Data Article

Dataset on the bearing capacity of curved profiles obtained by roll forming process

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A R T I C L E   I N F O

Article history:
Received 2 January 2019
Received in revised form 1 February 2019
Accepted 5 February 2019
Available online 7 March 2019

A B S T R A C T

The paper shows experimental data concerning the bearing capacity of curved profile sheets achieved by roll forming process. Two different restraint configurations were considered, respectively named A and B and representing the only bending and the axial-bending conditions. Two different experimental setup, i.e. single span with and without horizontal restraints were adopted. Trapezoidal and sinusoidal steel sheets with variable thickness and curvature radius were tested. Setup configurations, collapse mechanisms and load-deﬂection diagrams are presented.

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Specifications table

| Subject area         | Engineering |
|----------------------|-------------|
| More specific subject area | Design of steel structure |
| Type of data         | Table, ﬁgures, diagrams |
| How data was acquired| Displacement were acquired through jack and sensors. Forces were acquired through load cells |
| Data format          | Analysed |
| Experimental factors | The proﬁles used for the tests were achieved through roll forming process of ﬂat steel sheets. Flat specimens were also considered for comparison. |
| Experimental features| Load-deﬂection diagrams, failure load values for each experimental conﬁguration, pictures representing setup and collapse mechanism. |

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https://doi.org/10.1016/j.dib.2019.103749
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1. Data

Curved profile steel sheets are widely used for engineering and architectural applications, allowing to provide high performing solutions and good aesthetic requirements. By the way, current European design standards for steel structures do not provide any indication concerning how to determine the bearing capacity of such kind of profiles, limiting their practical adoption. A wide experimental test campaign was performed within the framework of the positively concluded European project GRISPE “Guidelines and recommendations for integrating specific profiled steel sheets in the Eurocodes (GRISPE)” funded by the Research Fund for Coal and Steel (RFCS-CT-2013-0018). Experimental tests aimed to determine the bearing capacity of curved profile sheets, with reference to the ‘original’ flat condition. In the present paper, data achieved from the above-mentioned experimental campaign are presented.

Tests were performed at the Karlsruhe Institute of Technology (KIT — Germany) on two different typologies of curved specimens, obtained by roll forming process: the corrugated sheets produced by Bacacier® and the trapezoidal sheets manufactured by Arcelor Mittal Construction France were studied. The experimental test campaign was performed with the aim to develop new simple methodologies for the design of curved profile sheets with different geometrical and mechanical characteristics and restraint conditions, comparing them with methods used for flat sheets.

Table 1 summarizes the main characteristics of considered steel sheet specimens, in terms of materials and geometry of the source flat samples (Fig. 1 and Fig. 2). Two different thicknesses were considered, respectively equal to 0.63 mm and 1.00 mm; different curvature radii (R) were applied resulting in profiles with variable geometry in terms of length (b) and maximum mid-span deflection (f) (Fig. 3).

### Table 1

| Type of profile | Steel grade according to EN 10346:2009 | Height [mm] | Width [mm] | Thickness [mm] |
|----------------|-------------------------------------|------------|------------|----------------|
| Bacacier 18/76 | S320GD                               | 18         | 912        | 0.63 and 1.00  |
| Arcelor Mittal 39/333 | S320GD                        | 39         | 1000       | 0.63 and 1.00  |

Fig. 1. Cross section of the sinusoidal profile 18/76.
2. Experimental design, materials and methods

2.1. Experimental test setups

Experimental tests were performed using two different configurations representing two different stress conditions, in the following respectively called Configuration A and Configuration B. Configuration A refers to single span tests without horizontal restraints: in this conditions, curved profile sheets are subjected only to bending actions. In Configuration B, single span specimens present horizontal restraints: curved steel sheets are then subjected to combined bending moment and axial force, behaving like an arch. The overall test setup is presented in Fig. 4.

In both configurations, the uniformly distributed pressure load condition was reproduced through a system of transverse steel sections and timber blocks. The load was introduced into the valleys of the corrugated sheets or into the bottom flanges of the trapezoidal ones through four lines loads located at 0.125, 0.375, 0.625, 0.875 of the span length, in a symmetric configuration. Due to the isostatic load distribution system, the 4 line-loads are equal.

The transverse steel sections were clamped to the profile; oil was used to reduce the friction between the transverse steel beams at the supports of the load distribution system. The load was applied in displacement control by monitoring the vertical deflection of the sheet; deflections were measured by two trip wire displacement sensors placed in the mid-span under the bottom flanges.

