



## CARMEN GEOPROIECT S.R.L.

**Geotechnical investigations for civil and industrial constructions,  
communication paths, slope stability estimates, accident expertise at  
foundations and landslides**

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**Work:** **Landscape rearrangement and regeneration for increasing  
activity – Splaiul Unirii urban area, Bucharest**

**Beneficiary:** **Sector 3 City Hall**

**Title of the**  
**Documentation:** Geotechnical investigation on a  
landscaping site –  
Splaiul Unirii, Sector 3, Bucharest

**Executant: SC CARMEN GEOPROIECT SRL**

**Administrator,  
Eng. Dumitriu Bogdan**

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M.C.T.C. No. 06372 A f

**DECEMBER 2019**

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No. 1337 Date: 4 December 2019

**REPORT**  
**regarding the quality verification for the “AP” requirement of the**  
**Geotechnical investigation on the landscaping site –**  
**Splaiul Unirii, Sector 3, Bucharest**

**1. IDENTIFICATION DATA:**

- General designer:
- Specialist designer: SC CARMEN GEOPROIECT SRL
- Investor: Sector 3 City Hall
- Submission date of the project for verification: 4.12.2018
- Design phase: D.T.A.C.

**2. MAIN CHARACTERISTICS OF THE GEOTECHNICAL INVESTIGATION:**

- Construction: street furniture; landscaping works;
- Destination: landscaping;
- Address: Splaiul Unirii, in the Mihai Bravu Boulevard – Mărășești Boulevard area, Sector 3, Bucharest;
- Site conditions and neighbourhoods: the land falls into the geotechnical category I, the site is adjacent to the concrete slope of the Dâmbovița River; the lithological structure of the foundation ground investigated:
  - o 0.00 – 2.00 m Filling made up of vegetal soil, clay, dusty clay, sand, gravel mixed with small fragments of brick and concrete;  
Based on the archive data existing in the area, the depth of the fillings has values between 1.6 and 3.0m, their age being over 30 years. These fillings highlight:
  - o up to 5.7m a cohesive horizon of reduced consistency, with high compressibility;
  - o up to 11...13m a medium-pressed non-cohesive layer with loose areas or cohesive lenses of reduced consistency;
  - o below depths of 11...13m a pressed up to medium-pressed non-cohesive layer;
- The groundwater level is below the depth of 2.00m.

**3. RECOMMENDED FOUNDATION SOLUTION:**

- direct foundation/ballast cushion; the foundation layer indicated: fillers/compacted ballast with a thickness of at least 0.5m;
- foundation depth of constructions: min. -1.00m;
- basic conventional pressure  $P_{conv} = 100 \text{ kPa}$  on the filling/150kPa for the ballast cushion;
- indicated foundation system: there are no restrictions.

**4. RECOMMENDATION:**

- It is required to obtain the approval of the engineering geologist regarding the nature of the foundation land;
- The protection of the foundation ground from the influence of water has to be achieved.

**5. DOCUMENTS TO BE SUBMITTED FOR VERIFICATION:**

- Technical report: 8 pages;
- Drawn parts: 1 annex.

**6. CONCLUSIONS ON THE VERIFICATION:**

- Following the verification, we consider that the Geotechnical investigation elaborated by S.C. CARMEN GEOPROIECT S.R.L. Bucharest is COMPLIANT, and it is therefore signed and stamped as compliant with the “guidance for the technical quality verification of projects” developed by M.L.P.T.L - D.G.R.A.T. in November 1996.

I received 2 (two) copies  
Specialized designer  
Engineering geologist Bogdan Dumitru  
*Illegible signature*

I delivered 2 (two) copies  
“Af” Technical Verifier  
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**S.C. CARMEN GEOPROIECT S.R.L.**

## **Table of contents**

### Chapter title

1. General geological data	
2. Local geomorphological and geological framework	
3. Seismological data	
4. Climate data	
5. Foundation ground of the construction	
5.1. Field investigation works	
5.2. Lithological structure of the foundation ground	
5.3. Geotechnical calculation characteristics	
5.4. Probable absolute settlement	
6. Conclusions and recommendations	
Site plan .....	Annex 1



**S.C. CARMEN GEOPROIECT S.R.L.**

## **Geotechnical study on site**

### **Landscaping, Splaiul Unirii, Sector 3, Bucharest**

This geotechnical investigation was prepared at the request of the beneficiary and aims to present the geotechnical conditions on the site, on which the landscaping of the area is to be carried out.

