CONE 650: CONSTRUCTION LABOR PRODUCTIVITY

Field Study 02: MATERIAL MANAGEMENT SYSTEM (MMS)

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1. THE OPERATION AND THE MATERIAL NEEDED

1.1 Overview of the operation.

Located at 10300 Campus Point Drive, near Torrey Pines, is a multi-phase development project for medical buildings. DPR Construction is the general contractor for the project's third phase. Phase 3 of the project is an 800,000 sf building. It consists of seven stories, two sub grade parking and mechanical floors with five above grade open spaces. In addition to being the general contractor for the building core and shell, DPR Construction is the general contractor for the tenant improvement for one of the building's tenants. The position of working for both the developer and the future tenant has allowed them to collaborate, design, and build a medical research facility that can serve both party's needs.

For this case study, our group conducted a case study of material management systems for the building's structural steel core. The structural steel scope is subcontracted out by DPR Construction to Henrick.

The process of steel erection consists of the placement, connection, and inspection of steel columns and beams while integrating the placing the metal decking and reinforcing steel rebar. The responsibilities of metal decking and reinforcing steel rebar belong to other subcontractors, but the placement of the material is integrated into the structural steel subcontractor's duties because it requires their crane.

The process of placement for all of the materials utilized a mobile crawler crane and is broken in phases and locations. Due to the limitation of the crane's span, the crain circulates to five different points surrounding the building. Once all building components are placed by the crane in its section, the crain moves to its next location. The process is broken into sections below.

1. Steel columns for two floors are placed. The steel columns have a height of two stories.
2. Steel beams for the columns lower section are placed and connected via bolts.
3. Metal decking is then placed on the same floor.
4. Reinforcing steel rebar is placed on top of the metal decking.
5. The crane will then move to its next point around the building.
6. Steps two through five are repeated until the entire lower floor has its beams, decking, and reinforcing steel rebar.
7. The beams and columns are then inspected and adjusted to ensure plumbness and level. once approved, they are welded
8. Steps two through seven are then repeated for the already placed columns' on the second level.

This process is repeated until the entire building's structural core is complete.

1.2 Material required for operation

H section steel columns and Steel I beams are the main components for the building steel core. A mobile steel crane is used to transport the material from its staging area to the point of installation. smaller materials that are required are field supports, safety bolts and wire, clamps, stiffeners, bent plates.

The beams, columns and bent plates are engineered to order. The other items listed are commodities and ordered as needed.

The major steel components typically require a lead time of twelve to six months, but for this specific project they were ordered six months before delivery. The commodity materials have a much smaller lead time, three to four business days.

