



CONSTRUCTION
INNOVATION AND
SUSTAINABLE
ENGINEERING



 POLITECNICO DI MILANO

Il nuovo progetto di Norma prEN 10370

Hotel Ascot – Milano, Mercoledì 29 Maggio 2019



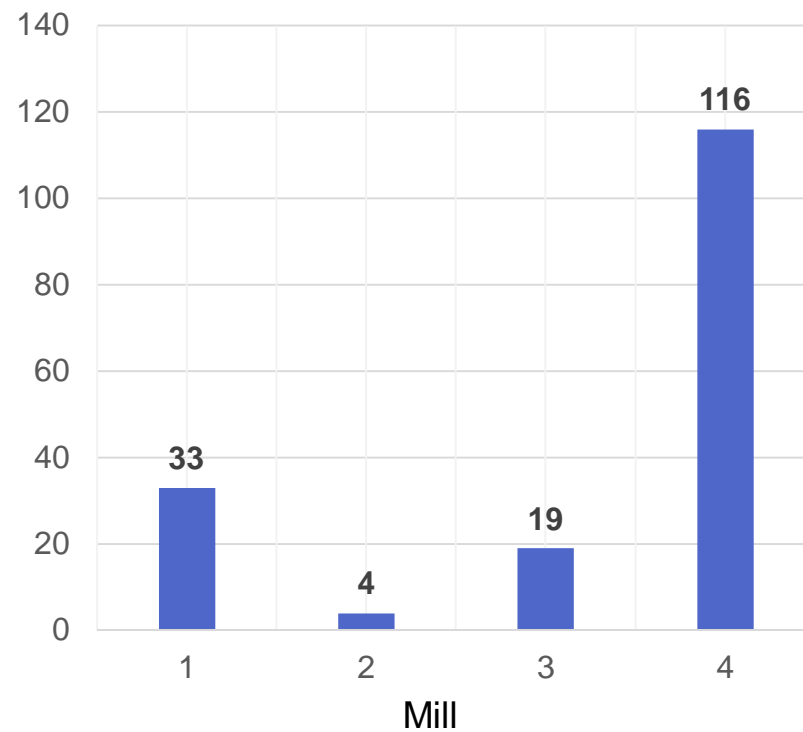
Evaluation of conformity

Report on some production data, analysis of the data and FPC proposal

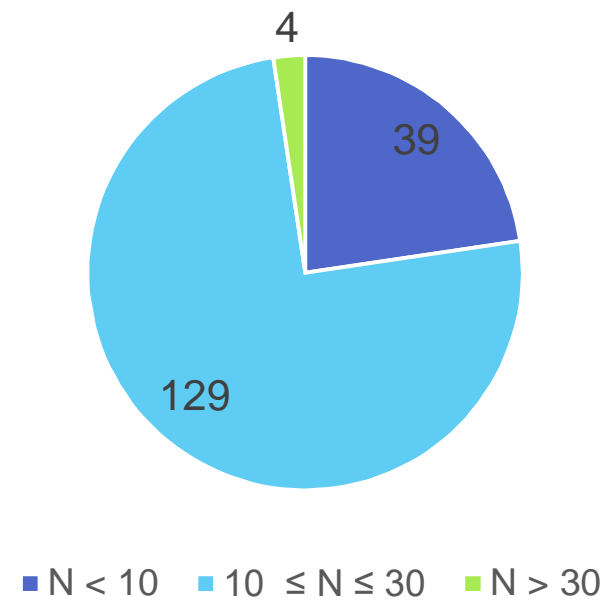
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Casts & Tests

Casts per year



Number of tensile tests per cast



75-80% Useful Data



Table 1: FPC Proposal.

Operation	Standard properties ^c		Fatigue ^d
	Casts ^a	Test samples per cast ^b	
Initial type testing	3	10	5 samples for each cast
	2	15	
	1	30	
Continuous surveillance ^e	3	10	5 samples once a year
	2	15	
	1	30	

^a If the number of available casts is more than 3, choose 3 casts randomly. If the number of available casts is less than or equal to 3, choose all casts.
^b In the case it has been rolled more than 1 diameter from the same cast, choose the test samples mixing various diameters, such that, during various years, all diameters are tested.
^c For standard properties tests shall be performed on the characteristics described in Table 11.
^d Where required.
^e Once a year



Table 2: Products with sufficient numerosity according to the FPC proposal.

