MoDOT

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Missouri Department of Transportation
Patrick K. McKenna, Director

1.888.ASK MODOT (275.6636)

March 1, 2021

Dear Research Partner:

The Missouri Highways and Transportation Commission requests proposals from qualified organizations—namely private consultants, universities, and research organizations—to furnish professional services as described in the following request for proposal to be coordinated by the Research Unit of the Construction and Materials Division.

Please submit a proposal for project **TR202122** entitled, **"Load and Resistance Factor Rating Methodology Recommendations for Missouri Bridges."** Your submittal must include a work plan, the proposed project team and its background, and any related projects now active or recently completed by your firm. The project team must be led by a licensed professional engineer in the state of Missouri and the final report must be sealed, in accordance with the provisions of Chapter 327 RSMo.

The selection committee will use Qualification Based Selection. A "not to exceed" budget amount is included in the RFP to assist with the required scope, but budgets are not to be included with the proposal submissions, and will not be presented to the selection committee.

Please submit all proposals to MoDOTResearchRFP@modot.mo.gov by **April 13, 2021** at **10:00 AM (CST)**. More information about project contracting in general can be found at https://www.modot.org/information-researchers under RFP documents.

Sincerely,

Jen Harper
Research Director

Background

Load and Resistance Factor Rating, also referred to as LRFR, is an American Association of State Highway and Transportation Officials (AASHTO)-adopted guide manual for the condition evaluation of bridge structures. Since April 2000, when LRFR was introduced as the next step in load rating of bridges reported to the NBI, the bridge community's understanding of LRFR methods has improved and some State DOTs have started using the load and resistance factor method for rating of bridges. In 2006, FHWA issued a memorandum requiring the use of the LRFR method with HL-93 loading for all new and reconstructed bridges that were designed by LRFD Specifications. A table was provided in the memorandum outlining different scenarios where load rating data reported on the NBI needed to be reported using the LRFR method. The memo did not require existing bridges to be re-rated using the LRFR method.

MoDOT has recently updated our load rating policy to better reflect the wide range of heavier vehicles legally travelling along Missouri roads. These updated rating practices are predominately based on the Load Factor Rating (LFR) methodology, with the allowance for the allowable stress rating methodology in special situations (example is timber bridges). The updated rating practices also includes the LRFR methodology for general load ratings, but not for load posting determinations. MoDOT would like to implement load posting policy with the LRFR methodology that is consistent with our current policy using LFR and provides similar results in terms of the number of bridges requiring load postings. Due to the differences between LRFR and LFR, a simple conversion to LRFR does not seem realistic. As part of this study, a small list of vehicles will need to be analyzed on a representative group of bridges for the different rating methods. The results will need to be tabulated for comparison and recommendations provided on ways to implement LRFR rating to provide for similar load posting results as LFR rating.

Objectives

The objectives of this project are, but not limited to, the following:

- Assist MoDOT with adoption of LRFR through the following areas:
    - Review MoDOT’s current load rating vehicle models and load posting thresholds and make recommendations on how these models should be incorporated into the LRFR Method.
    - Determine if the LRFR standard live load factors are still applicable to MoDOT’s load rating vehicle models and provide recommendations for any changes needed for these standard factors.
    - Provide recommendations for the use of the various system factors and condition factors in LRFR, and correlations on how a good inspection program may influence their use.
    - Review MoDOT’s current practice for determining load posting needs on bridges and provide recommendations on how to utilize LRFR to produce similar outcomes with respect to the total number of bridges requiring posting.
    - Provide recommendations for the use of the LRFR method for superload and routine overweight permit load rating analysis.
    - Review MoDOT’s current AASHTOWare load rating models for a sample of bridges and provide recommendations for the additional items needed to allow for analysis with LRFR.

