

Unit 5

Steel Frame Construction

Part I Illustrated Words and Concepts

Figure 5-1 Steel Column Base Details

Figure 5-2 Tower Cranes and a Mobile Crane

Part II Passages

Passage A The Construction Process (Fabrication)

Passage B The Construction Process (Erection)

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Part I Illustrated Words and Concepts

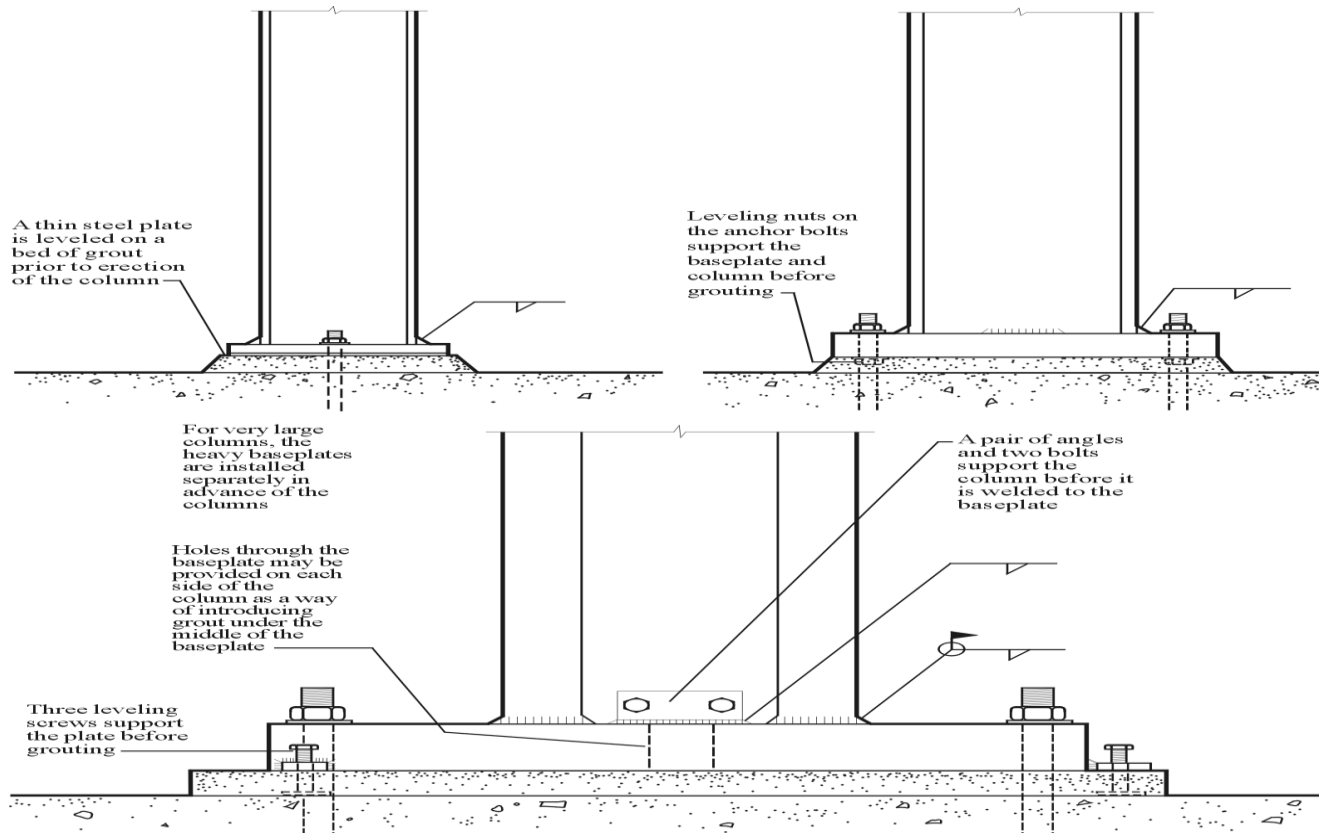


Figure 5-1 Steel Column Base Details

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Part I Illustrated Words and Concepts

