

STATE OF OHIO
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISIONS FOR
STRUCTURE MONITORING DURING INCREMENTAL LAUNCHING
SUM-8-0199 L/R (PID NO. 91710)
October 6, 2022 – Revised March 21, 2023 (Prebid Addendum 3)

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01 DESCRIPTION

This work consists of labor, equipment, and materials to install and maintain a structure monitoring system in accordance with the requirements in this special provision. The monitoring system will consist of various sensors, cabling, conduits, pull boxes, junction boxes, cabinets, and data acquisition equipment. The Contractor shall retain an Independent Monitoring Firm (IMF) to be responsible for the acquisition, installation, maintenance, and removal of the monitoring system. The IMF shall also be responsible for continuously recording the required monitoring data and reporting this data to the Engineer and immediately reporting exceedance of any specified thresholds. The monitoring system shall be used during incremental launching of both the Southbound and Northbound bridges. For each respective bridge, the system shall be installed prior to the first incremental launch movement until the bridge is lowered and secured to all permanent HLMR bearings. The Contractor will be responsible for providing access for the IMF.

The specified locations of the sensors provided in this Special Provision are based upon the Engineer's anticipated erection methods as indicated in the plans. If the Contractor changes the method of erection, the Engineer will review the Contractor's proposed erection manual and recommend if changes to the locations of the sensors is required to best capture the intended data.

The work also includes geometric control survey of the bridge girders and piers during launching. This work may be performed by either the IMF or the Contractor.

02 INDEPENDENT MONITORING FIRM (IMF)

The Contractor shall retain an IMF to acquire, install, maintain, and remove the monitoring system. The IMF shall also provide continuous recording of the required monitoring data, report this data to the

Engineer and immediately report exceedance of any specified thresholds. Continuous reporting shall be instantaneous via cellular phone data connection and shall be made available to the Engineer at all times via password secured internet access.

The IMF shall be a firm with previous experience in the design and installation of structural monitoring systems of similar type and size. The Contractor shall submit the qualifications of the IMF to the Engineer for approval in accordance with Section 03. At a minimum the firm must submit three examples of previous similar work providing continuous structure monitoring of steel and concrete bridges.

03 SUBMITTALS

The Contractor shall submit the following in accordance with procedures in CMS 501. Submittals must be reviewed and approved by the Engineer prior to purchasing or installation:

1. Qualifications of IMF including a minimum of three previous examples of similar projects with structural monitoring of steel and concrete bridges. The projects must include continuous data logging and wireless remote access to data.
2. Location and installation plan for all sensors, cable, and data acquisition equipment.
3. A complete list of all proposed sensors and data acquisition equipment along with manufacturer's specifications and manuals.
4. Certificate of calibration for all sensors indicating calibration in accordance with the appropriate ASTM standard testing procedure.
5. Plan for protecting all equipment before, during, and after installation.
6. Emergency contact information for the IMF, to be available 24 hours per day, seven days per week during the incremental bridge launching.
7. Contractor's plan for providing access to the IMF and Engineer to all monitoring equipment throughout construction.

04 MONITORING REQUIREMENTS

The structure monitoring system shall at a minimum continuously monitor the following items for the northbound and southbound bridges respectively from the commencement of girder launching until all girders have been lowered and secured onto the permanent HLMR bearings. Sketches indicating the survey target and sensor locations are included for the southbound bridge. Locations for the northbound bridge are similar. Provide survey targets and sensors for the following:

1. Air temperature.
2. Wind speed and direction.
3. Location and elevation of the tip of launching nose at both exterior girders with a fixed survey monitoring point. (T-N2, T-N5)
4. Location and elevation of the south end of girder at the connection to the launching nose at both exterior girders with a fixed survey monitoring point. (T-R1, T-R6)
5. Location and elevation of points on each exterior girder located at regular intervals along the length of the girder not to exceed 50 feet using fixed survey monitoring points. Provide a fixed survey monitoring point at each final bearing location on the exterior girders. (T-X1, T-X6)
6. Girder top and bottom flange stresses for each girder under the launching kingpost connection using strain gages. (G-K1T through G-K6T, G-K1B through G-K6B)

