TECHNICAL REPORT

LEGNOTRE INDUSTRIALE SPACER FOR FORMWORK 40 KN / m^2

REFERENCES

- DIN 18218:2010-01 Pressure of fresh concrete on vertical formwork;
- UNI EN 1993-1-1 Design of steel structures;
- Directive 2009/104/CE_ Annex I Minimum Requirements;

RAW MATERIAL

Cold rolled steel plate obtained by cold plastic deformation of low carbon wire rod.

Reference standard: UNI EN 10139

Classification: DC01 C690

Geometric characteristics:

Width = 18,50-19,00 mm

Thickness = 1,65-1,70

Mechanical characteristics:

Ultimate tensile strength = 820-900 MPa

Yield strength = 790-870 MPa

Elongation A80 min = 2%

Elongation A80 max = 3%

For the technical data sheet and the test certificate see respectively Annex A and Annex B.

CALCULATION DIAGRAM

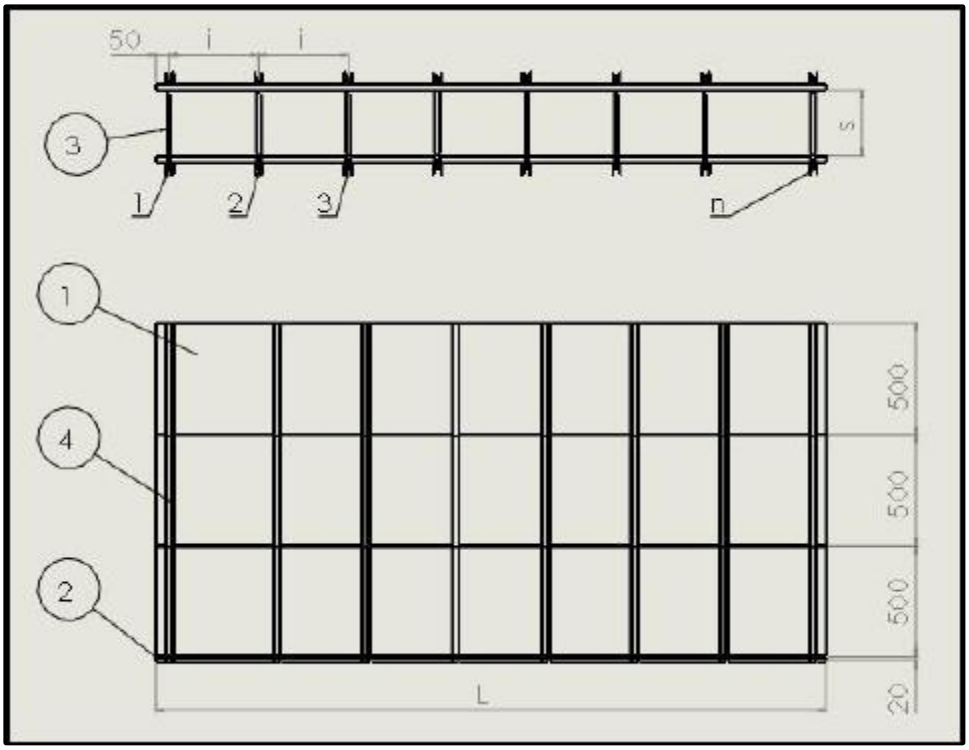

Fig. 1 : Schematic diagram of a formwork in place

References in Fig. 1 :

1 = Single wooden panel, fixed sheet height equal to 500 mm and variable length L;

2 = Wooden floor base, fixed height equal to 20 mm and variable length L;

3 = Individually numbered spacer: 1,2,3,…,n;

4 = Vertical strut that joins together spacers and wooden panels through wedges.

5 = First and last spacer placed at a maximum of 10 cm from the edge of each panel.

LOADS

The spacers are disposable equipment, since they remain inside the solidified concrete, moreover they are deemed subject to a sheer traction load deriving from the pushing force of the fresh concrete introduced in the formwork.