The speed application ranged between 6 and 15 mm/min; a cell load with a maximum capacity of 50 kN was used.
In the case of Configuration A (Fig. 4a), the specimens were free to move in the horizontal direction. No axial forces (or, in general negligible values of axial forces) appeared in cross-section in the middle of the span, where the bending moment reached its maximum value. The presence of the horizontal restraints in Configuration B (Fig. 4b), on the other hand, leads to additional axial forces in cross-section whereby an arch support effect arises. Thus, bending moments and axial forces act in the cross-section in the middle of the span. In Configuration B the static system of the test specimen is hyperstatic: the internal forces do not depend only from the applied load but also from the stiffness parameters of the beam and its supports. The statistic evaluation is applied on the failure loads to determine an individual characteristic (failure) load for each subset.

The ratios among bending moment and axial compression varied according to the curvature of the specimen. Fig. 5, Fig. 6 and Fig. 7 show the test setup adopted for the two different types of steel sheet in the two different flat and curved configurations (A, B).

2.2. Tested specimens

Both sinusoidal and trapezoidal curved sheets of thickness equal to 0.63 and 1.00 mm were tested adopting Configuration A. For the combined bending and axial condition (Configuration B) only trapezoidal curved profiles with thickness equal to 0.63 mm were used. Table 2 summarizes the main
characteristics of tested specimens, being 'R' the curvature radius of the curved profile, 'b' its resulting length, 'L' the distance between supports and 's' the horizontal length and 'f' the maximum height of the curved profile, as simply presented in Fig. 3.

The effective radius of curvature differs from the designed value, due to tolerances in the curving process. The real height of the arch in correspondence of the two ends was then measured, adopting the mean value to identify the real 'R'. Since the spread among the heights of the test family is small, the mean radius is considered representative for all the specimens of the same family.

Table 3 summarizes the effective geometry of tested specimens. For each specimens a specific tag including the typology of profile (18—sinusoidal; 39—trapezoidal), the height of the profile (f) and the
Table 2
Main characteristics of tested specimens.

| Configuration | Profile R (mm) | B (mm) | L (mm) | s (mm) | f (mm) | α (°) | n. tests |
|---------------|---------------|--------|--------|--------|--------|-------|----------|
| A 18/76 tN = 0.63 mm | ∞ | 2200 | 2000 | 2200 | 0 | 0 | 3 |
| 18/76 tN = 1.00 mm | ∞ | 3200 | 3000 | 3200 | 0 | 0 | 1 |
| 39/333 tN = 0.63 mm | ∞ | 3200 | 3000 | 3200 | 0 | 0 | 3 |
| 39/333 tN = 1.00 mm | ∞ | 4200 | 4000 | 4200 | 0 | 0 | 2 |
| B 39/333 tN = 0.63 mm | 6 | 3239 | 3000 | 3200 | 217 | 30.93 | 2 |

Table 3
Effective geometry of the curved profile sheets.

