

# 1.

## STEELMAKING

### CONTINUOUS CASTING



**PROCESS MONITORING**  
CC mould with optical fiber

**NANOTECHNOLOGY**  
Control of second phase particles

**PROCESS CONTROL**  
Refractory temperature measurement

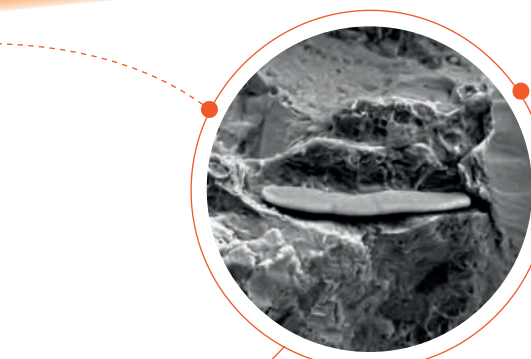


### INGOT CASTING

**BILLET STRAIGHTENING**  
Residual stress



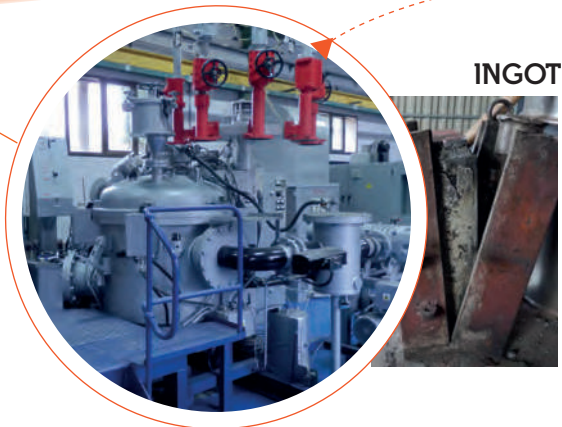
**EAF TAPPING**  
Liquid steel and slag flow



**INGOT**

**FIELD EMISSION ELECTRON MICROSCOPE**  
Analysis of inclusions, fractures and structures

**INDUCTION VACUUM MELTING & CASTING FURNACE**  
Manufacturing of new steels



# 2.

## METALWORKING

**DATA ANALYSIS AND TREATMENT**  
Thermographic temperature control



### ROLLING

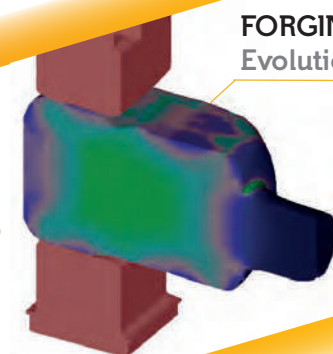


**VALIDATION OF MATHEMATICAL MODELLING**  
Characterization of thermal profiles

**OPEN DIED FORGING**  
OF PARTS UP TO 150 TONS



**FORGING PROCESS**  
Evolution of effective strain



**PASS DESIGN**  
Stress, strain and damage criteria

**PRESS 500 TONS**  
Cold and hot upsetting



**HEAT TREATMENT FURNACES**



**CASTING MOULD DESIGN**  
Ingot casting solidification



**DILATOMETER**  
Determination of CCT diagrams and critical points

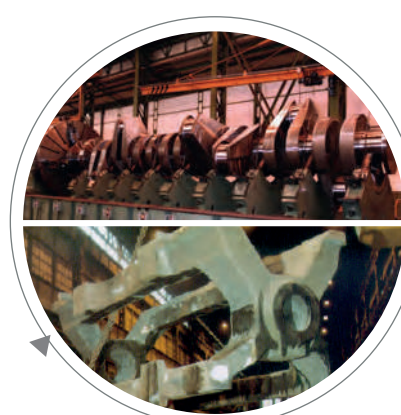


**THERMAL-MECHANICAL SIMULATOR**



# 3.

## PRODUCT

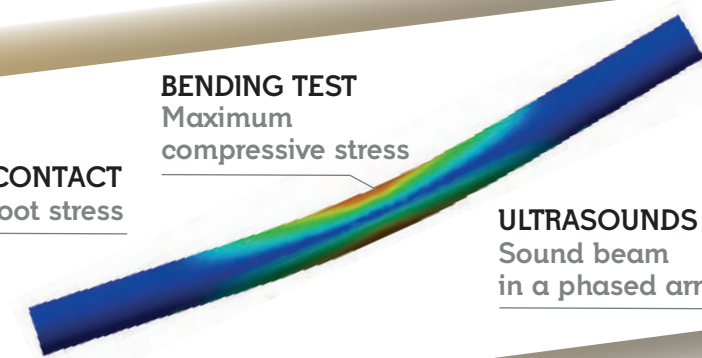


Engineering Steel Long Products  
Stainless Steel Long Products  
Steel Casting and Forgings

