

Weathering Steel Primer

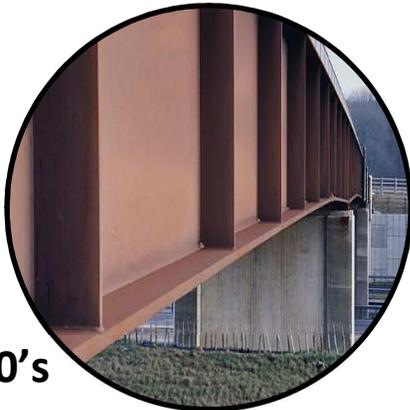
a.k.a. Cor-ten Steel Primer (**COR**rosion resistant – high **TEN**sile) STEEL



Historical Highlights

1957-63

Sarrinen's John Deere Headquarters:
First Use of Cor-Ten in Architecture.

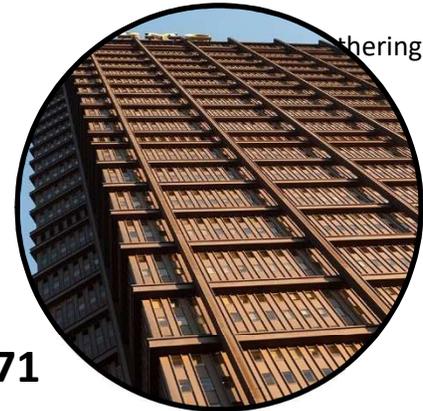


1960's

Cor-Ten wide use as a low-maintenance alternative to painted steel in bridge and roadway construction

1930's

The United States Steel Corporation developed Cor-Ten, primarily for use in railway coal wagons



Weathering Steel

1971

US Steel Tower features its proprietary Cor-Ten in 64 stories of exposed steel



1980's ...

Richard Serra's Cor-Ten sculptures celebrate the power and properties of steel

1969

Roche and Dinkaloo
Knights of Columbus Headquarters
uses plum colored glazed brick hide



1968

Ford Foundation Building
Roche and Dinkaloo protégés of Sarrinen use Cor-Ten inside and out

