



MEMORANDUM

TO: City of Portland – Planning Board
FROM: Jim D. Wentworth, P.E.
DATE : February 21st, 2018
SUBJECT: Maine Medical Center – Constructability Review

Kleinfelder was tasked by the City of Portland’s Planning Department to assist in the constructability review for the vertical expansion of Maine Medical Center’s existing visitors parking garage.

Maine Medical Center along with Turner Construction have submitted a construction option matrix to the City of Portland with five construction options outlined which have been investigated as part of this project’s development.

These options were the starting points for Kleinfelder’s review; and ultimately upon review were the *clear choice options* that this type of project and site would warrant. In order to develop a project of this magnitude, it is necessary to vet out construction options from each side of the parking garage (North, South, and East, and West, as well as from within the garage, as is shown in the Cast in Place Option 1. An additional Option 6 was added which investigated the construction from the East end of the visitor garage.

As you will see further in this memo, Option 4 is the recommended option by Kleinfelder and is also the favored option of Maine Medical Center. This memo summarizes the review by Kleinfelder of the five options presented, but also investigates some additional pertinent data Kleinfelder has associated with these options.

This site poses a challenging and congested construction site, and many factors such as overall public safety (*general public, hospital staff, and contractor staff*), traffic movements, construction type (*parking garage*), construction equipment and capacities (*crane*), and duration (*schedule*) all play a role in a successful project.

Documents that have been reviewed as part of this effort include:

- Visitor Garage Construction Option Comparison (Matrix)
- Maine Medical Center Construction Management Plan -Traffic and Road Closure studies: January 2nd, 2018
- Maine Medical Center Construction Management Plan - Logistics Plans and Studies-East Towers and Visitors Garage, Central Utility Plant: Last update February 9th, 2018, pages 1-29



- Maine Medical Center/Turner – Construction Management Plan-East Tower, Visitor Garage, Central Utility Plant. Last Updated February 13th, 2018 for PB February 27th, 2018
- 440 Ton Leibherr Crane Chart and Boom/Jib Configuration: February 5th, 2018
- Email from Dominic Gagnon with data assumptions for Option 1: CIP, and Option 2: South side retaining walls: February 9th, 2018
- Submitted Congress Street Cross Section with Crane Layout: February 12th, 2018

The following are each option listed with constructability comments and recommendation:

Option 1- Cast in Place (CIP)

- Cast in Place (CIP) concrete is not a preferred nor typical construction technique used in parking garage construction due to concrete quality control, longevity of structure, time/schedule, and overall increased cost. The existing MMC employee garage is a cast in place structure and has these maintenance and longevity issues. (i.e. efflorescence, concrete spalling, resistance to deicing chemicals)
- SGH Engineering has determined that the overall structure was designed to handle an additional 3 stories at approximately 80-85 lbs. per square foot. Kleinfelder was not tasked to perform independent calculations to verify these loading parameters. However, in our engineering judgement, a CIP structure could likely weigh more than a precast structure based on additional reinforcing steel needed for post tensioning along with additional concrete in the post tensioning anchorage zones. This is solely based on engineering judgement and not calculations.
- For a CIP structure, the existing visitor garage interior and exterior support columns and walls would most likely also need to be reinforced in order to handle any additional weight that a CIP structure and the support formwork/falsework would pose to the structure.
- Without performing and bearing capacity calculations, it is likely that the existing foundation and support soil that exists under the building would need reinforcement to hold a CIP type structure.
- Based on overall constructability for these long Double Tee beams the following are factors that would add cost and duration into a CIP type structure:
 - Forming, concrete placement, concrete curing for Double Tee type beams would be labor intensive which would add cost and affect duration of project schedule.
 - ***A crane would still be needed to perform the work for lifting formwork materials, steel tendons, concrete, and other various construction materials, therefore impacts to traffic to Congress Street would still occur frequently. It is our opinion, without fully developing a full construction schedule for a CIP type structure that the duration and temporary impacts to traffic, associated with CIP construction, would cumulatively be more than the 8 weeks of associated shutdown currently proposed with Option 4. Due to CIP concrete curing and forming this type of project could take up to 4-6 months to complete.***
 - Post tensioning the tendons, grouting, and equipment/ jacks to perform this post tensioning in place would be needed. A post tensioning procedure would be very difficult to perform with accuracy in this type of location and environment. (i.e. Staging of post tensioning jacking equipment, worker falsework)



- There is a high probability that the entire parking garage would need to be empty during this type of construction operations based on temporary falsework and shoring needs to cast the concrete in place would be from a bottom up approach. (All floors to be braced from ground up).