7. Girder top and bottom flange stresses for each girder under the north launching back stay anchor connection using strain gages. (G-S1T through G-S6T, G-S1B through G-S6B)
8. Compressive stress in each kingpost using strain gages. (G-P1 through G-P6)
9. Rotation near the top of pier for each pier using tilt meters. (I-1 through I-5)
10. Deflection of the east and west end of the top of each pier cap using fixed survey monitoring points. (T-P1L through T-P5L, T-P1R through T-P5R)
11. The applied jacking force in each jack including both compression for launching and tension for retracting using load cells. (LC-2 and LC-5)

All required data shall be transmitted via wireless cellular connection and automatically post-processed by the IMF into table and graphical format. The post-processing shall make any adjustments to the collected data to convert strains to stresses, adjust for temperature, etc. The tables and graphical data shall be available to the Engineer to monitor current conditions with no delay via password secured internet access with a commercial web browser such as Internet Explorer or Chrome. A minimum capacity of twenty secure user accounts shall be provided.

05 NOTIFICATIONS

The structure monitoring system shall be equipped to automatically detect exceedance of threshold values for each of the required data listed in Section 04 which shall be agreed up by the contractor, engineer, and IMF prior to beginning work. In the event of exceedance of a threshold value, the IMF shall immediately notify designated staff from the Contractor, the Engineer, and ODOT by both email and text message. The text message shall clearly indicate that a threshold exceedance warning has been detected and state which threshold has been exceeded.

In the event of the threshold exceedance, the Contractor shall immediately cease work. The Contractor shall coordinate with the Engineer and submit a corrective action plan to the Engineer for approval. If the corrective action plan cannot be determined or requires further investigations, the Contractor shall commence retracting the structure until the end of the leading girder is supported on the launching rollers with only the launching nose cantilevered beyond the pier. Launching may not start again until the corrective action plan is approved.

Based on the erection sequence in the plans, suggested threshold values for notification include:

	Max. Allowable Deflection (for both NB & SB Bridges) (inch)
Pier 1	0.50
Pier 2	2.00
Pier 3	3.50
Pier 4	1.80
Pier 5	0.40

	Max. Flange Stress (KSI)
NB Top Flange at Kingpost	19.4
NB Bottom Flange at Kingpost	17.1
SB Top Flange at Kingpost	23.9
SB Bottom Flange at Kingpost	21.3

Monitors on load cells shall provide notification if loads exceed 10% of the predicted jacking loads for the current stage of construction.

06 PROTECTION AND MAINTENANCE OF EQUIPMENT

The Contractor shall take all necessary steps to protect sensors, cabling, and data acquisition equipment from disturbance or damage due to their operations during construction of the bridge. The following minimum precautions shall be taken during installation of sensors and data acquisition equipment:

1. The Contractor shall avoid direct contact between strain gages and launching equipment such as rollers, jacks, or guides.
2. Wiring shall be secured to the structure and routed in a manner to minimize risk of damage due to launching operations.
3. All data acquisition equipment shall be secured to the structure or to the ground and resistant to vandalism yet accessible to the IMF and the Engineer.
4. Provide durable waterproof enclosures for all data acquisition and communication equipment in compliance with the equipment manufacturer's written directions.
5. Provide insulated or climate controlled enclosures for data acquisition and communication equipment if recommended by the manufacturer in the written directions.
6. The IMF shall provide a schedule to the Contractor and the Engineer for any elements of the monitoring system requiring battery replacement. The Contractor shall replace batteries according to the recommended schedule.
7. After installation the Contractor shall not move, dislodge, disturb, disconnect, reconnect, cut, or relocate wires, instruments, or related instrumentation controls or recorders; or remove any labeling of the instruments, wires, or related instrumentation controls or recorders without the approval of the Engineer and the IMF.

07 MATERIALS AND EQUIPMENT

The monitoring system components shall be selected by the IMF and submitted to the Engineer for approval in accordance with Section 03. The system will consist of various sensors located throughout the bridge connected to a data collection system with remote access capabilities. To the extent possible all sensors and data collection systems shall be supplied by the same manufacturer to assure compatibility, except as noted in these special provisions. The IMF shall be responsible for selecting and providing compatible equipment. If any element of the sensors, cabling, data acquisition system, wireless communications, data post-processing, or internet access to the data is not compatible the IMF shall correct the incompatibility at no cost to the Department. The anticipated materials for this system are described in this section.