2012

Barclays Center
Use of "Pre-Weathered" Cor-Ten to reduce staining homogenize the



Weathering Steel

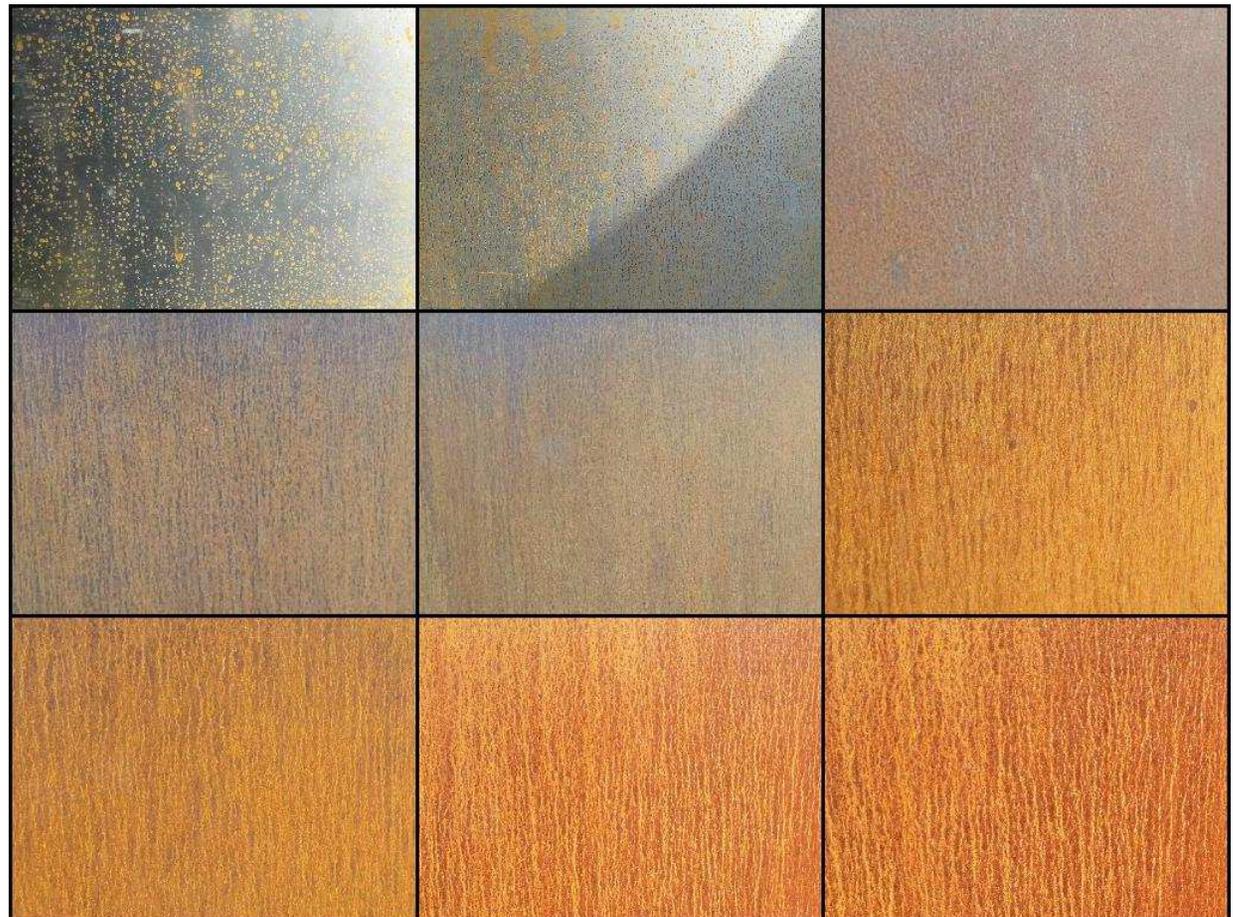
COR-TEN (**COR**rosion resistant – high **TEN**sile) STEEL A588 Steel

The Basics:

Weathering Steel contains quantities of copper, chromium, nickel, and other alloying elements that enhance corrosion resistance. When the steel rusts under normal atmospheric conditions, it forms a protective oxide film that bonds with the surface of the steel. Over a relatively short period, the film forms a stable rust layer in fine, dense grains that adheres to the base metal and is much less porous than rust which develops on carbon steel.

The degree of exposure has a strong influence on the weathering process. Steel exposed to rain, sun and wind weathers more quickly than steel in a sheltered location. The oxide on a sheltered surface tends to be rougher, less dense and less uniform.

Atmospheric environment also impacts oxide development. Frequent wet-dry cycles – for instance moisture in the form of rainfall and dew that is dried by wind and sun – are key to the weathering process [1, 2, 3]



SPECIFIERS BEWARE

Classic examples of buildings with steel as major construction material.

Cor-Ten®



U.S. STEEL TOWER

- The U.S. Steel Tower is the tallest skyscraper in Pittsburgh and the 37th tallest in United States. The 64-story tower was finished in 1970 and is 256 meters high.
- The Steel Tower truly stands apart, due to its unique triangular shape with intended corners.
- The main frame is made out of steel, also displayed on the exterior of the building throughout huge Corten steel columns that resist the corrosive effects of all the weather conditions.
- The tower has over 40,000 metric tons of structural steel and 214,000 square meters of leasable office space. On clear sunny days, the Steel Tower is visible from as far as 80 km.
- Abramovich and Fritz were the chief architects.

US STEEL Disclaimer

Consistent with United States Steel Corporation's ("USS") policy over the last two decades, U. S. Steel reiterates and reminds **that COR-TEN® steel sheet products should not be sold when the intended use is for an architectural application, such as roofing and siding.** U. S. Steel has consistently maintained this position because of the risk of corrosion from factors beyond the control of the COR-TEN® steel licensee (e.g. improper design, fabrication, erection and/or maintenance).