The data included in this study are to be used for the preparation of the construction authorization documentation.

The studied site is located on the terrace and meadow area of Dâmbovița river and it is located on the land on Splaiul Unirii, on the sector between Mihai Bravu Boulevard and Mărășești Boulevard, on the direction to the centre. The land is located in the central-eastern area of Bucharest.

The land is covered by a concrete platform, small green spaces, sidewalk and tree vegetation in the green areas. The location of the area is shown in the attached plan. The investigation surveys in the studied area are shown in the location plan (Annex 1).

From a geomorphological point of view, the investigated area is located in the Bucharest Plain, Colentina Field, on the meadow and terrace area of Dâmbovița river.

This study was based on geological and geotechnical data obtained through direct field and laboratory investigations, carried out in the construction foundation ground and based on existing studies at private sites in the studied area, in accordance with the design standard NP 074/2014 and the design theme, made available to the beneficiary.

#### **1. General geological data**

From a geological point of view, the Bucharest area is located on a subsidence basin with highly developed sediments (about 2000 m thick), belonging to the Miocene, Pliocene and Quaternary ages, arranged discordantly over the Cretaceous foundation of the Romanian Plain.

The foundation is made up of Proterozoic crystalline formations; it was strongly denuded at the beginning of the Palaeozoic; the relief being brought to the stage of peneplain. Subsequently, it suffered only epeirogenic movements and geological faults.

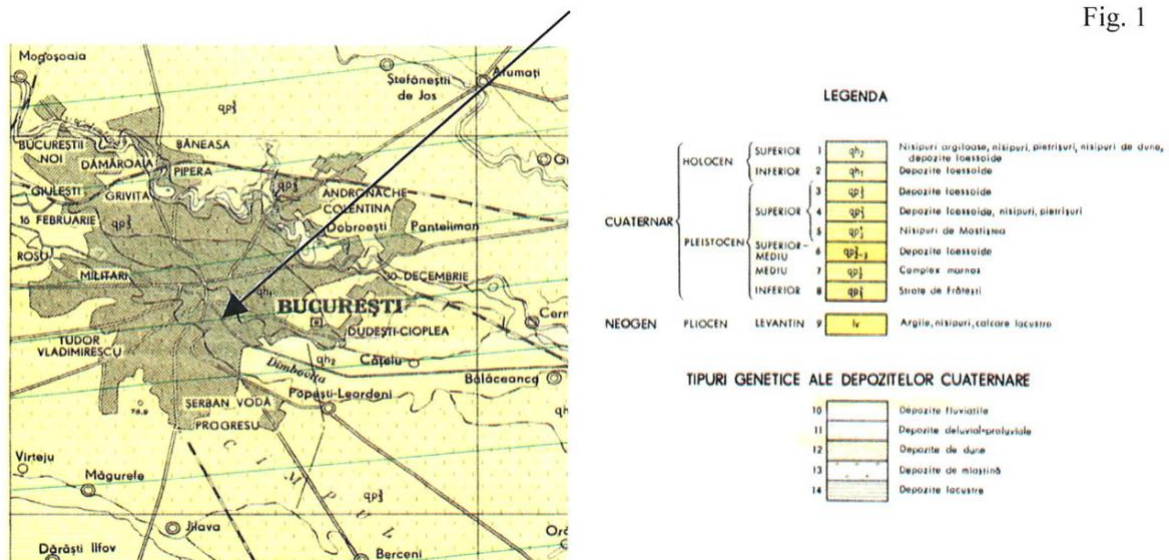
Within the sedimentary cover, represented by a succession of formations, starting with the lower carboniferous layer and ending with the quaternary ones, two sections can be delimited, both lithologically and structurally. Basically, over the foundation, an old sedimentary layer consisting of bituminous brown limestone, carboniferous clays (Carbonifer), red clays, limestone, dolomites, marls, marnocalcium (Triassic), sandstone, black bituminous limestone, dolomite, limestone (Jurassic), limestone, calcarearenite, marnocalcare (Cretacic) is developing with a thickness of 3000-5000 m and at 2000 m depth, at Balotești and about 500 m, in the

south of the municipality. This sedimentary layer was caught in the tectonics of the foundation, being affected by its faults; there is a general fault from S to N, the inclination increasing in the northern sector of the municipality.