Characteristic parameters that describe the process of introducing the fresh concrete into the formwork (as the filling speed; the direction of the pouring of the fresh concrete with respect to the vertical direction of the rising of the free surface), parameters for setting the type of concrete that is being used, tools and methods used for compacting the pouring concrete and compliance with the time span required for the consolidation of the concrete - all these parameters refer to the procedures laid down in the standard DIN 18218: 2010.

In particular, the spacers covered by this report are restricted to being used with wood panels (see Fig.1) which, in turn, are to be used with a maximum pressure of 40kN /m^2.

As specified in Paragraph 5.1 of the standard DIN 18218: it has been decided to use a characteristic value of lateral fresh concrete pressure "σ_{hk}" equal to 40 kN/m^2, multiplied by the coefficient "$Y_{F''}$ = 1.5 (partial safety factor) as indicated in Paragraph 4.2 of the standard DIN 18218. Thus, design value of lateral fresh concrete pressure "σ_{hd}" is equal to:

$\sigma_{hd} = Y_F \times \sigma_{hk}$ = 1,5 x 40 = 60 kN/m^2.

Furtherly restricting the equation to a hydrostatic type of calculation, therefore:

σ_{hk} *(value of lateral fresh concrete pressure) = Yc (density of fresh concrete) x h (height of concrete)*

where:

Yc =25 kN/m^3 density of the fresh concrete;

h= height of fresh concrete.

If σ_{hk} *(value of lateral fresh concrete pressure) = 40 kN*

h (height of fresh concrete) = 40kN/m^2 : 25kN/m^3 = 1,6 meters

h = height limit to remain within the limits of the "σhd" by using a pressure calculation of the hydrostatic type.

It is permitted to raise the free surface of the poured concrete above h = 1.6 m, making a calculation of the design value of lateral fresh concrete pressure "σ_{hd}" according to the standard DIN 18218: 2010.

Once more, according to the standard DIN 18218: 2010, the diagram of the distribution of fresh concrete pressure over the height of formwork is not to be assumed triangular (hydrostatic pressure) but it is to be assumed rectangular (Fig.1 DIN 18218: 2010), precisely for those cases when the free surface of the fresh concrete exceeds the height limit for the hydrostatic type of calculation, h = 1.6 m.

Referring to Fig. 1, to each spacer is assigned an area of relevance "A_R" which is affected by the "σ_{hk}" generated by the fresh concrete and which is thus expressed:

$A_R = i_V \times i_L$

Where: A_R = *Area of relevance of 1 spacer [mm^2];*

i_V = *interaxis between the spacers in a vertical direction [mm].*

i_L = *interaxis between the spacers in a longitudinal direction [mm].*

i_V *=500 mm determined by the height of the panels used in building the formwork (see Fig.1).*

Subsequently, the interaxis between the spacers "i_L" will be obtained, so that the spacer is thus tested.

GEOMETRY

Fig. 2 shows the geometric characteristics of the spacers.