1. **Vibrating Wire Surface Mounted Strain Gages:** The gage contains a steel wire that is tensioned between the ends of a hermetically sealed outer steel tube. A pair of mounting blocks is used to bolt the gage at its ends to the steel member. A removable electromagnetic coil assembly attached to the outer steel tube plucks the wire causing it to vibrate. The frequency of the wire vibration is read as an electric signal and converted to a corresponding strain. The electromagnetic coil assembly also contains a thermistor for temperature measurement at the gage location. The gage can easily be removed from the mounting blocks at any time after installation allowing for replacement of the gage. Vibrating wire surface mounted strain gages shall be Geokon 4000,

Roctest SM-5A, or an equivalent approved by the Engineer. Do not weld strain gage attachments to flanges identified in the plans as tension (T).

2. Vibrating Wire Tilt Meters: The gage is used for measuring changes in rotation of an element. The model indicated has a pendulous mass that can move in one direction with gravity. A vibrating wire gage is used to restrain movement on the elastic hinge and is calibrated with regards to degree of rotation. Mount the unit in a vertical orientation with a bracket per the manufacturer's recommended details. Vibrating wire tilt meters shall be Geokon 6350 or an equivalent approved by the Engineer.
3. Load Cells: Load cells are transducers that convert the load acting on the load cell to an electric signal via embedded sensors. Load cells shall be compatible with the Contractor's selected jacking equipment, shall be rated to meet or exceed the load capacity of the jack, and shall be approved for use by the jack manufacturer. Load cells may monitor compression only or may monitor both tension and compression forces.
4. Data Acquisition System: The purpose of the data acquisition system is to measure the responses from various sensors located throughout the bridge, store the data, and provide remote access to the data to the Engineer. The data acquisition system may consist of multiplexers, data loggers, vibrating wire interfaces, power supply, Ethernet interface, multidrop interfaces, and wireless cellular internet service. These systems shall be specified by the IMF, installed at the direction of the IMF, tested and certified by the IMF, and maintained in accordance with IMF instructions to ensure continuous monitoring and continuous access to monitoring data.
5. Cabling: Cabling is used to connect various pieces of the data acquisition system. This is not to be confused with the sensor cables themselves, which are purchased from the manufacturer to be integral from the sensor to the multiplexer. All cabling shall be in accordance with CMS 632 and shall be compatible with the data acquisition equipment. All cabling shall be labeled within 12 inches of the terminus indicating the equipment they are connected to on each end. The labels shall be type written in at least 10 point font and shall be weatherproof.
6. Temporary Enclosures, Junction Boxes, and Cabinets: Temporary enclosures, junction boxes, and cabinets are required to house electronic equipment for the data acquisition system during construction. These items shall be selected by the IMF to contain, secure, and protect from the elements the equipment listed in this section. At a minimum these items shall be weatherproof, electrically grounded, located and adequately sized to be accessible to the IMF and Engineer, and locked. Other measures such as being insulated or climate controlled shall be as recommended by the IMF and the manufacturer. Temporary enclosures shall be provided and installed in accordance with CMS 625.

08 INSTALLATION OF MONITORING SYSTEM

The IMF will have responsibility of installation of the monitoring system. The system shall be installed in accordance with a detailed design and specifications provided by the IMF. The following requirements shall apply:

1. Approval of monitoring system: Submit the monitoring system for approval in accordance with Section 03.
2. Handling of monitoring system: The IMF shall store all sensors and data acquisition equipment in a climate-controlled facility prior to installation. The equipment shall not be exposed to environmental conditions beyond the manufacturer's recommendations. Any equipment that is improperly stored will be rejected by the Engineer and the IMF will be responsible to replace at no additional cost to the project.

