2).

(3) Setting tests in accordance with Part 4, Table 5.0.

(4) If there is an application for anchorage in C 12/15; tests are required in concrete with a compressive strength $f_{cm} \leq 20$ MPa (measured on cylinders) or $f_{cm} \leq 25$ MPa (measured on cubes).

(5) Valid for $\gamma_2 = 1.2$, for other values of γ_2, see Part 1, 6.1.2.2.2.

(6) Tests carried out with the installation expansion determined by the setting tests.

(7) Tests carried out with the reference expansion determined by the setting tests.

(8) If anchors are not similar in respect of geometry then other sizes shall also be tested.

Table 5.1c Suitability tests for undercut anchors for multiple use

	1	2	3	4	5					6	7	8	9
	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
					s	i	m	i	l	load/dis-placement behaviour	ultimate load req.α(2)		
	(a) Setting tests in low strength concrete	C20/25	0	$d_{cut,max}$	10	10	10	10	10		-	(14)	
0	(b) Setting tests in high strength concrete	C50/60	0	$d_{cut,min}$	10	10	10	10	10		-	(14)	
	(c) Setting tests with impact screw driver	C20/25	0	$d_{cut,max}$	10	10	10	10	10		-	(14)	
1	Installation safety – anchorage intensity	C20/25 (3)	0.2	(4)	5	5	5	5	5		$\geq$ 0.8 (5)	(4)	5.2.1
3	Functioning in low strength concrete	C20/25 (3)	0.35	$d_{cut,max}$	5	5	5	5	5	6.1.1.1	$\geq$ 0.75		5.2.1
4	Functioning in high strength concrete	C50/60	0.35	$d_{cut,min}$	5	5	5	5	5		$\geq$ 0.75		5.2.1
6	Functioning under repeated loads	C20/25 (3)	0	$d_{cut,m}$	-	-	3	-	-	6.1.1.1 and Part 1 6.1.1.2(b)	$\geq$ 1.0	(6)	5.6
7	Functioning under sustained loads on bevelled wqashers	C20/25	0	$d_{cut,m}$	5	5	5	5	5		1.0		
8	Sensitivity to brittle fracture	C50/60	0	$d_{cut,m}$	5	5	5	5	5		$\geq$ 0.9	(13)	

Notes to Table 5.1c

(1) Anchor size: s = smallest i = intermediate m = medium l = largest

(2) For α, see Part 1, Equation (6.2).

(3) If there is an application for anchorage in C 12/15; tests are required in concrete with a compressive strength $f_{cm} \leq 20$ MPa (measured on cylinders) or $f_{cm} \leq 25$ MPa (measured on cubes).

(4) Test conditions in accordance with Part 3, 5.1.2 b.

(5) Valid for $\gamma_2 = 1.2$, for other values of γ_2, see Part 1, 6.1.2.2.2.

(6) If anchors are not similar in respect of geometry then other sizes shall also be tested.

(7) Tests are required only for concrete screws acc. to Part 3, Figure 2.6. Details of test and assessment are given in Part 3.

Table 5.1d Suitability tests for bonded anchors for multiple use

	1	2	3	4	5					6	7	8	9
	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Part 5
					s	i	m	i	l	load/dis-placement behaviour	ultimate load req.α(2)		
1	Installation safety (5)	C20/25 (3)	0	$d_{cut,m}$	5	-	5	-	5		$\geq$ 0.8 (4)	(5)	5.1.2.1 (a) to (d)
3	Functioning in low strength concrete	C20/25 (3)	0.35	$d_{cut,m}$	5	-	5	-	5	6.1.1.1	$\geq$ 0.75		5.1.2.2
4	Functioning in high strength concrete	C50/60	0.35	$d_{cut,m}$	5	-	5	-	5		$\geq$ 0.75		5.1.2.2
6	Functioning under repeated loads	C20/25 (3)	0	$d_{cut,m}$	-	-	5	-	-	6.1.1.1 and Part 1 6.1.1.2(b)	$\geq$ 1.0		5.1.2.4
7	Functioning under sustained loads	C20/25 (3)	0	$d_{cut,m}$	-	-	5	-	-	6.1.1.1 and Part 5 6.1.1.1(e)	$\geq$ 0.9		5.1.2.5
8	Functioning under freeze/thaw condition	C20/25 (3)	0	$d_{cut,m}$	-	-	5	-	-	6.1.1.1 and Part 5 6.1.1.1(f)	$\geq$ 0.9		5.1.2.7
9	Functioning with installation direction	C20/25 (3)	0	$d_{cut,m}$	-	-	5	-	-	6.1.1.1 and Part 5 6.1.1.1(g)	$\geq$ 0.9		5.1.2.8

Notes to Table 5.1d

(1) Anchor size: s = smallest i = intermediate m = medium l = largest

(2) For α, see Part 5, Equation (6.13).