The sedimentary suite ends with quaternary deposits, very varied from a lithological point of view, represented by alternations of clays, dusts and various types of sands and gravels. Over these lacustrine and fluvial deposits, in the terrace areas were deposited loess deposits of aeolian type, which reach here and there a thickness of up to 20 m. The superficial development of the quaternary deposits is presented in the extract from the regional geological map (Fig. 1).

In the upper part of the quaternary deposits (about 200 m) seven characteristic sedimentary structures were delimited:

- a) - fillings: anthropic deposits and cohesive materials (0-10 m);
- b) - upper clayey-sandy level: loess deposits and lenses of clayey sands (2-20m);
- c) "Colentina layers": gravel, uneven grain size (2-20 m);
- d) - intermediate lacustrine level: clays, sandy clays, clay sands (<12 m);
- e) "Mostiștea strata": thin sand banks (5-15 m);
- f) lower lacustrine level: fine clays and sands (10-60 m); the complex "Stones of Frățești": three banks of pebbles and sands separated by two clay horizons (100-180 m).



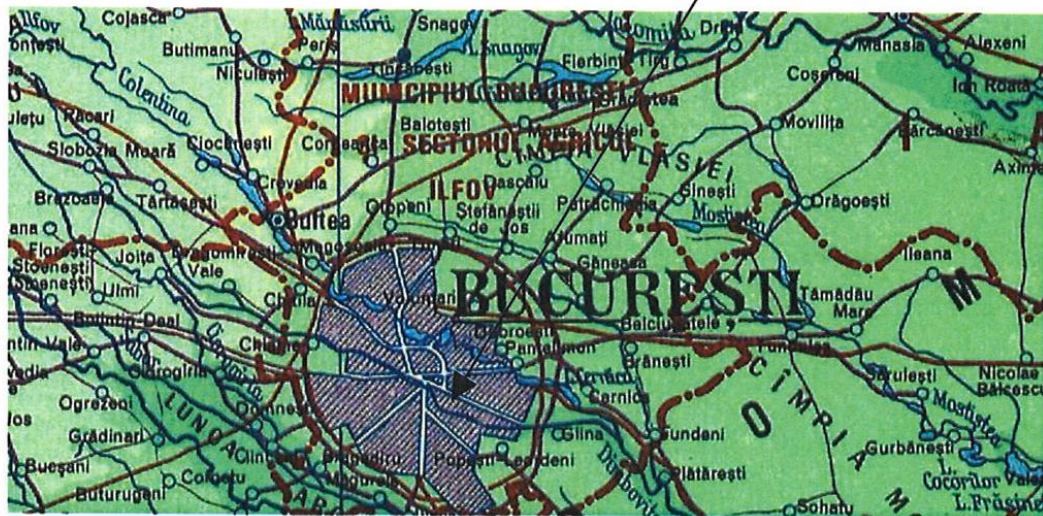
## 2. Local geomorphological and geological framework

From a geomorphological point of view the studied site is located in the Bucharest Plain, the subdivision of the Colentina Field, on the terrace and meadow area of the Dâmbovița river (Fig. 2).

Characteristic of this area, the upper Pleistocene and lower Holocene terrace deposits (the first three upper structures) have an average thickness of about 20 m. The Colentina strata within this terrace complex contain the zonal aquifer, while the permeable levels belonging to the Frățești strata (Lower Pleistocene) rocks upstream pressure-type aquifers.



Fig. 2



### 3. Seismological data

The Bucharest area, with a relatively new geological structure, consisting of deformable lands, of medium consolidation, is a sensitive area for the seismic manifestations of Vrancea county.