3. Installation of strain gages: The IMF shall be responsible for installation of strain gages as detailed in this Special Provision. The individual in charge of strain gage installation shall have a minimum of four years of experience with the installation of similar sensors. Installation includes running attached wiring from the strain gage to the appropriate multiplexer in the appropriate junction box. Vibrating wire surface mounted strain gages shall be designed to be mounted to steel surfaces. The sensors shall be mounted to brackets per the manufacturer's recommendations. The brackets shall attach to the steel with 3/8" bolts. After the brackets are removed, fill all empty bolt holes with a 3/8" diameter Type III ASTM A325 bolt with washer and nut. Care shall be taken to route cabling in a manner that protects it from ongoing construction activity.
4. Installation of tilt meters: The IMF shall be responsible for installation of tilt meters as detailed in this Special Provision. The individual in charge of tilt meter installation shall have a minimum of four years of experience with the installation of similar sensors. Installation includes running attached wiring from the tilt meter to the appropriate multiplexer in the appropriate junction box. Surface mounted tilt meters shall be mounted to manufacturer recommended steel brackets designed to be attached to concrete surfaces using stainless steel anchors.
5. Orientation of strain gages: Sensors shall be installed with their axes parallel to the longitudinal axis of the gaged member.
6. Installation of Load Cells: Load cells shall be secured per the jack manufacturer's instructions between the jack base and the jack anchor pin, or between the plunger and the launching roller pin. If the selected load cell is compression-only, the IMF shall also provide strain gage sensors on the tension resisting elements of the jacking assembly to monitor tension forces in the event the girder launching operation is retracted.
7. Acceptance of instrumentation: The IMF shall prove that instrumentation are in good working order and functioning prior to acceptance and payment for instrumentation. The IMF shall check all sensors after initial installation and at other times specified by the IMF. After all sensors are connected into the data loggers, the IMF shall verify that each sensor is providing reasonable data and is being properly collected by the logger.
8. Repair of defective equipment: The IMF shall repair or replace any sensors, cabling, or data acquisition equipment determined to be defective after initial installation.

09 GEOMETRY CONTROL SURVEY

The Contractor shall monitor deflections in the steel girder system during incremental launching. The Contractor shall furnish competent engineering and surveying personnel and equipment as well as a detailed plan to establish and verify elevations, vertical alignment, and horizontal alignment at every stage of construction. At a minimum the longitudinal, transverse, and vertical position (x, y, and z coordinates) of the tip of the launching nose shall be surveyed every 10-foot increment of launching. Based on the elevation the Contractor shall verify that the deflection is within the calculated tolerances that ensure the launching nose will land on the roller with proper alignment by comparing it to predicted values provided by the Contractor's engineer. If the projection indicates misalignment, the Contractor shall make corrections by adjusting jacking forces, adjusting differential between jacks, applying force at the lateral guides, or other means as permitted in the approved erection plan. Other fixed points along the girders spaced not to exceed 50' increments shall be surveyed at a minimum every 30 feet of incremental launching. Survey points shall include all permanent bearing locations along the girder.

The ends of the top of pier caps shall be surveyed every 10 feet of incremental launching to assure that the deflection of the top of pier cap is within the expected range of deflections based on the friction resistance of the roller system, including differential deflection between the left and right sides of the

pier. If deflections exceed the maximum allowable deflection, stop work immediately and notify the Engineer. The Contractor shall examine the structure launching equipment to determine the cause of the excessive deflections and propose a corrective action plan to the Engineer for approval prior to restarting launching operations. Permissible deflections at the top of pier are provided in Section 5. Surveyed deflections of the pier tops are intended to serve as a cross-check of the tilt meter readings and both types of monitoring are required.