(3) If there is an application for anchorage in C 12/15; tests are required in concrete with a compressive strength $f_{cm} \leq 20$ MPa (measured on cylinders) or $f_{cm} \leq 25$ MPa (measured on cubes).

(4) Valid for $\gamma_2 = 1.2$, for other values of γ_2, see Part 5, 6.1.2.2.2; Table 6.1.

(5) Tests in accordance with Part 5, Table 5.1 for the different applications.

Table 5.1e Suitability tests for load-controlled expansion anchors for multiple use

	1	2	3	4	5					6	7	8	9
	Purpose of test	Concrete	Crack width Δw (mm)	Drill bit	Minimum number of tests for anchor size (1)					Criteria		Remark	Test procedure described in Annex A
					s	i	m	i	l	load/dis-placement behaviour	ultimate load req.α(2)		
1	Installation safety – anchorage intensity	C50/60	0.2	$d_{cut,m}$	5	5	5	5	5	6.1.1.1	$\geq$ 0.8 (3)	(4)	5.2.1
3	Functioning in low strength concrete	C20/25 (5)	0.35	$d_{cut,max}$	5	5	5	5	5		$\geq$ 0.75		5.2.1
4	Functioning in high strength concrete	C50/60	0.35	$d_{cut,min}$	5	5	5	5	5		$\geq$ 0.75		5.2.1
6	Functioning under repeated loads	C20/25 (5)	0	$d_{cut,m}$	-	-	3	-	-	6.1.1.1 and Part 1 6.1.1.2(b)	$\geq$ 1.0	(6)	5.6

Notes to Table 5.1e

(1) Anchor size: s = smallest i = intermediate m = medium l = largest

(2) For α, see Part 1, Equation (6.2).

(3) Valid for $\gamma_2 = 1.2$, for other values of γ_2, see Part 1, 6.1.2.2.2.

(4) Installation of anchor with 50% of the load given by the manufacturer's installation instructions.

(5) If there is an application for anchorage in C 12/15; tests are required in concrete with a compressive strength $f_{cm} \leq 20$ MPa (measured on cylinders) or $f_{cm} \leq 25$ MPa (measured on cubes).

(6) If anchors are not similar in respect of geometry, friction between cone and sleeve and friction between sleeve and concrete, then other sizes shall also be tested.

5.1.3 Tests for admissible service conditions

The test conditions are given in Part 1, 5.1.3 and Annex B. The test procedure is described in Annex A.

In all tests carried out in cracked concrete, the crack width Δw shall be $\geq$ 0.2mm.
For applications in concrete C12/15, additional tests are not necessary.

The additional tests for bonded anchors to investigate the effect of increasing temperature, low installation temperature, minimum curing time and durability in accordance with Part 5, 5.1.3.1 and 5.1.4 have to carried out.
If design method C is used, tests for determination of required spacings and edge distances can be omitted if the following values are observed:

	deformation-controlled expansion anchors	all other anchors
spacing s_{cr} edge distance c_{cr} thickness of concrete member	$\geq$ 200 mm and $\geq 4\ h_{ef}$ $\geq$ 150 mm and $\geq 3\ h_{ef}$ $\geq$ 80 mm and $\geq 2\ h_{ef}$	$\geq$ 200 mm and $\geq 4\ h_{ef}$ $\geq$ 100 mm and $\geq 3\ h_{ef}$ $\geq$ 80 mm and $\geq 2\ h_{ef}$

If design method A or B is used, Parts 1 to 5 and Annex B are decisive.

5.3 Methods related to 4.3 (hygiene, health and the environment)

For bonded anchors, Part 5, 5.3 applies.

6 ASSESSING AND JUDGING THE FITNESS OF ANCHORS FOR AN INTENDED USE

6.1 Assessing and judging related to 4.1 (mechanical resistance and stability)

For the criteria of the different tests Part, 1, 6.1 applies with the following modifications.
For bonded anchors, the criteria in accordance with Part 5, 6.1 have to be considered.

