

Approval body for construction products  
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and  
Laender Governments



## European Technical Assessment

ETA-06/0189  
of 21 December 2016

English translation prepared by DIBt - Original version in German language

### General Part

Technical Assessment Body issuing the  
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

Shuttering kit "QUAD-LOCK"

Product family  
to which the construction product belongs

Non load bearing shuttering kit "QUAD-LOCK" based on  
shuttering elements of EPS

Manufacturer

QUAD-LOCK  
Building Systems GmbH  
Blumenstraße 1  
80331 München  
DEUTSCHLAND

Manufacturing plant

Q1  
Q2  
Q3  
Q4

This European Technical Assessment  
contains

37 pages including 27 annexes which form an integral  
part of this assessment

This European Technical Assessment is  
issued in accordance with Regulation (EU)  
No 305/2011, on the basis of

Guideline for European technical approval of "Non load-  
bearing permanent shuttering kits/systems based on  
hollow blocks or panels of insulating materials and  
sometimes concrete", ETAG 009,  
used as European Assessment Document (EAD)  
according to Article 66 Paragraph 3 of Regulation (EU)  
No 305/2011.

This version replaces

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## Specific Part

### 1 Definition of the product and intended use

#### 1.1 Definition of the construction product

The shuttering system "QUAD-LOCK" is a non load-bearing permanent shuttering kit based on shuttering elements and accessory parts (see Annexes A2 to A8) applicable as formwork for plain and reinforced concrete walls cast in-situ.

The shuttering elements are generally used for external load-bearing walls as well as for internal load-bearing walls.

Finishes are not part of the shuttering system "QUAD-LOCK".

#### 1.2 Shuttering elements

The shuttering elements (see Annexes A4 below, A6 below, A7 and A8) consist of inner and outer shuttering leaves of high density, expanded polystyrene (EPS shuttering leaves, see Annexes A2, A3 and A4 above) and HDPE ties. These components are assembled on site.

The EPS shuttering leaves are one-layered and the HDPE ties provide thicknesses of the concrete core of 96 mm, 147 mm, 197 mm, 248 mm, 299 mm and 350 mm, as indicated in Table 2 of Annex A1. Additionally the "Extender Tie" enables the extension of the thickness of the concrete core by 305 mm.

The EPS shuttering leaves are available in three thicknesses:

- 57 mm [2 1/4"] thick "Regular Panel" (Annex A3 above),
- 108 mm [4 1/4"] thick "Plus Panel" (Annex A3 below) and
- 102 mm [4"] thick "Extra Panel" (insulation element) (Annex A4 above).

The thickness of the inner EPS shuttering leaf range is either 57 mm or 108 mm and the thickness of the outer EPS shuttering leaf range is also 57 mm or 108 mm. Additionally the insulation element "Extra Panel" enables the extension of the thicknesses of the inner and outer EPS shuttering leaves by 102 mm (see Annex A6). The length of all shuttering elements is 1219 mm and the height is 305 mm (see Annexes A3 and A4 oben).

The insulation element "Extra Panel" is not used as a shuttering element but to improve the insulating property of the wall (see Annexes A4 and A6 below). The "Extra Panel" has to be incorporated inside the cavity of the concrete core before concreting. Thereby the thickness of the concrete core is reduced by 102 mm (see Annexes A4 and A6 below). It is possible to combine the "Extra Panel" with the "Regular Panel" or the "Plus Panel" without a negative influence of these shuttering elements (see Annex A9).

Ties are moulded from high density plastic (polyethylene) (HDPE ties) and are colour coded in dependence of their length (see Annexes A1 Table 2, A2, A5, A6 and A8).

The top and the bottom of each EPS shuttering leaf incorporate an interlocking arrangement to form a tight joint (see Annex A3).

Slots, at 51 mm [2"] centres, are also incorporated in the top and bottom to receive the HDPE ties.

The surfaces are generally smooth. There are also element-high slight vertical grooves at 51 mm [2"] centres with deeper grooves at 305 mm [12"] centres on the outside face of each EPS shuttering leaf. At these points the HDPE ties are installed so that their mid-axis and the mid-axis of the deeper grooves are in alignment with one another. Furthermore there is an internal vertical tapering at the end of the EPS shuttering leaf to form wall corners.

The vertical ends of the EPS shuttering leaves are smooth and form a tight but unsealed joint. Sealing foam is used to seal these vertical joints, where required, and to fill in gaps caused by inaccuracy of foundation level to between any of the formed joints.

The shuttering elements are dry laid in staggered vertical joints (brick bond).

The formwork requires alignment and support during concrete placing (see Annex B10).

The system can be used to construct straight and curved walls (minimum radius 885 mm to inside face) with right, obtuse and acute angles.

Steel reinforcement can be fixed directly to the HDPE tie web. Flanges incorporated within the HDPE tie design provide a fixing for dry lining, cladding and temporary propping or bracing. The maximum centre distance of HDPE ties in longitudinal direction of the shuttering elements shall be 305 mm [12"]. At rectangular corners, T-walls, non rectangular corners, openings or highly stressed areas the HDPE ties shall be placed closer (see Annexes B4 to B8). In these situations HDPE ties can be split to allow close centres to be achieved.

The shuttering elements are interlocked and build up horizontally and vertically into a tight and rigid formwork. The wall is formed by filling of the shuttering elements with concrete. The formwork is used in conjunction with concrete class C16/20 (according to EN 206) to built plain concrete walls or in conjunction with concrete of classes in the range from C20/25 to C50/60 (according to EN 206) to built reinforced concrete walls.

### **1.3 Accessory parts**

#### **1.3.1 Wire top ties (metal ties, only on top the wall), (Annex A2)**

Wire top ties, bent from 5 mm galvanized wire, are used to provide additional support of assembled EPS shuttering leaves at the top of the wall. Combined with metal tracks (see clause 1.3.2) they guarantee a clean, straight finish on top of the wall.

#### **1.3.2 Metal tracks (only at the bottom and top of wall) (Annex A2)**

Pressed steel tracks are available in 57 mm and 108 mm widths and min. 0,8 mm [0,0325"] thick galvanized steel sheet. Track is used at the base of the wall construction, to provide a locating position and add stability during concrete placing, and at the top of the EPS shuttering leaves to protect joints from wet concrete and provide temporary stability.

#### **1.3.3 Metal corner brackets (Annex A2)**

Inner and outer corners are strengthened during the concrete placing by galvanized steel brackets (for rectangular as well as for non rectangular corners). This eliminates the use of external bracing during the concrete placing.

## **2 Specification of the Intended use in accordance with the applicable European Assessment Document**

The kit is intended to be used for the construction of internal walls as well as external walls above or below ground which are load-bearing (structural) or non load-bearing (non structural), including those which are subjected to fire regulations.

When using this type of construction below ground a waterproofing according to applicable national rules shall be provided depending on whether non pressing water or pressing water is to be dealt with. The waterproofing shall be protected from mechanical damage by an impact resistant protective layer.

According to EOTA TR 034 the following use categories apply:

- Category IA 2: Product with no direct contact to (e. g. covered products) but possible impact on indoor air.
- Category S/W 3: Product with no contact to and no impact on soil water, ground- and surface water.

The performance given in Section 3 are only valid if the shuttering elements are used in compliance with the specifications and conditions given in Annex B1.

The verification and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the shuttering kit of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the manufacturer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

### **3 Performance of the product and references to the methods**

#### **3.1 Mechanical resistance and stability (BWR 1)**

##### **3.1.1 Resulting structural pattern**

In end use conditions walls made with shuttering elements "QUAD-LOCK" are walls of a continuous type according to ETAG 009, clause 2.2.

##### **3.1.2 Efficiency of filling**

Considering the instructions of Annex B1 and the installation guide of the manufacturer the efficient filling without bursting of the shuttering and without voids or any uncovered reinforcement in the concrete core is possible.

The requirements according to ETAG 009, clause 6.1.2 are met satisfactorily.

##### **3.1.3 Possibility of steel reinforcement**

The instructions in the installation guide of the manufacturer are appropriate to install steel reinforcement for walls according to EN 1992-1-1 or corresponding national rules.

The requirements according to ETAG 009, clause 6.1.3 are met satisfactorily.

#### **3.2 Safety in case of fire (BWR 2)**

##### **3.2.1 Reaction to fire**

Shuttering elements "QUAD-LOCK" made of expanded polystyrene (EPS) fulfil the requirement of Class E according to EN 13501-1<sup>1</sup>.

##### **3.2.2 Resistance to fire**

The walls will be exposed to fire on one site only.

According to ETAG 009, Annex C, Table 1, for a continuous type of load-bearing walls ("REI") or non load-bearing walls ("EI") and a minimum concrete strength of C16/20, the system meets the criteria "REI" and "EI" according to Table 1.

<sup>1</sup> A European reference fire scenario for facades has not been laid down. In some Member States the classification of permanent shuttering systems according to EN 13501-1 might not be sufficient for the use in facades. An additional assessment of permanent shuttering systems according to national provisions (e.g. on the basis of a large scale test) might necessary to comply with Member States regulations, until the existing European classification system has been completed.

Table 1: Determination of "REI" of load-bearing walls and "EI" of non load-bearing walls

Thickness of concrete core [mm]	"REI"	"EI"
<b>96</b>	-	60
<b>147</b>	90	120
<b>197</b>	120	120
<b>248</b>	120	120
<b>299</b>	120	120
<b>350</b>	120	120

The conditions for this classification are:

- The design of the building has to take into consideration the secondary effects of fire. Especially constraints, introduced by thermal strain, should be sufficiently low and appropriate building joints should be foreseen. The rules, valid in place of use, govern. Structural requirements on work in normal conditions, valid in the place of use, may require larger dimensions. Concrete cover for the reinforcement has to be observed according to the rules valid in the place of use.
- A normal-weight concrete as defined in EN 206 or EN 1992-1-1 shall be used. As far as European standards EN 206 or EN 1992-1-1 are not in force, an equivalent concrete according to national rules, valid in the place of use, is acceptable. The strength of concrete shall be between C16/20 and C50/60 according to EN 206. In lack of availability of European standard EN 206, alternatively a concrete according to national rules, valid in the place of use, with a compressive strength which fits the range given above, is also considered as appropriate.

### 3.3 Hygiene, health and environment (BWR 3)

#### 3.3.1 Content and/or release of dangerous substances

Essential characteristic	Performance
Contents of dangerous substances	The product does not contain CMR-substances actively used (in accordance with Regulation (EC) No 1272/2008) and no HBCDD.
Release scenario regarding BWR 3: IA2	

#### 3.3.2 Water vapour permeability

The tabulated design value of the water vapour diffusion resistance coefficient of expanded polystyrene (EPS), according to EN ISO 10456 is  $\mu = 60$ .

Using this value to verify the annual moisture balance or the maximum amount of interstitial condensation according to EN ISO 13788 will be on the safe side.

The values for the water vapour diffusion resistance of concrete depending on type and density are tabulated in EN ISO 10456.

#### 3.3.3 Water absorption

The requirements according to ETAG 009, clause 6.3.3 are met satisfactorily.

#### 3.3.4 Watertightness

Because finishes are not part of the shuttering system "QUAD-LOCK" the "No performance assessed" option in ETAG 009, Table 3 is used.

### **3.4 Safety and assessibility in use (BWR 4)**

#### **3.4.1 Bond strength between layers of an EPS shuttering leaf respectively between EPS shuttering leaves and concrete core and resistance to impact load**

Under end use conditions the EPS shuttering leaves are durable fixed by the HDPE-ties, included the insulation element "Extra Panel" which can be incorporated inside the cavity of the concrete core. The bond strength is at least equal to the resisting pressure of fresh concrete of the EPS shuttering leaves, see clause 3.4.2.

Concrete walls (without consideration of the finishes), constructed with shuttering system "QUAD-LOCK" and designed according to EN 1992-1-1 respectively in lack of availability of EN 1992-1-1 according to national design rules, lead to the assumption that concrete core insures an adequate resistance of the complete wall under normal used impact loads.

The requirements according to ETAG 009, clause 6.4.1 are met satisfactorily.

#### **3.4.2 Resistance to pressure of fresh concrete**

To resist the pressure of fresh concrete the bending tensile strength of the EPS shuttering leaves shall be more than

- 200 kPa for the "Plus Panel" respectively
- 350 kPa for the "Regular Panel",

see designation code "BS200" respectively "BS350" of EPS in Annex A1, Table 1.

Because the insulation element "Extra Panel" is used to improve the insulating property of the wall the verification of the resistance to pressure of fresh concrete respectively the bending tensile strength of 170 kPa of these elements is not necessary, see designation code "BS170" of EPS in Annex A1, Table 1.

The tensile strength of the HDPE-ties and the junction tensile strength between the HDPE ties and the "Extender Tie" shall be at least 2400 N. The pull-out strength between HDPE ties and the EPS shuttering leaves shall be at least 1800 N.

The requirements according to ETAG 009, clause 6.4.2 are met satisfactorily.

#### **3.4.3 Safety against personal injury by contact**

Delivered on site the shuttering elements do not have sharp or cutting edges.

Because of the soft surface of the EPS shuttering leaves there is no risk of abrasion or of cutting people.

The requirements according to ETAG 009, clause 6.4.3 are met satisfactorily.

### **3.5 Protection against noise (BWR 5)**

#### **3.5.1 Airborne sound insulation**

The "No performance assessed" option in ETAG 009, Table 3 is used.

#### **3.5.2 Sound absorption**

The "No performance assessed" option in ETAG 009, Table 3 is used.



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### 3.6 Energy economy and heat retention (BWR 6)

#### 3.6.1 Thermal resistance

The nominal value of thermal resistance  $R_{D,element}$  of the shuttering elements in end use conditions (see Annex A9, with concrete core without rendering) is the sum of the nominal value of thermal resistance of the EPS shuttering leaves  $R_{D,EPS}$  and the concrete core  $R_{D,concrete}$ . The nominal value of thermal resistance of the EPS shuttering leaves  $R_{D,EPS}$  shall be calculated in accordance with EN ISO 6946 with a nominal value of thermal conductivity of the EPS shuttering leaves of  $\lambda = 0,0346 \text{ W/(m}\times\text{K)}$  (for 57 mm "Regular Panel"),  $\lambda = 0,0370 \text{ W/(m}\times\text{K)}$  (for 108 mm "Plus Panel") respectively  $\lambda = 0,0369 \text{ W/(m}\times\text{K)}$  (for 102 mm "Extra Panel") according to EN 13163, clause 4.2.1 and the nominal value of thermal resistance of the concrete core  $R_{D,concrete}$  shall be calculated in accordance with EN ISO 6946 with a nominal value of thermal conductivity  $\lambda$  of the concrete core depending on the density  $\rho$  tabulated in EN ISO 10456 and considering the influence of the HDPE ties by an reduction factor, see Table 2, according to the influence of the thickness of the EPS shuttering leaves.

Table 2: Reduction factor

Thickness of EPS shuttering leaves		Reduction factor
inner leaf [mm]	outer leaf [mm]	
57	57	0,961
57	108	0,967
108	108	1,0
57	210	1,0
108	210	1,0
57	312	1,0
108	312	1,0
159	212	1,0
210	312	1,0

The planner shall consider the metal accessory parts (wire top ties, metal tracks, metal corner brackets, see Annex A2) as thermal bridges, where relevant, for determination of the nominal value of thermal resistance  $R_{D,element}$ .