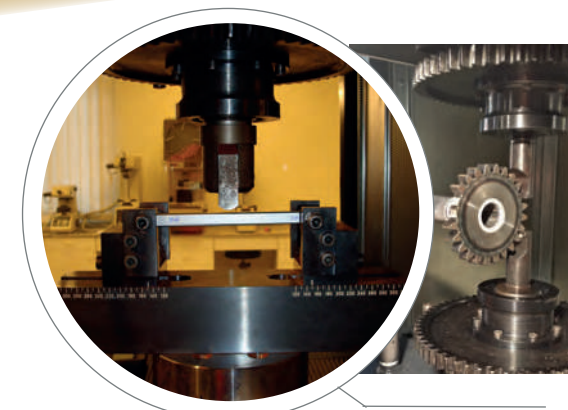
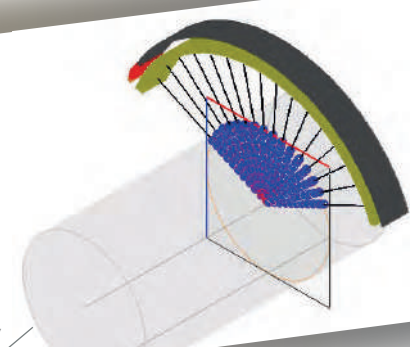
**GEAR CONTACT**  
Tooth root stress



**BENDING TEST**  
Maximum compressive stress



**ULTRASOUNDS**  
Sound beam in a phased array



**MECHANICAL CHARACTERIZATION EQUIPMENTS**  
Tensile and fatigue limit at room and high temperature

**ULTRASONIC EQUIPMENT**  
Cleanliness control



**MICROHARDNESS TESTER**  
Hardness profiles at different loads



**CN LATHE**  
Machinability testing



**OPTO-DIGITAL MICROSCOPES**  
Tool wear and microstructure characterization





ACENOR I+D  
Foundation of the R&D center

30  
YEARS OF  
R&D

With the vision of  
being the metallur-  
gical reference for  
Sidenor and its  
customers.

Our mission is to  
create, develop,  
transfer and protect  
Sidenor Technology  
in order to reach  
innovative solutions  
in the production  
and use of steel  
materials and steel  
components.