2. THE MATERIAL MANAGEMENT SYSTEM

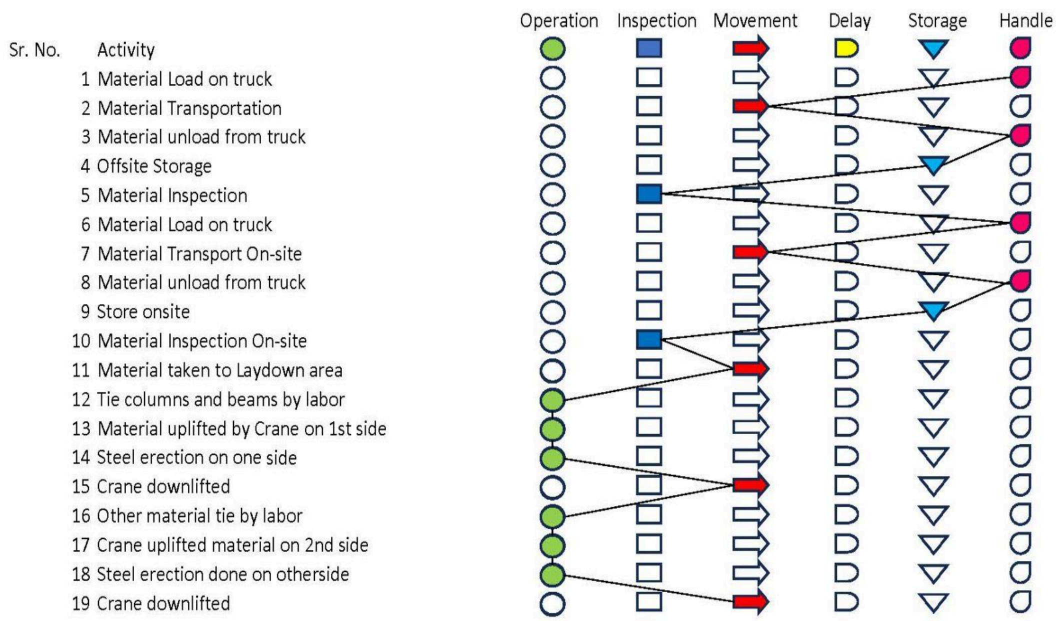

Table 1 Process chart

2.1 Ordering

The steel beams and columns come from a single source, a steel mill in Arkansas. The other commodity materials are ordered from various supplies on an as needed basis. The superintendent for Henrick emphasized that these commodity materials are never the limiting factor for their work.

The field made the request for the structural steel six months before they started the steel erection. This order happened in April 2023 when the design was between the 50 and 75 CD phase. The reason that this steel mill has a long lead time is because it only produces one type of steel member for a scheduled amount of time. If the project required a certain kind of steel member and the mill was not scheduled to produce it anytime soon, then they would have to wait.

2.2 Delivery

2.2.1 Frequency and Quantity

Materials are delivered daily and the quantity of material delivered is for the day’s amount of work it was delivered on. The rebar and metal decking are ordered by their respective parties but in weekly deliveries.

2.2.2 Organization and Preparation

2.2.2.1 Pre-assembly

The structural steel is not pre-assembled before it is delivered on site. Certain components are pre-assembled onsite before their installation. For example, some moment frames for the roof deck were pre connected at the ground level before being transported to the roof, via the crane. This pre-assembly approach is only used for the final/roof level because it is the only level that has steel columns that do not span two floors in height. An image of a pre assembled steel moment frame is shown below.

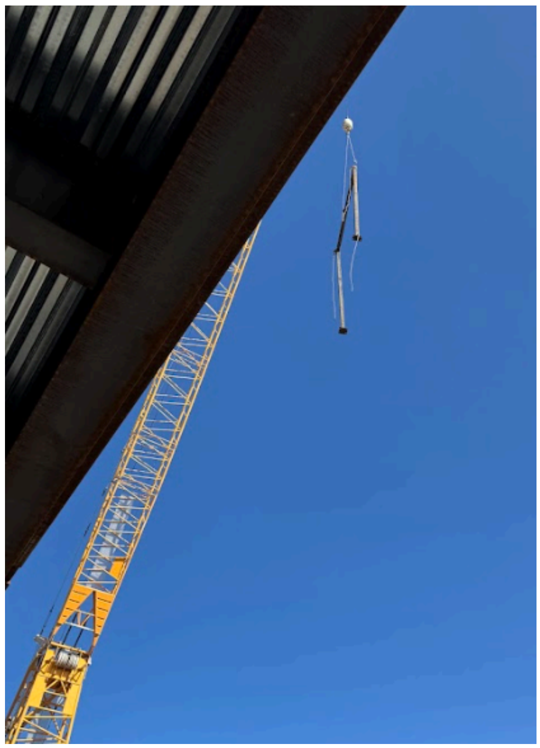

Figure 1: shown above is a steel moment frame being lifted by the crane from the ground layout area to the top constructed floor.

2.2.2.2 Pre-organized

The steel is pre-organized into packages that coincide with the installment process down to the order of beams or columns to the order it should be installed in. In other words, once one beam is lifted, the ground level crew will take the next beam in the collection and that beam belongs in the next spot in the steel structure assembly process. This enables the team to take the next beam or column, from the collection, and place it in the next spot in their process without having to move to different locations for different components. This process is notably faster than having to find a certain type of material for a location of installment and the inverse of that reason.

The commodity items used for this project are kept directly next to the locations they will be used. For example, clamps and safety bolts are located in excess at the top of the building where beams and columns are being placed and they are at the ground level where the building materials are being attached to the crane.

2.2.2.3 Pre-processing

The materials do not require any sort of processing on site before they are installed. every beam and column is cut to the required length at the mill.