#### 3.6.2 Heat capacity

The values for the heat capacity of concrete and expanded polystyrene are tabulated in EN ISO 10456.

### 3.7 General aspects

#### 3.7.1 Resistance to deterioration

##### Physical agent

As given in the designation code "DS(70,-)3" of the EPS (see Annex A1) the relative changes of the EPS shuttering leaves in length, width and thickness under specified temperature and humidity conditions shall not exceed 3 % after exposing them for 48 h at 70 °C, according to EN 13163.

The requirements according to ETAG 009, clause 6.7.1.1 are met satisfactorily.



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#### Chemical agent

Ties are made of high density plastic (polyethylene) (HDPE). There is no corrosion of the HDPE ties in concrete.

The finishes of the wall are not part of the ETA. Determination of the cleaning agent of the surface is not possible.

The requirements according to ETAG 009, clause 6.7.1.2 are met satisfactorily.

#### Biological agent

The application of EPS as insulation material for decades has shown that it sufficiently protects against fungi, bacteria, algae and insects.

EPS does not provide a food value and in general it does not contain voids suitable for habitation by vermin.

The shuttering system "QUAD-LOCK" does not contain any biocides.

The requirements according to ETAG 009, clause 6.7.1.3 are met satisfactorily.

### **3.7.2 Resistance to normal use damage**

#### Normal use impacts

Concrete walls (without consideration of the finishes), constructed with shuttering system "QUAD-LOCK" and designed according EN 1992-1-1 respectively in lack of availability of EN 1992-1-1 according national design rules, lead to the assumption that concrete core insures an adequate resistance of the complete wall under normal used impact loads.

The requirements according to ETAG 009, clause 6.7.2.1 are met satisfactorily.

#### Incorporation of ducts

The instructions in the installation guide of the manufacturer are appropriate to produce horizontal perforations through the walls, which are necessary for passing through ducts, see Annex B1.

The requirements according to ETAG 009, clause 6.7.2.2 are met satisfactorily.

#### Fixing of objects

Fixing of objects in the EPS shuttering leaves is not possible. The part of fixings which is significant for the mechanical resistance shall be in the concrete core.

The requirements according to ETAG 009, clause 6.7.2.3 are met satisfactorily.

### **4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to the legal base**

In accordance with guideline for European technical approval ETAG 009, June 2002, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011, the applicable European legal act is: [98/279/EC] as amended by European legal act [2001/596/EC].

The system to be applied is: 2+

**5 Technical details necessary for the implementation of the AVCP system, as provided for the applicable EAD**

Technical details necessary for the implementation of the AVCP system are laid down in the control plan, deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 21 December 2016 by Deutsches Institut für Bautechnik

Andreas Kummerow  
p. p. Head of Department

*beglaubigt:*  
Alex

### Characteristics of shuttering kit

The shuttering kit "QUAD-LOCK" consists of the following components:

- shuttering leaves
- ties and
- accessory parts.

#### Shuttering leaves

The EPS shuttering leaves are made of expanded polystyrene (EPS) according to EN 13163 composed of polystyrene particle foam. The parameters and characteristics of the EPS are indicated in Table 1.

Table 1: Parameters and characteristics of the EPS according EN 13163

EPS leaves			Designation code of the EPS according EN 13163	Mean value of density $\rho$ [kg/m <sup>3</sup> ]	Nominal value of thermal conductivity $\lambda$ [W/(m×K)]
Type	Type of EPS element	Thickness [mm]			
"Regular Panel"	shuttering element	57	EPS-EN 13163-- L(3)-W(2)-S(2)-P(5)- DS(70, -)3-BS350-DS(N)5-TR400	30	0,0346
"Plus Panel"	shuttering element	108	EPS-EN 13163-- L(3)-W(2)-S(2)-P(5)- DS(70, -)3-BS200-DS(N)5-TR200	24	0,0370
"Extra Panel"	Insulation element	102	EPS-EN 13163-- L(3)-W(2)-S(2)-P(5)- DS(70, -)3-BS170-DS(N)5-TR200	18	0,0369

#### Ties

The ties are moulded of high density plastic (polyethylene) (HDPE ties).

The tensile strength of the HDPE ties and the junction tensile strength between the HDPE ties and the "Extender Tie" shall be at least 2400 N. The pull-out strength between HDPE ties and the EPS shuttering leaves shall be at least 1800 N.

#### Shuttering elements

- The shuttering elements (composed of EPS shuttering leaves and HDPE ties) correspond to the information and drawings given in Annexes A4, A6, A7 and A8.
- The dimensions of the shuttering elements are given in Table 2. Information on the calculation value of the thermal resistance are given in Annex A9.
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Shuttering kit "QUAD-LOCK"

Components of the Insulating Concrete Forming (ICF) System

Annex A1  
Page 1 of 2

Table 2: Dimensions of the EPS shuttering elements

Thickness of the wall [mm]	HDPE ties (Colour)	Thickness of EPS shuttering leaves		Thickness of concrete core [mm]
		inner [mm]	outer [mm]	
210	black	57	57	96
260	blue	57	108	96
		57	57	147
311	yellow	108	108	96
		57	108	147
		57	57	197
362	green	108	108	147
		57	108	197
		57	57	248
413	red	108	108	197
		57	108	248
		57	57	299
464	brown	108	108	248
		57	108	299
		57	57	350
210 + 305 or 260 + 305 or 311 + 305 or 362 + 305 or 413 + 305 or 464 + 305	"Extender Tie" * orange	any combination of EPS shuttering leaves as per above		enables the extension of the thickness of the concrete core by 305 mm

\* It is possible to combine the "Extender Tie" with every other HDPE-tie of Table 2.

### Accessory parts

The accessory parts correspond to the information and drawings given in Annex A2. The accessory parts are:

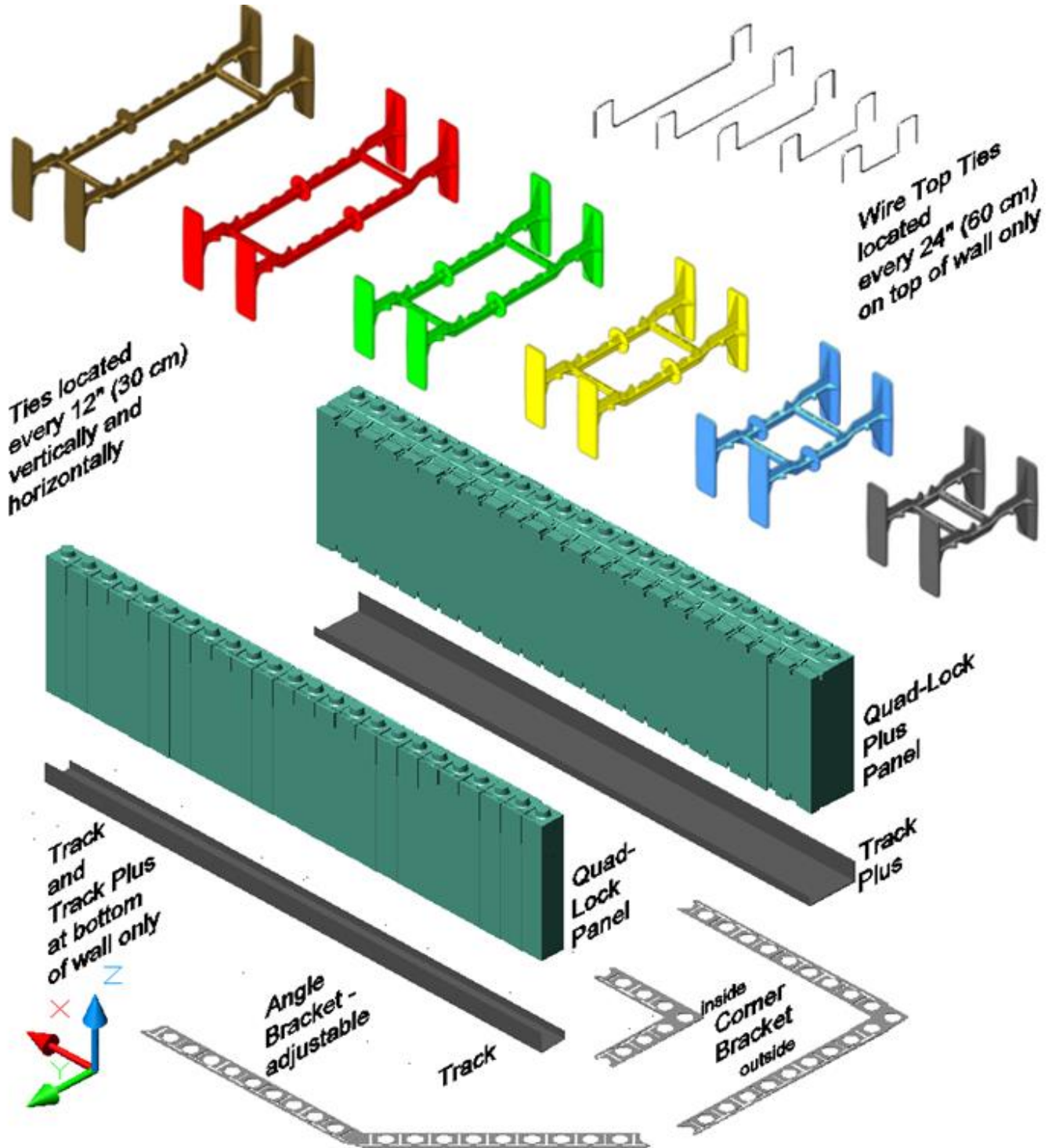
- wire top ties made from 5 mm galvanized wires,
- metal tracks made of galvanized steel of 1 mm thickness and
- metal corner brackets made of galvanized steel of 1 mm thickness.

Shuttering kit "QUAD-LOCK"

Components of the Insulating Concrete Forming (ICF) System

Annex A1  
Page 2 of 2

**QUAD-LOCK components for the constructing of walls, inclusive wall corners (for rectangular as well as for non rectangular corners) and T-walls of various concrete thicknesses and values of thermal resistance**

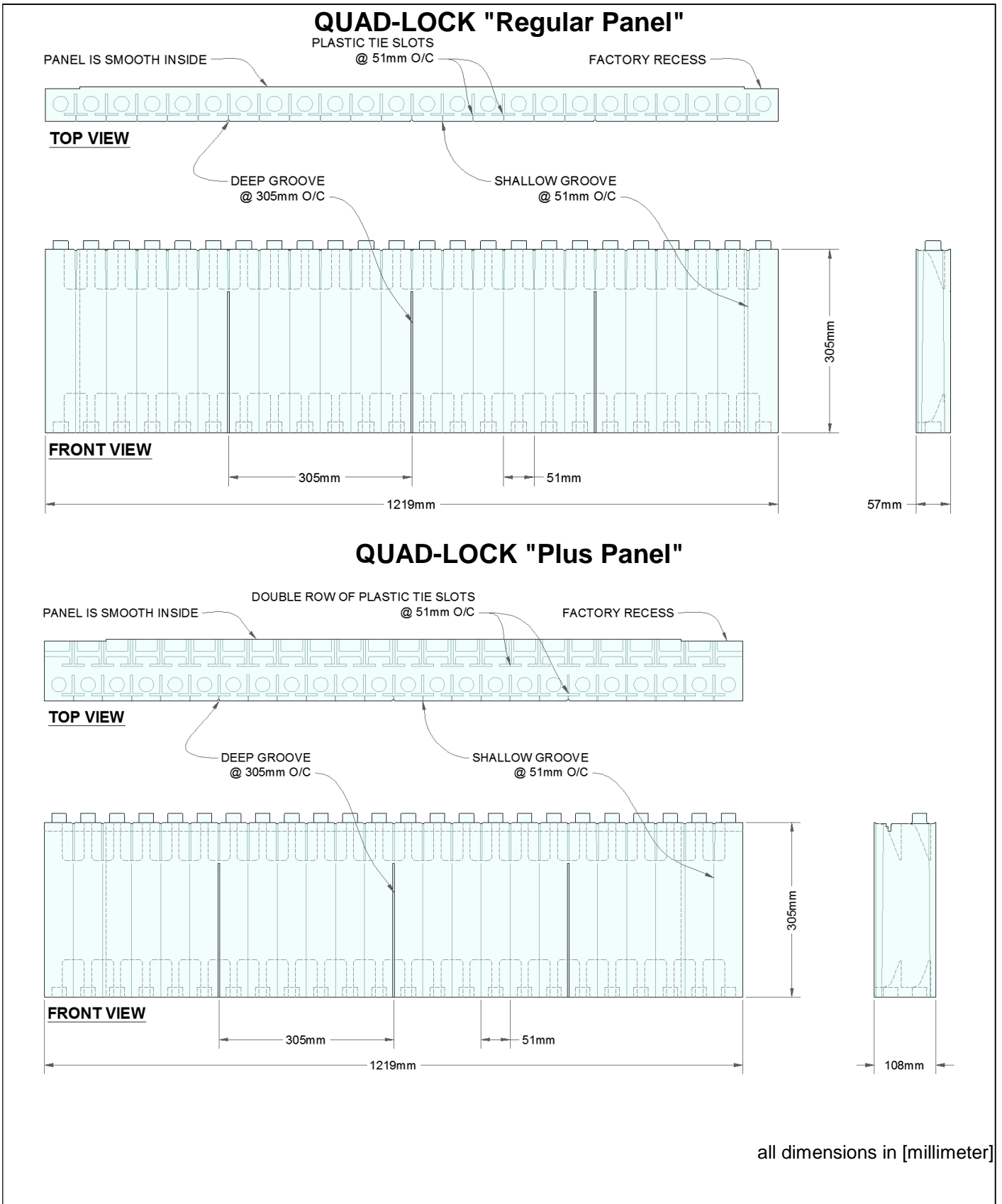


Shuttering kit "QUAD-LOCK"