*Based on the information provided and reviewed, **Option 1 is not recommended.***

Option 2- South Side Approach

- Overall Safety of Area: The location of the Emergency room entrance/exit is located on the South side of the visitor parking garage and therefore general *public safety and emergency access* of this public service would be extremely limited if this option was chosen.
- Two retaining walls exists along the South side of the existing parking garage. Kleinfelder did not have access to as built plans of these two retaining walls nor was scoped to perform any structural check calculations on these two walls.
 - Based on the design loadings, per email of Dominic Gagnon February 9th, 2018 per SGH Engineering; the retaining walls as designed assumed a vertical surcharge pressure in the order of 500 pounds per square foot for the wall. It is reasonable to state that the 440 T Liebherr crane as proposed, with a frame weight of approximately 94,800 lbs. and allowable counterweight of 341,800 lbs. distributed over a total track area of 240 square feet (3'11"x30'8" each track), without accounting for the boom and precast units, has the ability to produce in excess of 1800 lbs. per square foot of surcharge.
 - A slightly smaller crane than the 440T Liebherr could be used from this South side of the garage; however surcharge pressures of 1500-1800 lbs. per square foot would not be unreasonable to experience for the crane size needed to lift the 30 ton precast units.
 - MMC and Turner investigated a 600 Ton hydraulic crane for this option, also this crane was also ruled out due to wall surcharge capacity and overall site logistics.
- Temporary shoring of these two retaining walls is not a feasible option based on their location. Any type of shoring such a sheet pile type wall, soldier pile wall, or pile platform would need crane access to perform the temporary work as well. It is not known, but assumed, that there are buried utilities in this section of roadway which would complicate any pile driving or shoring processes.
- There is limited *safe area* to operate any type of crane swing radius on this South side of the building. This area is terraced with a retaining wall. The total area is approximately 120 ± feet by 100 ± feet. A safe area for a crane to operate would be a minimum 60± feet by 60± feet which is not available.
- Overall staging of materials in the area on the South side would be limited.
- Delivery and access of precast units (85' long truck) to the South side would be limited based on turning movements associated with street configurations, on street parking, and utility pole locations around the area.

*Based on the information provided and reviewed, **Option 2 is not recommended.***



Option 3- North Side Approach, One lane

- Congress Street is approximately 43'9"± curb to curb based on cross section provided by Turner.
- The sidewalk abutting the visitor garage is approximately 10'6"± in width.
- The sidewalk on the North side of Congress is approximately 11' ±in width.
- The proposed 440 Ton Liebherr Crane is approximately 45 feet in length from front of track to back of counterweight. This crane configuration takes up the majority of the roadway and overhanging 2-3± feet of the sidewalk.
- The Main boom on the crane cannot operate totally vertical and will use all of the available 10'6"± sidewalk area to face the garage.
- There is no available *safe width* for emergency or passengers vehicles to travel through the area based on the crane operating parameters.
- There is limited available width (7-8 feet ±) for protected pedestrian traffic along the North sidewalk.

*Based on the information provided and reviewed, **Option 3 is not feasible or recommended.***

Option 4- North Side Approach, Two lane (Road Closure)

- Safety-All work is completed in closed section of road, there will be no vehicular traffic present in the area. Overall this option is the safest for general public and contractor based on constructability.
- This option has similar site and crane parameters as Option 3, but calls for a shutdown Congress Street for 8 weeks.
- The 440 T Liebherr crane configuration is needed to reach up and over existing parking garage for lifting and reach capacity reasons to install the 30 Ton precast Double tee beams.
- Two other type of cranes where investigated: Mobile Hydraulic, and Tower Crane.
 - Each crane has limitations:
 - A Tower Crane, which is typically used in building construction, does not have the 30 Ton capacity for the distance needed to lift the precast beams and set them into place.
 - A mobile crane does not have the 30 Ton capacity to reach up and over the building.
- The 440 T Liebherr crane will have two sections of crane boom: Main Boom-161 feet, Jib-161 feet. (320 ± feet).
- A 300 foot length of Congress from pedestrian skybridge to Weymouth is necessary to assemble the crane along with its boom and jib.
- A single phase power utility line exists at corner of Congress and Weymouth which will not affect boom assembly.
- There is no additional street or sidewalk width with this crane configuration to safely use this option with emergency vehicular traffic.
- Delivery of the 85 foot long precast units for this option from Weymouth to Congress is feasible.



