EXPLORING FIBER-REINFORCED PLASTIC BRIDGES FOR WILDLIFE

MONTANA COLAB

SAFE PASSAGES: EXPLORING NEW MATERIALS FOR THE INTEGRATION OF LANDSCAPE AND INFRASTRUCTURE

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TO: Western Transportation Institute

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CC: Nina-Marie Lister (Director, Ecological Design Lab); Renee Callahan (Executive Director, ARC Solutions); Jeremy Guth (Steering Committee, ARC Solutions)

RE: Safe Passages: Exploring New Materials for the Integration of Landscape and Infrastructure Montana Wildlife Crossing and Design CoLab

EVENT DATE: April, 2018

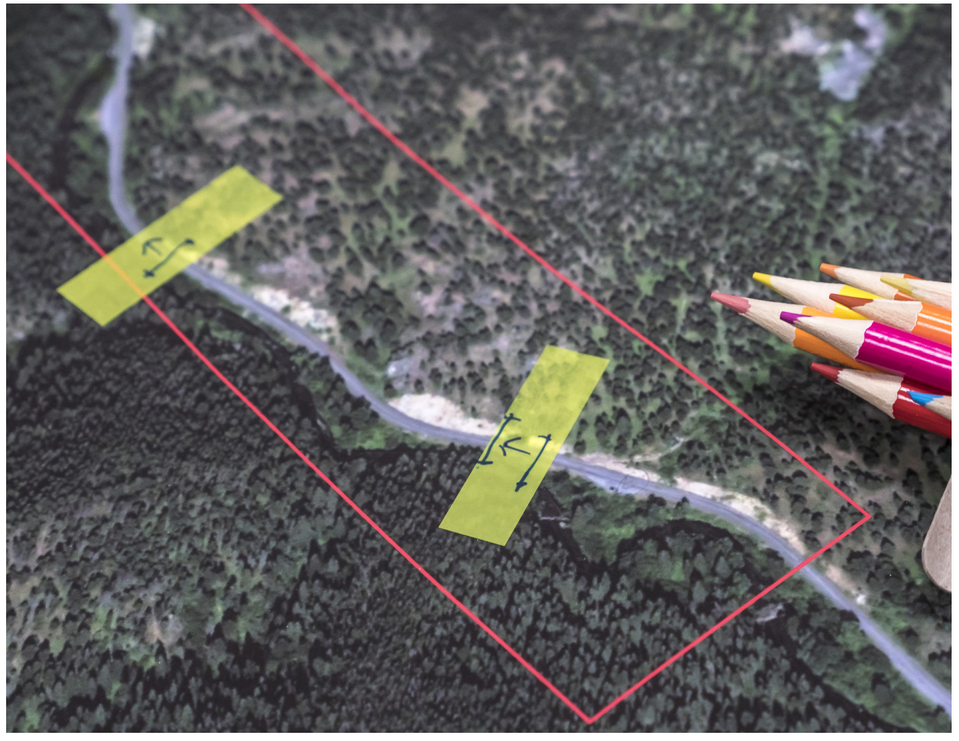
BACKGROUND

The Ecological Design Lab, along with ARC Solutions, were invited by the Western Transportation Institute and Montana State University, to lead a professional workshop to explore new materials, design and building solutions for Hyalite Canyon Road as well as Bozeman Pass in Montana, USA.

A team of practitioners from the Western Transportation Institute, the Ecological Design Lab, and ARC Solutions facilitated a two day-intensive design CoLaboratory (CoLab), contributing individual subject-matter expertise, and facilitating the participation of the project team, the invited experts, and the community representatives throughout the CoLab process.

The CoLab is an interdisciplinary collaborative workshop used as a team-based method for design research and development, across fields including, but not limited to: planning, ecology, landscape, architecture and engineering. The intent is to advance integrated strategies and solutions to complex problems for which there are currently few protocols, and little or no agency practice.

In this context, the CoLab workshop is also an experiential learning process and professional development opportunity to evolve interdisciplinary design solutions.