- Review MoDOT's current practice for determining single lane live load distribution factors on slab bridges and provide recommendations on a similar approach using LRFR.
- Review MoDOT's current methodology for load rating culverts with LFR and make recommendations for any changes that may be needed using LRFR.
- Provide recommendations on how MoDOT's current approach of using a combination of single lane and multi-lane rating results and the truck traffic volume for determining load posting needs could be implemented in the LRFR method.
- Provide recommendations on whether the current live load factors used for special hauling vehicles would be appropriate for use on MoDOT's commercial zone vehicle models.
- Provide recommendations on whether to include serviceability limit states on prestressed concrete bridge load ratings, which are currently optional for legal load ratings and for permit load ratings.
- Investigate MBE requirements for load rating of structures with spans over 200 feet and provide ways to allow for reasonable load rating of these structure without a refined analysis.
- Provide recommendations for the use of LRFR Service 2 load factors for steel bridges, which tend to result in significantly lower posting values when compared to serviceability checks using LFR.

- Perform analysis of steel, prestressed and reinforced concrete AASHTOWARE bridge models provided by MoDOT to compare current MoDOT processes to a new process using the LRFR method.

Project Requirements

Task 1: Project Management

The Contractor shall facilitate a kickoff meeting with MoDOT to review the work plan, scope, and schedule; and establish a protocol for regular ongoing communication and coordination with the team. This proposal will serve as the Draft Work Plan, to be discussed in the kickoff meeting. Upon comments received during the meeting and/or in writing, the Contractor will incorporate those comments into a Final Work Plan.

The Contractor will schedule and conduct a quarterly status meeting to review progress for the previous period and anticipated work for the next period. Contractor will also develop minutes for the kickoff meeting and each of the quarterly status meetings. If additional meetings are deemed beneficial or necessary for continued development of the project, the Contractor may arrange and conduct more frequent update meetings.

Task 2: Literature Review

The Contractor shall conduct a literature review of LRFR practices in some of Missouri's adjoining states, primarily those that have similar posting thresholds.

Task 3: Gather MoDOT LFR Methodologies, Bridge Model Data and Other Relevant Background Information

The Contractor shall coordinate with MoDOT Bridge Division personnel to collect and catalogue those processes currently undertaken for load rating analysis of Missouri bridges. Information collected may include, but is not limited to:

- AASHTOWare load rating bridge models;
- Current posting thresholds for MoDOT legal load models;
- Current posting policy; and,
- Superload and Overweight permit policies.

Task 4: Compare and Evaluate MoDOT Load Rating to LRFR

The Contractor shall compare collected materials and methodologies from Task 3 to those employed in LRFR methodologies. This process will help to identify those areas where current policies or procedures differ from those of LRFR, and where similarities may be drawn.

The Contractor shall assess those areas where significant difference is noted between LFR (MoDOT) process differs from LRFR methods, in addition to addressing the questions or areas of interest raised by MoDOT's Bridge Division (see attachment).

Task 5: Analyze Steel, Prestressed Concrete and Reinforced Concrete Bridges

The Contractor shall perform analyses on 100 independent models each, for steel, prestressed concrete and reinforced concrete bridges, to compare MoDOT's current process to a new process using LRFR. MoDOT will provide AASHTOWare load rating models for this activity.

Task 6: Provide Recommendations for LRFR Adoption

Based on the result of the previous tasks, the Contractor shall draft recommendations for MoDOT to implement LRFR method for load rating practices, while also focusing in on those areas for consideration noted by MoDOT Bridge Division (see attachment).

Task 7: Develop Report, Research Summary and Presentation

The Contractor shall develop a final report detailing the tasks completed during the project, including any and all findings generated during the project's duration. The Contractor shall provide a 1-2 page research summary that states the project objectives, findings and conclusions. The Contractor shall also prepare a summary of recommended changes in the load rating section of MoDOT's Bridge Inspection Rating Manual. A presentation for MoDOT and stakeholders, summarizing important or significant details of the project, may also be provided at MoDOT's request.

Project Deliverables

For templates and forms for reports and plans, visit https://www.modot.org/information-researchers

Email Communications

E-mail and phone communications between the Principal Investigator(s) and MoDOT contacts as necessary are required to provide on-going updates of progress throughout the project.

Data Management Plan

The plan is a formal document that describes the data that is acquired, created or produced during the project, specifies who owns it and who can access it as well as information on how it will be described, managed, analyzed, stored, shared and preserved during and after the project is over. Please refer to templates on the website.

Quarterly Reports

Quarterly reports should be submitted throughout the project on the last day of March, June, September and December. The quarterly reports are not intended to replace any additional correspondence between the research team and MoDOT needed to keep the project moving. Please refer to template on the website.