*Based on the information provided and reviewed, **Option 4 is recommended.***

Incentive/disincentives for allowable closure days (User cost/day), liquidated damages for end dates (Cost/day), traffic detours and signage, are all parameters that can be employed by the City to minimize the closure efforts with Option 4.

Option 5- Crane Placed in vacant Employee parking garage area

- This option poses construction scheduling delays and logistics, based on current schedule of additions onto visitor garage complete (2018), and new East Tower heliport complete (2019).
- The new employee parking garage on St. John would need to be constructed (2019) prior to demolition of existing employee garage.
- A crane with 480 ± lineal feet of boom/jib would be needed to reach up and over elevator/stairwell that currently exists between two parking garages.
 - This is an additional **160 lineal feet** of boom/jib added to the current 440T crane configuration proposed.
- Safety of general public working over **LIVE** stairwell needs to be taken into consideration.
- Crane assembly along Congress has limitations on South side of pedestrian skybridge:
 - Approximate 500 ± feet would be needed from pedestrian skybridge into Valley Street to assemble crane, boom and jib (480 ± feet from bullet above)
 - Closure of Congress to assemble crane.
 - Utility line interferences and needed utility relocations: Three phase power lines at Congress and Forest, Congress and Gilman, Congress and Valley.
 - Hospital main electrical feed from Gilman

*Based on the information provided and reviewed, **Option 5 is not recommended.***

Option 6- Crane Placed on East side of Visitor garage

- The existing medical building that was constructed within the last 10 years and is located on this East side of the visitor parking garage would need to be demolished and rebuilt with this option. This would have substantial costs with no value added.
- This option also would pose construction scheduling delays and logistics, based on current schedule of additions onto visitor garage complete (2018), and new East Tower heliport complete (2019).
- The steep slope in this location would case a need for temporary retaining wall to be built to support Crescent Street.
- A similar size Crane as the Liebherr 440 Ton crane would be needed as in Option 5 to construct the addition.



- Impacts to traffic on Congress Street would still occur due to building demolition, crane assembly/disassembly, and delivery of precast units, which would in cumulative duration would account for more than the eight weeks for Option 4.

Based on this information, Option 6 is not recommended.

Schedule Overview

The overall construction schedule of an 8 week closure of Congress Street was reviewed and is listed below as *Schedule 1*. This schedule allows for 8 precast pieces set per day. It is realistic that 10 precast pieces may be set a day or even 12 pieces. It is also realistic that construction delays such as deliveries and/or adverse weather conditions may cause delays and allow only 6 pieces to be set per day.

Two other schedule scenarios were investigated based on 8 pieces per day.

Schedule 2 assumes a 6 days a week schedule and resulted in a 7 week closure.

Schedule 3 assumes a 7 days a week schedule and resulted in a 6 week closure.

It is recommended that the 8 week schedule be allowed, but set with allowable penalties for not opening on time.

It is not recommended to go to a 7 day work week as shown in Schedule 3. Consideration needs to be given in any schedule that as days get added to the work week there exists safety concerns with rested employees, decreased efficiency, a work area increase for complacency, as well as increase in cost premiums.

- *Schedule 1*
 - 8 week -5 day/week-8 pieces (assumed) per day-proposed
- *Schedule 2*
 - 7 week -6 day/week-8 pieces per day- Open by June 18th-19th
- *Schedule 3*
 - 6 week-7 day plus holiday-Open by June 8th-9th

In conclusion, taking all the project parameters into consideration:

- Safety to the overall general public
- Existing building and wall capacities
- Crane capacities and locations
- Schedule duration
- Impacts to Congress Street

Closing Congress Street for an 8 week duration is the recommendation that Kleinfelder fully supports and would have proposed if developing this type of project independently for a client. It is recommended that the City work with Maine Medical Center to tighten up the schedule, as previously mentioned in this memo, with the use of incentive/disincentives, liquated damages associated with possible street damage, proper detour signing, and proper public outreach campaign.