Damage Engineering Insights:
commercial • manufacturing • energy • infrastructure

STRUCTURAL ENGINEERING ASPECTS OF DAMAGE STRUCTURAL STEEL IN BUILDINGS, MACHINERY, AND EQUIPMENT

Plasticity of Steel – Effects of Overheating – Boxing Columns

Structural engineering is a broad engineering discipline. The many structural engineering facets to building, machinery, and mechanical equipment damage make it our most requested engineering discipline.

Structural steel is one of the most common building materials found in commercial, manufacturing, energy and infrastructure facilities. We have selected a few interesting insights:

CAUSE—Steel is a ductile material. When overloaded, it deforms ***plastically*** before failing completely. This property makes steel an ideal building material because a steel member will often transmit signs of failure before failing, such as cracking of interior or exterior finishes. The painted surface peeling is a similar symptom of overloaded steel components in equipment or buildings. The fracture surfaces of overloaded steel typically have a grainy surface.

COST—If an incident involves ***overheating*** or fire, the question often arises: Does structural steel need to be replaced, or can it be repaired? The answer is often determined by the type of steel—hot-rolled or cold-rolled. Crane booms are often made from cold-rolled steel; steel that gained additional strength by purposely being deformed is called cold-worked. Hot-rolled steel, on the other hand, is simply left to cool after its shape was formed at high temperature.

Excessive operating temperatures in equipment or heat from a building fire can cause a loss of strength, resulting in deformation of the member. In the case of hot-rolled steel, it is a temporary loss of strength. Hot-rolled steel typically has the microstructure of a steel that has been exposed to high temperature; thus, as it cools, it regains its strength. Overheated cold-rolled steel will often be annealed (its microstructure returned to a hot-rolled structure) and lose many of its cold-worked properties.

For cold-rolled steel, a Rockwell hardness test can be a quick indicator of whether the heat damage was permanent. Significant softening of the steel is indicative of the steel being annealed. For hot-rolled steel, temporary overheating typically represents a temporary loss of strength, so the answer to the question of whether it needs to be repaired or replaced usually rests on the significance of the deformation.

DOWNTIME—The daily cost of downtime often changes the balance between repairing and replacing. Schedule analysis can identify the critical path items which can lead to determining where alternate methods may make sense. Extra steel can be added to the columns or beams, changing their cross-sections and thereby effecting a repair of the damage. This often takes the form of ***boxing*** a wide flanged beam or column. (Flat steel is welded to the tips of the flanges, creating a box-like shape that has greater strength than the original wide flanged I-beam shape.)

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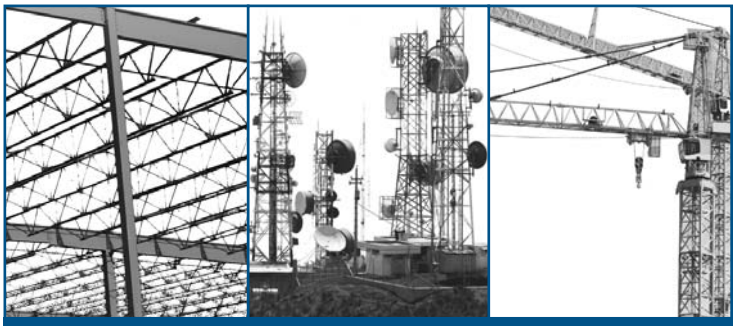

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