Weathering steel

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"Corten" redirects here. For the commune in Moldova, see Corten, Taraclia.

Iron-carbon alloy phases

Ferrite

- Allotropes of ferrite include:
  α-iron (Alpha ferrite)
  δ-iron (Delta ferrite)
  β-iron (Beta ferrite)
  ε-iron (Hexaferrum)
  γ-iron (Gamma ferrite)

- Austenite (γ-iron + carbon in solid solution)
- Cementite (iron carbide, Fe_3C)
- Graphite (allotrope of carbon)
- Martensite (metastable phase)
- ε-carbon (transitional carbide, $Fe_{24}C$)

Microstructures

- Spheroidite
- Pearlite (88% ferrite, 12% cementite)
- Bainite
- Ledeburite (austenite-cementite eutectic, 4.3% carbon)
- Tempered martensite (martensite + ferrite + ε-carbon or cementite, or both)

Steel classes

- Crucible steel
- Carbon steel (≤2.1% carbon; low alloy)
- Spring steel (low or no alloy)
- Alloy steel (contains non-carbon elements)
- Maraging steel (contains nickel)

- Stainless steel (contains ≥10.5% chromium)
- **Weathering steel**
- Tool steel (alloy steel for tools)

Other iron-based materials

- Cast iron (>2.1% carbon)
- Ductile iron
- Gray iron
- Malleable iron
- White iron
- Wrought iron (contains slag)

- V
- T
- E

Cor-Ten steel – Fulcrum (1987) by Richard Serra

Hebrew version of the *Love*sculpture made of Cor-Ten steel.

Weathering steel, best-known under the trademark **COR-TEN**steel and sometimes written without the hyphen as "**Corten steel**", is a group of steel alloys which were developed to eliminate the need for painting, and form a stable rust-like appearance if exposed to the weather for several years.

United States Steel Corporation(USS) holds the registered trademark on the name COR-TEN.[1] Although USS sold its discrete plate business toInternational Steel Group (nowArcelor-Mittal) in 2003,[2] it still sells COR-TEN branded material in strip-mill plate and sheet forms.

The original COR-TEN received the standard designation A 242 ("COR-TEN A") from the ASTM International standards group. Newer ASTM grades are A 588 ("COR-TEN B") and A 606 for thin sheet. All alloys are in common production and use.

Contents

[hide]

1 Properties
- 1.1 ASTM A 242
- 1.2 ASTM A 588

2 Use

3 Disadvantages

4 References

5 External links

[edit]Properties

"Weathering" means that due to their chemical compositions, these steels exhibit increased resistance to atmospheric corrosion compared to other steels. This is because the steel forms a protective layer on its surface under the influence of the weather.

The corrosion-retarding effect of the protective layer is produced by the particular distribution and concentration of alloying elements in it. The layer protecting the surface develops and regenerates continuously when subjected to the influence of the weather. In other words, the steel is allowed to rust in order to form the 'protective' coating.

Chemical composition of Cor-ten grades[3]

Grade	%C	%Si	%Mn	%P	%S	%Cr	%Cu	%V	%Ni
Cor-ten A	0.12	0.25-0.75	0.20-0.50	0.07-0.15	0.030	0.50-1.25	0.25-0.55		0.65
Cor-ten B	0.16	0.30-0.50	0.80-1.25	0.030	0.030	0.40-0.65	0.25-0.40	0.02-0.10	0.40

The mechanical properties of weathering steels depend on which alloy and how thick the material is.[4][5]

[edit]ASTM A 242

The original A 242 alloy has a yield strength of 50,000 pounds per square inch(340,000 kPa) and ultimate tensile strength of 70,000 psi (480,000 kPa) for light-medium rolled shapes and plates up to 0.75 inches (19 mm) thick. It has yield strength of 46,000 psi (320,000 kPa) and ultimate strength of 67,000 psi (460,000 kPa) for medium weight rolled shapes and plates from 0.75–1 inch (19–25 mm) thick. The thickest rolled sections and plates – from 1.5–4 in (38–102 mm) thick have yield strength of 42,000 psi (290,000 kPa) and ultimate strength of 63,000 psi (430,000 kPa).

[edit]ASTM A 588

A 588 has a yield strength of at least 50,000 psi (340,000 kPa), and ultimate tensile strength of 70,000 psi (480,000 kPa) for all rolled shapes and plate thicknesses up to 4 in (100 mm) thick. Plates from 4–5 in (102–127 mm) have yield strength at least 46,000 psi (320,000 kPa) and ultimate tensile strength at least 67,000 psi (460,000 kPa), and plates from 5–8 in (127–203 mm) thick have yield strength at least 42,000 psi (290,000 kPa) and ultimate tensile strength at least 63,000 psi (430,000 kPa).