2.3 Quality

The structural steel is required to meet the design requirements when it is installed, however this is not managed on site. The quality of the steel is determined in the design phase of the project and achieved in the mill. By the time that the steel components have arrived on site they have gone through quality checks too.

2.4 Storing and Handling

The structural steel arrives at the site via delivery trucks. The trucks then align themselves with the northeastern side of the project site. A Telehandler forklift is then used to move the material from the truck to its storage location. When the material is needed/is on deck to be installed, it is taken from the storage location to the layout area. the layout area changes depending on which location the crane is at. Once at the layout site, the material is then prepped to be lifted by the crane and carried to the location it will be installed at. crew members then attach the steel member enough for it to be safe, but so that they can also make minor adjustments after inspection. Once inspected and approved, the steel is then welded and fully attached to the structure. An image of the project's general layout and a layout sketch of the material placement and movement are shown below. The layout sketch takes place when the crane is in location one, as observed during the material study.

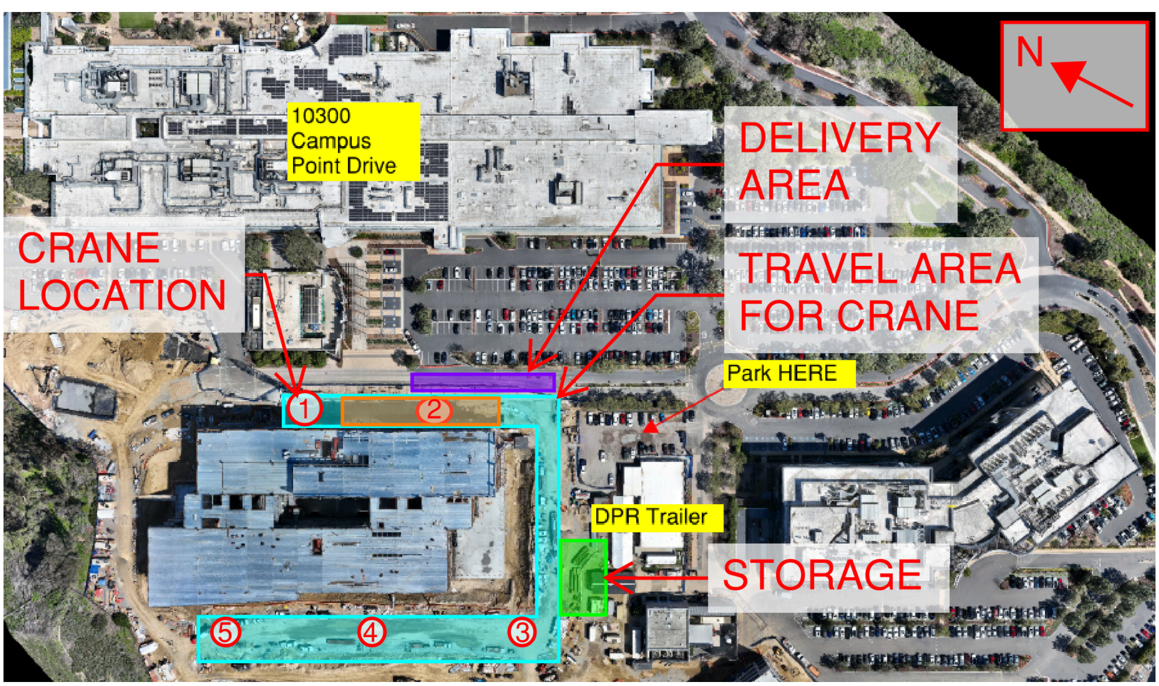

Figure 2: Shown above is the project's general layout that is associated with the structural steel structure and the process associated with its construction.