According to the maps annexed to the standard PI 00-1 / 2013, the peak value of the acceleration of the land for design, for earthquakes with the average recurrence interval  $IMR = 225$  years with a 20% probability of exceeding in the next 50 years, is:  $a_g = 0.30$  g, and the control period (corner) of the response spectrum  $T_c = 1.6$  sec.

### 4. Climate data

- The average annual air temperature is  $10^{\circ}\text{--}11^{\circ}\text{C}$ , with a minimum monthly average of  $-3.2^{\circ}\text{C}$  (January) and a maximum monthly average of  $+22^{\circ}\text{C}$  (July); the absolute maximum reached the value of  $+41.5^{\circ}\text{C}$ ; the absolute minimum was  $-33.1^{\circ}\text{C}$ .
- The average annual precipitation amounts are 501-600 mm.
- The freezing depth of the region where the site is located is 80-90 cm (according to STAS 6054-77).
- The number of days with snowfall - 20-25 days/year.
- The number of days with snow cover is 40-60 days.
- Wind directions, frequency and average speeds:
  - ✓ North-East: frequency 23.2%; average speed 3.5 m/s.
  - ✓ East: frequency 12%; average speed 3.2 m/s.
  - ✓ South-West: frequency 8.1%; average speed 1.8 m/s.

## **5. Foundation ground of the construction**

### **5.1. Field investigation works**

According to the standard NP 074/2014 (Chapter A. 1.3) the foundation ground of the future constructions falls within the geotechnical category 1 (6 - 9 points), with reduced geotechnical risk.

The related score (9 points) results from:

- Field conditions: average land - 3 points;
- Groundwater: without any depletions – 1 point;
- Classification of the construction by importance category: low - 1 point; - Neighbourhoods: no risks - 1 point;
- Seismic calculation area  $a_g \geq 0.25$ : - 3 points.

The studied site was investigated by 5 geotechnical drillings of 2.00 m in depth from which disturbed samples were taken. The drillings were carried out with a Pioneer type drilling rig. The samples were analysed in our own geotechnical laboratory authorized by ISC for grade 11.

The positions of the investigative surveys are shown on the site sketch (Annex 1).

### **5.2. Lithological structure of the foundation ground**

The lithological succession intercepted and presented in the drilling sheets is as follows:

- 0.00 m – 2.00 m                      Filling made of vegetal soil, clay, dusty clay, sand, gravel mixed with small fragments of brick and concrete;

Based on the archive data existing in the area the depths of the fillings have values between 1 and 3.0m, their age being over 30 years. These fillings rest:

- up to 5.7 m a cohesive horizon of reduced consistency, consisting of sandy clays and dusty clays to clay powders and sandy powders, of soft consistency with high compressibility;
- up to 11..13 m a thick non-cohesive medium layer with loose areas or cohesive lenses of small consistency;
- below depths of 11..13 m a pressed to medium-pressed non-cohesive layer;

The groundwater level is located at depths greater than 2.0m.

### **5.3. Geotechnical calculation characteristics and foundation solutions**

The foundation ground for light constructions (platforms, street furniture) will be on the filling with a conventional pressure of 100 kPa.

For fence foundations, garrets, sidewalks, support walls, the foundation will be made below the freezing depth on a ballast cushion with a thickness of at least 0.50m and a conventional pressure of 150 kPa.

The geotechnical calculation characteristics were established on the basis of archive data, according to design standard NP 122/2010. Table 1 shows the variation of the geotechnical characteristics and the calculation values for the land in the area of influence of the construction foundation.



Table 1

Lithological type	$\gamma$ (kN/m <sup>3</sup> )	$\varphi$ (°)	C (kPa)	E (kPa)	Ip (%)	Ic/I <sub>d</sub>	e	$\bar{P}_{conv}$ (kPa)
Fillings	17	12	20	8.000	-	-	0.8	100*
Cohesive horizon	19	14	40	10.000	30	0.55/-	0.7	220*
Non-cohesive horizon	20	26	0	30.000	-	/0.5	0.6	300*

\* According to design standard NP 112/2014,  $\bar{P}_{conv}$  values are established for foundations having the width of the sole  $B = 1.0$  m and the foundation depth  $D_f = -2.00$  m. For other depths and widths of foundations the conventional pressure will be corrected according to design standard 112/2004 Annex D point D.2.1, D.2.2.

