STRUCTURAL STEELS

Rising high with Dillinger steel

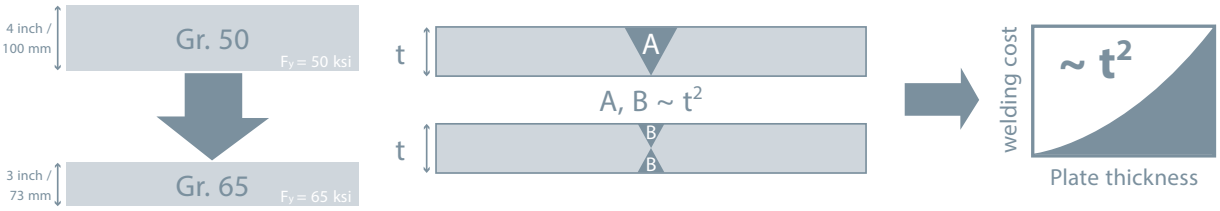
DILLINGER

MODERN CONCEPTS OF STEEL

It pays off to select modern and innovative grades and high quality steels as early as the planning and design phase: this is how outstanding modern and sustainable structures engineered in steel evolve, via consistent exploitation of the potentials nowadays available thanks to smart product developments during steel production.
Modern innovations in steel permit not only more slender architectural aesthetics, but also highly efficient, cost optimized fabrication. The special benefits of these new developments in steel are summarized below and are then illustrated by a number of selected high rise building projects which used the outstanding capabilities of Dillinger.

Higher strength steels

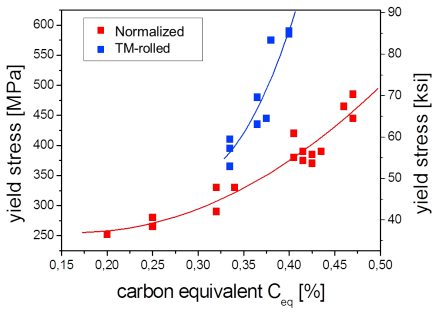
A steel with a minimum yield strength of 50 ksi / 345 MPa (e.g. ASTM A572-50) used to be classified as a higher strength steel, whereas nowadays steels of a yield strength class of at least 65 ksi / ~ 450 MPa and up to 100 ksi / 690 MPa are frequently deployed. There is a good reason for this: these new "higher strength" steels permit significant savings on weight and space (e.g. when used in columns), and thus on costs, and provide an ideal example of the sustainable use of resources in structural engineering. Up to 30% of material thickness can be saved, depending on the stress situation, when using a grade 65 rather than a grade 50, thus allowing lighter designs, more slender columns and longer spans.



In addition to the obvious cost benefits of using less material, higher strength steels also offer other advantages. Firstly, the lower overall weight has beneficial implications for foundation design. In addition, welding costs are significantly lower, since they decrease at a greater rate than plate thickness.
Dillinger's high strength steels (e.g. ASTM A572-65, ASTM A1066-65 or ASTM A1066-70) are therefore an excellent alternative to a classical grade 50. They possess excellent workability properties and can be used with great cost efficiency even at high thickness.
If a steel with a 65 ksi yield strength should run up against its limitations, particularly in heavily stressed components, however, the use of a steel with 100 ksi / 690 MPa will open up new design potentials. Here, thanks to this steel's good workability, Dillinger can also provide the ideal solution for even more lightweight and filigree structures in structural engineering - in the form of DILLIMAX 690.

Thermomechanically rolled steels for excellent weldability

To attain higher strengths additional elements must be alloyed into the steel, but will, however, necessitate greater care in welding. In these cases, higher strength thermomechanically rolled steels, such as ASTM A1066-65, provide the ideal compromise between high mechanical strength and excellent weldability, since the extra strength for these plates is largely obtained by means of the special rolling process. High alloying element contents are thus avoided and an extremely low carbon equivalent is achieved.
The widely used CEV and CET carbon equivalents can in this context serve as an indicator of weldability: the lower the CEV or CET, the better the weldability. Therefore, these can be also used to calculate the preheat temperature necessary for welding of a steel.