COLAB ATTENDEES

Participants were divided into two working groups, balanced in the range of expertise represented on each team, including but not limited to: engineering, ecology, wildlife biology, landscape architecture, urban planning, road ecology and community engagement.

Each team was assigned a different site, requiring unique problem-solving approaches and subsequent final products.

- Western Transportation Institute
- Ecological Design Lab
- ARC Solutions
- Montana State University Students, Professors and Partners
- Academic partners from McGill University and the University of Toronto

PURPOSE

Two sites in Montana, Site A and Site B, were identified for exploration through the CoLab process. Both locations present opportunities in Montana for planned and future wildlife crossings. Site A represents a “typical” location in Montana with potential for wildlife crossing infrastructure. Site B represents a proposed location for the development of a wildlife crossing.

Site A - Hyalite Canyon Road: The Hyalite Canyon Road, a two-lane, federal highway, is representative of many locations in Montana where wildlife crossings are needed. The area is densely forested and travels along the Hyalite Creek. The highway travels through the Gallatin National Forest and ends at the Hyalite Reservoir - where there exists strong opportunities for recreational intervention.

Site B - Bozeman Pass: The Bozeman Pass Highway, a four-lane highway with two-lane frontage road, is a proposed location for a future wildlife crossing. This road is characterized by three road sections divided by medians. The site is bounded to the north with a conservation easement, and the railway through the south. This site presents challenges in adapting a structure equipped for high volume interstate systems. The surrounding landscape provides habitat consisting of grasslands and scattered forests.

Each team was assigned either the Site A or Site B specifications, and were asked specifically to consider the following in their approach and final product:

Design elements and considerations:

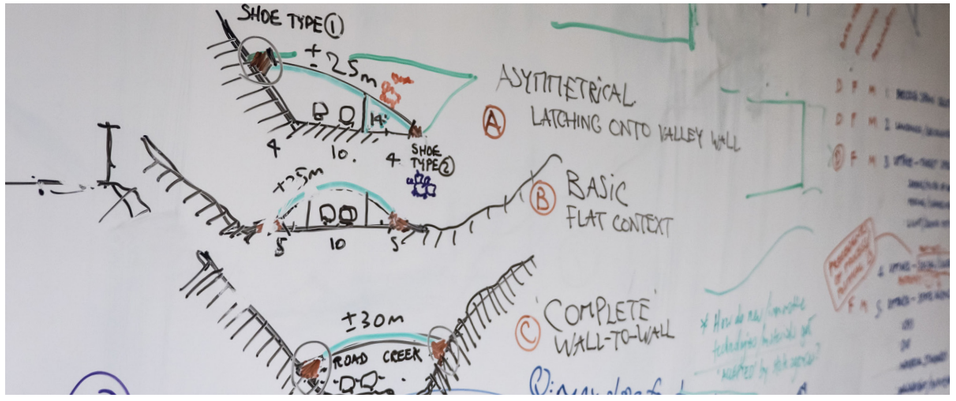
- Modularity and adaptability;
- Maintenance;
- Assembly;
- Target species movement;
- Landscape approaches;
- Surface plantings;
- Mitigation for road noise and light; and
- Engineering for landing in a two-lane versus four-lane scenario

Barriers and Opportunities:

- Procurement and tendering processes;
- Institutional agencies and processes

Participants were given detailed technical appendices that overviewed: construction methods and materials; existing implementation methods in the North American Context; and technical specifications under fatigue and stress. In addition to the structural opportunities and limitations discussed by both teams, particular attention was paid to considerations of vegetative loads, and soil depth requirements.

By engaging in the CoLab process, the project team sought to ensure that the crossing infrastructure sets a model worldwide for design excellence, engineering, quality and effectiveness. The CoLab format provides a peer-review mechanism for external experts to provide feedback to the project team, as well as identify opportunities, challenges, and collaboratively work towards innovative design solutions. The design concepts and implementation recommendations generated in the workshop are outlined in this report.