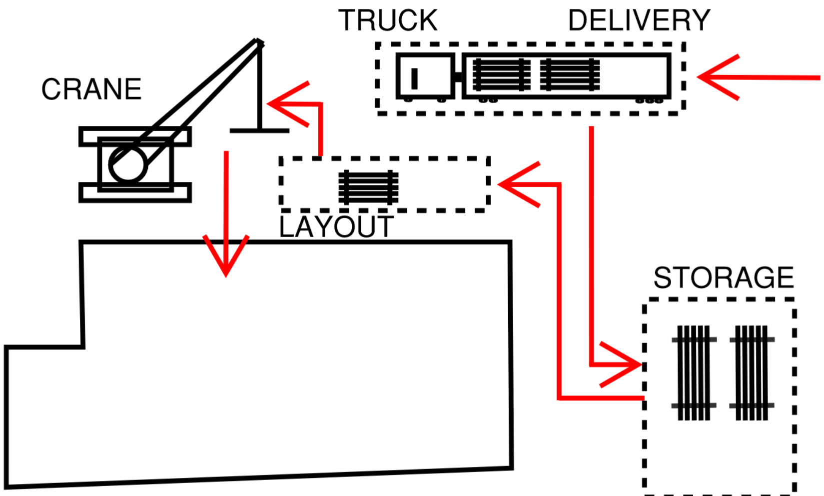

Figure 3: Shown above is a flow diagram that shows the flow of material/steel on the jobsite. The process begins with its delivery to the site and ends with its installation point.

2.4 Finding and Retrieving the Material needed

All the material that is stored is organized according to the order of need and with labels written onto the side of the steel member. In addition to numeric labels, they have QR code stickers. The combination of the order of organization, labels, and QR code leads to it taking minimal time to find the correct material. The reason that they had both labels and QR codes is to ensure that there is a label if one gets rubbed off or removed.

Major steel components are labeled and organized for one specific instance in the entire project. That means that if everything has an order and a time to be placed and installed. The commodity items, like the bolts and nuts, do not necessarily have a specific location, but there are specific kinds that are required for certain instances. This is a structural requirement that ensures steel connections are strong and able to withstand all possible loads. Companies try to standardize as much as possible, but frequently need to tailor material selections based on the unique characteristics of each location.

2.5 Material Preparation / Processing / Installation.

All material required for one day's worth of work is delivered from the mill to the site in a condition that does not require any modification or organizing.