Interim Presentation

An interim presentation shall be scheduled near the mid-point of the project to update MoDOT on the progress and the direction of the project. The purpose of the interim presentation is to evaluate the progress and determine if any mid-project corrections are necessary.

Draft Final Report and Research Summary

These drafts should be final products except for revisions based on MoDOT's review. A final report must include a completed Technical Report Documentation page. Please refer to **Publication Guidelines** and summary template on the website.

Final Report and Final Research Summary

After MoDOT's review is complete and documents have been edited to MoDOT's satisfaction, final documents should be submitted as a Word documents (unless otherwise instructed). Please refer to **Publication Guidelines** and summary template on the website.

Final Presentation

May be required. The contractor will present the results, recommendations, and implementation ideas to MoDOT and other stakeholders. The contractor will coordinate location, date, and meeting fees with MoDOT. For stakeholder and agency participants, any travel and lodging fees are to be covered by individual attendees or their firms. MoDOT and stakeholders will provide feedback to the contractor, especially related to implementation.

Task-Specific Deliverables

Task	Deliverables
1	Schedule and conduct kickoff meeting. Kickoff meeting minutes. Draft and final work plans. Quarterly project status meetings.
2	None.
3	None.
4	None.
5	None.
6	None.
7	Final report and research summary. Presentation. Final project meeting.

Project Schedule

The following is an estimate of the project timeline or information on key dates within the project, presuming the project starts **May 28, 2021**. Proposals need to include a work plan with a proposed timeline. For a sample of a work plan template, see link below. Changes to our estimated project timeline below will be considered, however, timeline extensions cannot be guaranteed. The project timeline will be discussed and finalized during the kickoff meeting.

For report templates and forms, visit https://www.modot.org/information-researchers.

Date	Milestone
On or before 6/11/2021	A kick-off meeting with MoDOT will be scheduled to discuss project requirements and deliverables. The dates of key milestones and deliverables will be determined from this meeting.
9/30/2021	Quarterly report.
12/31/2021	Quarterly report.
3/4/2022	Interim presentation must be provided by this date.
3/31/2022	Quarterly report.
6/30/2022	Quarterly report.

Date	Milestone
9/30/2022	Quarterly report.
11/30/2022	Draft report and draft research summary are due. The draft documents shall be submitted to MoDOT approximately two months prior to the final report.
1/31/2023	Final report and final research summary are due. The final documents shall be due approximately one month before the end of the contract. This is to allow all billing to be completed prior to the end of the project. If determined necessary by MoDOT, a final presentation may also be due at this time.
2/28/2023	Final invoice due and contract ends.

Special Notes

Project budget is not to exceed **$175,000**. A budget is not to be included in the proposal, but will be required for the contract and must be within this limit. For a sample Budget template, report templates and forms, see https://www.modot.org/information-researchers.

To cover the cost of two Special Consultant/Agency Option AASHTOWare Bridge Rating (BrR) licenses, necessary for the model analysis during Task #5, an additional **$11,000** will be allowed outside of the not to exceed project budget referenced above.

RFP Requirements

- "Contracting Documents" provide further details and links to the required forms. They are available at https://www.modot.org/information-researchers.
    - **Organization's Project Experience**: The proposal must clearly identify the Organization's experience in offering the services requested in this RFP during the past three (3) years. The description should include a list of the agencies which your organization has served during this time period or currently serves. Please highlight any work you have done with other state agencies or local governments.
    - **Team Member Experience**: Please list all team members (including subcontractors) proposed to work on the project. Attach licenses, certifications and resumes for key personnel.
    - **Organization's Client References**: Proposals should indicate the name, title, and telephone number of at least three clients within the past three years.
- Proposals must be no more than 11 pages in length with a font size no less than 11 points. This length limit **does not include** the Proposal Submission Form, Organization's Project Experience, Team Member Experience, Organization's Client References and optional cover letter (if included, one page maximum).
- Proposals must be submitted as one combined PDF document. The submission should **only include the required documents** organized in the following order: 1) Proposal

Submission Form; 2) Cover Letter (Optional; 1 page maximum); 3) Body of Proposal (including work plan); 4) Organization's Project Experience; 5) Team Member Experience; and 6) Organization's Client References.