Source: [US Steel Web Site](#)

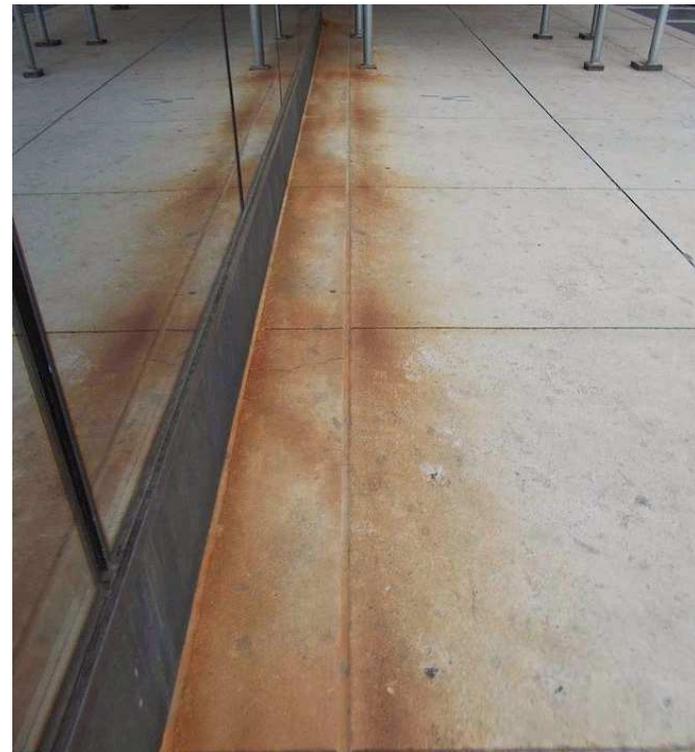
Issues to Consider: Corrosion and Staining

Weathering steel is not rustproof in itself. If water accumulates in pockets, those areas will experience higher corrosion rates, so provision for drainage must be made. Ensuring that weld-points weather at the same rate as the other materials may require special welding techniques or material.[3]



Weathering steel is sensitive to humid subtropical climates and environments laden with sea salt. In such environments it is possible that the protective patina may not stabilize but instead continue to corrode. For example the former Omni Coliseum built in 1972 in Atlanta 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 [3]

Weathering Steel releases dissolved iron when water washes over exposed surfaces. The precipitation of the dissolved iron can cause staining on adjacent surfaces, particularly when the steel is subjected to frequent rainfall during its early months of exposure. Although staining potential usually decreases as the oxide is formed, it may be present for an indefinite period, depending on environmental factors [1]