Components of the Insulating Concrete Forming (ICF) System

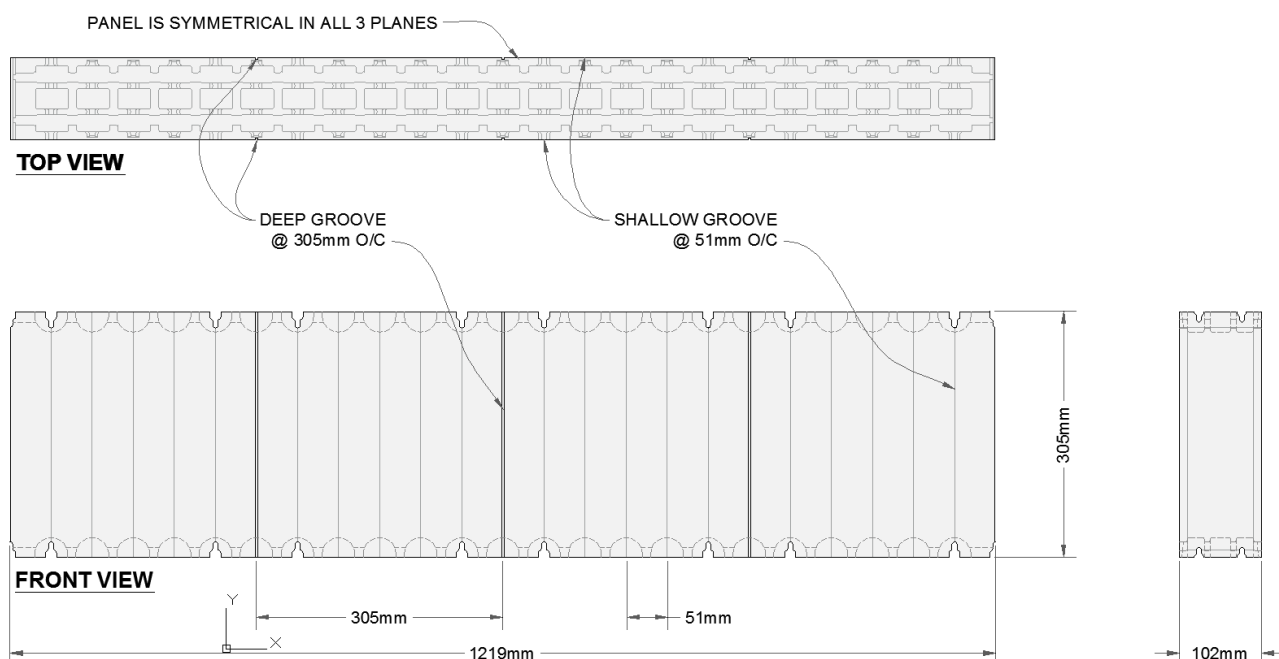
Annex A2

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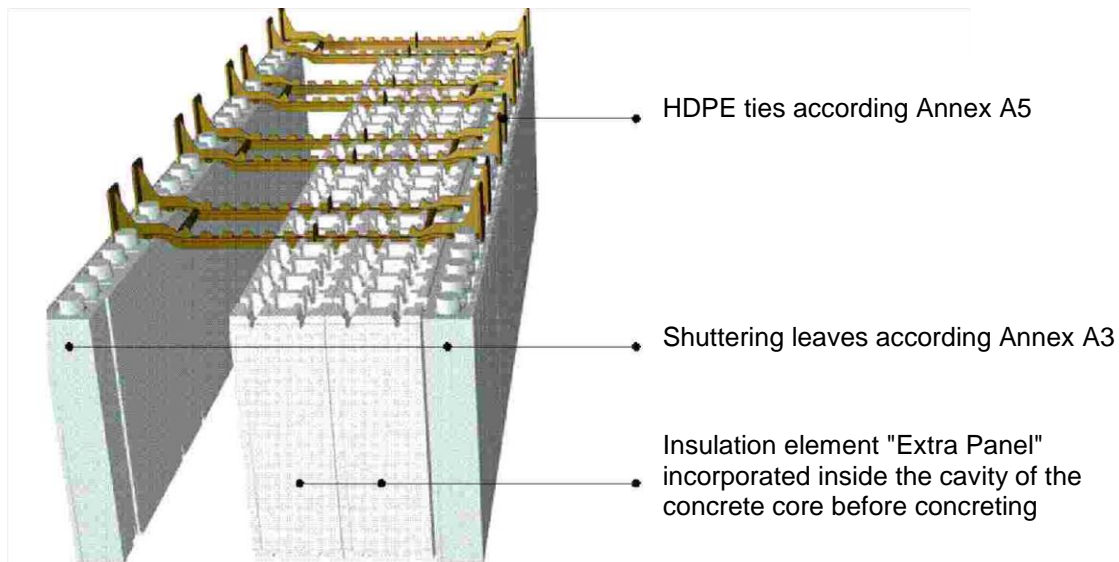


Shuttering kit "QUAD-LOCK"	Annex A3
Dimensions of the shuttering leaves "Regular Panel" and "Plus Panel" made of expanded polystyrene (EPS shuttering leaves)	

### QUAD-LOCK "Extra Panel"



The 102 mm [4"] thick insulation element "Extra Panel" has to be incorporated inside the cavity of the concrete core before concreting. Thereby the thickness of the concrete core is reduced by 102 mm. It is possible to combine the "Extra Panel" with the "Regular Panel" or the "Plus Panel".



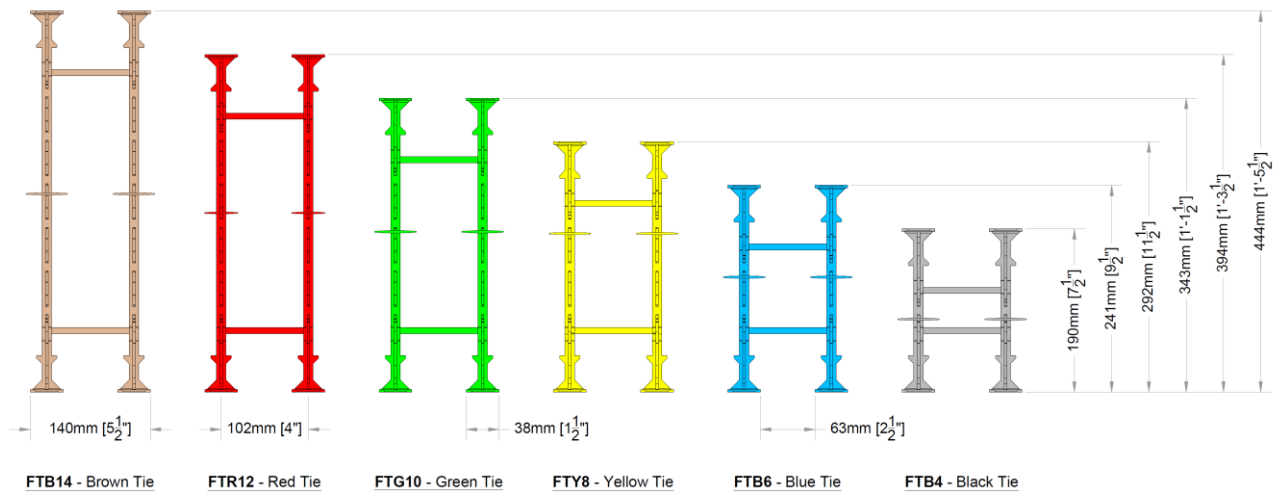
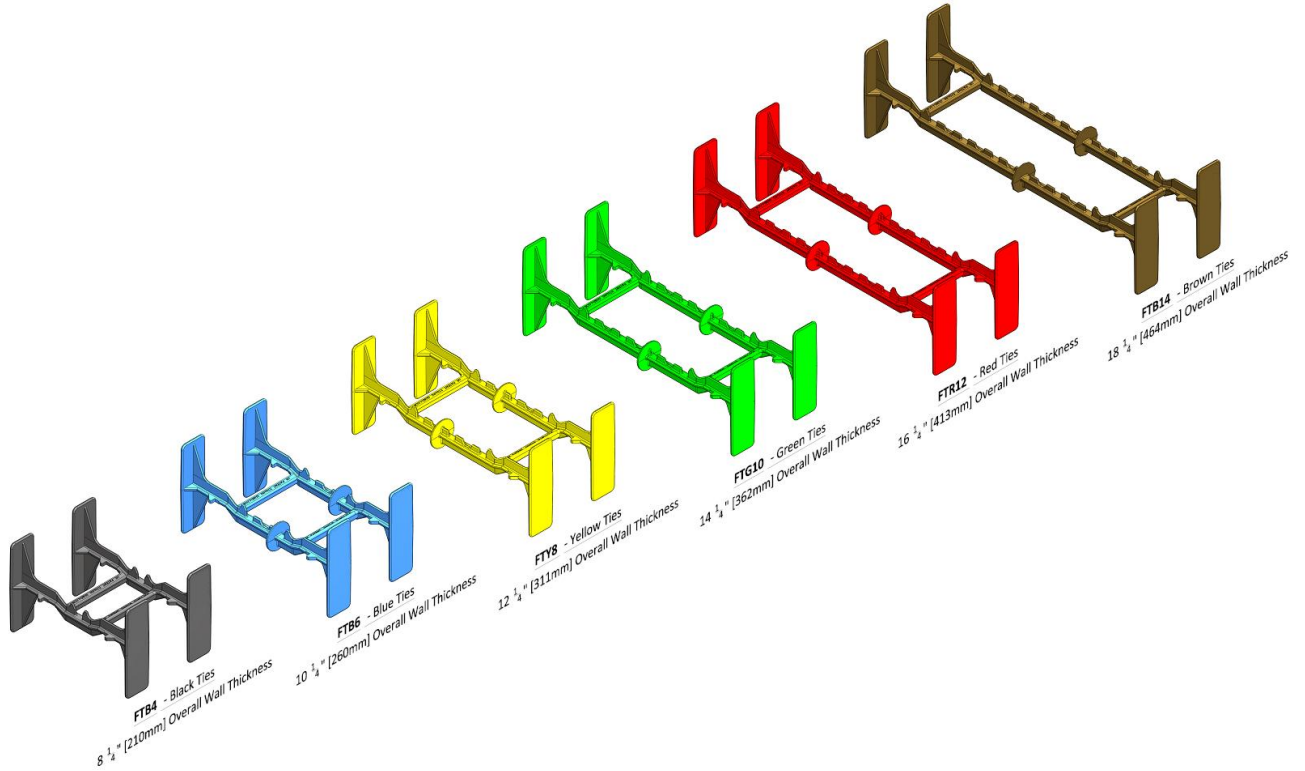
Shuttering kit "QUAD-LOCK"

Dimensions of the shuttering leaf "Extra Panel" made of expanded polystyrene (EPS shuttering leaves)

Annex A4



## QUAD-LOCK HDPE ties for various wall thicknesses and concrete thicknesses



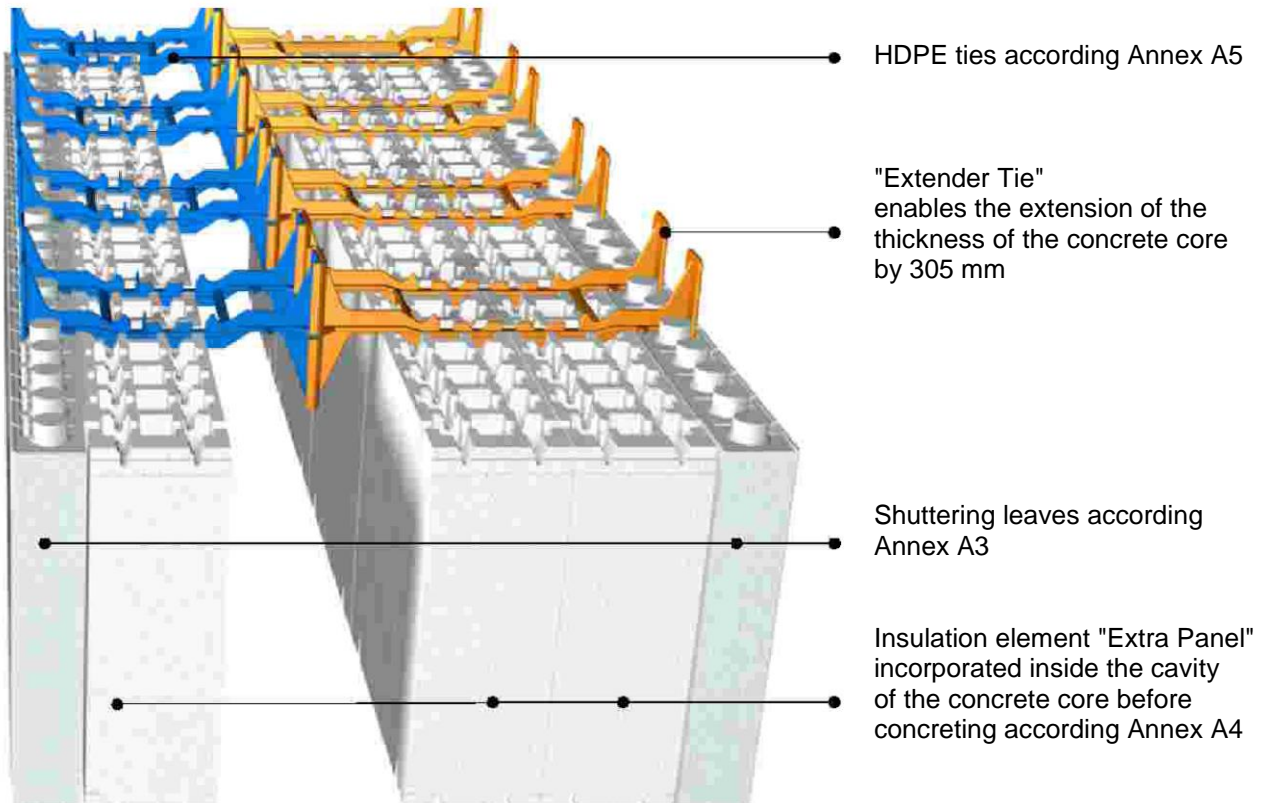
all dimensions in [millimeter] and [inches]

Shuttering kit "QUAD-LOCK"

Dimensions of the ties made of high density plastic (HDPE ties)

Annex A5

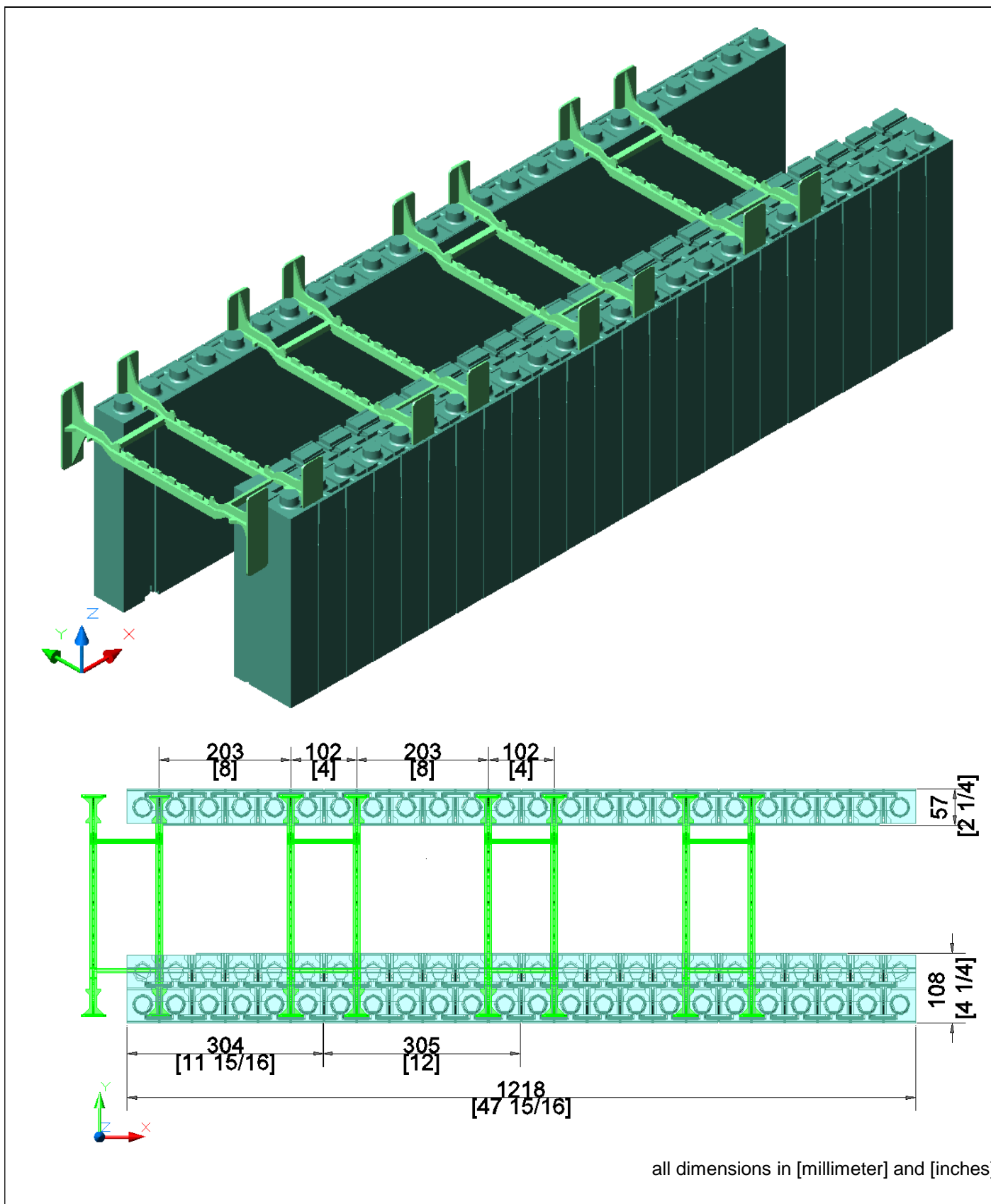
**QUAD-LOCK "Extender Tie" enables the extension of the thickness of the concrete core by 305 mm**