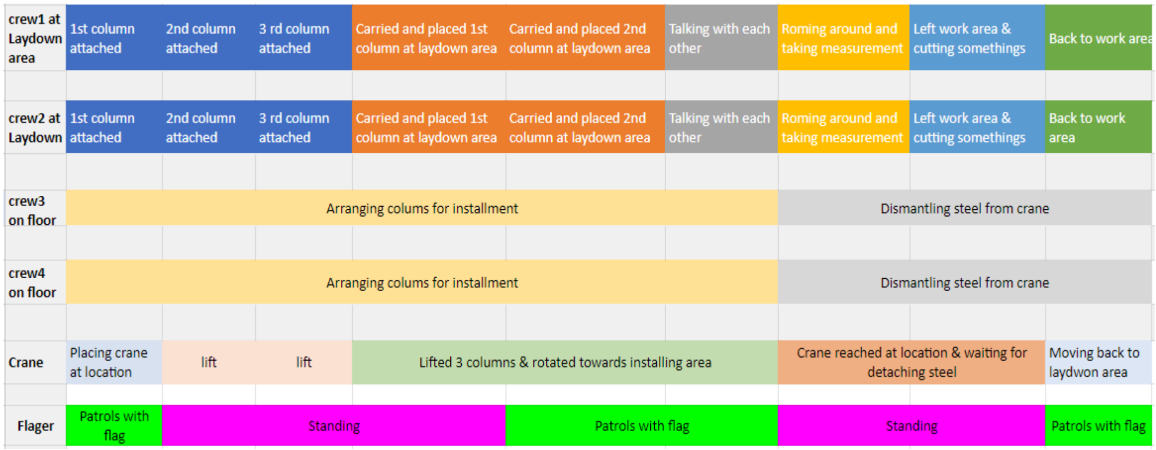

Figure 3: Crew Balance Chart

During the steel erection process described, Crew 1 and Crew 2 sequentially attached the 1st, 2nd, and 3rd columns before the crane lifted them to the 3rd floor for installation. Upon reaching the installation area, Crew members 3 and 4 assisted in detaching steel from the crane and preparing it for installation. Simultaneously, Crew 1 and Crew 2, who had been working at the laydown area, proceeded to carry and place the next set of columns. Following this, they conducted measurements, then left the laydown area to engage in discussions outside while also performing cutting tasks away from the laydown area. As dismantling of columns on the 3rd floor commenced, the crane returned to the laydown area, marking the completion of one cycle of steel erection. The total duration for one cycle of steel erection was observed to be 7 minutes and 91 seconds. Additionally, a 5th crew member was present as a flagger at the laydown area, showing safety flags for crane operations while it was moving. This coordinated effort exemplifies the synchronized workflow involved in erecting steel structures with multiple crews and crane operations.

2.6 Excess material/waste

Most of the construction process does not involve processing of material and does not produce waste from processing. However some waste is generated from the materials, such as pallets, used to aid the transport of the material. Safety lines that perimeter the building’s ledges, create waste when their components are cut from the columns. According to the steel subcontractor superintendent, the amount of waste from the means previously mentioned is negligible.

2.7 Material inspections/checks

Material inspections are a critical part of quality control in construction projects, occurring at multiple stages from material delivery to final installation.

Delivery Inspection: Quality checking and inspection of material conducted daily at the shop before delivery by the receiving team (superintendent). They check delivered quantities match order according to documentation, confirm material specification and check all the defects happen during transportation.

Lay-Down area Inspection: This type of Inspection is conducted regularly by quality inspectors in material storage areas while material arrives at site. It involves checking for any damage that may occur during transportation and handling. Quality inspectors verify materials match the specification, quantities, and documentation provided. They also ensure that proper storage and handling procedures are followed to prevent further damage or degradation.

Installation Inspection: This inspection takes place during the installation or assembly process of materials, components, or equipment. It ensures that the installation follows the approved plans, specifications, and installation procedures. Labors check for proper alignment, clearances, connections, and fastening of the installed items. They verify that the materials are installed in the correct locations and orientations.

3. EVALUATE THE MATERIAL SUPPLY SYSTEM

Waste	Criterion	Score	Justification
Lead time	What is the lead time for the materials needed?	3	6 months, 3-4 business days
Waiting	Does the MSS provide ENOUGH material to prevent work delays?	5	Material ordered and stored in the mill. Days worth of work is on site.
Defects	Does the MSS provide the CORRECT material?	5	Quality check done in shop before delivered
Inventory	Does the MSS keep the “right” amount of inventory?	5	Yes, they deliver enough material for a day’s amount of work
Transportation	Is the material HANDLED MORE THAN ONCE in order to get to installation point?	4	Archanza to store, store to laydown area, laydown area to installation point
Movement	Does the MSS bring the material WITHIN 12 FT of installation point?	1	No, it does not
Over processing (Complexity)	Does the material require TOO MUCH SEARCHING, REORGANIZING, PROCESSING, ASSEMBLY before it is ready to install?	4	Every material is neatly laid out, QR codes
Over processing (Assembly complexity)	Is the assembly DIFFICULT/ COMPLICATED (1) vs EASY/SIMPLE (5)?	3	relatively not complicated/repetitive process
Overproductio n	Does the MSS provide MORE material than needed (in terms of defects, damaged, waste)	5	only what is needed is provided
Response speed	How fast does the MMS respond to changes (conditions / designs/needs)?	1	B/c steel is in early design and procurement times, ability to respond to changes would be extremely difficult

4. SUGGEST IMPROVEMENTS

After visiting the project our team has identified opportunities for improving the Material Management System used for the structural steel.

1. Since the operation of installation has integrated the lifting and installation of metal decking and rebar and their respective crews, when one crew is working, two other crews are not. Joining the three different crews into just one crew could eliminate the wasted abilities. Removing the two excess crews could decrease labor costs and increase safety by limiting the number of individuals in a hazardous area.
2. Storing the material in the layout area could reduce the amount of time spent transporting and handling the material. additionally, just leaving the material on the delivery truck and using the truck’s bed as a layout area could be even more beneficial
3. Improving the system's responsiveness to changes in conditions, designs, or needs could enhance adaptability and efficiency. By increasing the system's agility, it can better accommodate modifications during early design and procurement stages.