SAFE AND EFFICIENT STRUCTURAL DESIGNS

ASTM A 1066 the fabricator's choice

The ASTM standard A1066 High-Strength Low-Alloy Structural Steel Plate Produced by Thermo-Mechanical Controlled Process (TMCP), which was introduced in 2011 for the first time, describes plates produced by the advantageous process of thermomechanical rolling.
ASTM A1066 steels are defined in grades 50, 60, 65, 70, 80. Regarding their strength properties the ASTM A1066 grades fully conform with the respective grades in ASTM A572, so from a design point of view A1066 grades can be applied in the identical way as the A572 grades. But regarding processability, fabrication and safety big benefits are exploitable when using A1066 steels. First, while the standard ASTM A572 does not require any toughness properties by standard, A1066 steel grade has toughness requirements automatically included (35 lbs-ft at -10°F). Secondly, as TMCP steels generally need less alloying to achieve the strength properties, the ASTM standard A1066 guarantees these low alloying and beneficial weldability by restricting the carbon equivalent CEV of its steel grades to maximum values.
So by choosing ASTM A1066 steels all the benefits of TMCP steels (less preheating, better toughness, better surface quality, ...) will apply to the fabrication and construction. To facilitate the usage and application of A1066 steels, also from a regulatory point of view, a double certification to A572 steel grades is possible (e.g. A1066-65/A572-65)

Dillinger A1066-65 steel's very low carbon equivalent means that this steel can be welded at a significantly reduced preheat temperature. Correct selection of parameters can, in fact, make it possible to dispense with preheating entirely, even in higher plate thickness ranges. A1066-65 thus achieves greater strengths with no losses of workability.
Because it produces its own feed material, Dillinger has at its disposal extremely thick, high quality slabs. Perfectly harmonized coordination with Dillinger's rolling and cooling technology thus permits production of heavy plates in the advantageous ASTM A1066-65 grade up to a plate thickness of 150 mm (6 in) - with a guaranteed low CEV carbon equivalent.

Typical carbon equivalents for different steel grades (plate thickness 3 in / ~ 75 mm)

Steel grade	typical CET / %	typical CEV / %	max. CEV / % acc. to ASTM
A572-50 Normalized	0.33	0.42 - 0.44	not defined
A1066-50 TMCP	0.24	0.38	0.40
A572-65 Normalized	-	0.52	not defined
A1066-65 TMCP	0.26	0.40	0.45

Carbon equivalents:
CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15
CET = C + (Mn + MO)/10 + (Cr + Cu)/20 + Ni/40

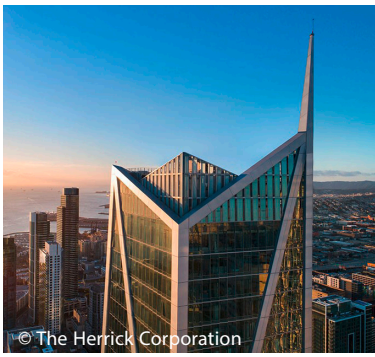
Outstanding dimensional program by Dillinger

Using large, wide and heavy steel plates allows significant savings in fabrication cost and time by e.g. reducing the number of welds or improving the fatigue life of a steel structure. Due to the long plate rolling tradition and the exceptional production facilities of Dillinger, including strong rolling forces and the thickest slab in the world, Dillinger heavy plates can enter dimensional ranges hardly accessible by any other mill.
Widths up to 5,200 mm (200 in), single plate weights up to 42 t and plate thickness exceeding 500 mm (19 in); for the beneficial delivery condition TMCP, like A1066-65/A572-65 up to 150 mm (6 in).
These outstanding possibilities help the fabricator and designer to economize, e.g. by reducing lamellar welds in thick walled steel columns or by using wide plates to reduce butt welds in a bridge deck. Furthermore, the high deformation ratio possible with Dillinger production capabilities enables to deliver these plates even in high thickness with excellent toughness and through thickness properties.