[edit]Use

Broadcasting Tower, Leeds,United Kingdom.

Abetxuko Bridge by J. Sobrino, PEDELTA, Vitoria, Spain.

Weathering steel is popularly used in outdoor sculptures, such as in the largeChicago Picasso sculpture, and as exterior facades, for its rustic antique appearance. Examples include The Barclays Center,Brooklyn, NY[6], The Angel of the North,Gateshead, UK and the Humanities and Arts complex at Leeds Metropolitan University - Broadcasting Place - Leeds, UK [7]

It has also been used in bridge and other large structural applications such as the New River Gorge Bridge, the newer span of the Newburgh–Beacon Bridge, and the creation of the Australian Centre for Contemporary Art (ACCA).

It is very widely used in marine transportation, in the construction of Intermodal containers.[8]

The first use of COR-TEN for architectural applications was the John Deere World Headquarters in Moline, Illinois. The building was designed by architectEero Saarinen, and completed in 1964. In 1977, Robert Indiana created aHebrew version of the *Love* sculpture using the four-letter word ahava (אהבה, "love" in Hebrew) made from COR-TEN for the Israel Museum Art Garden inJerusalem, Israel.

COR-TEN was used in 1971 for an order of electric railcars built by the St. Louis Car Company for Illinois Central Railroad. The use of COR-TEN was seen as a cost-cutting move in comparison with the contemporary railcar standard of stainless steel. A subsequent order in 1979 was built to similar specs, including COR-TEN bodies, by Bombardier. The cars were painted, a standard practice for COR-TEN railcars. However, the durability of COR-TEN did not live up to expectations, with rust holes appearing in the railcars. Ironically, painting may have contributed to the problem, as painted weathering steel is no more corrosion-resistant than conventional steel, because the protective patina will not form in time to prevent corrosion over a localized area of attack such as a small paint failure. Most of these railcars still operate out of Chicago.[9]

[edit]Disadvantages

Using weathering steel in construction presents several challenges. Ensuring that weld-points weather at the same rate as the other materials may require special welding techniques or material. Weathering steel is not rustproof in itself. If water is allowed to accumulate in pockets, those areas will experience higher corrosion rates, so provision for drainage must be made. Weathering steel is sensitive to salt-laden air environments. In such environments, it is possible that the protective patina may not stabilize but instead continue to corrode. Hawaii's Aloha Stadium, built in 1975, is one example of this. The former Omni Coliseum, built in 1972 in Atlanta, Georgia, never stopped rusting, and eventually large holes appeared in the structure. This was a major factor in the decision to demolish it just 25 years after construction. Weathering steel's normal surface weathering can also lead to rust stains on nearby surfaces.

The U.S. Steel Tower in Pittsburgh, Pennsylvania was constructed by U.S. Steel in part to showcase COR-TEN steel. The initial weathering of the material resulted in a discoloration of the surrounding city sidewalks, as well as other nearby buildings. A cleanup effort was orchestrated by the corporation once weathering was complete to clean the markings. A few of the nearby sidewalks were left uncleaned, and remain a rust color. This problem has been reduced in newer formulations of weathering steel. Staining can be prevented if the structure can be designed so that water does not drain from the steel onto concrete where stains would be visible.

[edit]References

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4. ^ "Structural, Carbon & HSLA Steel Plate". *A new vision of steel*. Chapel Steel. 1987. Retrieved 24 September 2010.
5. ^ *Manual of Steel Construction, 8th Edition Second Revised Printing*. Chicago: American Institute of Steel Construction. p. Chapter 1, page 1–5.
6. ^ Elizabeth A. Harris (August 27, 2012). "Constructing a Facade Both Rugged and Rusty". nytimes.com. Retrieved 10 September 2012.
7. ^ Ruth Bloomfeld (November 11, 2009). "Feilden Clegg Bradley's Leeds complex completed". bdonline.co.uk. Retrieved 24 September 2010.
8. ^ "Shipping Container Homes Globally". Retrieved 2009-05-24.
9. ^ "Photos of the South Shore Line in the Dunes region of Northern Indiana". people.ku.edu. Retrieved 24 September 2010.

[edit]External links

Wikimedia Commons has media related to: ***COR-TEN-Steel***

- Report on Weathering Steel in TxDOT Bridges from the Texas Department of Transportation (4464 KB). Contains recommended details to avoid staining.*Note: wrapping of piers was later found not to be cost-effective.*
- Stadium rust to get $12.4M treatment an article from the Honolulu Advertiser
- A Primer on Weathering Steel: a white paper from the National Steel Bridge Alliance
- Corten FAQ from the American Institute of Steel Construction
- Weathering steel: A technical overview of weathering steels for bridges and general construction