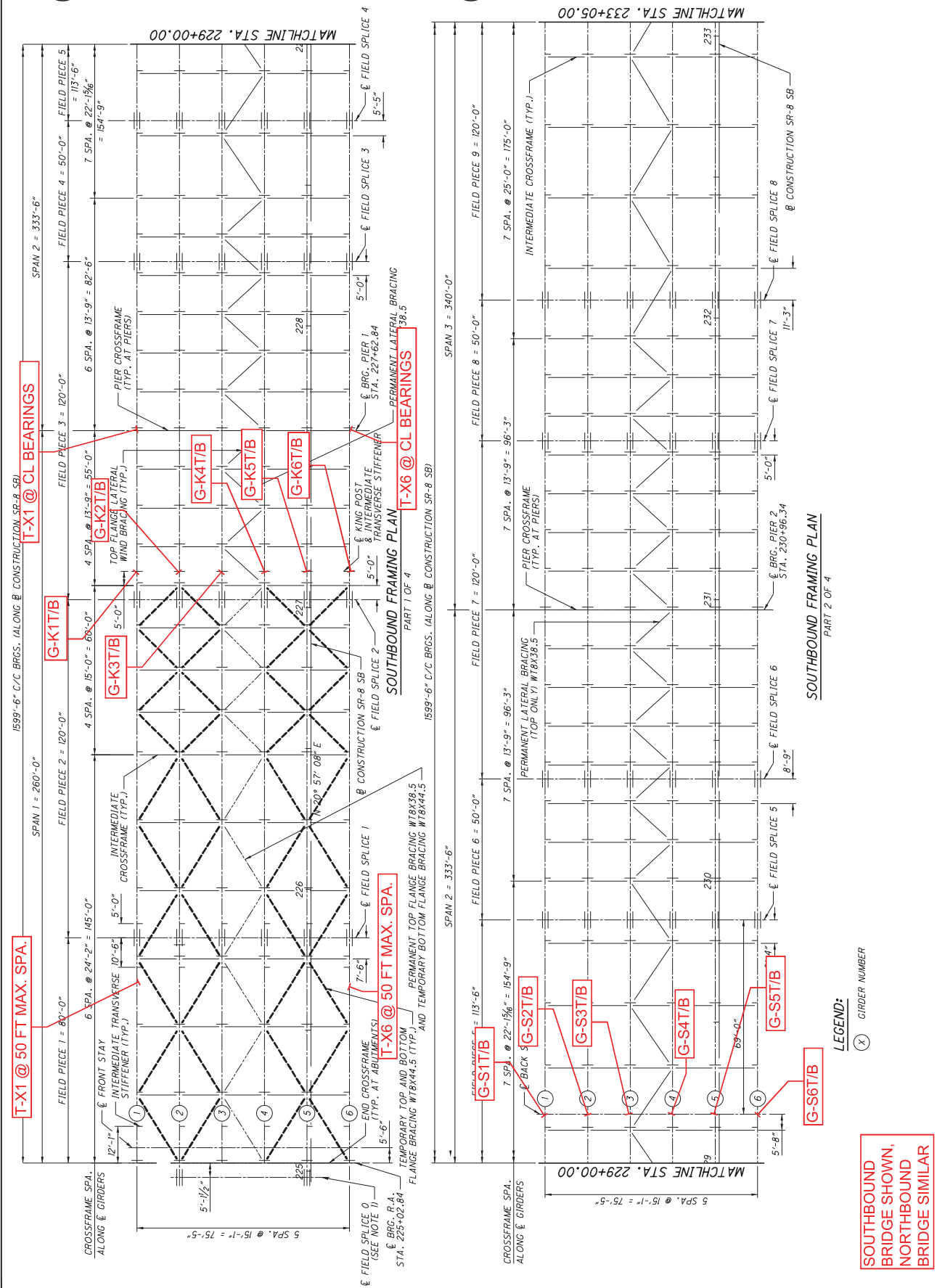
The survey requirements shall be implemented for all piers and for the two exterior girders of each respective bridge. All survey data shall be post-processed into tables and graphical format and promptly made available to the Engineer through the same internet access as all other monitoring data.

10 BASIS OF PAYMENT

The work described in this special provision shall be paid for as a lump sum at the contract price. Payment shall be no more than 50% of the contract price of the bridge construction monitoring system (for both the NB and SB Bridges) payable upon all submittals in Section 03 approved and all instrumentation, cabling, and data acquisition equipment received by Contractor. The remaining portion of the lump sum bid items shall be paid for each structure once the launch is completed and instrumentation is removed.

Item	Unit	Description
530	Lump Sum	Special – Structure, Misc.: Bridge Construction Monitoring

DESIGNED	ABD	RECEIVED	DATE
CHECKED	ABD	REVISID	7/19/2019
ELP	ABD	STRUCTURE FILE NUMBER	1700370/1700371
DESIGN AGENCY	ms consultants, inc. 2221 Schrock Road Columbus, Ohio 43229		