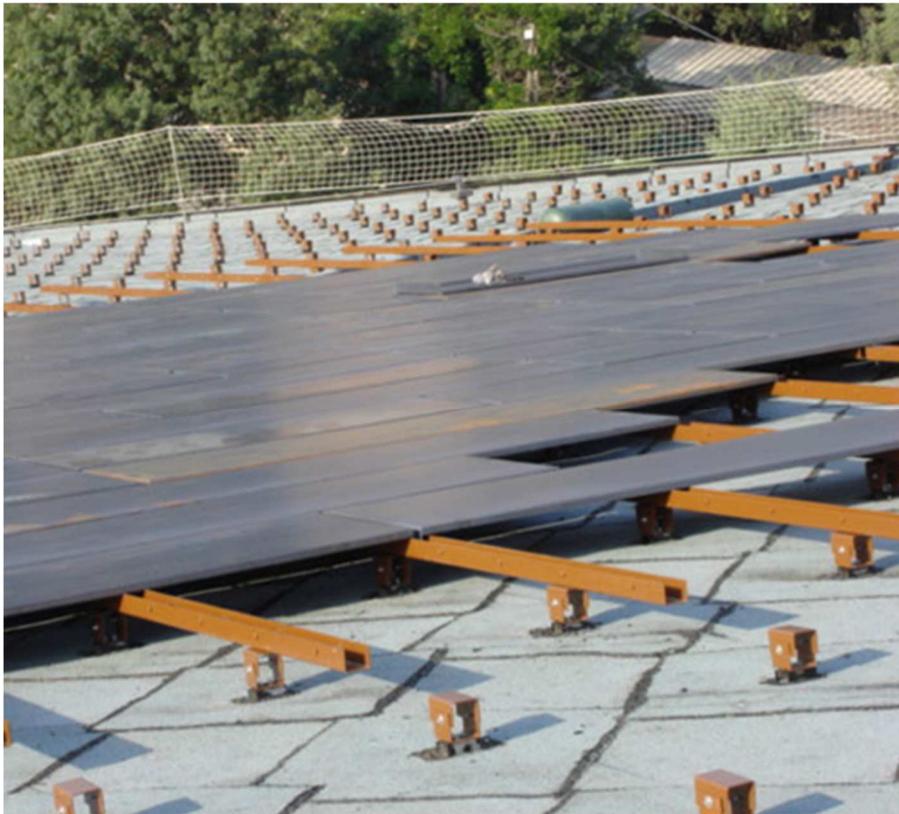


Detailing: Approaches to Corrosion Prevention

Weathered steel does not “rust proof” steel components. Corrosion will develop where water accumulates in pockets, or joints.

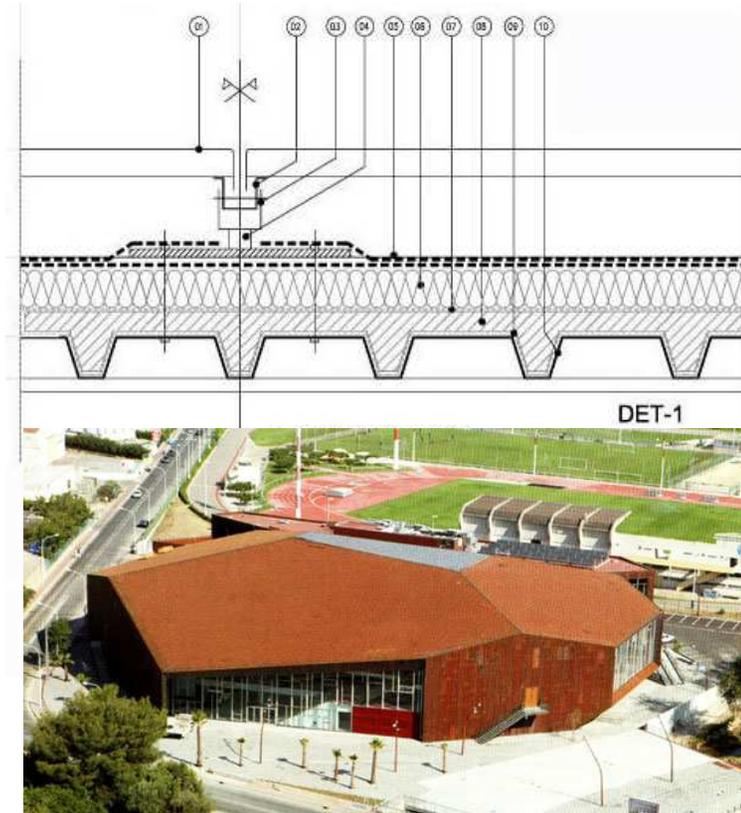
The retention of water, dirt and other debris must be avoided and natural drainage should be designed into the structure. Tubular and box sections should be sealed or adequately vented to allow air circulation, prevent condensation and allow for drainage

Joints should be sealed to prevent water intrusion or the lap area contact surfaces should be coated to prevent rust. In overlapping joints, water can be drawn into the joint area by capillary action. This causes a breakdown of the normal oxide formation and “pack rust” forms [1]



Multi-Sports Stadium (Cannes, France)

*Sheets of Corten are installed as a “rain screen”
Troughs serve as supports and run-off collection*



Detailing: Stain Mitigation

Staining of adjacent light colored materials presents a challenge in both detailing (to reduce run-off) material selection (darker materials) tend to reveal less staining than glass or concrete