**5.4. The probable absolute settlement** of constructions, under the conditions of small loads brought by the planned constructions, will have insignificant values.

## 6. Conclusions and recommendations

- This study was prepared on the basis of the geological and geotechnical data obtained through direct field and laboratory investigations, the archival data, carried out on the construction foundation ground, according to the standard NP 074/2014.
- From a geomorphological point of view, the studied site is located in the Bucharest Plain, on the terrace area of Dâmbovița river.
- The Bucharest area, with a relatively new geological structure, consisting of deformable lands, of medium consolidation, is a sensitive area for the seismic manifestations typical to Vrancea county, falling within the macrozone of 81 intensity, according to the maps attached to the standard P 100-1/2013, the peak acceleration value of the ground for design purposes, for earthquakes with the average recurrence interval IMR=225 years and a 20% probability of exceeding in the next 50 years, is:  $a_g = 0.30$  g, and the control (corner) period of the  $T_c$  response spectrum = 1.6 sec.
- The average annual precipitation amounts are 501-600 mm.
- Freezing depth is 80-90 cm (according to STAS 6054-77).
- According to NP 074/2014 the foundation ground of the future constructions falls into geotechnical category 1, with low geotechnical risk.
- The lithological succession, intercepted by the executed drilling, is the following:
  - 0.00 – 2.00 m Filling made of vegetal earth, clay, dusty clay, sand, gravel mixed with small fragments of brick and concrete;

Based on the archive data existing in the area the depth of the fillings shows values between 1.6 and 3.0m, their age being over 30 years. These fillings rest:

- up to 5.7 m a cohesive horizon of reduced consistency, consisting of sandy clays and dusty clays to clay powders and sandy powders, of soft consistency with high compressibility;

- up to 11..13 m a medium thick non-cohesive layer with loose areas or cohesive lenses of small consistency;
- below depths of 11..13 m a pressed to medium-pressed non-cohesive layer;
- The groundwater level is located at depths greater than 2.0m.
- The conventional pressure ( $\overline{P}_{conv}$ ) according to NP 112/2014 has the value of **100 kPa on the filling and 150 kPa on the compacted ballast cushion.**
- The calculated settlement will have insignificant values for the expected objectives, under the conditions of the foundation according to the recommendations of this study.
- The minimum foundation depth for new foundations will be -1.00 m;
- Measures will be taken to avoid ground infiltration of surface water (rainfall, etc.), both during the execution period and during the exploitation of the constructions and from accidental losses of hydropower networks. In order to ensure the protection against seepage, the construction will be provided with a watertight 1.00 m wide sidewalk with a slope oriented to the outside that will lead the meteoric waters to an evacuation system;
- Before the excavations for the foundations are completed, the land will be levelled and properly arranged for the outflow of rainwater;
- Before casting the equalization concrete, a report will be drawn up to ascertain the nature of the founding ground by the engineering geologist;
- After the excavation is completed, before the equalization concrete is poured, the soil will be compacted;
- The rate of casting of the foundation concrete must be fast and preferably in a dry period;
- According to the Guidelines for resource consumption on items included in the bill of quantities for earthworks Ts/1995 elaborated by ISPCF SA, the encountered lithology is as follows:
  - Filling - weak cohesive properties, hard terrain category for manual excavation and category II for mechanized excavation, 1800-1900 kg/m<sup>3</sup> excavation weight and a loosening after executing 8%-17% of the excavation;
- Any problem related to the founding ground will be solved together with the engineering geologist.
- The engineering geologist of the company SC CARMEN GEOPROIECT SRL or an Af project verifier can take care of obtaining the approval. it is recommended to notify the person who will issue the approval at least one day in advance.

Prepared by,  
Engineering geologist Dimoiu Andreea  
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**SITE PLAN OF THE GEOTECHNICAL RESEARCH WORKS**  
Landscape redevelopment area, Splaiul Unirii, Sector 3, Bucharest



## LEGEND

**F1** Geotechnical investigation drilling

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## Annex 1

S.C. CARMEN GEOPROIECT S.R.L.