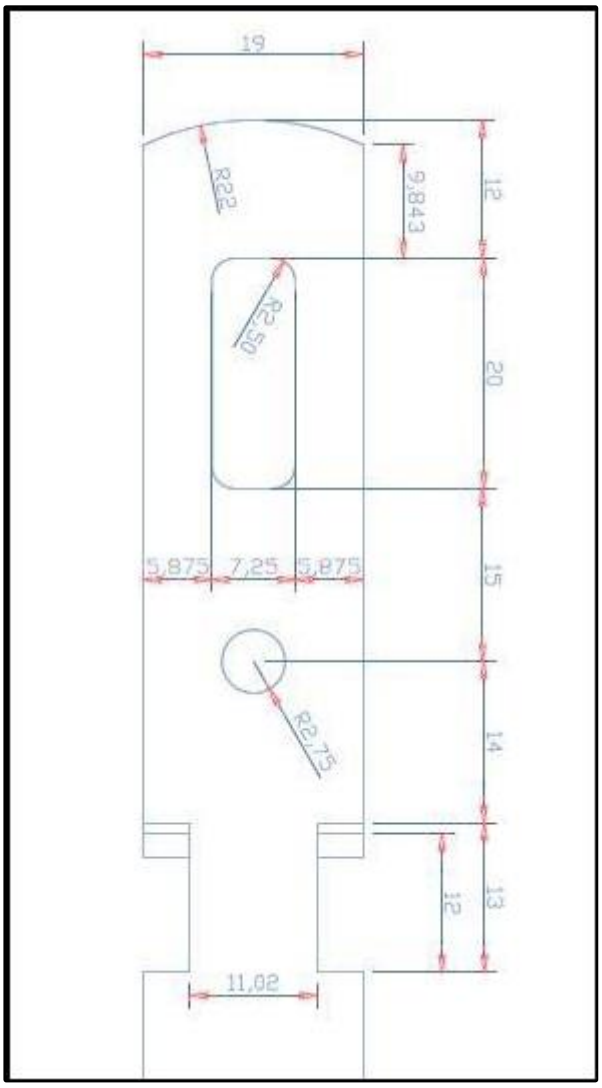

Fig.2 : Detail of the Spacer's Head

TESTS

Annex C shows the test report n ° 15198-2019 carried out by RTM BREDA SRL and comprises the results obtained in the ultimate tensile strength tests of several Spacers; the tests were carried out on spacers of different lengths, of the same material, but of different lots. Spacers of different lengths are made with different molds; by doing so, the most cautious combinations of material/mold are obtained for the tests.

With each mold a different resistant section is obtained.

From here on, reference will always be made to the minimum resistant section, of nominal width equal to 11.02 mm (see Fig.2) which in Annex A is identified as a calibrated section, and it is where the breakage of all the tested samples happens.

Minimum section:

With reference to the table on page 2 of Annex C, the minimum section "A min" "is equal to:

A min = 1,66 x 11,12 = 18,46 mm^2

Minimum tensile strength "Rm min" :

With reference to the table on page 2 of Annex C, the minimum tensile strength "Rm min" obtained is equal to:

Rm min = 16200 / (1,81 x 11,07) = 808 Mpa

Amplification coefficient "Kt max":

With reference to the table on page 2 of Annex C, the maximum amplification coefficient "*Kt max*" calculated is obtained and it is connected to the cutting of the bent tongues of the spacers:

Kt max = Rm max / Rm min = 900 / 808 = 1,11

Where: - Rm max = Max ultimate tensile strength [*MPa*] *of the material taken from Annex A, technical data sheet*

-Rm min = Min ultimate tensile strength [*MPa*] *of the material taken from Annex C, technical data sheet*

Minimum tensile force:

At this point it is possible to obtain the tensile force which causes the spacer to break:

F min = (Rm min / *Kt max)* x *Amin = (820 / 1,11) x 18,46 = 13637 N*

The force deriving from the longitudinal interaxis between the spacers i_O = 400 mm:

F = i_L *x* i_V x σ_{hd}"= 0,4 x 0,5 x 60000 = 12000 N

13637 > 12000 VERIFIED

Thus, the maximum longitudinal interaxis between the spacers "i_L" is to be used where the characteristic value of lateral fresh concrete pressure "σhk" (calculated according to DIN18218) is required to be equal to 40 kN/m^2 , the maximum value of i_L allowed on wooden panels (with i_V= 500 mm) is i_L = 400 mm.

CONCLUSIONS

Hereunder follows an extract of the Directive 2009/104 /CE - Annex I, with regard to the minimum general requirements applicable to work equipment - Item 2.7:

"Where there is a risk of rupture or disintegration of parts of the work equipment, likely to pose significant danger to the safety and health of workers, appropriate protection measures must be taken".

The spacers produced by the company Legnotre Industriale Srl have been verified according to the prescriptions of the standard DIN 18218: 2010-01, so that point 2.7 of Annex I of the Directive 2009/104 /CE can be considered fulfilled, as far as the structural dimensioning of the spacers is concerned.

Finally, we want to give an account of the safety factors used in this calculation report, as follows:

- 1.5 with respect to the loads;
- stress intensity factor Kt_max = 1.11;
- 13637/12000 = 1,136 with respect to the final collapse (or ultimate state);

Combining the factors relating to the loads and the final collapse (or ultimate state), we obtain a global safety factor equal to vs = 1.5 x 1.136 = 1.7.