Shuttering kit "QUAD-LOCK"

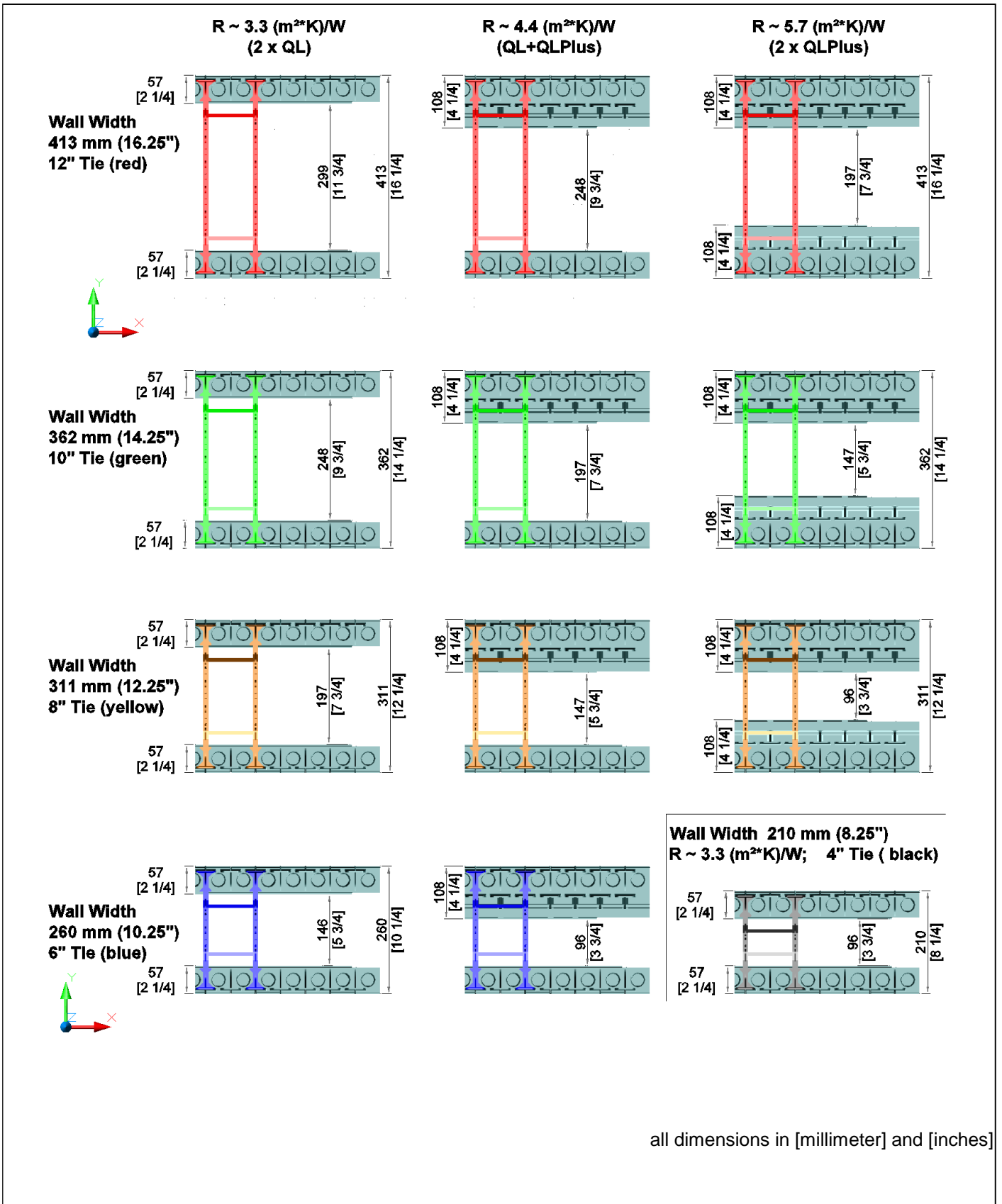
Dimensions of the "Extender Tie" made of high density plastic (HDPE tie)

Annex A6



Shuttering kit "QUAD-LOCK"	Annex A7
Placement of the HDPE ties	

English translation prepared by DIBt



Shuttering kit "QUAD-LOCK"	Annex A8
Thicknesses of walls and concrete cores	

English translation prepared by DIBt

**Values of wall elements for some combinations of "QUAD-LOCK" shuttering elements**

Sample with 147 mm concrete core		Nominal value of thermal conductivity $\lambda$				Nominal value of thermal resistance of shuttering elements								
		Typ	Regular	Plus	Extra	Beton	$R_{D,element}^*$	reduction factor (clause 3.6.1)	including factor $R_{D,element}/factor^*$	EPS shuttering leaves $R_{D,EPS}^*$	concrete core $R_{D,concrete}^*$			
		[W/m·K]	0,0346	0,0370	0,0369	2,5								
Thickness of concrete core	Thickness of the wall	[m <sup>2</sup> ·K/W]												
Regular (QPX2, 57mm)	Plus (QPX2 Plus, 108mm)	EXTRA (QPXTRA, 102mm)	FTB4 (schwarz)	FTB6 (blau)	FTB8 (gelb)	FTG10 (grün)	FTR12 (rot)	FTB14 (braun)	XT (orange)					
96	210		X							3,333	0,961	3,203	3,295	0,038
147	260			X						3,354	0,961	3,223	3,295	0,059
197	311				X					3,374	0,961	3,242	3,295	0,079
248	362					X				3,394	0,961	3,262	3,295	0,099
299	413						X			3,414	0,961	3,281	3,295	0,120
350	464							X		3,435	0,961	3,301	3,295	0,140
400	514	X							X	3,455	0,961	3,320	3,295	0,160
451	565		X						X	3,475	0,961	3,340	3,295	0,180
502	616			X					X	3,496	0,961	3,359	3,295	0,201
553	667				X				X	3,516	0,961	3,379	3,295	0,221
604	718						X		X	3,536	0,961	3,398	3,295	0,242
655	769							X	X	3,557	0,961	3,418	3,295	0,262
96	260				X					4,605	0,967	4,453	4,566	0,038
147	311					X				4,625	0,967	4,472	4,566	0,059
197	362						X			4,645	0,967	4,492	4,566	0,079
248	413							X		4,666	0,967	4,512	4,566	0,099
299	464								X	4,686	0,967	4,531	4,566	0,120
350	514	X							X	4,706	0,967	4,551	4,566	0,140
400	565		X						X	4,726	0,967	4,570	4,566	0,160
451	616			X					X	4,747	0,967	4,590	4,566	0,180
502	667				X				X	4,767	0,967	4,610	4,566	0,201
553	718						X		X	4,788	0,967	4,630	4,566	0,221
604	769							X	X	4,808	0,967	4,649	4,566	0,242
96	311					X				5,876	1,0	5,876	5,838	0,038
147	362						X			5,897	1,0	5,897	5,838	0,059
197	413							X		5,917	1,0	5,917	5,838	0,079
248	464								X	5,937	1,0	5,937	5,838	0,099
299	514		X						X	5,957	1,0	5,957	5,838	0,120
350	565			X					X	5,978	1,0	5,978	5,838	0,140
400	616				X				X	5,998	1,0	5,998	5,838	0,160
451	667					X			X	6,018	1,0	6,018	5,838	0,180
502	718						X		X	6,039	1,0	6,039	5,838	0,201
553	769							X	X	6,059	1,0	6,059	5,838	0,221
96	311					X				6,097	1,0	6,097	6,059	0,038
147	362						X			6,118	1,0	6,118	6,059	0,059
197	413							X		6,138	1,0	6,138	6,059	0,079
248	464								X	6,158	1,0	6,158	6,059	0,099
299	514		X						X	6,179	1,0	6,179	6,059	0,120
350	565			X					X	6,199	1,0	6,199	6,059	0,140
400	616				X				X	6,219	1,0	6,219	6,059	0,160
451	667					X			X	6,239	1,0	6,239	6,059	0,180
502	718						X		X	6,260	1,0	6,260	6,059	0,201
553	769							X	X	6,280	1,0	6,280	6,059	0,221

Shuttering kit "QUAD-LOCK"

Thicknesses of wall and concrete core and nominal values of thermal resistance  $R_D$

English translation prepared by DIBt

Values of wall elements for some combinations of "QUAD-LOCK" shuttering elements																							
* The nominal value of thermal resistance of the shuttering elements, the EPS shuttering leaves and the concrete core is calculated in accordance with clause 3.6.1 with following factors:			Nominal value of thermal conductivity $\lambda$								Nominal value of thermal resistance of shuttering elements	reduction factor (clause 3.6.1)	including factor $R_{D, element, factor}^*$	EPS shuttering leaves $R_{D, EPS}^*$	concrete core $R_{D, concrete}^*$								
			Typ		Regular		Plus		Extra							Beton							
			[W/m·K]		0,0346		0,0370		0,0369							2,5							
Sample with 147 mm concrete core		Thickness of concrete core		Regular (QPX2, 57mm)	Plus (QPX2 Plus, 108mm)	EXTRA (QPXTRA, 102mm)	FTB4 (schwarz)	FTB6 (blau)	FTT8 (gelb)	FTG10 (grün)	FTR12 (rot)	FTB14 (braun)	XT (orange)	Nominal value of thermal resistance of shuttering elements									
		[mm]												m <sup>2</sup> ·K/W									
			96	362																			
			147	413					X									7,369	1,0	7,369	7,331	0,038	
			197	464											X				7,389	1,0	7,389	7,331	0,059
			248	514					X							X			7,409	1,0	7,409	7,331	0,079
			299	565	X	X	X									X			7,430	1,0	7,430	7,331	0,099
			350	616					X							X			7,450	1,0	7,450	7,331	0,120
			400	667						X						X			7,471	1,0	7,471	7,331	0,140
			451	718							X				X	X			7,491	1,0	7,491	7,331	0,160
			502	769									X			X	X		7,511	1,0	7,511	7,331	0,180
															X	X			7,531	1,0	7,531	7,331	0,201
			96	413											X				8,640	1,0	8,640	8,602	0,038
			147	464												X			8,661	1,0	8,661	8,602	0,059
			197	514					X							X			8,681	1,0	8,681	8,602	0,079
			248	565		X	X			X						X			8,701	1,0	8,701	8,602	0,099
			299	616							X					X			8,722	1,0	8,722	8,602	0,120
			350	667								X				X			8,742	1,0	8,742	8,602	0,140
			400	718									X			X			8,762	1,0	8,762	8,602	0,160
			451	769											X	X			8,782	1,0	8,782	8,602	0,180
96	413										X					8,862	1,0	8,862	8,823	0,038			
147	464											X				8,882	1,0	8,882	8,823	0,059			
197	514					X							X			8,902	1,0	8,902	8,823	0,079			
248	565	X		2X			X						X			8,922	1,0	8,922	8,823	0,099			
299	616							X					X			8,943	1,0	8,943	8,823	0,120			
350	667								X				X			8,963	1,0	8,963	8,823	0,140			
400	718									X			X			8,983	1,0	8,983	8,823	0,160			
451	769											X	X			9,004	1,0	9,004	8,823	0,180			

Shuttering kit "QUAD-LOCK"

Thicknesses of wall and concrete core and nominal values of thermal resistance  $R_D$



English translation prepared by DIBt

**Values of wall elements for some combinations of "QUAD-LOCK" shuttering elements**

Sample with 147 mm concrete core		Thickness of concrete core	Thickness of the wall	Nominal value of thermal conductivity $\lambda$							Nominal value of thermal resistance of shuttering elements						
				* The nominal value of thermal resistance of the shuttering elements, the EPS shuttering leaves and the concrete core is calculated in accordance with clause 3.6.1 with following factors:													
				Typ	Regular	Plus	Extra	Beton	$R_{D,element}^*$	reduction factor (clause 3.6.1)	including factor $R_{D,element}/factor^*$	EPS shuttering leaves $R_{D,EPS}^*$	concrete core $R_{D,concrete}^*$				
[W/m·K]	0,0346	0,0370	0,0369	2,5	[m <sup>2</sup> ·K/W]												
		[mm]	Regular (QPX2, 57mm)	Plus (QPX2 Plus, 108mm)	EXTRA (QPXTRA, 102mm)	FTB4 (schwarz)	FTB6 (blau)	FTB8 (gelb)	FTG10 (grün)	FTR12 (rot)	FTB14 (braun)	XT (orange)					
	147	514				X						X	10,154	1,0	10,154	10,095	0,059
	197	565					X					X	10,174	1,0	10,174	10,095	0,079
	248	616						X				X	10,194	1,0	10,194	10,095	0,099
	299	667	X	X	2X				X			X	10,214	1,0	10,214	10,095	0,120
	350	718								X		X	10,235	1,0	10,235	10,095	0,140
	400	769									X	X	10,255	1,0	10,255	10,095	0,160
	147	565					X					X	11,425	1,0	11,425	11,366	0,059
	197	616						X				X	11,445	1,0	11,445	11,366	0,079
	248	667		X	2X				X			X	11,465	1,0	11,465	11,366	0,099
	299	718							X			X	11,486	1,0	11,486	11,366	0,120
	350	769									X	X	11,506	1,0	11,506	11,366	0,140
	147	616						X				X	12,918	1,0	12,918	12,859	0,059
	197	667							X			X	12,938	1,0	12,938	12,859	0,079
	248	718	X	X	3X				X			X	12,958	1,0	12,958	12,859	0,099
	299	769									X	X	12,979	1,0	12,979	12,859	0,120
	147	667							X			X	14,189	1,0	14,189	14,131	0,059
	197	718		X	3X				X			X	14,209	1,0	14,209	14,131	0,079
	248	769									X	X	14,230	1,0	14,230	14,131	0,099

Shuttering kit "QUAD-LOCK"

Thicknesses of wall and concrete core and nominal values of thermal resistance  $R_D$

Annex A9  
Page 3 of 3



## Installation

### 1 General

The manufacturer shall ensure that the requirements in accordance with clauses 1 and 3 of the "Special Part" of this ETA are made known to those involved in planning and execution. The installation guide is deposited with Deutsches Institut für Bautechnik and shall be present at every construction site. If the manufacturer's instructions contain provisions which differ from those stated here, the specifications of the ETA shall apply.