| Test spec. | Span L (m) | Height of the arch | Radius (m) | Slope at support |
|------------|------------|--------------------|------------|-----------------|
| Test spec. | left side  | right side | Mean value | Mean value | a/2 (arc) |
| 18-30-063-1 | 2 | 40 | 47 | 43.8 | 11.50 | 0.087 |
| 18-30-063-2 | 2 | 40 | 48 | 52.3 | 9.60 | 0.104 |
| 18-154-063-1 | 2 | 120 | 115 | 118.8 | 4.30 | 0.236 |
| 18-64-100-1 | 3 | 75 | 60 | 65.5 | 17.20 | 0.087 |
| 18-129-100-1 | 3 | 110 | 120 | 117.0 | 10.60 | 0.142 |
| 18-334-100-1 | 3 | 320 | 300 | 309.2 | 3.80 | 0.047 |
| 18-129-063-1 | 3 | 37 | 34 | 34.3 | 32.90 | 0.046 |
| 18-129-063-2 | 3 | 116 | 116 | 117.0 | 9.70 | 0.156 |
| 18-217-063-1 | 3 | 205 | 200 | 205.8 | 5.60 | 0.273 |
| 18-217-063-2 | 3 | 205 | 205 | 205.8 | 5.60 | 0.273 |
| 18-217-063-3 | 3 | 210 | 210 | 210.0 | 5.60 | 0.273 |
| 18-111-100-1 | 4 | 74 | 82 | 77.5 | 25.80 | 0.077 |
| 18-111-100-2 | 4 | 74 | 80 | 77.5 | 25.80 | 0.077 |
| 18-223-100-1 | 4 | 190 | 190 | 190.0 | 10.60 | 0.189 |
| 18-223-100-2 | 4 | 190 | 190 | 190.0 | 10.60 | 0.189 |
| 18-380-100-1 | 4 | 320 | 327 | 321.8 | 6.40 | 0.319 |
| 18-380-100-2 | 4 | 325 | 315 | 325.0 | 6.40 | 0.319 |
| H-39-217-063-1 | 3 | 200 | 210 | 206.3 | 5.56 | 0.273 |
| H-39-217-063-2 | 3 | 205 | 210 | 206.3 | 5.56 | 0.273 |
| H-39-380-063-1 | 4 | 330 | 350 | 347.1 | 6.02 | 0.338 |
| H-39-380-063-2 | 4 | 340 | 350 | 347.1 | 6.02 | 0.338 |
| H-39-380-063-3 | 4 | 335 | 345 | 335.0 | 6.02 | 0.338 |
| H-39-576-063-1 | 5 | 460 | 465 | 459.2 | 7.04 | 0.363 |
| H-39-576-063-2 | 5 | 450 | 455 | 459.2 | 7.04 | 0.363 |
| H-39-576-063-3 | 5 | 460 | 465 | 459.2 | 7.04 | 0.363 |
thickness was adopted. The leading character “H” in the test’s designation indicates tests performed in Configuration B (with horizontal restraints).

2.3. Material properties

The tested profiles were produced from coils consisting of steel grade S320 GD according to EN 10346:2015 [1]. Tensile tests were executed on 3 specimens per sheet and per thickness to determine the material properties, following the indication provided by EN 6892-1:2009 [2]. In the case of trapezoidal sheets, the specimens have been cut out from the tested sheets while in the case of sinusoidal sheets the producer provided the specimens, with the specimen shape 2 according to EN 6892-1:2009 [2] Table B1. The determination of the yield strength Rp0.2 and of the ultimate tensile strength Rm was based upon the measured sheet thickness exclusive of zinc coating. Data achieved are summarized in Table 4.

2.4. Experimental results

Test series, included specimens analysed adopting the same setup and showing the same failure modality, were analysed. Each test series consisted, moreover, of several subsets: a subset is a small series of tests with identical conditions (same profile type, same nominal sheet thickness, same test setup etc.). A subset usually consisted of 2 or 3 identical tests.

As a general remark, tests performed in Configuration A mainly evidenced failure by bending. In the case of Configuration B (bending moment and axial force) failure occurred due to a combination of global buckling and bending. Data achieved from tests performed in Configuration A are summarized in Table 6 and in Table 7 respectively for sinusoidal (18/76) and for trapezoidal profiles (39/333). The maximum load \( F_{\text{max}} \) represents the failure load including preload and neglecting the self-weight of the specimen.

A statistical evaluation of experimental data - performed taking into consideration the procedure provided by EN 1993-1-3 (table A2) [3] for the determination of coefficient - was used to evaluate the characteristic values of the bearing properties of curved profiles as follow:

| Table 4 |
|---|
| Results of experimental tensile tests for material properties. |
| Profile | Nominal Thickness \( t_N \) (mm) | Core Thickness \( t_K \) (mm) | Yield Strength \( R_{p,0.2} \) (MPa) | Tensile Strength \( R_m \) (MPa) | Ultimate elongation \( A_{L-80\%} \) (%) |
| 18/76 | 0.63 | 0.53 | 330 | 456 | 26.2 |
| | | 0.53 | 329 | 457 | 26.0 |
| | | 0.52 | 329 | 456 | 25.4 |
| | 1.00 | 0.99 | 342 | 387 | 29.3 |
| | | 1.00 | 346 | 387 | 27.6 |
| | | 0.99 | 358 | 392 | 27.9 |
| 39/333 | 0.63 | 0.58 | 406 | 430 | 27.6 |
| | | 0.58 | 411 | 430 | 27.6 |
| | | 0.58 | 408 | 431 | 27.0 |
| | 1.00 | 0.96 | 379 | 425 | 24.7 |
| | | 0.96 | 384 | 427 | 24.5 |
| | | 0.95 | 382 | 426 | 25.4 |

| Table 5 |
|---|
| Self-weight of the tested profiles. |
| Profile | Thickness (mm) | Self-weight \( \text{kN/m}^2 \) |
| Bacacier 18/76 | 0.63 | 0.059 |
| | 1.00 | 0.093 |
| Arcelor 39/333 | 0.63 | 0.060 |
| | 1.00 | 0.095 |
Table 6
Results of single span test without horizontal restraints in the case of sinusoidal profiles (18/76).