Selvazzano Dentro , 27/08/2019

Luchetti Ing. Marco

Iscr. Albo degli Ingegneri di Padova n.6342

ORDINE DEGLI INGEGNERI DELLA PROVINCIA DI PADOVA
MARCO LUCHETTI
INGEGNERE
SEZ. A - n° 6342
SETTORE: INDUSTRIALE

Annex A

SCHEDA TECNICA PIATTO DISTANZIALE

Prodotto: Piatto laminato a freddo realizzato mediante deformazione plastica a freddo di vergella basso C.

Normativa di riferimento: UNI EN 10139 DC01 C690

ANALISI CHIMICA

	C	*Mn*	*Si*	*P*	*S*
	[%]	*[%]*	*[%]*	*[%]*	*[%]*
min	-	-	-	-	-
max	*0,12*	*0,60*	*0,20*	*0,045*	*0,045*

CARATTERISTICHE GEOMETRICHE E MECCANICHE

Larghezza	*Spessore*	*Carico di rottura*		*Carico di snervamento*		*Allungamento A80*		*Strizione (*)*
[mm]	*[mm]*	*Rm min [MPa]*	*Rm max [MPa]*	*Rs min [MPa]*	*Rs max [MPa]*	*A80 min [%]*	*A80 max [%]*	*[%]*
18,50-19,00	1,65-1,70	820	900	790	870	2,0	3,0	40

* il valore della strizione è indicativo in quanto le dimensioni per il calcolo non sono determinabili con precisione.

Annex B

Azienda con i seguenti sistemi di gestione certificati:
- qualità secondo UNI EN ISO 9001:2015
- ambiente secondo UNI EN ISO 14001:2015

CERTIFICATO DI COLLAUDO

Inspection Certificate - Abnahmeprüfzeugins - Certificate de Réception

EN 10204 3.1
LAM 19,00X1,70

PRODOTTO C4200524
Product **LAM 19,00X1,70**
Erzeugnis
Produit
NORMATIVA
Standard

N° DOC. di TRASP. 07456 2019
Dispatch Note / Lieferschein / Avis d'expédition

N° ORDINE 201904180 / 4
Order / Bestellung / Commande

CONFERMA MAIL DEL 21/06/19
Confirmation / Auftragsbestätigung / Confirmation de commande

CLIENTE
Customer / Besteller / Client

LEGNOTRE INDUSTRIALE S.R.L.
VIA DELLA TECNICA 29/31 36075
MONTECCHIO MAGGIORE VI IT

COLATA N° Heat / Schmelze / Coulée	ANALISI CHIMICA di COLATA % - Heat Chemical composition % - Schmelze Chemische zusammensetzung % - Composition chimique sur coulée %														
	C	Mn	Si	P	S	Cr	Ni	Mo	Cu	Sn	Al	V	Ti	B	N
12594/2019	0.05	0.40	0.09	0.006	0.017	0.05	0.09	0.02	0.18						

	CARATTERISTICHE MECCANICHE - Mechanical properties - Mechanische kennwerte - Characteristics mecaniques									
	Diametro effettivo Actual diameter	Larghezza effettiva Actual Width	Altezza Effettiva Actual Height	Resistenza snervamento Yield Point	Resistenza rottura Tensile strength Rm	Allungamento Elongation A5	Strizione Reduction Z	Resilienza KV Impact Test		Durezza Hardness HRB
	mm	mm	mm	MPa	MPa	%	%	C°	J	
SUL PRODOTTO On product Am Endprodukt / Sur produit		18,96	1,66		895					

ALTRE PROVE:
Other tests

ANNOTAZIONI:
Notes

Si certifica che il materiale sopra descritto è conforme all'ordine.

We hereby certify that the material described above complies with the terms of the order contract.

Es wird bestatig dass die Lieferung den Vereinbarungen bei der bestellannahme entspricht.

Nous certifions que la livraison est conforme aux stipulations de l'acceptation de la commande.