1995

SIDENOR I+D

2005

GERDAU  
SIDENOR I+D

2012

GERDAU I+D

2016

SIDENOR I+D



| HARDNESS CONVERSION VALUES        |     |                           |      |     |
|-----------------------------------|-----|---------------------------|------|-----|
| Ø huella<br>bola 10 mm<br>29420 N | HB  | R<br>(N/mm <sup>2</sup> ) | HRB  | HV  |
| 5,75                              | 105 | 380                       | 62,0 | 110 |
| 5,65                              | 109 | 390                       | 64,6 | 115 |
| 5,54                              | 114 | 410                       | 67,0 | 120 |
| 5,44                              | 119 | 420                       | 69,0 | 125 |
| 5,34                              | 124 | 440                       | 71,0 | 130 |
| 5,25                              | 128 | 450                       | 73,1 | 135 |
| 5,17                              | 133 | 470                       | 75,1 | 140 |
| 5,08                              | 138 | 480                       | 77,0 | 145 |
| 5,00                              | 143 | 500                       | 78,8 | 150 |
| 4,93                              | 147 | 510                       | 80,5 | 155 |
| 4,86                              | 152 | 530                       | 82,1 | 160 |
| 4,78                              | 157 | 540                       | 83,5 | 165 |
| 4,71                              | 162 | 550                       | 85,0 | 170 |
| 4,66                              | 166 | 570                       | 86,1 | 175 |
| 4,59                              | 171 | 580                       | 87,3 | 180 |
| 4,53                              | 176 | 600                       | 88,5 | 185 |
| 4,47                              | 181 | 610                       | 89,6 | 190 |
| 4,43                              | 185 | 630                       | 90,7 | 195 |
| 4,37                              | 190 | 650                       | 91,8 | 200 |
| 4,32                              | 195 | 660                       | 92,8 | 205 |
| 4,26                              | 200 | 680                       | 93,7 | 210 |
| 4,22                              | 204 | 690                       | 94,6 | 215 |
| 4,18                              | 209 | 710                       | 95,5 | 220 |
| 4,13                              | 214 | 720                       | 96,3 | 225 |
| 4,08                              | 219 | 740                       |      | 230 |
| 4,05                              | 223 | 750                       | HRC  | 235 |
| 4,01                              | 228 | 770                       | 20,3 | 240 |
| 3,97                              | 233 | 780                       | 21,3 | 245 |
| 3,93                              | 238 | 800                       | 22,2 | 250 |
| 3,89                              | 242 | 820                       | 23,1 | 255 |
| 3,86                              | 247 | 830                       | 24,0 | 260 |
| 3,82                              | 252 | 850                       | 24,8 | 265 |
| 3,78                              | 257 | 860                       | 25,6 | 270 |
| 3,76                              | 261 | 880                       | 26,4 | 275 |
| 3,72                              | 266 | 890                       | 27,1 | 280 |
| 3,69                              | 271 | 910                       | 27,8 | 285 |
| 3,66                              | 276 | 930                       | 28,5 | 290 |
| 3,63                              | 280 | 940                       | 29,2 | 295 |
| 3,60                              | 285 | 960                       | 29,8 | 300 |
| 3,54                              | 295 | 990                       | 31,0 | 310 |
| 3,49                              | 304 | 1020                      | 32,2 | 320 |
| 3,44                              | 314 | 1060                      | 33,3 | 330 |
| 3,39                              | 323 | 1090                      | 34,4 | 340 |
| 3,34                              | 333 | 1120                      | 35,5 | 350 |
| 3,30                              | 342 | 1160                      | 36,6 | 360 |
| 3,25                              | 352 | 1190                      | 37,7 | 370 |
| 3,21                              | 361 | 1220                      | 38,8 | 380 |
| 3,17                              | 371 | 1260                      | 39,8 | 390 |
| 3,13                              | 380 | 1290                      | 40,8 | 400 |
| 3,09                              | 390 | 1330                      | 41,8 | 410 |
| 3,06                              | 399 | 1360                      | 42,7 | 420 |
| 3,02                              | 409 | 1400                      | 43,6 | 430 |
| 2,99                              | 418 | 1430                      | 44,5 | 440 |
| 2,97                              | 423 | 1470                      | 45,3 | 450 |
| 2,94                              | 432 | 1500                      | 46,1 | 460 |
| 2,91                              | 442 | 1540                      | 46,9 | 470 |
| 2,88                              | 450 | 1570                      | 47,7 | 480 |
| 2,86                              | 456 | 1610                      | 48,4 | 490 |
| 2,84                              | 466 | 1650                      | 49,1 | 500 |
| 2,81                              | 475 | 1680                      | 49,8 | 510 |
| 2,79                              | 483 | 1720                      | 50,5 | 520 |
| 2,76                              | 492 | 1760                      | 51,1 | 530 |
| 2,74                              | 500 | 1790                      | 51,7 | 540 |
| 2,72                              | 509 | 1830                      | 52,3 | 550 |
| 2,69                              | 517 | 1870                      | 53,0 | 560 |
| 2,67                              | 526 | 1910                      | 53,6 | 570 |
| 2,65                              | 535 | 1940                      | 54,1 | 580 |
| 2,63                              | 543 | 1980                      | 54,7 | 590 |
| 2,61                              | 552 | 2020                      | 55,2 | 600 |
| 2,59                              | 560 | 2060                      | 55,7 | 610 |
| 2,57                              | 569 | 2100                      | 56,3 | 620 |
| 2,55                              | 577 | 2140                      | 56,8 | 630 |
| 2,53                              | 586 | 2180                      | 57,3 | 640 |
|                                   |     | 2220                      | 57,8 | 650 |
|                                   |     |                           | 58,3 | 660 |
|                                   |     |                           | 58,8 | 670 |
|                                   |     |                           | 59,2 | 680 |
|                                   |     |                           | 59,7 | 690 |
|                                   |     |                           | 60,1 | 700 |
|                                   |     |                           | 610  | 720 |
|                                   |     |                           | 618  | 740 |
|                                   |     |                           | 62,5 | 760 |
|                                   |     |                           | 63,3 | 780 |
|                                   |     |                           | 64,0 | 800 |
|                                   |     |                           | 64,7 | 820 |
|                                   |     |                           | 65,3 | 840 |