| Test specimen | Span (mm) | tN (mm) | b (mm) | LV (mm) | Measured tN including zinc coating (mm) | Measured f (mm) | Measured b (mm) | Preload (kN) | Fmax (kN) | F_{uk} (kN) | M_{c,R,F} kNm/m |
|---------------|-----------|---------|--------|---------|---------------------------------------|----------------|----------------|--------------|-----------|-----------|-----------------|
| 18-0-063-1 (1)  | 2000      | 0.63    | 2200   | 2200    | 0.57                                  | 0              | 0              | 894          | 0.29      | 3.71      | 4.112           |
| 18-0-063-2 (1)  | 2200      | 0.56    | 0      | 0       | 895                                    | 4.07           |                |
| 18-30-063-1 (1) | 2201      | 0.59    | 40     | 47      | 890                                    | 3.91           |                |
| 18-30-063-2 (1) | 2200      | 0.55    | 40     | 48      | 892                                    | 3.93           |                |
| 18-30-063-3 (1) | 2200      | 0.56    | 45     | 56      | 888                                    | 3.97           |                |
| 18-30-063-4 (1) | 2200      | 0.56    | 48     | 60      | 890                                    | 4.01           |                |
| 18-30-063-5 (1) | 2200      | 0.55    | 120    | 115     | 890                                    | 4.01           |                |
| 18-154-063-1 (2) | 3200      | 0.99    | 75     | 60      | 885                                    | 4.10           |                |
| 18-154-063-2 (2) | 3200      | 0.99    | 70     | 70      | 885                                    | 4.10           |                |
| 18-154-063-3 (2) | 3200      | 0.99    | 64     | 60      | 885                                    | 4.10           |                |
| 18-154-063-4 (2) | 3200      | 0.99    | 60     | 65      | 885                                    | 4.10           |                |
| 18-154-063-5 (2) | 3200      | 0.99    | 110    | 120     | 885                                    | 4.10           |                |
| 18-129-100-1 (2) | 3200      | 1.01    | 110    | 120     | 885                                    | 4.01           |                |
| 18-129-100-2 (2) | 3200      | 1.00    | 110    | 125     | 885                                    | 4.01           |                |
| 18-129-100-3 (2) | 3200      | 0.99    | 90     | 85      | 885                                    | 3.90           |                |
| 18-334-100-1 (2) | 3200      | 1.00    | 320    | 300     | 885                                    | 3.80           |                |
| 18-334-100-2 (2) | 3200      | 1.00    | 325    | 295     | 885                                    | 4.00           |                |
| 18-334-100-3 (2) | 3200      | 1.00    | 315    | 300     | 885                                    | 4.00           |                |

In the table, the apex (1) identifies the test setup for flat profiles and the apex (2) identifies the test setup for curved profiles. The apex * identifies the specimens which reach collapse for plastic deformation, in the other cases the collapse is due to local buckling phenomena.
\[ R_k = R_m \cdot (1 - k \cdot s) \]

Being:
- \( R_m \) mean value of tensile stress of the subset.
- \( s \) standard deviation.
- \( k \) coefficient depending on the test number, according to the table A2 provided by EN 1993-1-3 [3].

For tests performed according to Configuration A, the characteristic bending moment in span was determined as follow:

\[
M_{c,Rk,F} = \frac{F_{uk} \cdot L}{b_V \cdot 8} + g \cdot L_V \cdot \left(\frac{2L - L_V}{8}\right)
\]

Being:
- \( F_{uk} \) the characteristic load in kN (including preload).
- \( b_V \) the width of the test specimen (this parameter has a value of, respectively, 912 and 1000 mm in case profile’s thickness equal to 0.63 mm and 1.00 mm).
- \( L_V \) the length of the test specimen.
- \( L \) the span length.
- \( g \) the self-weight of the test specimen, determined according to Table 5.

In case of sinusoidal sheets, the collapse occurred due to local buckling in correspondence of the crest for thickness equal to 0.63 mm; plastic deformations were otherwise evidenced in the case of 1.00 mm thickness. Trapezoidal sheets evidenced collapse due to local buckling of the upper flange (Table 7). Pictures of the different failure modes are presented in Figs. 8–13 (see Fig. 14).