Controllo Qualità / Quality Control / Qualitätsstelle / Contrôle de Qualité

C. Ascanio

Annex C

LAB N° 0025 L

RAPPORTO DI PROVA n° 15198 - 2019

Carrè (VI), 10/07/2019

Spett.le **LEGNOTRE INDUSTRIALE SRL**
VIA DELLA TECNICA, 29/31
36075 MONTECCHIO MAGGIORE VI
ITALIA

Ordine: prev 978-19 controfirmato del 21/06/2019

I risultati delle prove sottoriportati si riferiscono esclusivamente agli esiti dei controlli effettuati sui saggi di cui alla tabella sottostante arrivati in data 24/06/2019

ID RtmBreda	Descrizione	Identificazione del cliente
A	Piatto laminato	Piatto laminato
A01	Piatto laminato	Piatto laminato (L=150mm)
A02	Piatto laminato	Piatto laminato (L=200mm)
A03	Piatto laminato	Piatto laminato (L=250mm)
A04	Piatto laminato	Piatto laminato (L=300mm)

Rapporto di prova firmato da
Elisa Novello

E' vietata la riproduzione parziale del presente Rapporto di Prova senza l'autorizzazione di RTM BREDA. Dichiarazioni false, fittizie o fraudolente e modifiche del presente certificato costituiscono reato punibile secondo le norme penali vigenti.
L'eventuale campionamento del materiale secondo modalità statistiche è da intendersi a cura del cliente.
Gli spezzoni identificati dei saggi verranno conservati per un anno; dopo tale periodo saranno rottamati.
Ogni commento contrassegnato con # indica un parere o interpretazione non soggetto ad accreditamento Accredia.

RTM BREDA SRL

Sede legale e unità operativa:
Via Po, 84 - 20032 Cormano (MI)
Tel. +39 02 61543911
Fax +39 02 61543900

Unità operativa:
Via Bianche, 18 - 36010 Carrè (VI)
Tel. +39 0445 318511
Fax +39 0445 318500

info@rtmbreda.it - www.rtmbreda.it

C.F. e P.I. IT02679480240
REA MI 1807416
Cap. Soc. € 119.900,00 i.v.
Società unipersonale soggetta all'attività di Direzione e Coordinamento di Forgital Italy S.p.a.
Via G. Spezzapria, 1 - 36010 Velo D'Astico (VI)

RTM BREDA

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO
LAB N° 0025 L

Trazione a Temperatura Ambiente

Norma di prova: UNI EN ISO 6892-1:2016 **Procedura:** PT022

Strumento utilizzato: 02171 - Macchina di prova materiali - Zwick Roell

Prog.	Data	Velocità di prova	Tipo di provetta	Senso	Temp [°C]	Dimensioni [mm]	So [mm^2]	Lo [mm]	Rm [MPa]	Rp0.2% [MPa]	Rp0.02% [-]	A4D [%]	A5D [%]	E [GPa]	Z [%]	Z.R. (+)
A01	04/07/19	A4	Flat	-	Amb.	1,81 x 11,07	20,0	-	808	-	-	-	-	-	-	I
A02	04/07/19	A4	Flat	-	Amb.	1,66 x 11,12	18,5	-	861	-	-	-	-	-	-	I
A03	04/07/19	A4	Flat	-	Amb.	1,81 x 11,25	20,4	-	817	-	-	-	-	-	-	I
A04	04/07/19	A4	Flat	-	Amb.	1,69 x 10,99	18,6	-	889	-	-	-	-	-	-	I

Saggio	Note
A01	Fmax = 16200 N
A02	Fmax = 15900 N
A03	Fmax = 16600 N
A04	Fmax = 16500 N

(+) Z. R.: I= Zona di Rottura interna al tratto calibrato. E= Zona di Rottura esterna al tratto calibrato.

RTM BREDA SRL

Sede legale e unità operativa:
Via Po, 84 - 20032 Cormano (MI)
Tel. +39 02 61543911
Fax +39 02 61543900

Unità operativa:
Via Bianche, 18 - 36010 Carrè (VI)
Tel. +39 0445 318511
Fax +39 0445 318500

info@rtmbreda.it - www.rtmbreda.it

C.F. e P.I. IT02679480240
REA MI 1807416
Cap. Soc. € 119.900,00 i.v.
Società unipersonale soggetta all'attività di Direzione e Coordinamento di Forgital Italy S.p.a.
Via G. Spezzapria, 1 - 36010 Velo D'Astico (VI)