Sidenor I+D

## CONTACT

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Fax. +34 94 4871844

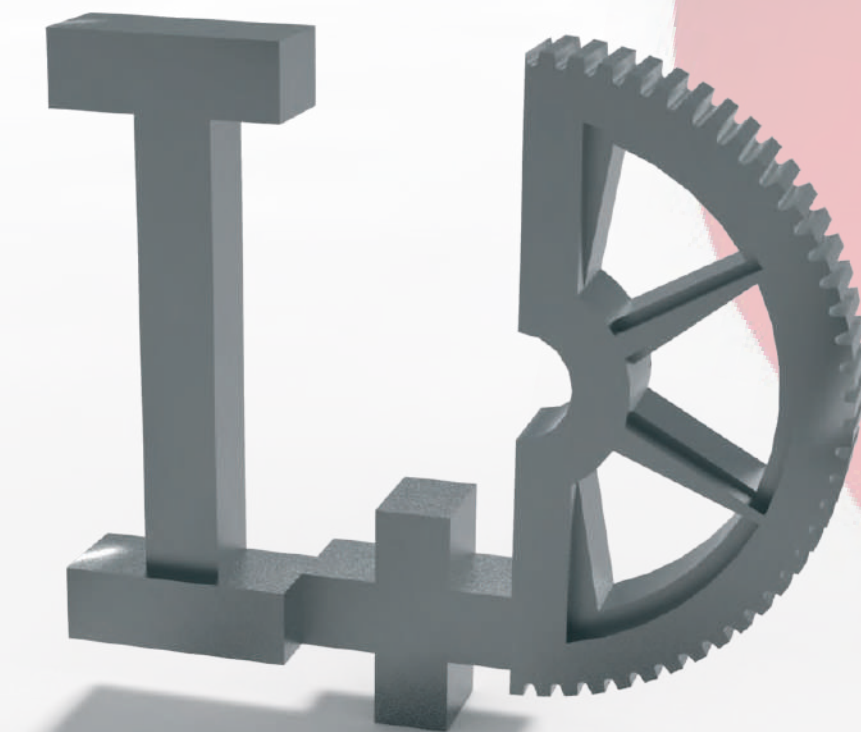
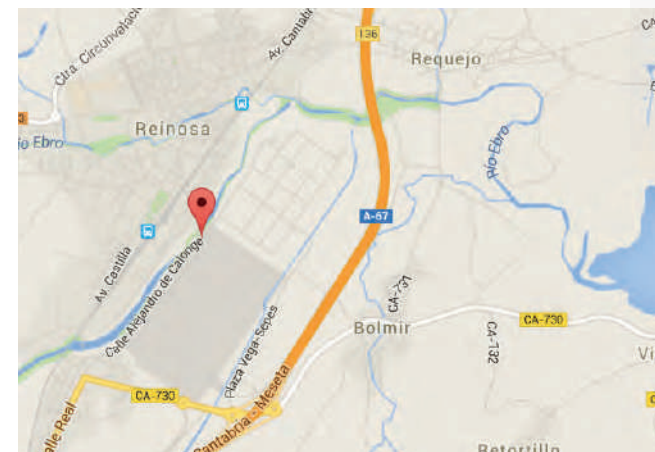
GPS Location:  
Latitude: 43.229041  
Longitude: -2.885671



### Reinosa

Paseo de Alejandro  
Calonge s/n  
39200 Reinosa (Cantabria)  
Tel. +34 942 775050

GPS Location:  
Latitude: 42.988955  
Longitude: -4.142732



Research and Development  
in Special Steels  
Process & Product