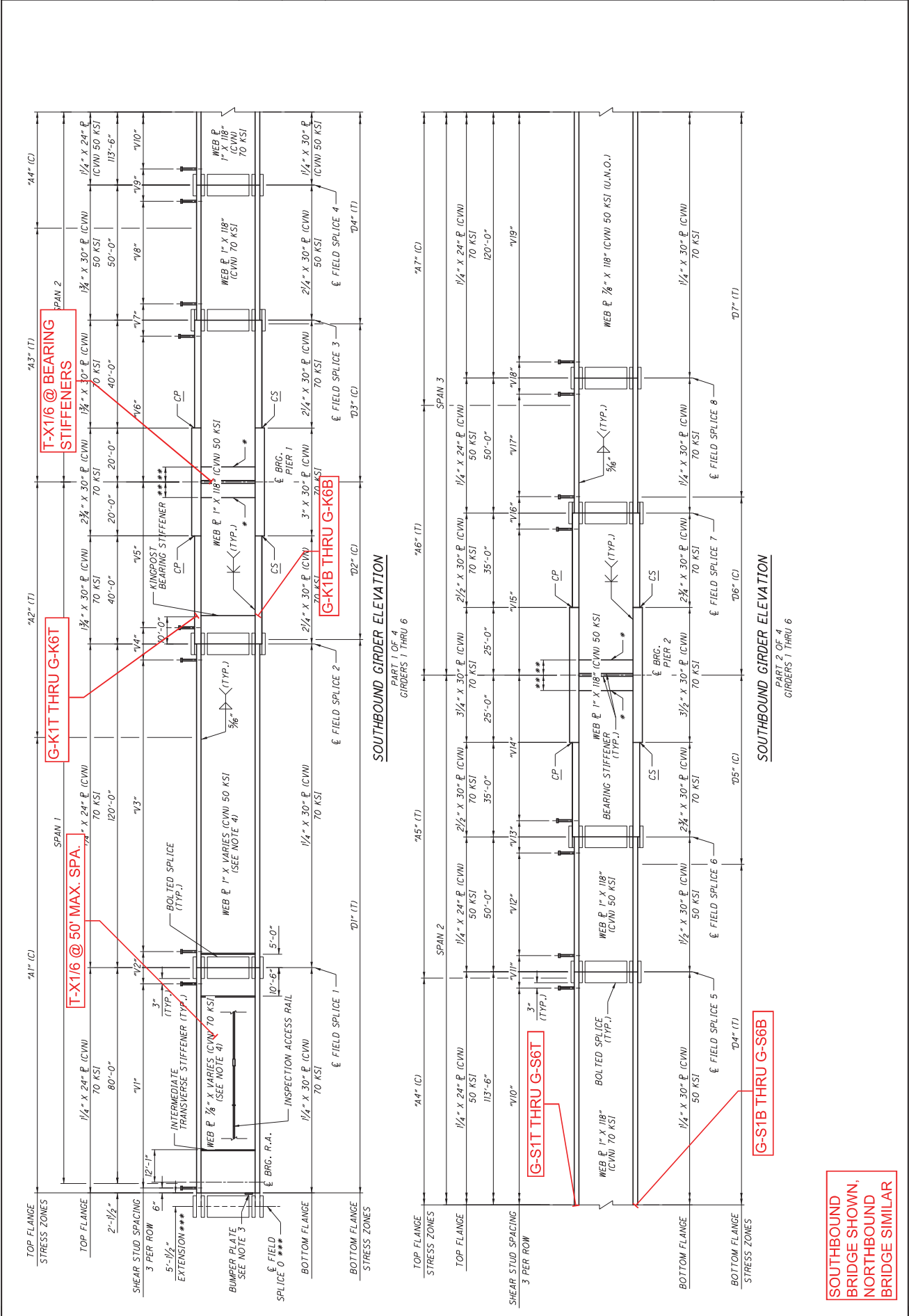


SOUTHBOUND BRIDGE SHOWN, NORTHBOUND BRIDGE SIMILAR

LEGEND:
 (X) GIRDER NUMBER

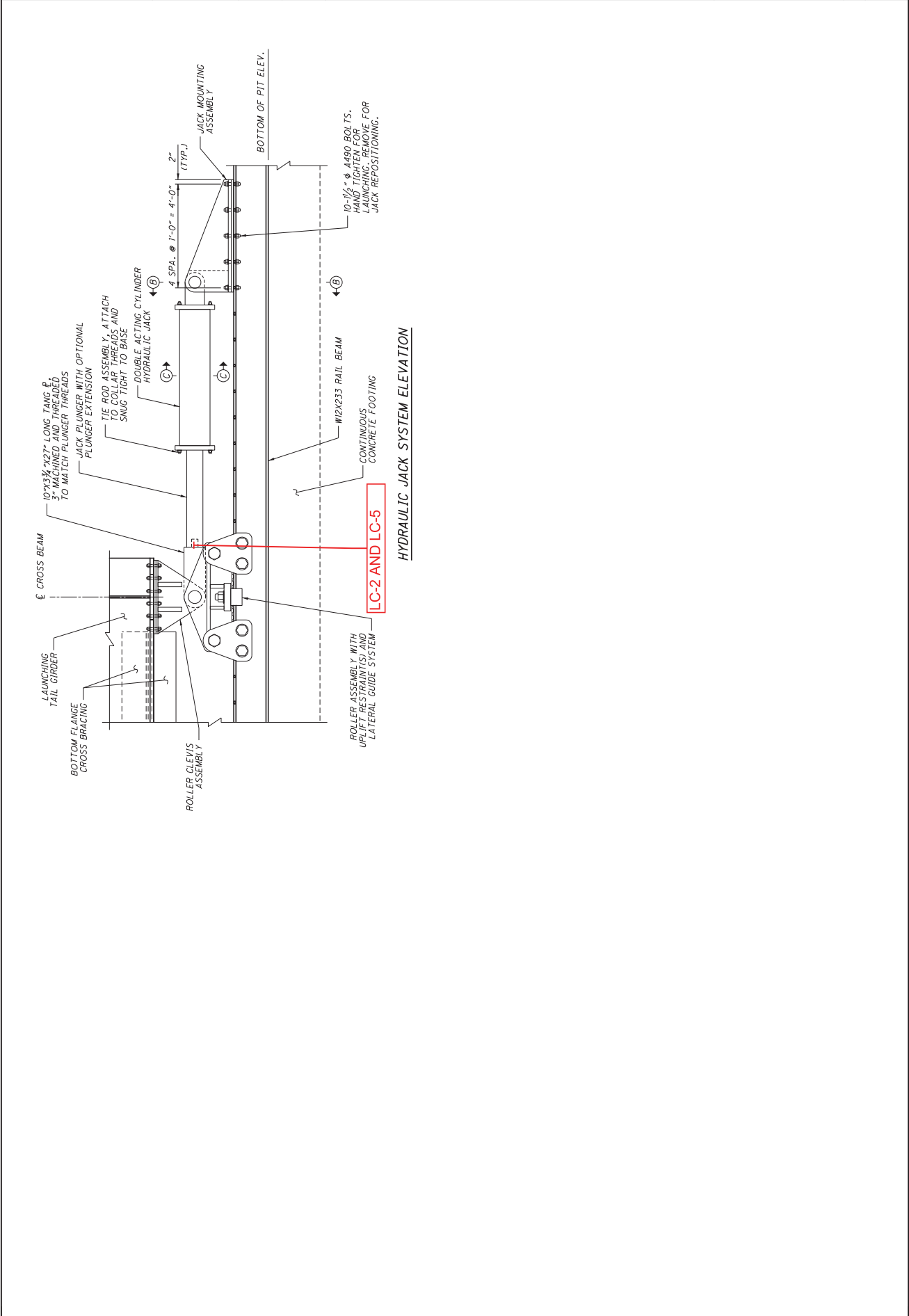
SOUTHBOUND FRAMING PLAN
 PART 2 OF 4

SOUTHBOUND FRAMING PLAN
 PART 1 OF 4



ms consultants, inc.

DESIGNED MJB	DESIGNED KCL	DESIGNED KRM	DESIGNED GLC	DESIGNED DATE 19-Sep	DESIGNED STRUCTURE FILE NUMBER 1700370/1700371	DESIGNED DATE 19-Sep	DESIGNED STRUCTURE FILE NUMBER 1700370/1700371	DESIGNED DATE 19-Sep	DESIGNED STRUCTURE FILE NUMBER 1700370/1700371
CHECKED MJB	CHECKED KCL	CHECKED KRM	CHECKED GLC	CHECKED DATE 19-Sep	CHECKED STRUCTURE FILE NUMBER 1700370/1700371	CHECKED DATE 19-Sep	CHECKED STRUCTURE FILE NUMBER 1700370/1700371	CHECKED DATE 19-Sep	CHECKED STRUCTURE FILE NUMBER 1700370/1700371



HYDRAULIC JACK SYSTEM ELEVATION

LC-2 AND LC-5

SUM-8-1.75
 PID No. 91710

LAUNCHING TAIL DETAILS (2 OF 4)
 BRIDGE NO. SUM-8-0199L/R - OVER RAILROADS
 (CSXT, W&E, AND METRO RTA), LITTLE CUYAHOGA RIVER, AND EAST NORTH STREET

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