In the following diagrams (Fig. 14), the relations among load and displacement are depicted for some of the executed tests. For each test two different curves are represented, since the displacement has been measured in two different points: in correspondence of the midspan sensor and in correspondence of the jack.

### Table 7

Results of single span test without horizontal restraints in the case of trapezoidal profiles (39/333).

| Test           | Span (mm) | \( t_N \) (mm) | \( b \) (mm) | \( L_V \) (mm) | Measured \( t_N \) including zinc coating (mm) | Measured \( f \) (mm) | Measured \( b \) (mm) | Preload (kN) | \( F_{max} \) (kN) | \( F_{uk} \) (kN) | \( M_{c,Rk,F} \) kNm/m |
|----------------|-----------|----------------|-------------|---------------|-----------------------------------------------|----------------------|---------------------|---------------|---------------------|------------------|---------------------|
| 39-0-063-1     | (1) 3000  | 0.63           | 3200        | 3200          | 0.66                                          | 0                    | 0                   | 668           | 0.43                | 2.09             | 1.915               | 0.785               |
| 39-0-063-2     | (1)       | 3200           | 0.65        | 3200          | 0.65                                          | 0                    | 0                   | 670           | 1.85                |                 |                     |                     |
| 39-0-063-3     | (2)       | 3200           | 0.65        | 3200          | 0.66                                          | 37                   | 34                  | 660           | 0.4                 | 1.92             | 1.867               | 0.767               |
| 39-64-063-1    | (1)       | 3200           | 0.65        | 3200          | 0.66                                          | 34                   | 32                  | 663           | 0.4                 | 1.84             | 1.776               | 0.733               |
| 39-64-063-2    | (1)       | 3200           | 0.65        | 3200          | 0.66                                          | 116                  | 116                 | 663           | 0.4                 | 1.84             | 1.776               | 0.733               |
| 39-129-063-1   | (1)       | 3200           | 0.65        | 3200          | 0.66                                          | 116                  | 120                 | 661           | 1.9                 |                 |                     |                     |
| 39-129-063-2   | (1)       | 3200           | 0.65        | 3200          | 0.66                                          | 116                  | 120                 | 661           | 1.9                 |                 |                     |                     |
| 39-217-063-1   | (2)       | 3200           | 0.64        | 3200          | 0.66                                          | 205                  | 200                 | 670           | 0.4                 | 1.61             | 1.546               | 0.647               |
| 39-217-063-2   | (2)       | 3200           | 0.66        | 3200          | 0.66                                          | 205                  | 205                 | 670           | 1.56                |                 |                     |                     |
| 39-217-063-3   | (2)       | 3200           | 0.68        | 3200          | 0.68                                          | 210                  | 210                 | 668           | 1.65                |                 |                     |                     |
| 39-0-100-1     | (1) 4000  | 1.00           | 4200        | 4200          | 1.02                                          | 0                    | 0                   | 665           | 0.49                | 2.8              | 2.699               | 1.539               |
| 39-0-100-2     | (1)       | 4200           | 1.01        | 4200          | 1.01                                          | 0                    | 0                   | 668           | 2.81                |                 |                     |                     |
| 39-111-100-1   | (1)       | 4208           | 1.01        | 4200          | 1.02                                          | 74                   | 82                  | 668           | 0.71                | 2.78             | 2.646               | 1.513               |
| 39-111-100-2   | (1)       | 4200           | 1.02        | 4200          | 1.02                                          | 74                   | 80                  | 668           | 2.7                 |                 |                     |                     |
| 39-223-100-1   | (2)       | 4232           | 1.02        | 4200          | 1.02                                          | 190                  | 190                 | 670           | 0.49                | 2.81             | 2.709               | 1.544               |
| 39-223-100-2   | (2)       | 4200           | 1.03        | 4200          | 1.03                                          | 190                  | 190                 | 670           | 2.82                |                 |                     |                     |
| 39-380-100-1   | (2)       | 4291           | 1.03        | 4200          | 1.03                                          | 320                  | 327                 | 670           | 0.49                | 2.82             | 2.728               | 1.554               |
| 39-380-100-2   | (2)       | 4200           | 1.04        | 4200          | 1.04                                          | 325                  | 315                 | 670           | 2.85                |                 |                     |                     |

In the table, the apex (1) identifies the test setup for flat profiles and the apex (2) identifies the test setup for curved profiles. The collapse of the specimens is due to local buckling phenomena.
Fig. 8. Failure mode (local buckling) of curved sinusoidal sheets profile (18/76), thickness 0.63 mm. Configuration A.