After installation of the shuttering elements (see clause 2 of this Annex) site-mixed or ready-mixed concrete is placed and compacted (see clause 3 of this Annex).

In end use conditions concrete walls of a continuous type<sup>1</sup> of plain or reinforced concrete will be formed according to EN 1992-1-1 or according to corresponding national rules.

For structural design purposes the thickness of the wall is shown in Annex A9.

In end use conditions the EPS shuttering leaves are the main part of the thermal insulation of the walls.

### 2 Installation of the shuttering elements

The shuttering elements are put together on site in layers without mortar or adhesive. To receive stable floor high formworks the vertical joints between two elements of one layer have to be shifted of at least a quarter of the element length, better a half of the element length, to the vertical joints of the previous and next layer (see Annex B3).

The HDPE ties are assembled on site into the inner and outer EPS shuttering leaves to reach complete shuttering elements. The HDPE ties shall be stacked (one upon the other) to avoid segregation of concrete.

First of all two layers of the entire floor plan are to be interlocked according to the installation guide of the manufacturer.

Afterwards levelling to the subsoil is performed (foundation, bottom, ground floor and ceiling). Voids between the EPS shuttering leaves and the uneven subsoil are to be sealed with PU foam before concreting.

Subsequently, according to the installation guide of the manufacturer, the shuttering elements are to be interlocked to floor height, levelled and fastened to the scaffolding supports (see Annex B10).

The scaffolding supports shall be arranged with a maximum distance of 1,20 m to 1,80 m to be connected over the entire wall height with the shuttering elements and to be fastened to the floor.

The necessary reinforcement according to static calculation shall also be installed according to the instructions in the installation guide provided by the manufacturer.

Rectangular corners, T-walls and non rectangular angles are to be formed according to Annexes B4 to B8. Typical junctions between walls and ceilings are to be formed according to Annex B12.

Further information is given in the installation guide.

### 3 Concreting

For the production of normal-weight concrete EN 206 shall apply. When compacted by vibration and by poking the consistency of the concrete shall be in the upper consistency range F3 or in the consistency range F4.

The maximum aggregate size shall be between 8 mm (for nominal concrete core thicknesses of 96 mm and 147 mm) and 16 mm (for nominal concrete core thicknesses of 197 mm to 350 mm).

Furthermore the concrete shall have rapid or medium strength development according to EN 206.

The "Extra Panel" has to be incorporated inside the cavity of the concrete core before concreting.

<sup>1</sup> see ETAG 009, clause 2.2

Shuttering kit "QUAD-LOCK"	Annex B1 Page 1 of 3
Installation	

Placing the concrete shall be performed only by persons who were instructed in the works and in the proper handling of the shuttering system.

Placing the concrete shall be performed in layers of maximum 1 m at a maximum concreting rate of 3 m/h. For curved and angled walls made with shuttering elements the concreting rate shall not exceed 1 m/h.

If equivalent national rules are not available the following instructions shall be considered:

Horizontal cold joints are to be arranged preferably at the height of the floor. If cold joints cannot be avoided within the height between the floors, vertical starter bars shall be installed. The starter bars shall meet the following requirements:

- Two adjacent starter bars shall not be situated in the same plane parallel to the surface of the wall.
- The distance between two starter bars in wall direction shall be at least 10 cm and not larger than 50 cm.
- The total section area of the starter bars shall not be less than 1/2000 of the section area of the concrete.
- Anchorage length of the starter bars on both sides of the cold joint shall be at least 20 cm.

Before the further placing of concrete, cement laitance and detached / loose concrete shall be removed and the cold joints shall be sufficiently pre-wetted. At the time of concreting the surface of the older concrete shall be slightly moist, so that the newly placed concrete can combine well with the older concrete.

If no cold joint is planned, placing of concrete in layers may only be interrupted until the concrete layer placed last has not yet set so that a good and even bond is still possible between the two concrete layers. When using internal vibrators the vibrating cylinder shall still penetrate into the already compacted lower concrete layer.

The concrete may fall freely only up to a height of 2 m, beyond that the concrete shall be cohered by discharge pipes or concreting tubes with a diameter of 100 mm at the most and shall be led shortly before the place of installation.

Cones from placing concrete are to be avoided by short distances of the places of fill in.

Planning shall allow for sufficient spaces in the reinforcement for discharge pipes or concreting tubes.

After concreting the walls may not deviate from the plumb line more than 5 mm per running meter wall height.

The ceiling shall only be placed on walls made of shuttering elements when the concrete core has sufficiently hardened.

#### 4 Ducts crossing and situated inside the wall

Horizontally passing ducts are to be installed according to the installation guide of the manufacturer and are to be taken into account when designing the wall.

Horizontal ducts situated inside the concrete cores and running parallel to the wall surfaces shall be avoided. If absolutely necessary, these are to be taken into account when designing the wall.

Also vertical ducts in the concrete core shall be considered, if their diameter exceeds 1/6 of the thickness of the concrete core and the distance of the ducts is less than 2 m.

#### 5 Reworking and finishes

Walls of the type "QUAD-LOCK" are to be protected by finishes (e. g. rendering, plasters, cladding, panelling, coatings). Finishes are not part of the kit and therefore not considered in this ETA. Preferably for external surfaces the rendering systems used should meet the requirements of ETAG 004. Other claddings may be used in accordance with the rules valid at the place of their use. The cladding respectively panelling or their substructures shall be anchored in the concrete core. The execution of the rendering shall be performed according to applicable national rules.

The protection by finishes should be implemented preferably within one month after erecting the load-bearing structure, because of the detrimental influence of weather and UV radiation on the surface of the EPS shuttering leaves.

Shuttering kit "QUAD-LOCK"	Annex B1 Page 2 of 3
Installation	

## 6 Indications to the manufacturer

### 6.1 Packaging, transport and storage

The shuttering elements have to be protected against damage, soiling and intensive action of water during transport and storage. If necessary the shuttering elements shall be covered.

### 6.2 Use, maintenance, repair

Regular checks should be carried out on renderings and finishes to ensure that any damage is detected and repaired as soon as possible.

The recommendations on use, maintenance and repair in ETAG 009, clause 7.5 shall be considered.

The shuttering elements have to be protected against high temperature, overheating and intensive exposure to weather and UV radiation. If necessary, the shuttering elements have to be covered.

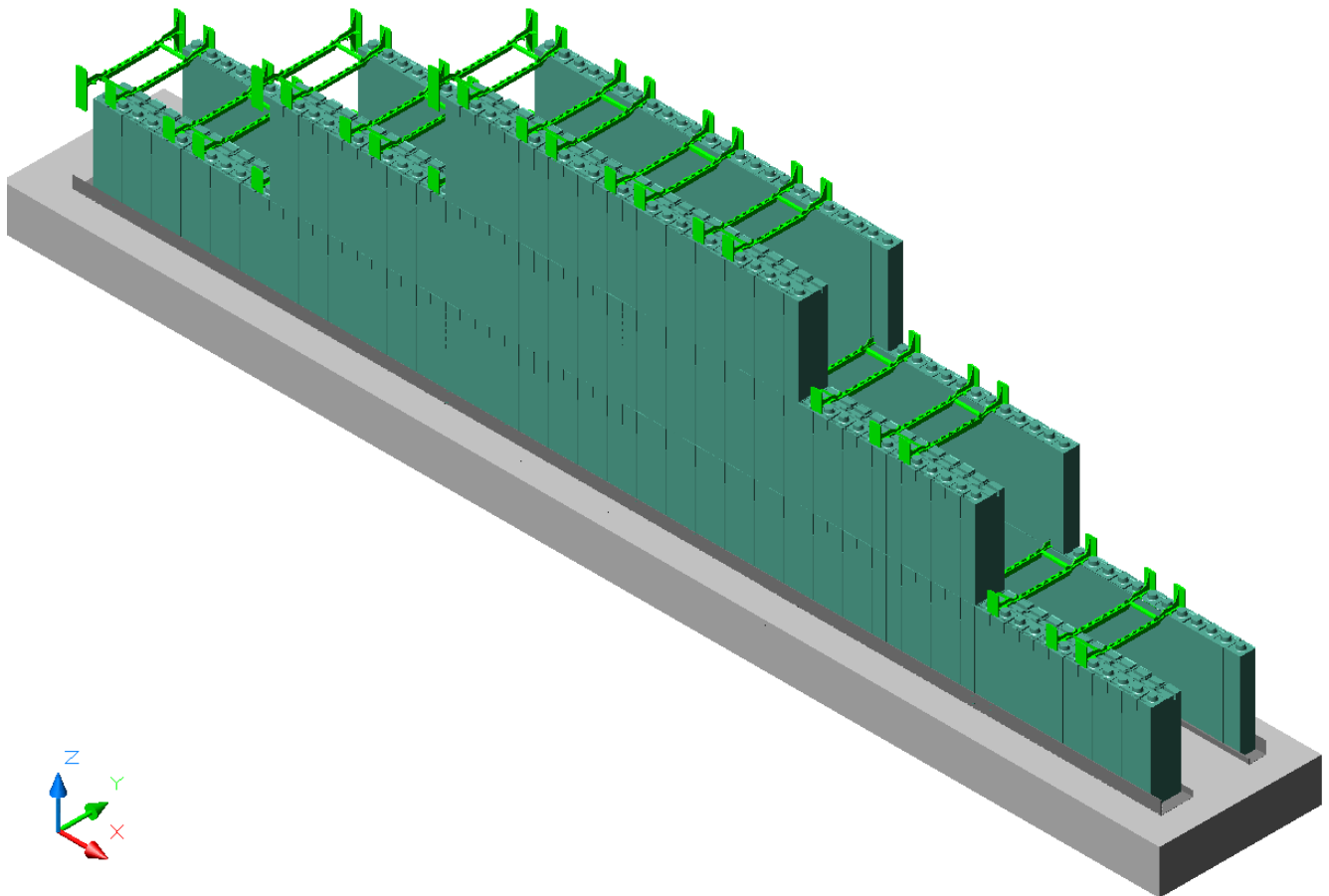
Shuttering kit "QUAD-LOCK"	Annex B1 Page 3 of 3
Installation	

standards and guidelines	issue	title
EN 206	2013	Concrete – Specification, performance, production and conformity
EN 1992-1-1	2004 +AC:2010	Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings;
EN 13163	2012 +A1:2015	Thermal insulation products for buildings – Factory made expanded polystyrene (EPS) products – Specification
EN 13501-1	2007 +A1:2009	Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests;
EN 13501-2	2016	Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services;
EN ISO 6946	2007	Building components and building elements – Thermal resistance and thermal transmittance – Calculation method (ISO 6946:2007);
EN ISO 10456	2007 +AC:2009	Building materials and products – Hygrothermal properties – Tabulated design values and procedures for determining declared and design thermal values (ISO 10456:2007 + Cor. 1:2009);
EN ISO 13788	2001	Hygrothermal performance of building components and building elements . Internal surface temperature to avoid critical surface humidity and interstitial condensation . Calculation methods (ISO 13788:2001);
ETAG 004	2013-06	Guideline for European technical approval of "External thermal insulation composite systems with rendering"
ETAG 009	2002-06	Guideline for European technical approval of "Non load bearing permanent shuttering kits/systems based on hollow blocks or panels of insulating materials and sometimes concrete"
Shuttering kit "QUAD-LOCK"		Annex B2
List of standards and guidelines		

The vertical joints between two elements of one layer shall be shifted of at least a quarter of the element length, better a half of the element length, to the vertical joints of the previous and next layer.

HDPE ties shall be placed every 305 mm [12"] vertically and horizontally in such a way that their mid-axis are in plane with the deeper vertical grooves at 305 mm [12"] centres on the outside face of each EPS shuttering leaf.