- The Offeror must respond to this RFP by submitting all the information required herein for its proposal to be evaluated and considered for award. Failure to submit all the required information shall be deemed sufficient cause for disqualification of a proposal from consideration.
- Proposals will be evaluated by an agency and stakeholder team with knowledge and backgrounds in relevant areas for this project. Selection of the successful Offeror will be based on the Offeror's demonstrated knowledge in the required areas, the merit of the proposed methods and approach in achieving the desired goals, the experience and qualifications of the team, the plan for ensuring implementation of results, and the adequacy and availability of team members to complete the work in a timely manner.
    - Correct proposal submission is one of the evaluation criteria. If submission instructions in this section are not followed, the **Offeror risks an automatic 10 point deduction (out of 100 total points)** when points are awarded during the Proposal Evaluation Process.

RFP Schedule

This document constitutes an RFP from qualified organizations to conduct the **TR202122 - Load and Resistance Factor Rating Methodology Recommendations for Missouri Bridges** study for the MHTC and Missouri Department of Transportation (MoDOT). MHTC reserves the right to reject any and all proposals for any reason whatsoever.

The following RFP Schedule of Events represents MoDOT's best estimate of the schedule that shall be followed. The time of day for the following events shall be between 7:30 am and 4:00 pm, Central Standard Time unless otherwise noted. MoDOT reserves the right at its sole discretion to expand this schedule, as it deems necessary, without any notification except for the deadline date for submitting a proposal. Time is of the essence for responding to the RFP within the submission deadlines.

The following timeline must be met for a proposal to be accepted.

Date	Action
3/1/2021	MoDOT posts RFP to the website at https://www.modot.org/research-requests-proposal.
3/18/2021 4:00 PM (CST)	Written comments or questions must be submitted to MoDOTResearchRFP@modot.mo.gov.
3/26/2021	MoDOT will post written responses publicly on the website at https://www.modot.org/research-requests-proposal.
4/13/2021 10:00 AM (CST)	Written proposals must be submitted to MoDOTResearchRFP@modot.mo.gov.
4/30/2021	MoDOT will notify submitters about project selection, or if needed about interviews to finalize selection.

Contracting Requirements

The successful team will be required to complete additional documentation and enter into a contract such as a "Standard Research Agreement" or "Task Order." Applicants should be aware of these additional needs so contracting can proceed in a timely manner.

As part of the eAgreements process, MoDOT uses an electronic signature tool, DocuSign, for signing agreements electronically. All parties of the agreement must agree to sign electronically in order to utilize the electronic signature option. If your proposal is selected, you will be informed about how to obtain your credentials for electronic signatures (including how to become a MoDOT vendor if you are not already).

Standard contracts, forms, attachment templates and additional information are available from the website at https://www.modot.org/information-researchers.

Proposal Submission

Submission Deadline

Proposals must be emailed by **10:00 AM (Central Standard Time)** according to email time stamp by the submission date in the RFP Schedule to the Research Director's attention (Jen Harper) at: MoDOTResearchRFP@modot.mo.gov. Please reference the project title since more than one RFP may be due at one time. Electronic proposals are required.

Submission Confirmation

You will receive an email confirmation after your proposal has been received. If you do not receive such a confirmation by **12:00 PM [noon] (Central Standard Time)** on the day of the deadline, please contact us at MoDOTResearchRFP@modot.mo.gov as soon as possible. Your submission should not be considered received until you have received your email confirmation.

MoDOT has recently updated our load rating policy to better reflect the wide range of heavier vehicles legally travelling along Missouri roads. These updated rating practices are predominately based on the load factor rating methodology (LFR), with the allowance for the allowable stress rating methodology in special situations (example is timber bridges). MoDOT would like to implement a policy with the load and resistance factor rating method (LRFR) that is consistent with our current policy, providing similar results. Due to the many differences between LRFR and LFR, a simple conversion does not seem realistic. As part of this study, a small list of vehicles will need to be analyzed on a representative group of bridges for the different rating levels. The results will need to be tabulated for comparison and recommendations provided on ways to implement LRFR rating to provide similar load posting results as LFR rating.

Below are some questions that need to be considered when developing an LRFR policy with this research project.