Site: Splaiul Unirii, at the intersection with Mihai Bravu Street,  
Sector 3, Bucharest

### DRILLING SHEET F1

Elevation to 0.00 Drilling	Lithology	Stratification	Sample No./Type*	Depth	Flow limit	Kneading limit	Plasticity index	Consistency index	Granulometric composition											Natural moisture	Volumetric weight	Dry volumetric weight	Porosity	Pore index	Degree of humidity	Free swelling	Carbonate content	Compressibility indices			Resistance at		Swelling pressure	
									Clay (Cl)	Fine dust (FSi)	Medium dust (Msi)	Coarse dust (Csi)	Fine sand (Fsa)	Medium sand (MSa)	Coarse sand (Csa)	Fine Gravel (FGr)	Medium Gravel (MGr)	Coarse gravel (CGr)	Boulders (Co)									Particle size uniformity coefficient	Oedometric module	Settlement coefficient at 200 kPa	Additional specific settlement on moistening	Friction angle		Cohesion
m				m	WL %	WP %	IP %	I <sub>c</sub>	mm 0.002	0.0063	0.02	0.0063	0.2	0.63	2	6.3	20	63	200	Cu	W %	γ kN/m <sup>3</sup>	γ <sub>d</sub> kN/m <sup>3</sup>	n%	e	Sr	UL %	%	M <sub>200-300</sub> kPa	e <sub>p2</sub> cm/m	i <sub>m300</sub> cm/m	Φ (°)	C kPa	kPa
2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																														

Site: Splaiul Unirii, at the intersection with Mihai Bravu Street,  
Sector 3, Bucharest

### DRILLING SHEET F2

2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																													

Site: Splaiul Unirii, at the intersection with Mihai Bravu Street,  
Sector 3, Bucharest

### DRILLING SHEET F3

2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																													

\*S-connecting piece; B-jar; C-core sample

#### Annex 2.1

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Engineering geologist Cristina Bârlea  
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S.C. CARMEN GEOPROIECT S.R.L.

Site: Splaiul Unirii, at the intersection with Nerva Traian Street,  
Sector 3, Bucharest

### DRILLING SHEET F4

Elevation to 0.00 Drilling	Lithology	Stratification	Sample No./Type*	Depth	Flow limit	Kneading limit	Plasticity index	Consistency index	Granulometric composition										Natural moisture	Volumetric weight	Dry volumetric weight	Porosity	Pore index	Degree of humidity	Free swelling	Carbonate content	Compressibility indices			Resistance at		Swelling pressure		
									Clay (Cl)	Fine dust (FSi)	Medium dust (Msi)	Coarse dust (Csi)	Fine sand (Fsa)	Medium sand (MSa)	Coarse sand (Csa)	Fine Gravel (FGr)	Medium Gravel (MGr)	Coarse gravel (CGr)									Boulders (Co)	Particle size uniformity coefficient	Oedometric module	Settlement coefficient at 200 kPa	Additional specific settlement on moistening		Friction angle	Cohesion
m				m	WL %	WP %	IP %	I <sub>c</sub>	mm 0.002	0.0063	0.02	0.0063	0.2	0.63	2	6.3	20	63	200	Cu	W %	γ kN/m <sup>3</sup>	γ <sub>d</sub> kN/m <sup>3</sup>	n%	e	Sr	UL %	%	M <sub>200-300</sub> kPa	e <sub>p2</sub> cm/m	i <sub>m300</sub> cm/m	Φ (°)	C kPa	kPa
2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																														

Site: Splaiul Unirii, no. 39, building M12,  
Sector 3, Bucharest

### DRILLING SHEET F5

2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																													

Site: Splaiul Unirii, at the intersection with Mărășești Boulevard,  
Sector 3, Bucharest

### DRILLING SHEET F6

2.00		Filling (clay, dusty clay with gravel and sand)	1/B	1.0																													

\*S-connecting piece; B-jar; C-core sample

#### Annex 2.2

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