6.1.1 Suitability

6.1.1.1 Criteria valid for all tests

(a) The requirement on the load/displacement curves in Part 1, 6.1.1.1 (a) applies. However, a reduction in load and /or a horizontal or near-horizontal part in the curve by uncontrolled slip of the anchor is not acceptable up to a load of:

$N_1 = 0.4\ N_{Ru}$ instead of $0.7\ N_{Ru}$ according to Equation (6.1a)

(b) There are no requirements on the scatter of the load/displacement curves.

(c) and (d) Part 1, 6.1.1.1 (c) and (d) apply.

6.1.2 Admissible service conditions

6.1.2.1 Criteria

(a) The requirement on the load/displacement curves in Part 1, 6.1.1.1 (a) applies. However, a reduction in load and/or a horizontal or near-horizontal part in the curve by uncontrolled slip of the anchor is not acceptable up to a load of:

$N_1 = 0.4\ N_{Ru}$ instead of $0.7\ N_{Ru}$ according to Equation (6.1a)

(b) There are no requirements on the scatter of the load/displacement curves.

(c) Part 1, 6.1.2.1 (c) applies.

6.1.2.2.1 Characteristic resistance of single anchor

Part 1, 6.1.2.2.1 applies.

For applications in C12/15 concrete, the characteristic resistances are to be derived from the admissible service conditions tests in C20/25 concrete by taking into account the usual relation ship of $\sqrt{\beta_w}$.

The rounded down characteristic resistances given in Part 1, paragraph (a) General are completed as follows: F_{Rk} [kN] = 0.75 / 0.9 / 1.2 / 1.5 / 2.0 / 2.5.

All further points of paragraph (a) and (b) continue to be valid.

6.3 Assessing and judging related to 4.3 (hygiene, health and the environment)

For bonded anchors, Part 5, 6.3 applies.

7 ASSUMPTIONS UNDER WHICH THE FITNESS FOR USE IS TO BE ASSESSED

7.1 Design methods for anchorages

The design of the fixture is such, that in the case of excessive slip or failure of one anchor the load can be transmitted to neighbouring anchors without significantly violating the requirements on the fixture in the serviceability and ultimate limit state.

For example the design of the fixture may specify the number n_1 of fixing points to fasten the fixture and the number n_2 of anchors per fixing point. Furthermore by specifying the design value of actions N_{Sd} on a fixing point to a value $\leq n_3$ (kN) up to which the strength and stiffness of the fixture are fulfilled and the load transfer in the case of excessive slip or failure of one anchor need not to be taken into account in the design of the fixture.

These definition is given by the Member States according to Annex 1.

Part 1, 7.1 applies and for bonded anchors Part 5, 7.1 applies.

7.2 Recommendations for packaging, transport and storage

Part 1, 7.2 applies and for bonded anchors, Part 5, 7.2 applies.

7.3 Installation of anchors

Part 1, 7.3 applies and for bonded anchors, Part 5, 7.3 applies.

Additionally, anchors shall not be installed in prestressed elements without taking account of the risk of the structural damage that may occur, due to their installation, particularly in zones where prestressing forces are applied.

In the absence of national regulations, it is recommended that the distance between the side of the drill hole and the outside of prestressed reinforcement is at least 50mm; for determining the position of the prestressed reinforcement in the structure, a suitable device (e.g. reinforcement detector) should be used.

8 ATTESTATION OF CONFORMITY

8.1 EC decision

The system of attestation of conformity specified by the European Commission as detailed in mandate Construct 96/195, Annex 3, is system **2+** described in Council Directive (89/106/EEC), Annex III 2.(ii), as follows:

(a) tasks for the manufacturer

(1) initial type-testing of the product;

(2) factory production control (see Part 1, 8.2.3);

(3) further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan (see Part 1, 8.2.2).

(b) tasks for the approved body

(4) certification of factory production control on the basis of:

- initial inspection of factory and of factory production control (see Part 1, 8.2.4);
- continuous surveillance, assessment and approval of factory production control (see Part 1, 8.2.4)

Note to (1):
Initial type-testing will be available as part of the work required for the assessment of products for ETA.
The tests will have been conducted by the approval body or under its responsibility (which may include a proportion conducted by an approved laboratory or by the manufacturer) in accordance with chapter 5 of this ETAG. The approval body will have assessed the results of these tests in accordance with chapter 6 of this ETAG, as part of the ETA issuing procedure.
Where appropriate this assessment shall be used by the approved body for Certificate of Conformity purposes.