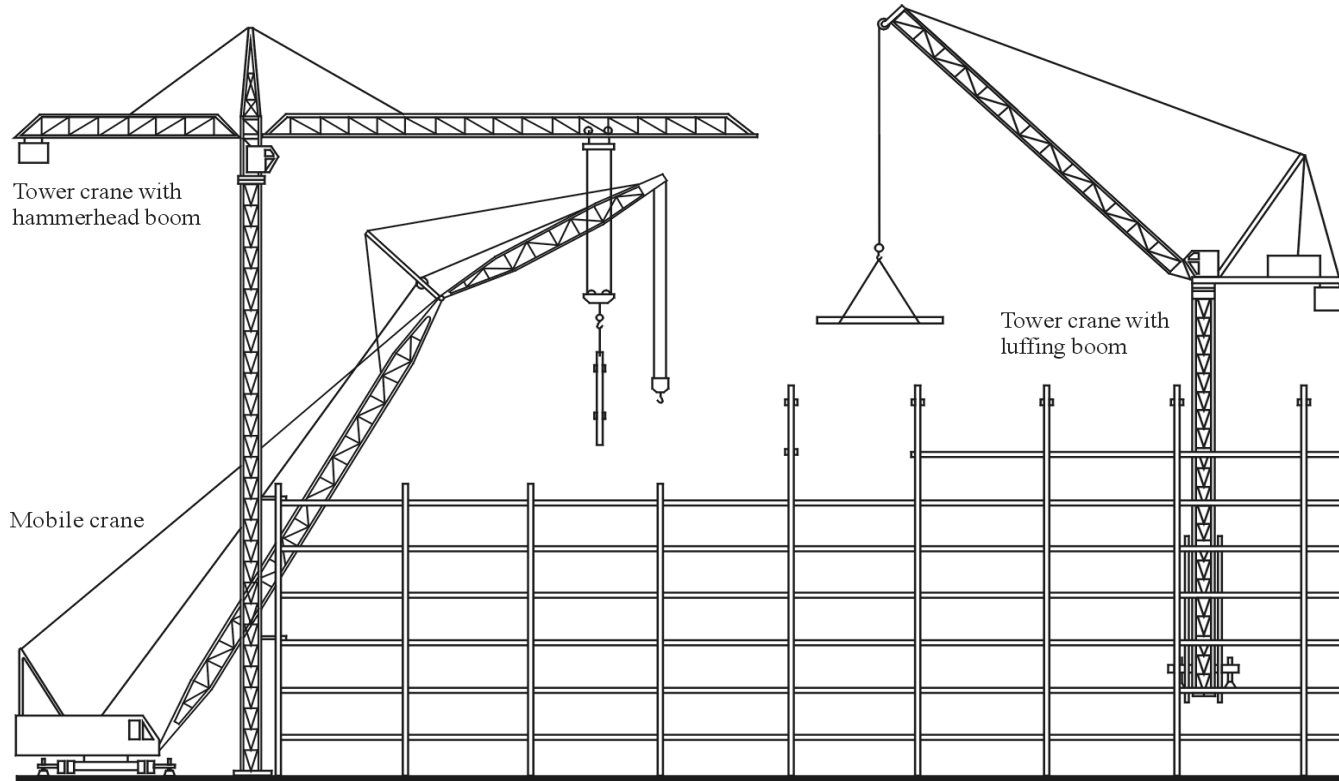


Figure 5-2 Tower Cranes and a Mobile Crane

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Part II Passages **Passage A**

The Construction Process (Fabrication)

A steel building frame begins as a rough sketch on the drafting board of an architect or engineer. As the building design process progresses, the sketch evolves through many stages of drawings and calculations to become a finished set of structural drawings.

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Part II Passages **Passage A**

These show accurate column locations, the shapes and sizes of all the members of the frame, and all the loads of the members, but they do not give the exact length to which each member must be cut to mate with the members it joins, and they do not give details of the more **routine** connections of the frame. These are left to be worked out by a **subsequent recipient** of the drawings, the fabricator.

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Part II Passages Passage A

The Fabricator

The fabricator's job is to deliver to the construction site steel **components** that are ready to be assembled without further processing. This work begins with the preparation in the fabricator's shop of detailed drawings that show exactly how each piece will be made, and what its precise dimensions will be. The fabricator designs connections to transmit the loads indicated by the engineer's drawings.

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Part II Passages **Passage A**

Within the limits of accepted engineering practice, the fabricator is free to design the connections to be made as economically as possible, using various combinations of welding and bolting that best suit available equipment and expertise. Drawings are also prepared by the fabricator to show the general contractor exactly where and how to install foundation anchor bolts to connect to the columns of the building, and to guide the erector in assembling the steel frame on the building site.

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Part II Passages **Passage A**

When completed, the fabricator's shop drawings are submitted to the engineer and the architect for review and approval to be sure that they conform exactly to the intentions of the design team. Meanwhile, the fabricator places an order with a producer of steel for the stock from which the structural steel members will be fabricated. When the approved shop drawings, with corrections and comments, are returned to the fabricator by the design team, revisions are made as necessary and full size templates of cardboard or wood are prepared as required to assist the shop workers in laying out the various connections on the actual pieces of steel.

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Part II Passages **Passage A**

Plates, angles, and tees for connections are brought into the shop and cut to size and shape with gas fueled cutting torches, power shears, and saws. With the aid of the templates, bolt hole locations are marked. If the plates and angles are not unusually thick, the holes may be made rapidly and economically with a punching machine. In very thick stock, or in pieces that will not fit conveniently into the punching machines, holes are drilled rather than punched.

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Part II Passages **Passage A**

Pieces of steel stock for the beams, girders, and columns are brought into the fabricator's shop with an overhead traveling crane or conveyor system. Each is stenciled or painted with a code that tells which building it is intended for and exactly where it will go in the building. With the aid of the shop drawings, each piece is measured and marked for its exact length, and for the locations of all holes, stiffeners, connectors, and other details. Cutting to length, for those members not

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Part II Passages Passage A

already cut to length at the mill, is done with a power saw or a flame cutting torch. The ends of column sections that must bear fully on base plates or on one another are squared and made perfectly flat by sawing, milling, or facing. In cases where the columns will be welded to one another, and for beams and girders that are to be welded, the ends of the flanges are beveled as necessary. Beam flanges are coped as required. Bolt holes are punched or drilled.