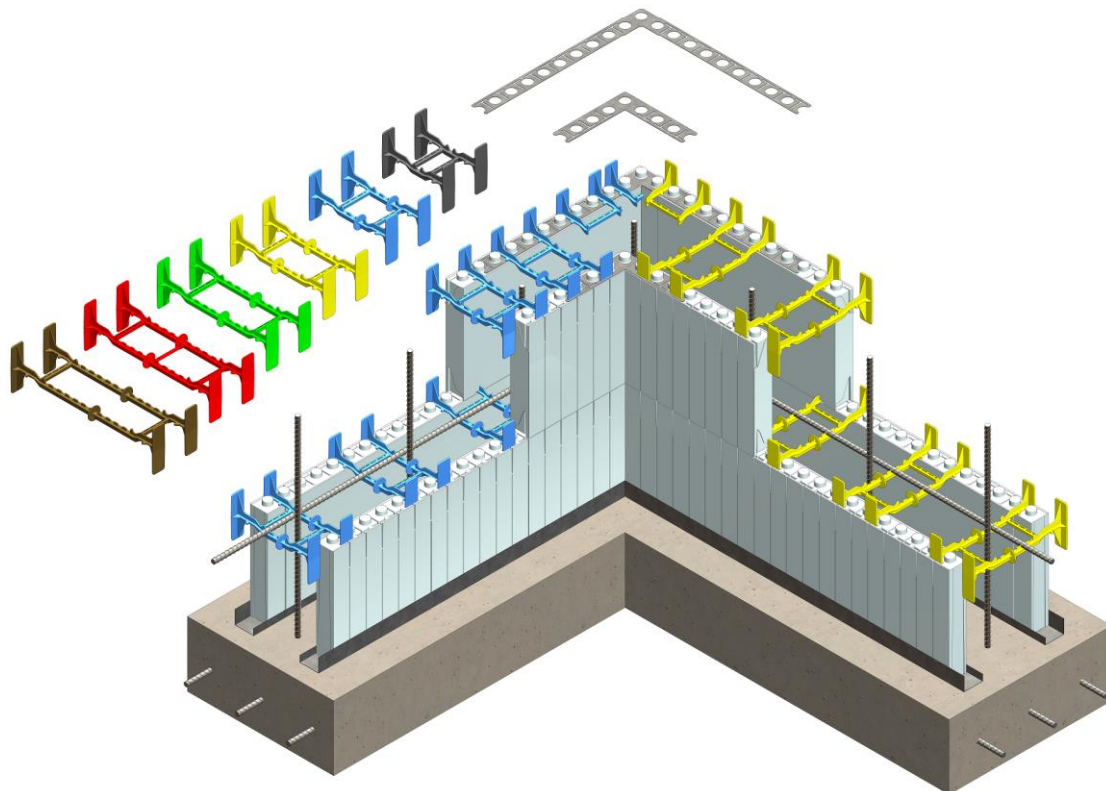
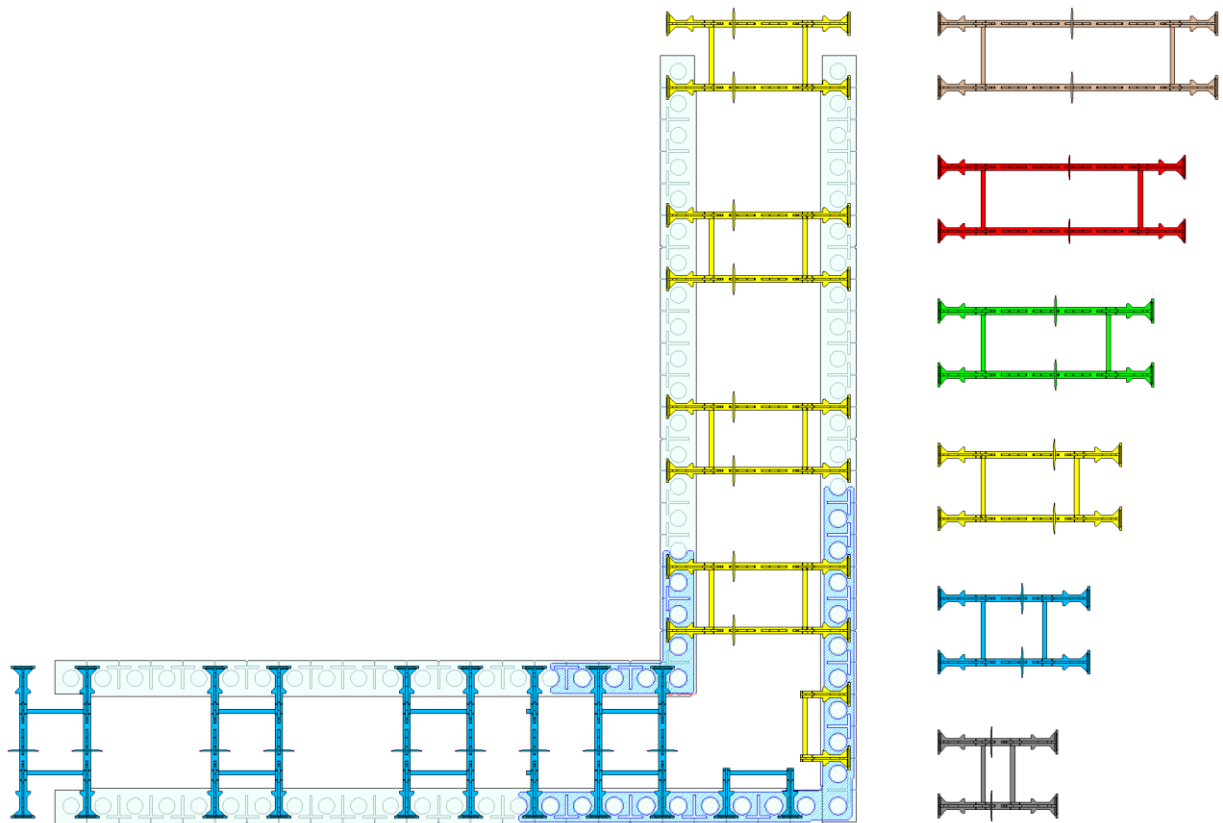
Metal tracks shall be securely fastened to concrete base.



Shuttering kit "QUAD-LOCK"

Arrangement of EPS shuttering leaves and HDPE ties in a straight part of a wall

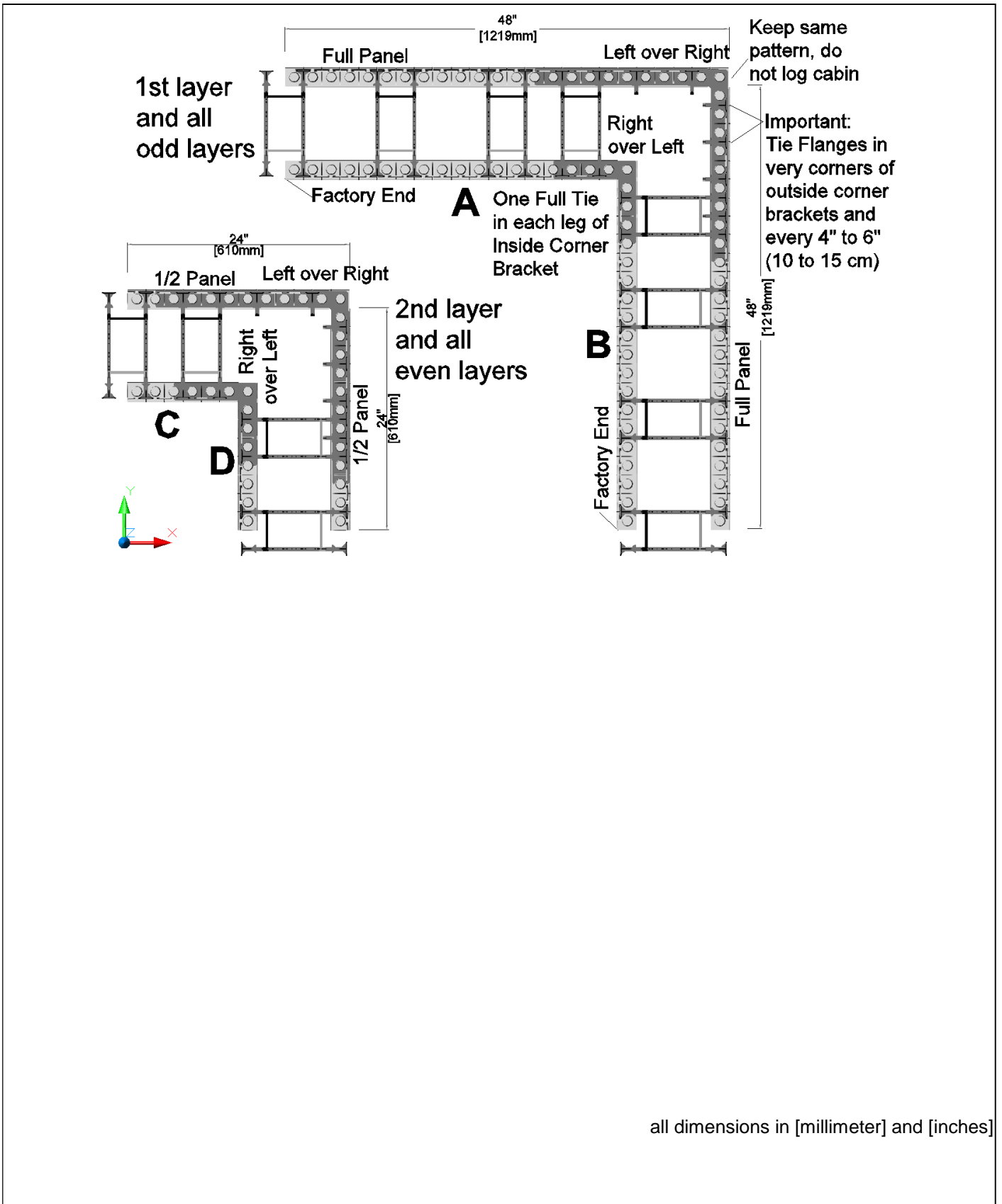
Annex B3



Shuttering kit "QUAD-LOCK"

Construction of rectangular corners:  
Placement of EPS shuttering leaves, HDPE ties and corner brackets

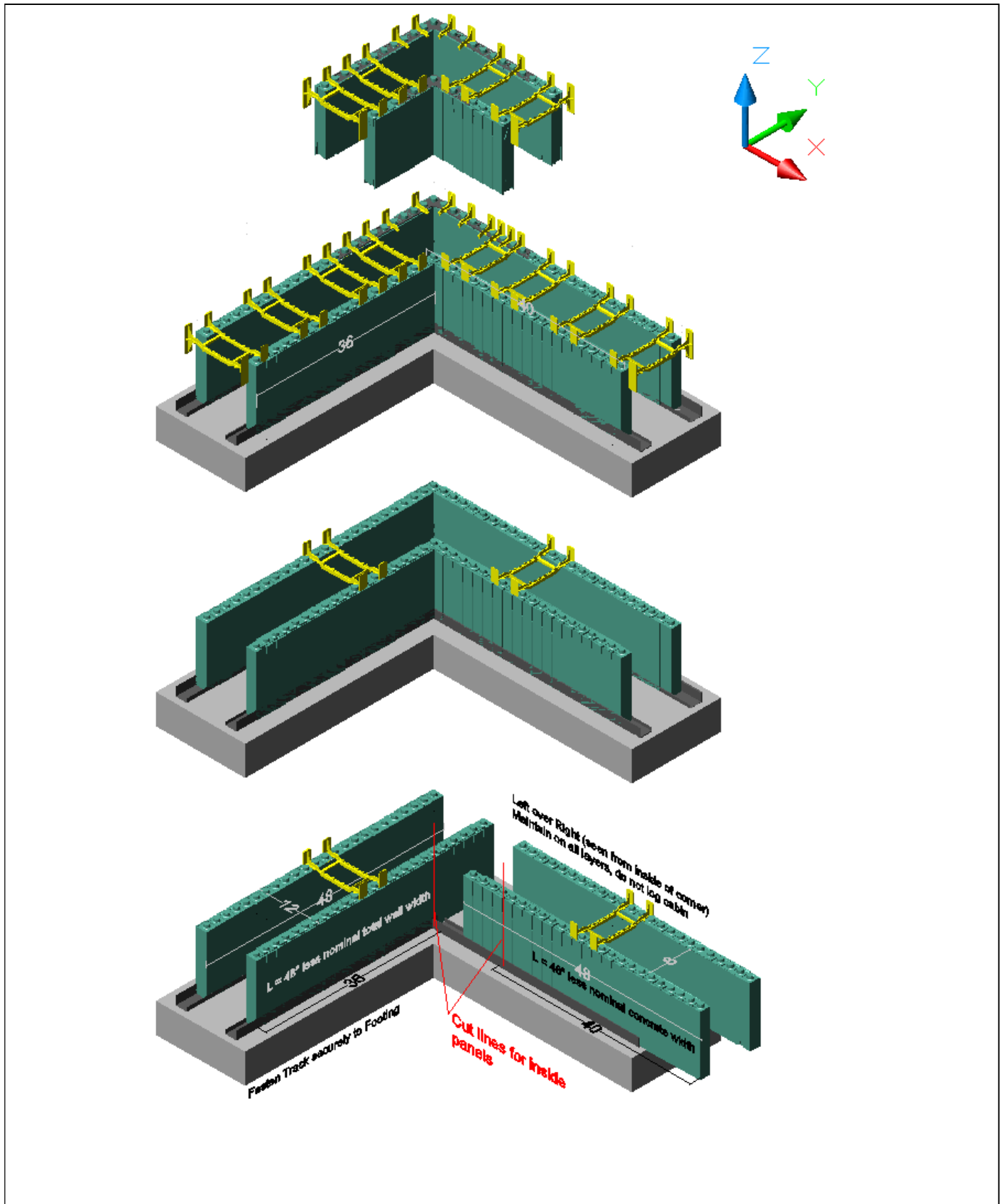
Annex B4



all dimensions in [millimeter] and [inches]

Shuttering kit "QUAD-LOCK"	Annex B5
Construction of rectangular corners: Placement of EPS shuttering leaves, HDPE ties and corner brackets	

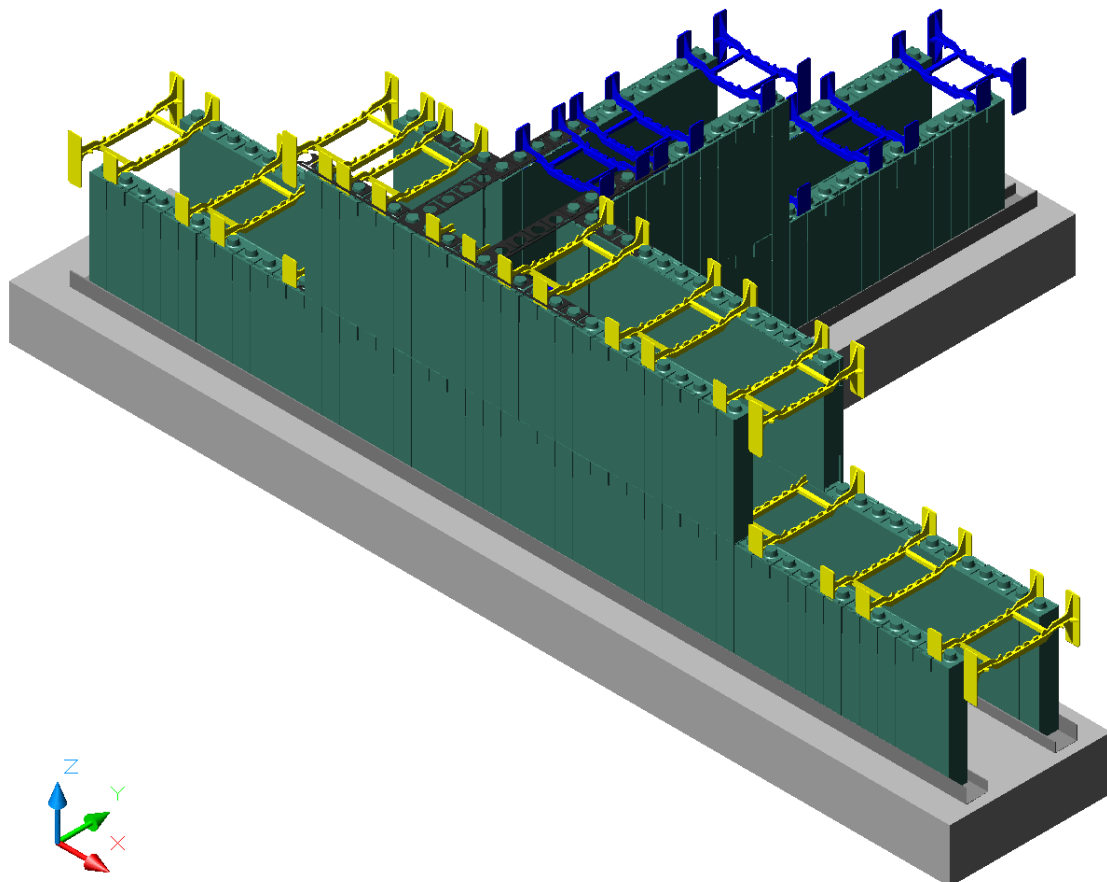
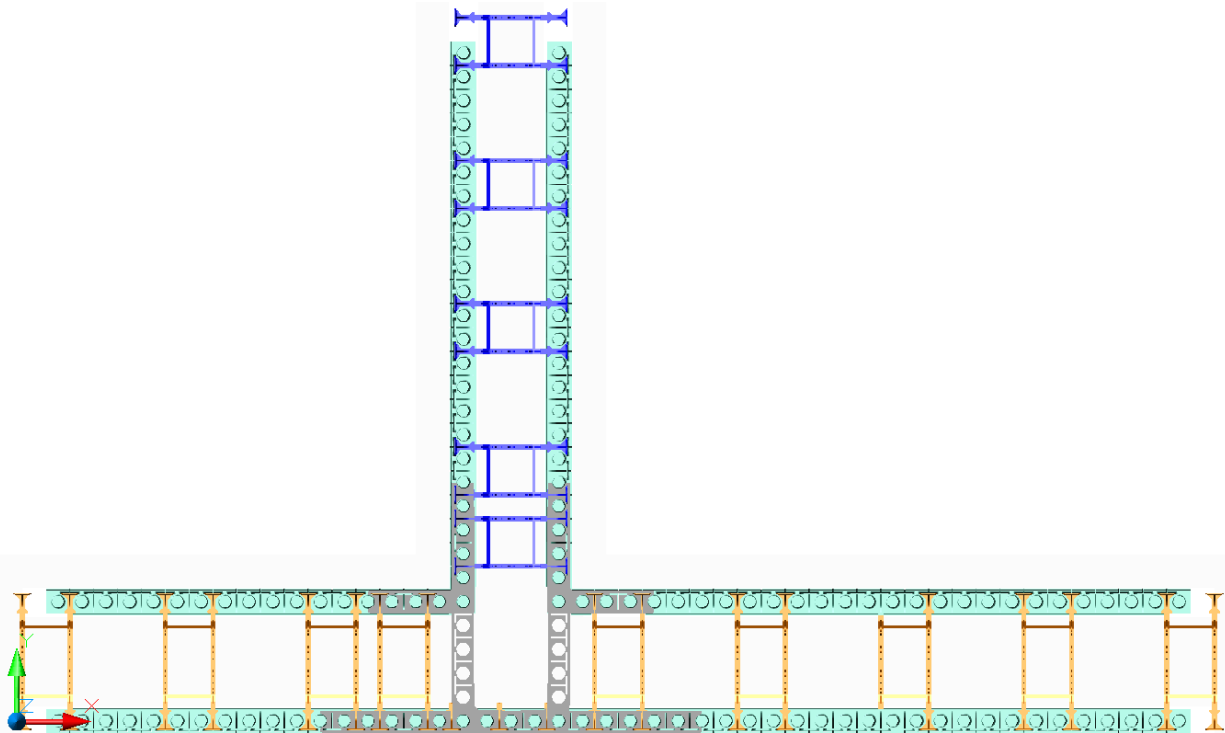