MAKING THE EXCEPTIONAL POSSIBLE

181 Fremont

Higher strength steel | Thermomechanically rolled steels for excellent weldability | Outstanding dimensional program by Dillinger



Located in San Francisco, in the South of Market District, the sleek and glassy 59-story mixed use skyscraper rises over 800 ft (244 m) above street level. Linked to the Transbay Transit Center via a sky bridge (in the 5th floor), the building, designed by Heller Manus Architects, is distinguished by its angled top and exoskeleton support structure resembling dozens of ship masts braced together and providing columnless interiors. This diagonal bracing gives it the appearance of a ship setting out from the shore.
The ship sail shape is no coincidence. Because of its height, the tower was specifically designed to respond to high wind forces as well as seismic events. It is said to be the most resilient and safest high building on the West Coast of the United States. Built above five basement levels, which are five floors 260 ft below street level, it was constructed in compliance with the new earthquake guidelines that allow it to achieve immediate re-occupancy and limited disruption to functionality after a 475-year earthquake.
For such a safety purpose, the steel exoskeleton with its integrated viscous dampers allows for a completely elastic superstructure that behaves like a giant shock absorber whenever there is seismic activity.
For this high strength steel exoskeleton, Dillinger delivered 3,700 t of special high strength steel ASTM A572-65 in thickness up to 5 in (> 125 mm).
In this project the steel ASTM A572-65 was mainly produced by thermomechanical rolling and double certified to ASTM A1066-65 to ensure excellent weldability, low carbon equivalents and high toughness requirements.

One World Trade Center

Higher strength steel | Thermomechanically rolled steels for excellent weldability

Completed in 2014 on the Ground Zero site of the 9/11 attacks, One World Trade Center (One WTC) recaptures the New York skyline and is the main building of the rebuilt World Trade Center complex in Lower Manhattan, New York City. It is a memorable architectural landmark, a new civic icon, for the city. With its 104 stories and 18-piece spire, it reaches the symbolic total height of 1,776 ft (541 m), deliberately reflecting the year of the signing of the Declaration of Independence.
Developed by the Port Authority of New York and New Jersey and designed by the renowned architect David Childs, the building incorporates an innovative mix of architecture, structure, urban design, memory, safety and sustainability. It is said to be one of the safest, technologically advanced and environmentally sensitive buildings in the world.
One WTC is a particularly eye catching building because of its unusual design and dimensions. Above a 200 ft cubic base, the tower's square edges are chamfered back, resulting in a faceted form composed of eight elongated isosceles triangles, whereby the resulting structure conveys an impression of having a twisting motion toward the sky.
For safety reasons, the tower structure is designed around a strong, redundant steel frame, consisting of beams and columns. Paired with a concrete core shear wall, the redundant steel frame confers substantial rigidity and redundancy to the overall building structure and provides column free interior spans for maximum flexibility. For this steel frame, Dillinger delivered around 700 t of ASTM A572-50-1 steel in thickness up to 6 in (> 150 mm) and around 600 t of the higher strength steel ASTM A572-65 in thickness up to 3 in (> 75 mm). To ensure excellent weldability, this higher strength steel grade was produced by thermomechanical rolling.

PROVEN IN IMPOSING PROJECTS

New York Times Tower

Outstanding dimensional program by Dillinger

Officially opened in November 2007, the New York Times Tower hosts the new headquarters for the "New York Times" newspaper. The permeable and transparent 52-story building rises in the heart of Manhattan in New York City, in the Times Square district, on the east side of the Eighth Avenue between West 40th and 41st streets. Designed by the renowned architect Renzo Piano, the 318.8 m / 1,046 ft high building reflects the ambient light and changes color throughout the day. It incorporates numerous environmentally sustainable features which are favorite themes in Piano's architecture: volume, views, light, respect for context, relationship to the street. Therefore, the ground floor lobby is not a closed space serving only as access to the offices on the floors above. It offers an open access to anyone as a shortcut through the block from 40th to 41st streets.