1. The load posting vehicles from Section 15 of MoDOT's BIRM need to be reviewed and a determination made on how they could be incorporated into the LRFR method. Most likely, they would just be modeled as a state specific legal load. Can our state specific load posting vehicles be screened with the HL93 (inventory/operating) design load check, like what is done for the AASHTO legal load models?

2. For our load rating vehicle models, are the standard AASHTO live load factors still applicable, or will we need to develop our own live load factors? For program maintenance purposes, the desire would be to use the standard factors.

3. What are recommendations for the use of the various system factors and condition factors in LRFR? Our understanding is that the system factors are optional. How would a good inspection program influence the use of these two factors?

4. With our current posting policy, we post bridges at a level of 86% of the operating rating using the LFR method. LRFR has a posting methodology which seems harsh for bridges at lower posting levels. It may cause us to close bridges we might ordinarily keep open. Is this assumption accurate? Should we stay with the 0.86 factor, use the LRFR equation or do something else?

5. In LRFR, how do we incorporate our approach of using a combination of single lane and multi lane live load distribution factors into our considerations of a load posting need? Our criteria considers the truck traffic volume for determining whether to use single lane or multi lane live load results for the load posting.

6. How should our superload and routine overweight permit load analysis be done with LRFR?

7. For our AASHTOWare load rating models of bridges, what are we missing that would need to be added to the models in order to do an analysis with LRFR?

8. We have a modified method for determining single lane live load distribution factors for slab bridges. The LFR code does not define a single lane distribution factor for slab bridges. What would be recommended for us to use for LRFR to have single lane versus multi lane rating results? We are aware that LRFR does have single lane and multi-lane distribution factors for slab bridges. Our research shows that the multi lane factors are similar between the LRFR and LFR methodologies. If we ratio the single lane and multi lane factors for the two methodologies, we have found that the single lane factors in LRFR seem to be more conservative than our LFR factors by about 25%.

9. We load rate culverts by developing a model of the top slab in a manner similar to slab bridges. We have a methodology for modification of live load distribution factors on box culverts. This methodology was developed after some research and is included in Section 15 of the BIRM. Would this approach of modifying the live load distribution factors still be applicable in LRFR?

10. Serviceability limit states are presented as optional on prestressed bridges in legal load ratings and all bridges for permit load ratings. Should we include these limit states as part of normal load rating practices, or exclude them as part of a normal rating? We have been hearing that there is some movement towards making these limit states mandatory instead of optional.

11. Our commercial zone vehicle models are similar to special hauling vehicles models in AASHTO. For LRFR ratings, should we use the SHV live load factor tables for the CZSU and CZRT rating models?

12. It may be worth having the researchers investigate a better way to handle rating structures with spans over 200'. In other words, can we get away from doing a refined analysis just because of loading concerns? Is there a loading or approach that allows us to use the multi lane and single lane distribution factors that are already defined for a bridge?

Additionally, below are some comments/facts that need to be considered when developing an LRFR policy with this research project.

13. For informational purposes, the posting thresholds for our legal load models are shown below.
    a. H20L, 30 tons (statewide legal load)
    b. MO3S2, 45 tons (statewide legal load)
    c. CZSU, 45 tons (commercial zones only)
    d. CZRT, 70 tons (commercial zones only)

14. For comparison of load rating methodologies and posting practices, we would desire to have an analysis done on 100 steel, 100 P/S, and 100 RC bridges to compare our current process to a new process using LRFR. AASHTOWare load rating models would be provided for these bridges. The researchers would need to run the models in the software to collect the results that would be used as part of the research. MoDOT would

need to investigate whether the researchers could use our software license or be required to acquire a license for the software.

15. Some of our past review of the LRFR method found an issue with the Service 2 load factor for steel bridges. The *Manual for Bridge Evaluation* (MBE) was using 1.3 for this factor instead of 1.0, which appears to be what many other service categories are using. This review indicated that our posted steel bridges, which were predominantly controlled by serviceability, ended up with much lower postings even though the capacity calculations were essentially identical. More information can be provided on this review.

16. Researchers should be aware of NCHRP Report 700. This report resulted in the reduction of many of the live load factors in the *MBE*. They used a large set of bridge models provided by states to calibrate load factors that were more in line with the existing LFR models.