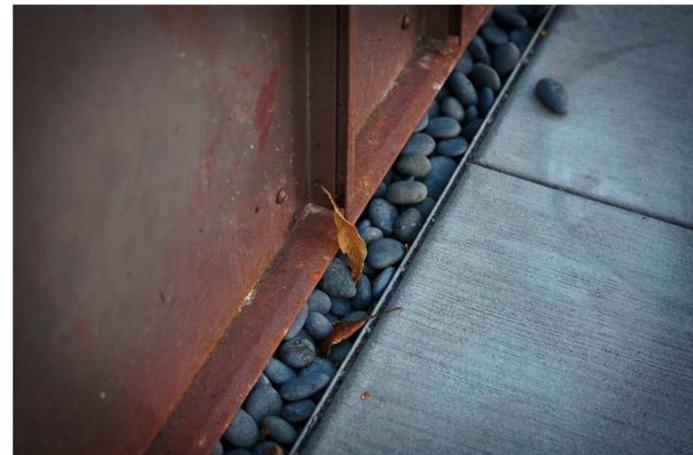
*Drip pans and overhangs can keep water away from stainable surfaces below. Detail exposed slab expansion joints (such as in pedestrian walkway slabs) with troughs below to catch runoff. Masonry surfaces subject to runoff can be sealed or coated to minimize stain penetration. After the steel's initial weathering process, staining is much less intense, so often the stained coating can be sandblasted off (taking the majority of the rust stains with it) or left to weather away (with the rust stains slowly fading over time). **The best way to avoid staining altogether is to positively control runoff.** (2)*



Plantings, grass absorb rust



Plum colored brick conceals rust staining in the K of C building



Rust runs off Corten on to a trench drain filled with dark river rock

Pre- Weathering

Façade Tek an Indianapolis based fabricator uses a process that subjects fabricated steel to mist accelerating the oxidizing process prior to installation. The company produced panels for the *Barclay Center* in Brooklyn. It would appear that stain mitigation results are reduced but not eliminated. The company is careful to say that it can not guarantee reduced run off (below in red)

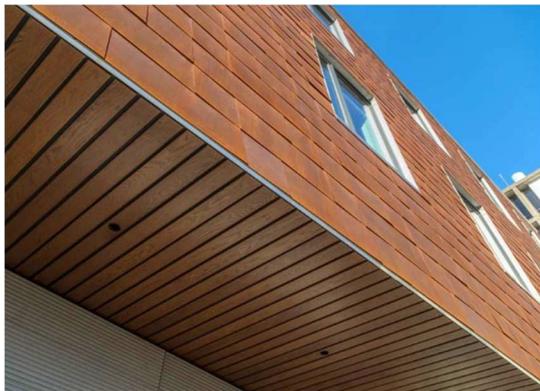


*A proprietary solution is applied to the exposed steel and allowed to oxidize over several days. This process is accelerated by simulating greater misting and drying cycles during this period. Once the initiation process is completed, the material is hung on a 30,000 square foot automated patina conveyor line that has two misting stations to simulate condensation cycles to accelerate the weathering process. The line runs 24 hours per day and 7 days per week till the protective coating that has been produced **and will provide reduced run-off**. This process results in the exposed steel having a relatively uniform rusty red-orange finish. Steel components are then removed from the line and shop assembled for field installation [4]*

Pre-Weathering

William Zahner's Zahner Inc is the foremost an architectural metals specialty company in the US. Located in St Louis the company has an enviable roster of "Starchitects" including Ghery, Herzog/De Meuron, among others. Bilbao's Titanium panels were developed and manufactured by Zahner. William Zahner developed Solanum Steel™, a proprietary pre-weathered finish, that is applied to ingots that have been selected and rolled at mill partners.