The building, which has been crowned with several awards, has also the particularity that it reveals the structural steel, beams and columns that are normally hidden from view. These are even essential design elements so that anyone can see how the structure is constructed and held up, adding thus visual interest to the façade. For this steel skeleton, Dillinger delivered around 4,000 t of steel (mainly ASTM A572-42/-50/ASTM A588 K) in thickness up to 8 in (> 200 mm) and plate weights exceeding 28 t.

New York Train Station

Higher strength steel **Thermomechanically rolled steels for excellent weldability**

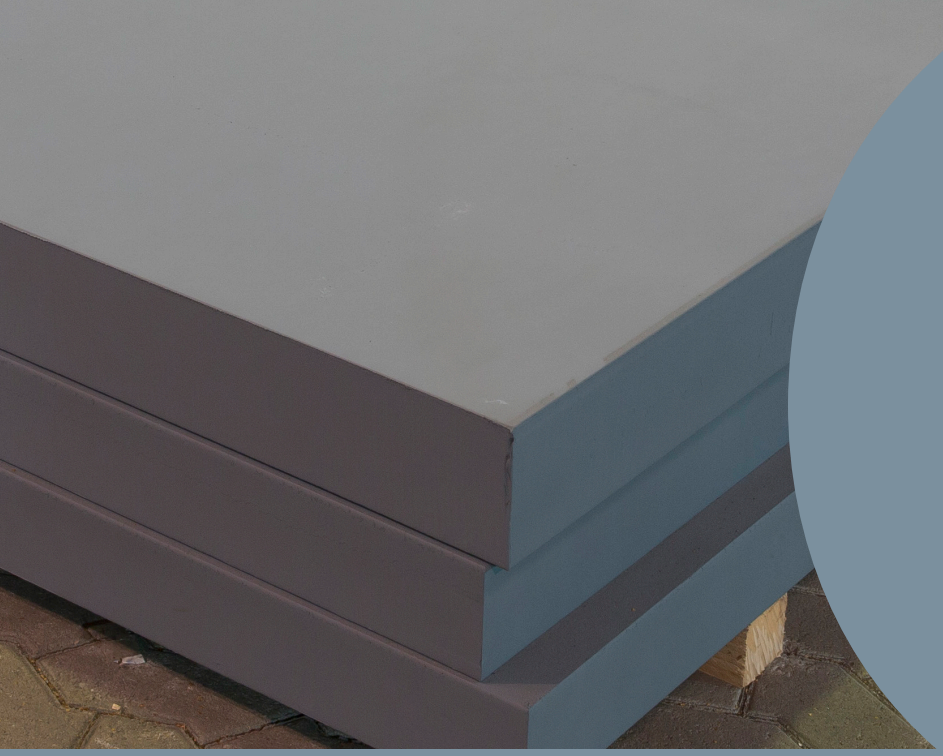
The World Trade Center Transportation Hub in Lower Manhattan, officially opened to the public in 2016. The hub, dubbed Oculus, the closed all seeing eye, has been erected over the Ground Zero to replace the Port Authority Trans-Hudson (PATH) train station.

Designed by the renowned Spanish architect Santiago Calatrava, the hub building, presenting an unusual architecture, does not leave indifferent and generates considerable commentary and public interest: white elephant, whale carcass, bird skeleton, hungry turkey, phoenix rising from the ashes and even a punk head with double Mohawk….the gigantic white steel structure provokes numerous comparisons around the world.

With this sculptural work evoking the image of a dove in flight, Santiago Calatrava wanted to convey "a symbol of peace and hope".

Outside, the elliptical shaped building impresses with its imposing rib cage like structure emerging from the ground. The 150 curved steel ribs, like skeleton wings, extend into the column free 160 ft high (49 m) and 365 ft long (111 m) concourse evoking the appearance of a huge carcass. The spine of the building consists of a large, glass, retractable skylight that will open every September 11th.

For this impressive building Dillinger delivered about 1,600 t heavy plates in grades ASTM A709 HPS70W and A709-50 to European steel constructors.



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