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Part II Passages **Passage A**

As a last step in fabricating beams, girders, and columns, stiffener plates are arc welded to each piece as required, and connecting plates, angles, and tees are welded or bolted at the appropriate locations. As much connecting as possible is done in the shop, where tools are handy and access is easy. This saves time and money during erection, when tools and working conditions are less **optimal** and total costs per **manhour** are higher.

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Part II Passages **Passage A**

Plate girders, built up columns, trusses, and other large components are assembled in the shop in as large units as can practically be transported to the construction site, whether by truck, railway, or **barge**. **Intricate** assemblies such as large trusses are usually preassembled in their entirety in the shop, to be sure they will go together smoothly in the field, then broken down again into transportable components.

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Part II Passages **Passage B**

The Construction Process (Erection)

The Erector

Where the fabricator's job ends, the erector's job begins. Some companies both fabricate and erect, but more often two operations are done by separate companies. The erector is responsible for assembling into a frame on the building site the steel components furnished by the fabricator. The erector's workers, by tradition, are called ironworkers.

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Part II Passages **Passage B**

Erecting the First Tier

Erection of a multistory steel building frame starts with assembly of the first two story tier of framing. Lifting of the steel components is begun with a truck-mounted or crawler-mounted mobile crane. In accordance with the erection drawings prepared by the fabricator, the columns for the first tier, usually furnished in sections two stories high, are picked up from organized piles on the site and lowered carefully over the anchor bolts and onto the foundation, where the ironworkers bolt them down.

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Part II Passages **Passage B**

Foundation details for steel columns vary. Steel baseplates, which distribute the concentrated loads of the steel columns across a larger area of the concrete foundation, are shop welded to all but the largest of columns. The foundations and anchor bolts have been put in place previously by the general contractor, following the plan prepared by the fabricator. The contractor may, if requested, provide thin steel leveling plates that are set perfectly level at the proper height on a bed of grout atop each concrete foundation.

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Part II Passages **Passage B**

The baseplate of the column rests upon the leveling plate and is held down with the **protruding** anchor bolts. Alternatively, especially for larger baseplates with four anchor bolts, the leveling plate is omitted. The column is supported at the proper elevation on **stacks** of steel shims inserted between the baseplate and the foundation, or on leveling nuts placed beneath the baseplate on the anchor bolts.

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Part II Passages **Passage B**

After the first tier of framing is plumbed up as described below, the baseplates are grouted and the anchor bolts tightened. For very large, heavy columns, baseplates are shipped independently of the columns. Each is leveled in place with shims, wedges, or shop • attached leveling screws, then grouted prior to column placement.

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Part II Passages **Passage B**

After the first tier of columns has been erected, the beams and girders for the first two stories are bolted in place. First, a raising gang, working with a crane, positions the components and inserts enough bolts to hold them together temporarily. A gang of bolters follows behind, inserting bolts in all the holes and partially tightening them. The two-story tier of framing is then plumbed up (straightened and squared) with diagonal cables and turnbuckles,

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Part II Passages Passage B

while checking the **alignment** with plumb bobs, transits, or laser levels. When the tier is plumb, connections are tightened, baseplates are grouted if necessary, welds are made, and permanent diagonal braces, if called for, are rigidly attached. Ironworkers **scramble** back and forth, up and down on the columns and beams, protected from falling by safety **harnesses** that are connected to steel cable **lifelines**.

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Part II Passages Passage B

Erecting the Upper Tiers

Erection of the second tier proceeds much like that of the first. Two-story column sections are hoisted into position and connected by splice plates to the first tier of columns. The beams and columns for the two floors are set, the tier is plumbed and tightened up, and another layer of **planks** , decking, or safety netting is installed.

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Part II Passages **Passage B**

If the building is not too tall, the mobile crane will do the lifting for the entire building. For a taller building, the mobile crane does the work until it gets to the maximum height to which it can lift a tower crane. The tower crane builds itself an independent tower as the building rises, either alongside the building or within an elevator shaft or a vertical space temporarily left open in the frame.

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Part II Passages **Passage B**

As each piece of steel is lowered toward its final position in the frame, it is guided by an ironworker who holds a rope called a tagline, the other end of which is attached to the piece. Other ironworkers in the raising gang guide the piece by hand as soon as they can reach it, until its bolt holes align with those in the mating pieces. Sometimes **crowbars** or hammers must be used to **pry**, wedge, or drive components until they fit properly, and bolt holes may, on occasion, have to be **reamed** larger to admit through slightly misaligned piece.

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Part II Passages **Passage B**

When an approximate alignment has been achieved, **tapered** steel drift pins from the ironworker's tool belt are **shoved** into enough bolt holes to hold the pieces together until a few bolts can be inserted. The bolters follow behind the raising gang, filling the remaining holes with bolts from leather carrying baskets and tightening them first with hand wrenches and then with impact wrenches. Field-welded connections are initially held in alignment with bolts, then welded when the frame is plumb.