Fig. 9. Failure mode (plastic deformation) of curved sinusoidal sheets profile (18/76), thickness 1.00 mm. Configuration A.

Fig. 10. Failure mode (local buckling of the upper flange) of curved trapezoidal sheets profile (39/333), thickness 0.63 mm. Configuration A.
Data achieved from Configuration B (tests with horizontal restraints) are summarized in Table 8 for trapezoidal profiles (39/333). Once again, $F_{\text{max}}$ represents the failure load including preload but without considering the self-weight of the tested specimen. Pictures of the different failure modes are presented in Figs. 15–20.

In the following diagrams (Fig. 21) the relations among load and displacement are depicted for some of the executed tests. For each test two different curves are represented, since the displacement has been measured in two different points: in correspondence of the midspan sensor and in correspondence of the jack.

In the following diagrams, the relations among load and displacement are depicted for some of the executed tests. For each test two different curves are represented, since the displacement has been measured in two different points: in correspondence of the midspan sensor and in correspondence of the jack.
Fig. 13. Failure mode (local buckling of the upper flange) of curved trapezoidal sheets profile (39/333), thickness 1.00mm. Configuration A.

Fig. 14. Load-midspan deflection diagrams derived from some of the executed experimental tests — Configuration A. The test TAGS correspond to Tables 6 and 7.
Fig. 14. continued
**Table 8**
Results of single span test with horizontal restraints of trapezoidal profiles (39/333) — Configuration B. In the table, the apex (1) identifies the test setup for curved profiles.

| Test          | Span (mm) | tN (mm) | b (mm) | LV (mm) | Measured tN including zinc coating (mm) | Measured f (mm) | Measured b (mm) | Preload (kN) | Fmax (kN) | Fu,k (kN) |
|---------------|-----------|---------|--------|---------|----------------------------------------|-----------------|-----------------|--------------|-----------|-----------|
| H-39-217-063-1 (1) | 4000      | 0.63    | 3200   | 0.66    | 200 210 670                             | 0.49            | 9.12            | 11.027       |
| H-39-217-063-2 (1) | 4000      | 0.63    | 3239   | 0.66    | 205 210 670                             | 0.49            | 8.95            | 11.43        |
| H-39-380-063-1 (1) | 4000      | 0.63    | 4239   | 0.66    | 330 350 670                             | 0.49            | 9.49            | 12.767       |
| H-39-380-063-2 (1) | 4000      | 0.63    | 4239   | 0.66    | 340 350 670                             | 0.49            | 11.43           | 12.767       |
| H-39-380-063-3 (1) | 4000      | 0.63    | 4291   | 0.67    | 460 465 665                             | 0.49            | 5.67            | 6.615        |
| H-39-576-063-1 (1) | 4000      | 0.63    | 4291   | 0.67    | 450 455 668                             | 5.17            | 5.17            | 6.83         |
| H-39-576-063-2 (1) | 4000      | 0.63    | 4291   | 0.67    | 460 465 665                             | 5.17            | 5.17            | 6.83         |

In the table, the apex (1) identifies the test setup for curved profiles. The collapse of the specimens is due to local buckling phenomena.

**Fig. 15.** Detail of plastic deformation occurred at the support. Configuration B.

**Fig. 16.** Failure mode (buckling of the arch) of curved trapezoidal sheets profile (39/333), thickness 0.63mm. Configuration B.
Fig. 17. Failure mode (buckling of the arch) of curved trapezoidal sheets profile (39/333), thickness 0.63mm. Configuration B.

Fig. 18. Side view of the failure mode (buckling of the arch) of curved trapezoidal sheets profile (39/333), thickness 0.63mm. Configuration B.

Fig. 19. Detailed view of the failure mode (buckling of the arch) of curved trapezoidal sheets profile (39/333), thickness 0.63mm. Configuration B.
Acknowledgements

The present work was developed inside the European Research Project GRISPE “Guidelines and recommendations for integrating specific profiled steel sheets in the Eurocodes” co-funded by the Research Fund for Coal and Steel (RFCS-CT-2013-0018). The authors would like to thank all the partners involved in the project for their contributions.

Transparency document

Transparency document associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2019.103749.
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