9 THE ETA CONTENTS

The ETA shall include a statement that the anchor may only be used if in the design and installation specifications for the fixture the excessive slip or failure of one anchor will not result in a significantly violation of the requirements on the fixture in the serviceability and ultimate state.

In addition to Part 1, 9 and Part 5, 9 the definition of multiple use in the various Member States should be given in the informative Annex of the ETA. The current version of the informative Annex is shown on the EOTA-Website : http://www.eota.be/.

ANNEX 1 (Informative)

The definition of multiple use according to the Member States is given in the following Table.

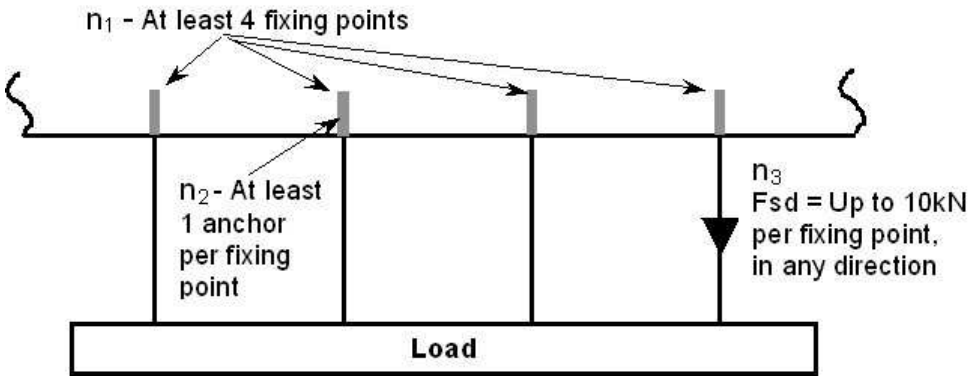
In the absence of a definition by a Member State the following default values may be taken (compare with 2.6):

$n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 3.0$ kN or

$n_1 \geq 3$; $n_2 \geq 1$ and $n_3 \leq 2.0$ kN.

The value n_3 might be increased if in the design it is shown that the requirements on the strength and stiffness of the fixture in the serviceability and ultimate states after the failure of one anchor are fulfilled.

Member States	**definition of multiple use**
Austria	
Belgium	
Denmark	**$n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 3.0$ kN or** **$n_1 \geq 3$; $n_2 \geq 1$ and $n_3 \leq 2.0$ kN**
Finland	
France	**$n_1 \geq 3$; $n_2 \geq 1$ and $n_3 \leq 4.5$ kN**
Germany	**$n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 3.0$ kN or** **$n_1 \geq 3$; $n_2 \geq 1$ and $n_3 \leq 2.0$ kN**
Greece	
Iceland	
Ireland	
Italy	
Luxembourg	
Netherlands	
Norway	
Portugal	**$n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 3.0$ kN or** **$n_1 \geq 3$; $n_2 \geq 1$ and $n_3 \leq 2.0$ kN**
Spain	
Sweden	**$n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 3.0$ kN** **if the correlation between bearing capacity of anchors is zero or near zero and the coefficient of variation of the anchor bearing capacity ≥ 0.25**

United Kingdom	**Multiple anchor use may be ensured by requirements on the number n_1 of fixing points to fasten the fixture and the number n_2 of anchors per fixing point. Furthermore by limiting the action F_{Sd} on a fixing point to a value $\leq n_3$ (kN) the requirements on the strength and stiffness of the fixture are fulfilled and the load transfer in case of excessive slip or failure of one anchor need not be taken into account in the design of the fixture.** **Either A $n_1 \geq 4$; $n_2 \geq 1$ and $n_3 \leq 10.0$ kN** **or B $n_1 \geq 1$; $n_2 \geq 4$ and $n_3 \leq 40.0$ kN.** **Examples:** **Definition A - Example**  **Typical examples include Pipework, ductwork and cable tray. It may be considered suitable for applications such as racking, handrails and balustrades. This definition also covers applications where the fixing points are arranged over an area such as suspended ceilings and light weight facades. It is not intended to cover heavy cladding panels such as pre-cast or natural stone cladding.** **Definition B - Example**