Shuttering kit "QUAD-LOCK"

Construction of rectangular corners – sequence:  
Placement and cutting of EPS shuttering leaves, HDPE ties and corner brackets

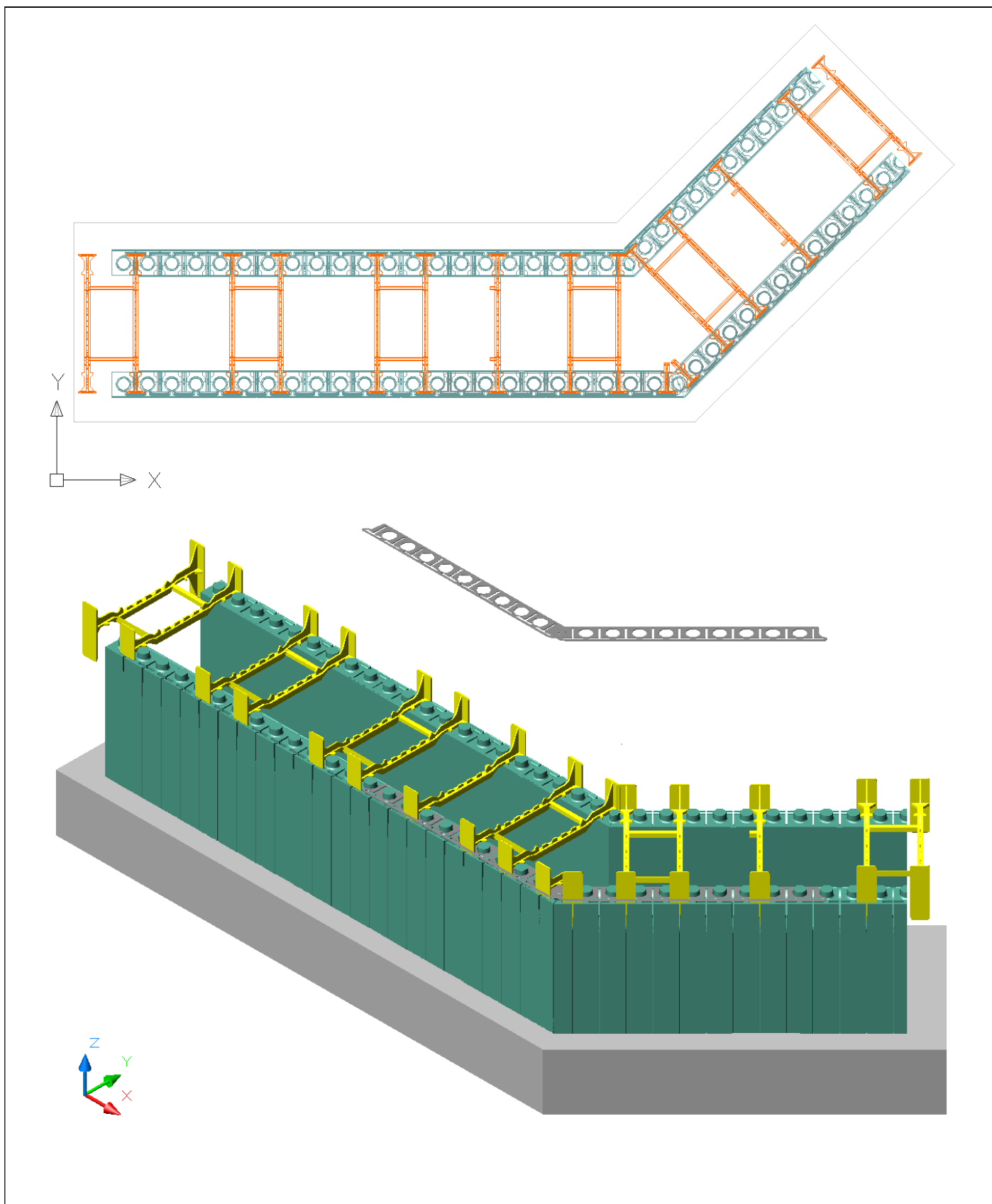
Annex B6



Shuttering kit "QUAD-LOCK"

Construction of T-walls:  
Placement of EPS shuttering leaves, HDPE ties and corner brackets

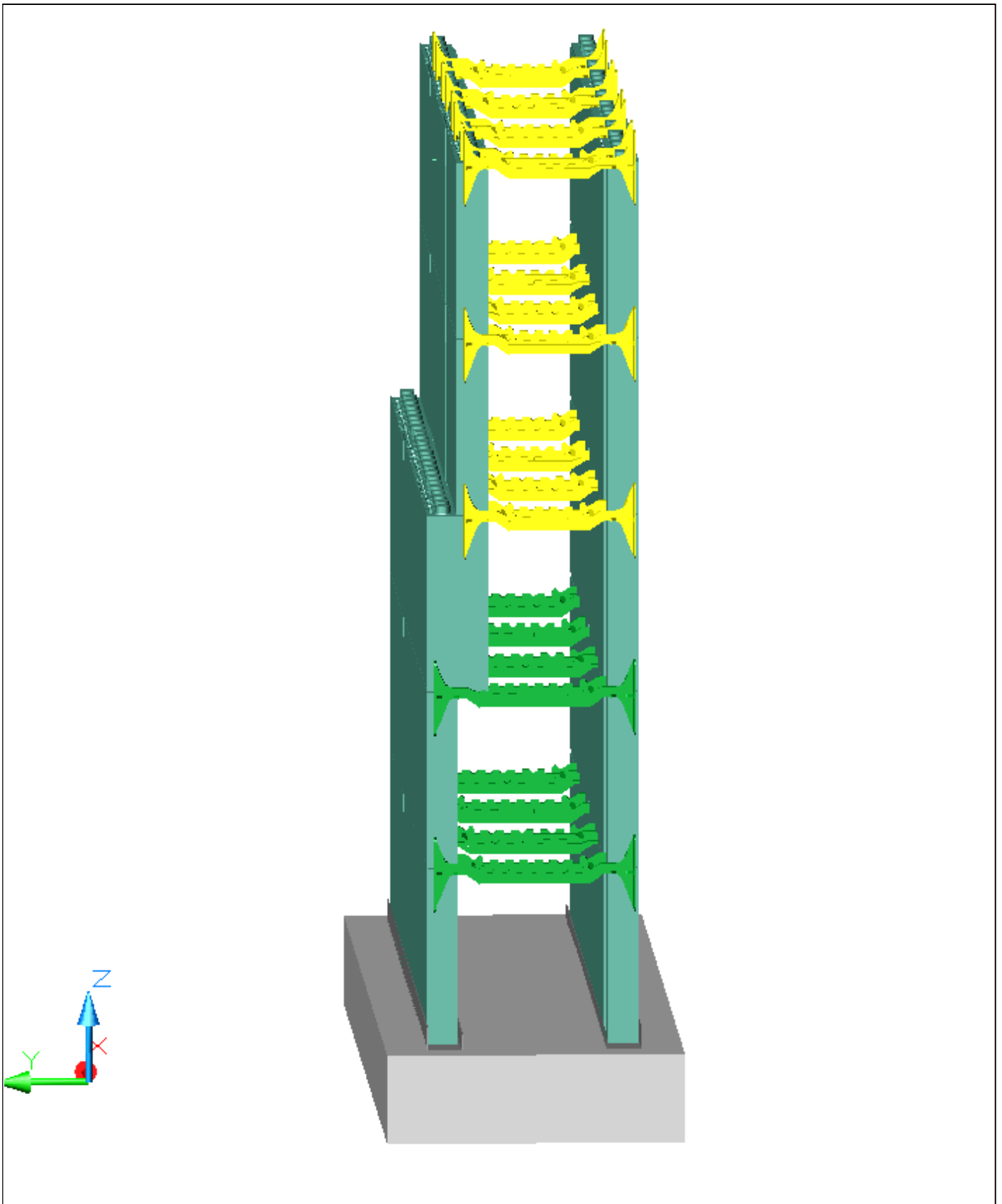
Annex B7



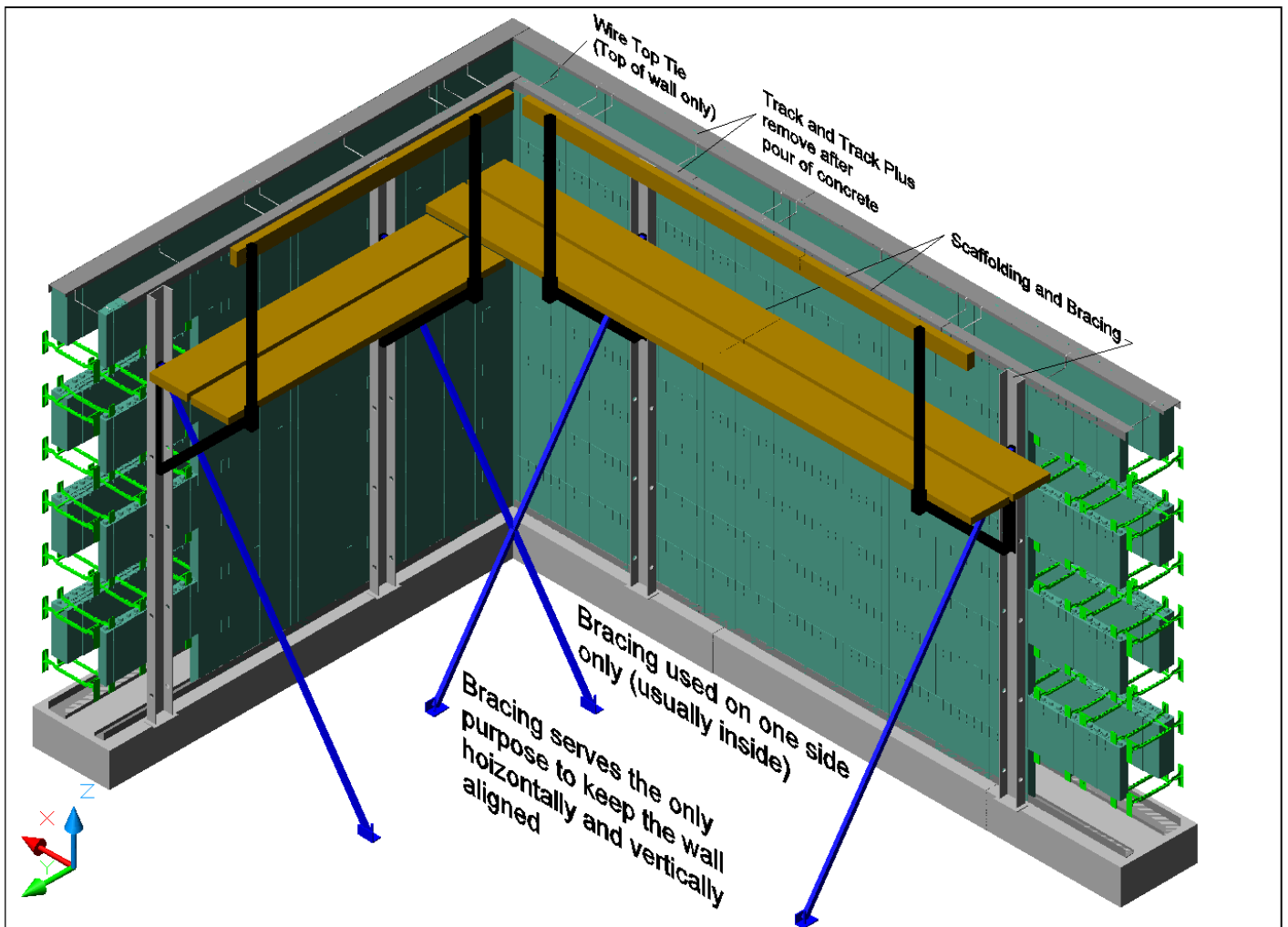
Shuttering kit "QUAD-LOCK"

Construction of non rectangular corners:  
Placement of EPS shuttering leaves, HDPE ties and angle brackets,  
no bracing outside required (regular bracing inside only)

Annex B8



Shuttering kit "QUAD-LOCK"	Annex B9
Construction of a transition between different thicknesses of a wall by using QUAD-LOCK "Plus Panel"	