N	Mill	T.P	R _{nom}	Casts per year
1	1	11.1	450	3
2	1	11.1	500	3
3	1	13.1	450	7
4	1	14.2	450	17
5	2	11.3	450	1
6	2	13.3	450	3
7	3	15.1	650	19
8	4	12.3	450	7
9	4	12.3	500	12
10	4	14.3	500	10
11	4	15.2	500	9
12	4	15.3	500	33
13	4	15.3	650	28

Legend

Product type (T):

11 AUSTENITIC 304

12 AUSTENITIC 304 with Nitrogen (N)

13 AUSTENITIC 316

14 AUSTENITIC 316 with Nitrogen (N)

15 DUPLEX

Process route (P):

1 bar from smooth wire

2 bar from ribbed wire

3 hot rolled ribbed bar

REMARKS

- Column 1: progressive number
- Column 2: mill identification number
- Column 3: product type.process route (according to the legend reported to the right)
- Column 4: yield nominal stress (N/mm²) according to the national codes (450 IT, 500 - 650 GB and present European Standard for Stainless Reinforcing Bars)
- Column 5: number of casts available for the statistical computations (30 sample tests for each extraction)

European Stainless Steel Working Draft Requirements

Properties	Ductility Class		
	A	B	C
Min. proof strength $R_{p0.2}$ (MP _a)	400 to 750 ^a		
Minimum values of $R_m/R_{p0.2}$	≥1,05	≥1,08	≥1,15 <1,35 ^b
Elongation at maximum force A_{gt} (%)	≥2,5	≥5	≥7,5
^a In EC 2 the minimum prof strength range is 400 ÷ 600 (MP _a) ^b In the case of austenitic and duplex stainless steels, because of their specific stress-strain constitutive relationship, the ratio is calculated by using the value of $R_{7.0}$ instead of R_m			

NTC Requirements

Characteristics	Requirements	Fractile (%)
Yield characteristic stress f_{yk}	≥ $f_{y \text{ nom}}$	5.0
Ultimate characteristic stress f_{tk}	≥ $f_{t \text{ nom}}$	5.0
$(f_t/f_y)_k$	≥1,15 <1,35	10.0
$(f_y/f_{ynom})_k$	≤ 1,25	10.0
Elongation at maximum force A_{gt} (%)	≥ 7,5 %	10.0



Table 3: NTC Requirements Checks.

N	Mill	T.P	R _{nom}	R _{0,2%}	R _m	R _{p0,2%/R_{nom}}
1	1	11.1	450	100%	100%	100%
3	1	13.1	450	100%	100%	100%
4	1	14.2	450	100%	100%	100%
5	2	11.3	450	100%	100%	100%
6	2	13.3	450	40%	100%	0%
8	4	12.3	450	100%	100%	0%

Table 4: European Stainless Steel Working Draft Requirements Checks.

N	Mill	T.P	R _{nom}	R _{7%/R_{p0,2%}}	A _{gt}
1	1	11.1	450	100% (C)	100% (C)
2	1	11.1	500	100% (C)	100% (C)
3	1	13.1	450	100% (C)	100% (C)
4	1	14.2	450	100% (C)	100% (C)
5	2	11.3	450	100% (C)	100% (C)
6	2	13.3	450	100% (C)	100% (C)
7	3	15.1	650	80% (B) 10% (A) 10% (NO)	70% (B) 30% (A)
8	4	12.3	450	100% (C)	100% (C)
9	4	12.3	500	90% (B) 10% (NO)	100% (C)
10	4	14.3	500	40% (B) 30% (A) 30% (NO)	100% (C)
11	4	15.2	500	60% (B) 10% (A) 30% (NO)	100% (C)
12	4	15.3	500	10% (B) 80% (A) 10% (NO)	100% (C)
13	4	15.3	650	20% (A) 80% (NO)	100% (C)

REMARKS

- 10 random extractions of 30 sample tests have been performed for each of the 13 products listed in Table 2. Green color indicates those performances which comply 100% to the relevant nation code. Red color indicates those performances which comply only in some percentage (written inside the box) to the relevant national code according to the ductility classes A, B, C.
- In particular, product identification n.6 and n.8 show that: in case of product n.6 the yield values demonstrate a too high standard deviation and in case n.8 yield values indicate a too high mean value as causes of non conformity.
- Following table 5 illustrates the 10 random extraction values of various performance characteristics of product n.1 and similarly table 6 for product n.3, table 7 for product n.6 and table 8 for product n.8.



Sampling results

Table 5: Product identification n.1 – Extraction values of various performance characteristics which comply 100% to the relevant nation code.