Solanum Steel™ is a Zahner-developed pre-oxidized weathering steel that provides artists, architects and designers with a range of resonant tones on an enduring surface. Zahner patina engineers inspect each and every plate surface. Each surface of the bare Solanum Steel™ is cleaned and prepared to eliminate oxides and contaminants The surface is produced by accelerating the natural weathering process and stabilizing the result. The surface is then exposed to a proprietary bath with specific atmospheric conditions to develop a hydrated oxide form of either ferrous oxide or ferrous hydroxide. The material is then arrested with a final bath that inhibits and slows oxidation to a standstill. The material is in its final stage of development. A sealed Solanum™ finish does not come off when rubbed, nor does it stain adjoining surfaces. The preweathering process for Solanum Steel™ reduces, and often eliminates, staining of surrounding surfaces [5]



Brown University Mathematic,s ARO



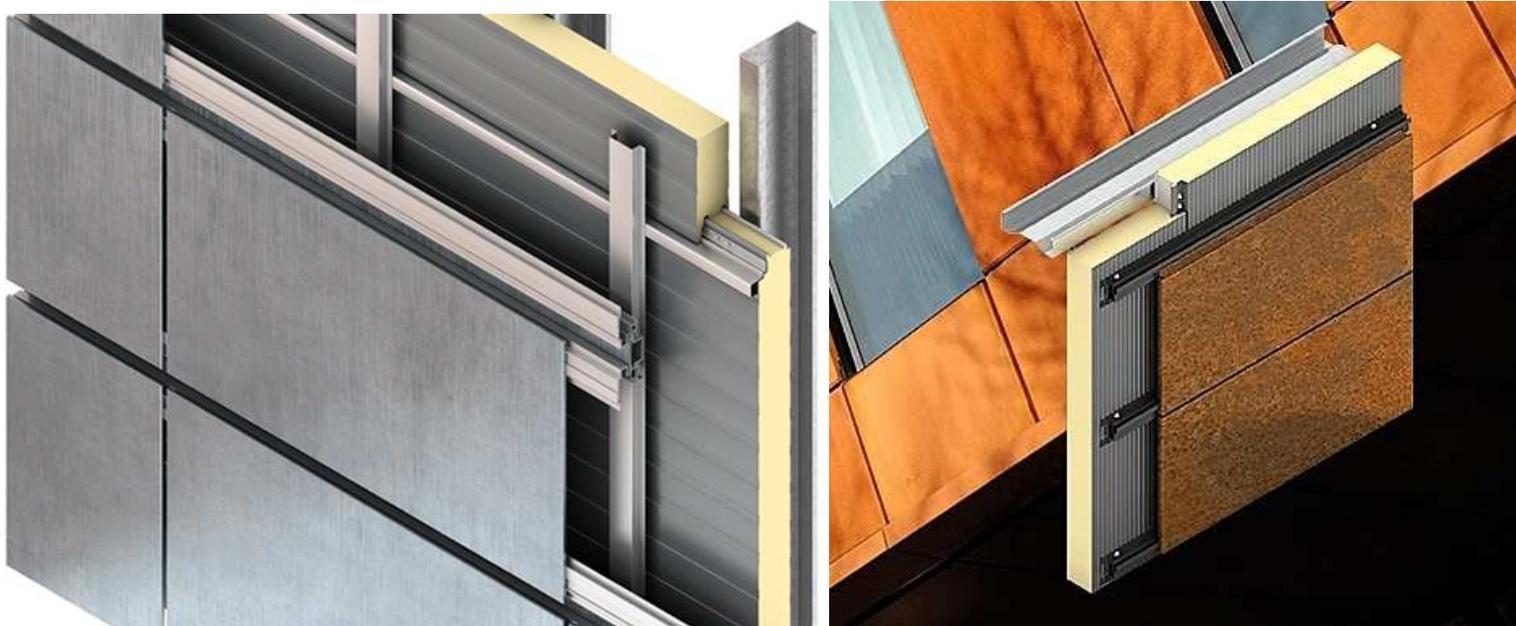
Arkansas House, Marlon Blackwell



Spaceport America Foster + Partners

Building Envelope Systems - Rain Screen

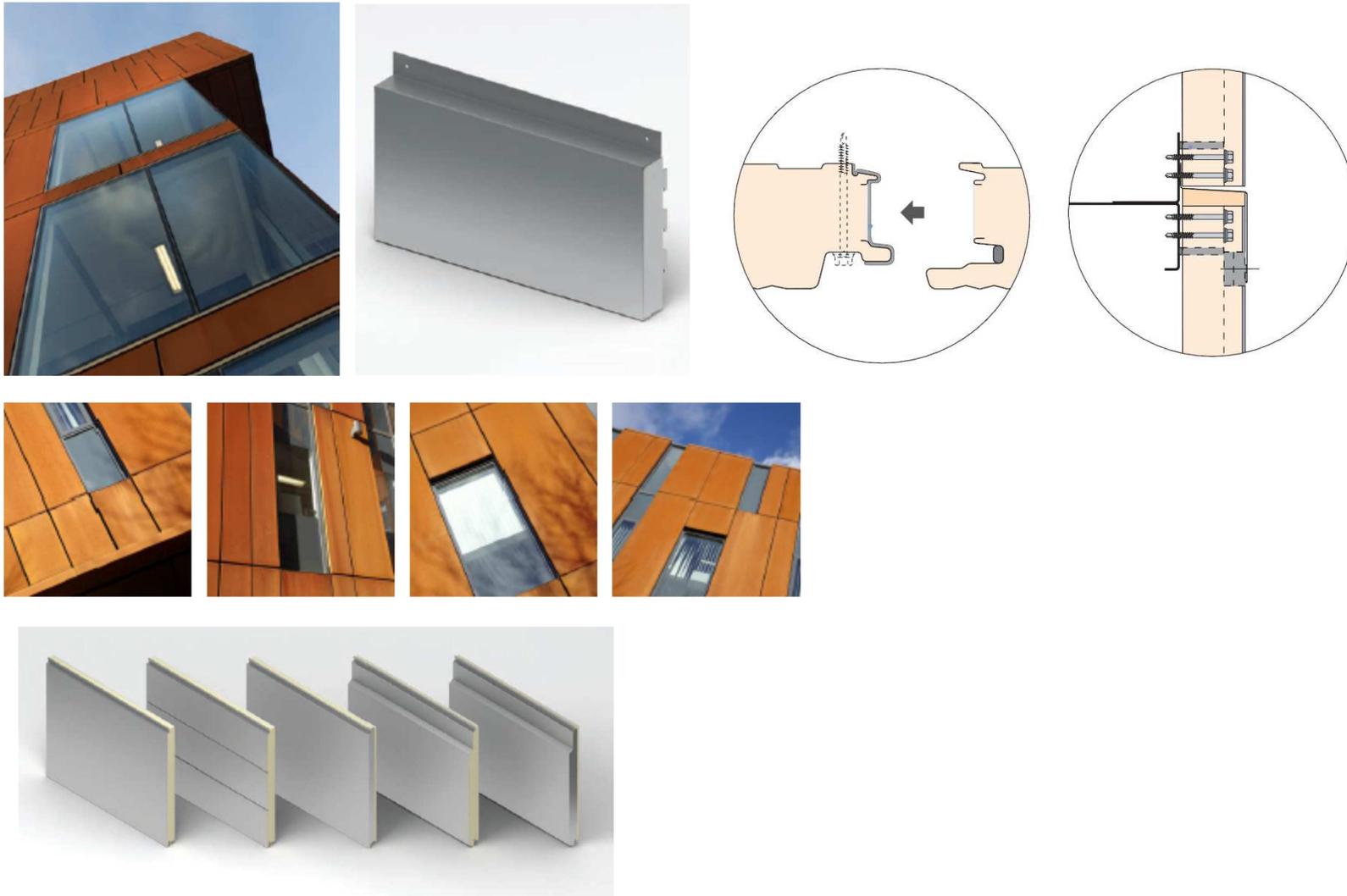
Corten Plate typically 3/16" thick serves as a rain screen over a secondary thermally Insulated/weatherproof System. The drainage plane must be carefully detailed to control transfer of rust laden run-off to building components and landscape areas below