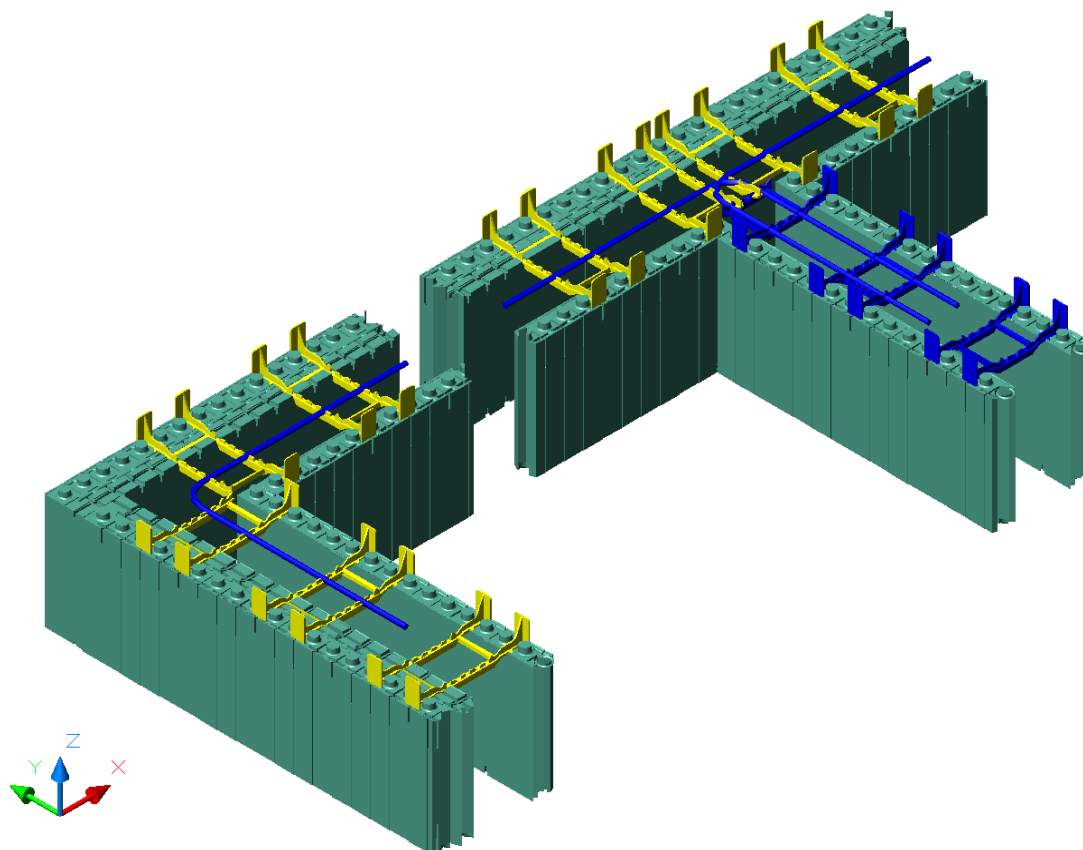
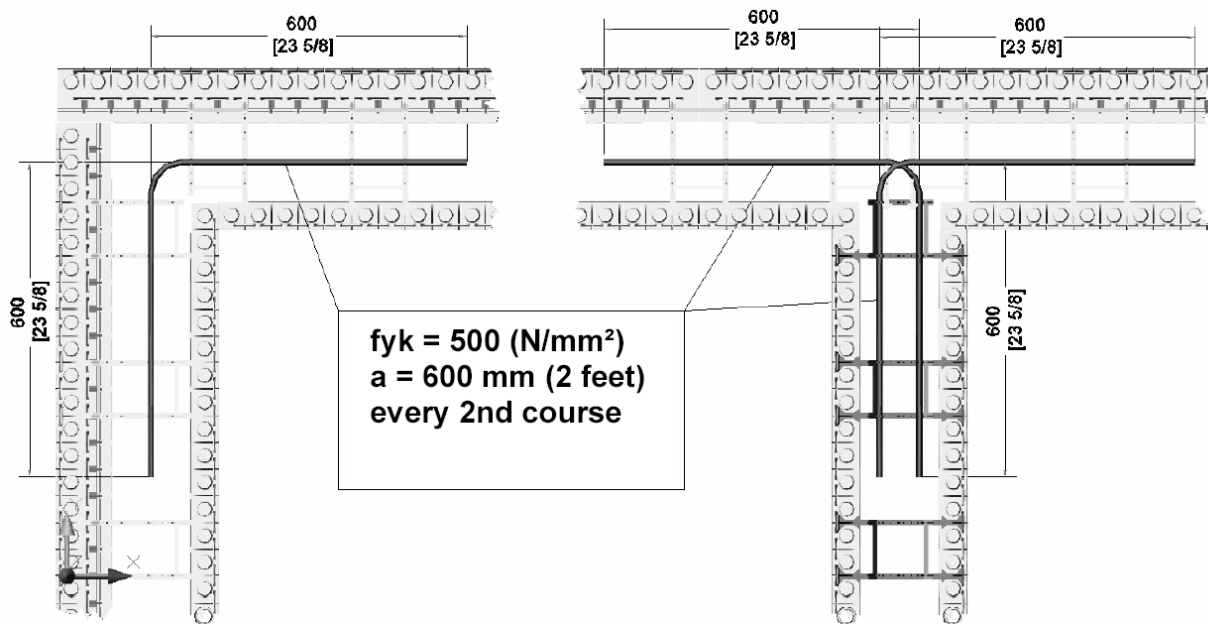
**Bracing 60 cm (2 feet) apart the corner and then with a distance of 120 cm to 180 cm (4 to 6 feet)**

Shuttering kit "QUAD-LOCK"

Bracing in order to keep the wall horizontally and vertically aligned during the placing of concrete

Annex B10

## Horizontal reinforcement steel for buildings higher than 5 floors



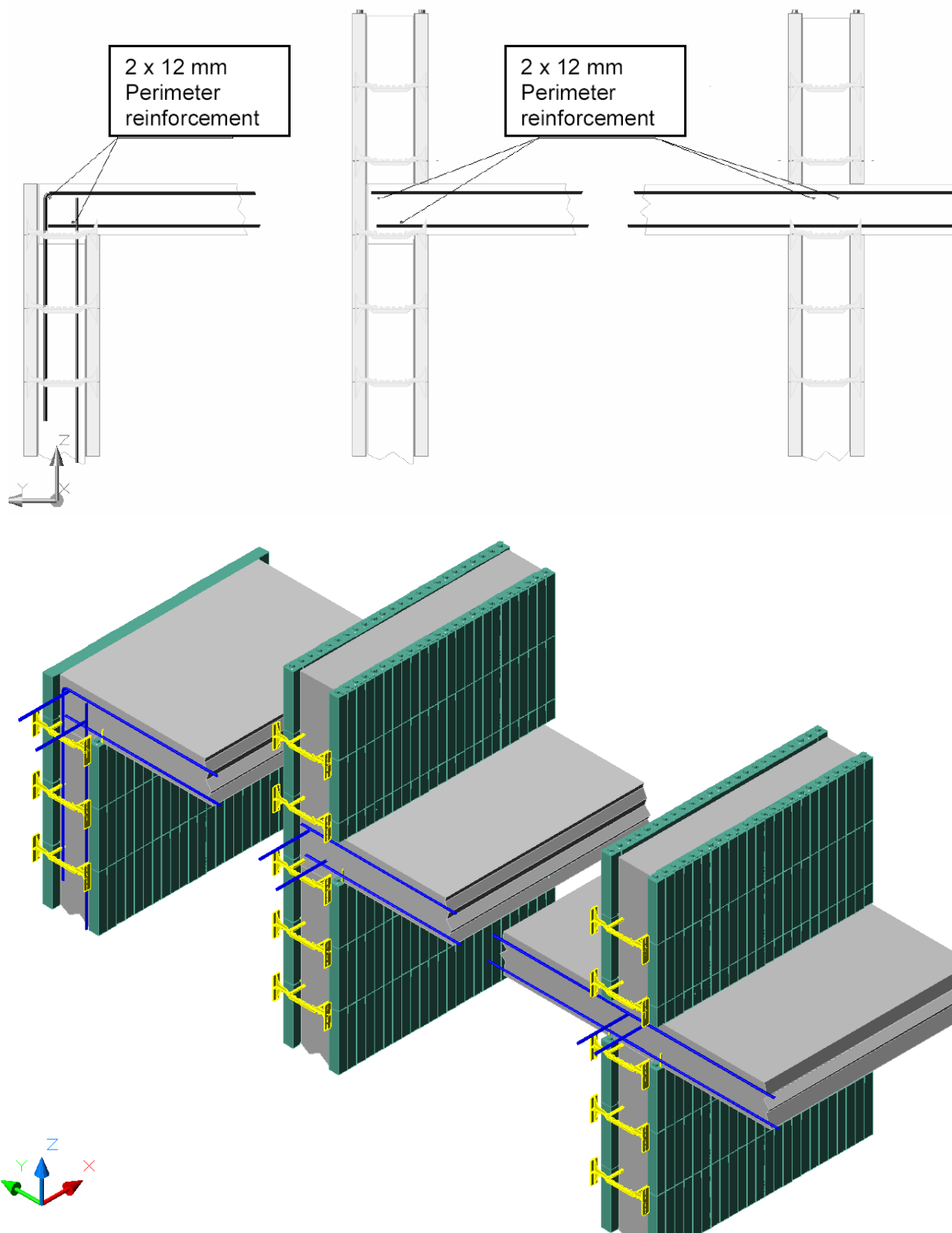
all dimensions in [millimeter] and [inches]

Shuttering kit "QUAD-LOCK"

Placement of horizontal reinforcement steel for buildings higher than 5 floors

Annex B11

## Wall and ceiling: vertical sections

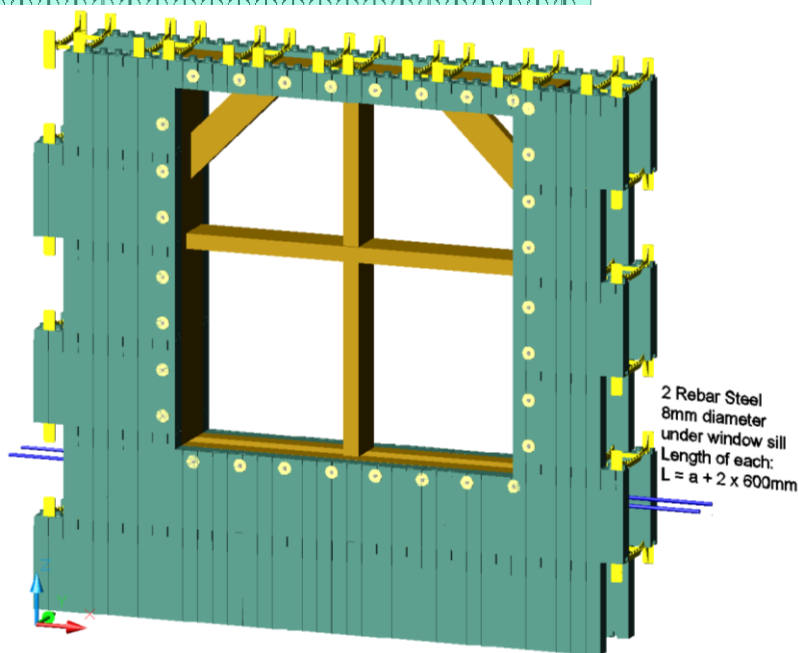
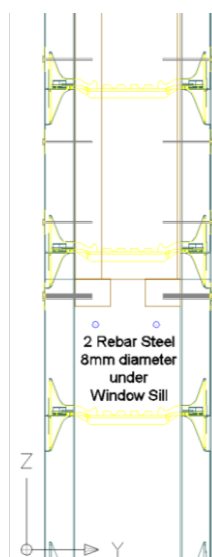
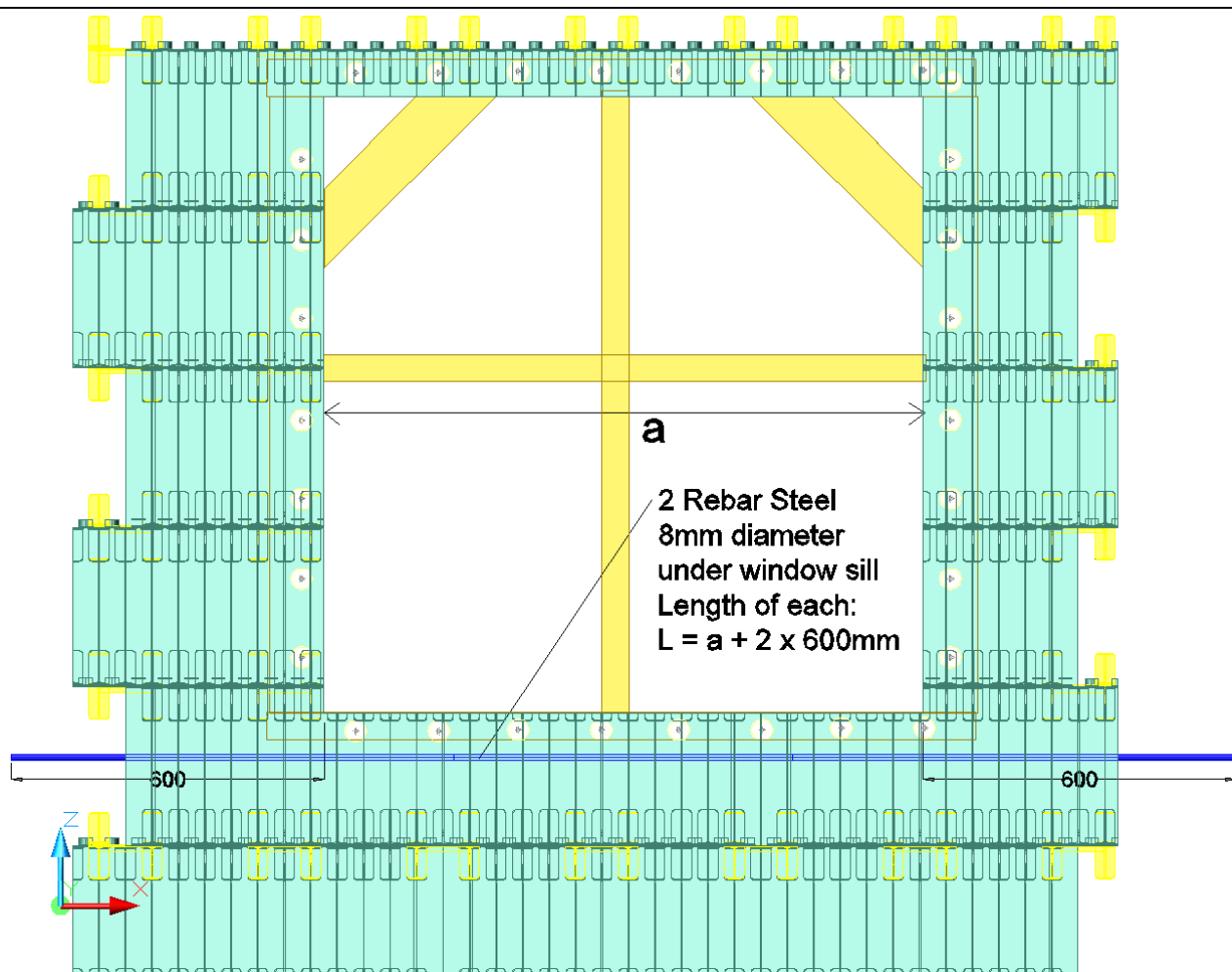


Shuttering kit "QUAD-LOCK"

Vertical sections at concrete floors

Annex B12





Shuttering kit "QUAD-LOCK"

Reinforcement steel under openings

Annex B13