R _m			R _{p0,2%}			A _{gt}			R _{7%/R_{p0,2%}}			R _{p0,2%/R_{nom}}			
656.6333	18.9181	617.2871	501.8667	10.1191	480.8209	25.2333	3.0136	20.2397	1.2487	0.0333	1.3038	1.1935	1.1153	0.0225	1.1525
656.7333	20.8491	613.3710	500.1667	8.1244	483.2694	25.7667	3.0250	20.7541	1.2503	0.0362	1.3103	1.1904	1.1115	0.0181	1.1414
657.3333	18.5050	618.8462	501.5667	7.9381	485.0570	26.3667	2.7976	21.7309	1.2482	0.0368	1.3092	1.1873	1.1146	0.0176	1.1438
657.4000	21.4839	612.7174	499.9000	8.6795	481.8481	26.2667	3.1287	21.0823	1.2526	0.0358	1.3120	1.1932	1.1109	0.0193	1.1429
658.2333	20.6926	615.1964	500.6667	7.3124	485.4582	26.2000	3.0671	21.1177	1.2532	0.0358	1.3125	1.1939	1.1126	0.0162	1.1395
656.9667	19.8711	615.6384	500.7333	8.6381	482.7677	25.8667	2.7883	21.2462	1.2500	0.0362	1.3100	1.1899	1.1127	0.0192	1.1445
657.4667	18.1787	619.6583	500.9000	8.3143	483.6078	25.6000	3.0917	20.4768	1.2477	0.0331	1.3025	1.1929	1.1131	0.0185	1.1437
656.8000	19.4199	616.4102	500.2667	7.3341	485.0132	26.2333	3.3598	20.6659	1.2490	0.0339	1.3052	1.1928	1.1117	0.0163	1.1387
655.0000	18.7561	615.9906	500.3000	7.7600	484.1607	26.2000	3.1557	20.9708	1.2478	0.0323	1.3014	1.1942	1.1118	0.0172	1.1404
656.5000	21.4552	611.8770	499.1667	6.5972	485.4457	26.2667	2.7029	21.7878	1.2515	0.0365	1.3120	1.1911	1.1093	0.0147	1.1336

Table 6: Product identification n.3 – Extraction values of various performance characteristics which comply 100% to the relevant nation code.

R _m			R _{p0,2%}			A _{gt}			R _{7%/R_{p0,2%}}			R _{p0,2%/R_{nom}}			
644.2333	14.4286	614.2244	499.7333	18.1259	462.0348	24.7000	2.7310	20.1745	1.2339	0.0294	1.2826	1.1852	1.1105	0.0403	1.1773
649.1333	16.8477	614.0933	500.8333	13.3134	473.1439	23.6667	3.3356	18.1393	1.2448	0.0306	1.2955	1.1941	1.1130	0.0296	1.1620
650.3667	19.5633	609.6786	503.9000	18.5739	465.2697	24.0667	2.8154	19.4014	1.2418	0.0335	1.2973	1.1862	1.1198	0.0413	1.1882
644.9000	15.8709	611.8914	505.3333	12.2343	479.8882	22.9333	3.2688	17.5167	1.2252	0.0294	1.2739	1.1766	1.1230	0.0272	1.1680
642.8000	12.9625	615.8403	497.2000	15.0090	465.9841	24.3333	2.6824	19.8884	1.2352	0.0274	1.2807	1.1898	1.1049	0.0334	1.1602
642.9333	15.3935	610.9176	501.6667	13.8547	472.8513	22.3333	3.9508	15.7865	1.2301	0.0268	1.2745	1.1857	1.1148	0.0308	1.1658
642.7667	17.4330	606.5092	498.3000	18.2552	460.3326	25.1333	2.5015	20.9882	1.2368	0.0301	1.2867	1.1869	1.1073	0.0406	1.1746
649.7333	18.5898	611.0699	504.0667	18.0649	466.4950	23.7667	2.2695	20.0060	1.2384	0.0293	1.2870	1.1898	1.1201	0.0401	1.1867
638.0667	13.3776	610.2437	503.3333	17.9258	466.0510	24.1000	2.6826	19.6547	1.2178	0.0140	1.2409	1.1946	1.1185	0.0398	1.1845
645.4000	18.8654	606.1634	501.3333	12.2540	475.8472	23.0667	3.4032	17.4274	1.2361	0.0281	1.2827	1.1896	1.1141	0.0272	1.1592



Sampling results

Table 7: Product identification n.6 – Extraction values of various performance characteristics and indication of a possible cause of non conformity (a too high standard deviation of the yield stresses $R_{p0.2\%}$)