Example: Kingspan *Design Wall 2000*

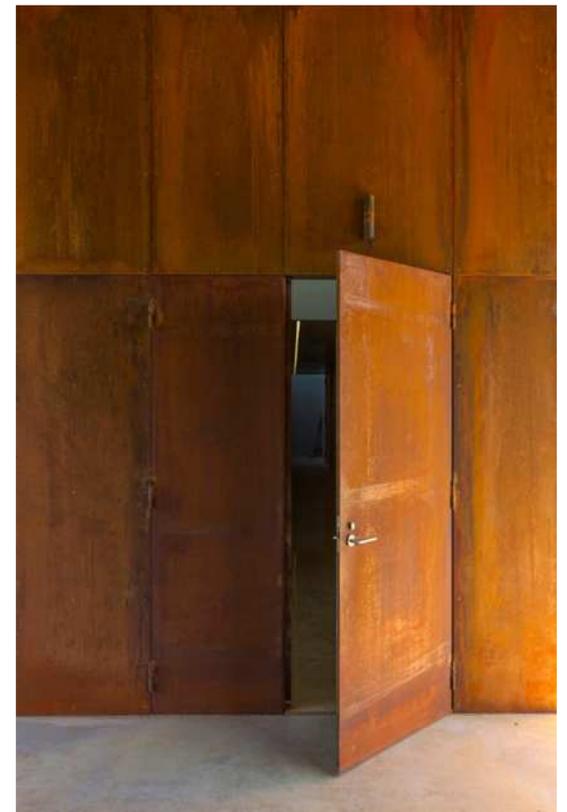
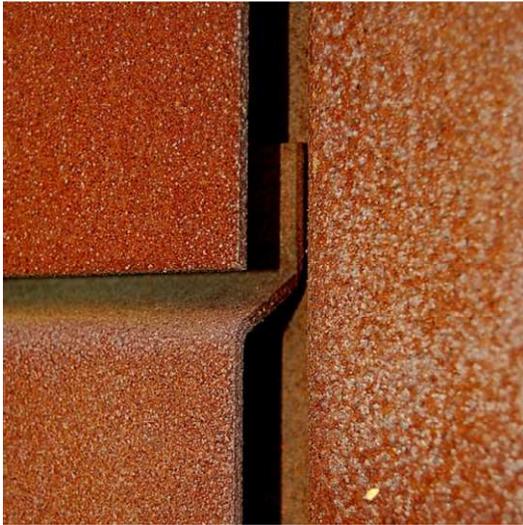
Building Envelope Systems - Thermal Panel

Thin gauge Cor-Ten sheet laminated over an insulated panel and attached to a horizontal/vertical structural system.



Example: Kingspan *Design Wall 2000*

Handsome Details



Sources

[1] *Weathering Steel* ArcelorMittal USA, 2016

<http://www.usa.arcelormittal.com/~media/Files/A/Arcelormittal-USA-V2/what-we-do/steel-products/plate-products/Weathering-steel.pdf>

[2] *Out in the Open ; Weathering steel in architectural applications;* Modern Steel Construction ; Keith A. Grubb, P.E., S.E ; February 2009

https://www.aisc.org/globalassets/modern-steel/archives/2009/02/2009v02_out_in_the_open.pdf

[3] *Weathering Steel*; Wikipedia

https://en.wikipedia.org/wiki/Weathering_steel

[4] Façade Tek Pre-weathered steel patina

<http://www.facadetek.com/advanced-materials/pre-weathered-steel-patina>

[5] Zahner; *Solarium Steel*

<http://www.azahner.com/solanum-steel.cfm>

Barclays Center, Architectural Record; December 16, 2012

<http://www.architecturalrecord.com/articles/7549-barclays-center>

Constructing a Facade Both Rugged and Rusty; New York Times; Elizabeth A. Harris; August 27, 2012

<http://www.nytimes.com/2012/08/28/nyregion/building-with-weathering-steel-both-rugged-and-rusty.html>

Images

<https://www.flickr.com/groups/309747@N24/pool/with/21915896876/>