R _m			R _{p0.2%}			A _{gt}			R _{7%} /R _{p0.2%}				R _{p0.2%} /R _{nom}		
725.6667	18.2952	687.6161	524.0667	31.2277	459.1188	28.1000	1.6828	25.3115	1.2623	0.0321	1.3156	1.2091	1.1646	0.0694	1.2796
725.0667	24.4342	674.2480	513.5000	36.6208	437.3353	27.7167	2.0160	24.3760	1.2708	0.0384	1.3345	1.2071	1.1411	0.0814	1.2760
726.3333	20.5650	683.5619	517.3667	30.9488	452.9989	28.1167	1.8644	25.0273	1.2696	0.0288	1.3174	1.2218	1.1497	0.0688	1.2637
727.4333	22.5751	680.4813	514.4667	33.7135	444.3487	27.7367	1.8312	24.7022	1.2780	0.0325	1.3320	1.2241	1.1433	0.0749	1.2674
725.0333	22.8390	677.5324	510.6000	35.5145	436.7363	28.3000	1.8057	25.3078	1.2786	0.0377	1.3410	1.2161	1.1347	0.0789	1.2654
723.6000	19.1700	683.7299	514.1333	33.6480	444.1516	28.4000	1.7528	25.4954	1.2658	0.0388	1.3300	1.2015	1.1425	0.0748	1.2664
727.4333	20.5689	684.6537	520.8667	29.8718	458.7387	27.9000	1.6698	25.1330	1.2610	0.0305	1.3115	1.2105	1.1575	0.0664	1.2675
726.3667	17.9549	689.0238	524.5000	28.1740	465.9032	29.2500	1.7469	26.3553	1.2661	0.0309	1.3173	1.2149	1.1656	0.0626	1.2693
725.8000	24.3330	675.1917	511.8333	34.5424	439.9914	27.9700	1.9997	24.6564	1.2715	0.0329	1.3260	1.2170	1.1374	0.0768	1.2646
728.4333	21.7504	683.1964	516.2333	33.1441	447.2997	27.9667	1.8817	24.8485	1.2725	0.0341	1.3291	1.2160	1.1472	0.0737	1.2692

Table 8: Product identification n.8 – Extraction values of various performance characteristics and indication of a possible cause of non conformity (a too high mean value of the yield stresses $R_{p0.2\%}$)

R _m			R _{p0.2%}			A _{gt}			R _{7%} /R _{p0.2%}				R _{p0.2%} /R _{nom}		
771.1667	19.2032	731.2274	535.0667	21.4684	490.4163	25.5333	3.0483	20.4822	1.2293	0.0331	1.2840	1.1745	1.1890	0.0477	1.2681
774.4333	27.7770	716.6622	533.8667	26.9850	477.7429	24.9667	3.0454	19.9202	1.2398	0.0400	1.3062	1.1735	1.1864	0.0600	1.2857
782.3000	31.5706	716.6390	533.5667	26.7036	478.0281	24.6000	2.1909	20.9696	1.2549	0.0298	1.3042	1.2056	1.1857	0.0593	1.2840
791.9333	22.0719	746.0279	548.2667	14.4603	518.1920	23.6333	2.6585	19.2280	1.2277	0.0427	1.2984	1.1570	1.2184	0.0321	1.2716
795.6333	16.3633	761.6007	545.9333	14.5150	515.7448	23.7667	2.8610	19.0259	1.2449	0.0409	1.3127	1.1771	1.2132	0.0323	1.2666
775.8333	25.6462	722.4938	535.2667	24.9080	483.4626	24.9000	2.9868	19.9508	1.2447	0.0349	1.3025	1.1869	1.1895	0.0554	1.2812
770.5667	20.3176	728.3097	534.6333	23.3792	486.0090	25.7333	2.4202	21.7229	1.2301	0.0315	1.2823	1.1778	1.1881	0.0520	1.2742
790.8000	17.2455	754.9325	548.4333	13.7732	519.7875	23.0333	2.5661	18.7811	1.2367	0.0307	1.2876	1.1859	1.2187	0.0306	1.2695
776.6000	28.4139	717.5042	533.2667	25.4097	480.4192	25.2000	3.5950	19.2428	1.2413	0.0404	1.3082	1.1743	1.1850	0.0565	1.2786
773.3333	26.5334	718.1487	537.0333	25.7862	483.4027	25.6333	2.8826	20.8567	1.2399	0.0308	1.2911	1.1888	1.1934	0.0573	1.2884