STRUCTURAL AND WEIGHT CONSIDERATIONS

The CoLab teams discussed different designs and materials of the crossing structures that may accommodate greater load potentials, through the following considerations:

- The need to balance and minimize the weight of the structure while still successfully providing habitat, as well as effective vegetative design. Finding the appropriate balance between these competing structural interests is critical to effective crossing design and engineering
- Variable soil depths and weights across a single structure
    - E.g., alternative vegetation that can be implemented, such as root wads, wool and gravel. Experts supported insight regarding soilless mixtures and the relationship to weight and depth requirements
    - Some vegetative options and their respective soil depths discussed included:
        - Full and native matrix point loads, including spot depth (may require deeper soils of 10-20 cm in depth)
        - Grasses and meadow mix (requires thin and porous soils of 5-10 cm in depth)
        - Soil-less materials including gravel and root wads or ‘fake cover’ (require gravel, loose sand and cobbles of less than 5 centimetres in depth)
- How a curved edge design can withstand a greater structural load at edge
    - E.g., designing the berm, as a beam design, to increase load bearing capabilities
    - E.g., a curved deck to support greater volumes of water drainage
    - E.g., the curve’s design could contribute to the overall strength
- The use of a fibre mesh for increased load bearing capacity
    - Could be woven or laid on top of the structure
    - Fibre would be less weight yet remains load-bearing

DESIGN DIRECTIVES

Many questions and comments were made pertaining to design directives of the wildlife crossing structure. These questions may used to frame future discussions for wildlife crossing implementation, and included:

- Can the structure be multi-functional in both its structure and designed uses?
- Will the system be an overpass or an underpass?
- What considerations exist for modularity, spot loads, and decking?
- What are the varying loads and vegetative mediums along the width of the structure (relating to the aforementioned section on structural and weight considerations)?
- What is the legibility of the structure and how can it be communicative and tell a story?
- Which precedents are applicable and exist to study and learn best practices?
    - E.g., Robarts (triangle grid), Yokohama terminal, Allianz Arena (porous wavy pathways of asphalt), among others

HABITAT CONSIDERATIONS

The primary function of wildlife crossings is to ensure the safe movement of animals across and within habitats. As such, teams discussed the following habitat considerations:

- Crossing design must successfully provide habitat despite potential structural and design limitations
- Engineers and designers should consider the bridge as habitat, rather than just as a infrastructure
    - The infrastructure can act as habitat for pollinators, bats and birds
    - The structure can utilize vines and trellis systems at the berm
- Plant selection can increase local vegetative diversity as well as wildlife diversity within, along and near wildlife crossing structures
- What are opportunities exist to connect critical regional areas
    - E.g., Site A is wolverine primary and female dispersal area

PROCUREMENT CONSIDERATIONS

Next, the teams were asked specifically to dedicate discussion time to procurement opportunities and obstacles. Existing procurement processes in Montana are not conducive to the construction and proliferation of wildlife crossings. The considerations for the procurement process which were discussed included:

Opportunities:

- Brand the crossing as an experimental project with opportunities for innovation (this is pertinent for the crossing at Site B)
- Demonstrate the quality of performance of crossings infrastructure
- Implement new approaches to Fiber Reinforced Polymer materials and systems
- Accelerate the construction process
- Enhance awareness of relatively low consequence of failure (especially Site A)
- Demonstrate a project capable of broad replication (especially Site A)
- Harness potential to fold crossing at Site A into planned improvement project on Hyalite Road (to distinguish itself as a stand-alone project)
- Capitalize adjacent land security: USFS/ Federal land on both sides of the crossing (applicable to both sites)

Obstacles:

- The prescriptive nature of existing procurement processes
- The need to demonstrate the quality of performance before widespread implementation and adoption is achieved
- The instances of poor performance of post Fiber Reinforced Polymer structures
- Existing systems are proprietary
- The requirement of many jurisdictions to select the lowest cost bid

Relating to procurement considerations, participants discussed potential funding avenues for both crossing areas and structures. The following funding models were presented:

- The Federal Lands Transportation Program (includes funds available for federal facilities)
- Private Partnerships have potential to raise private funds and leverage existing public funds
    - This is especially true for communities with large, avid recreationalist populations
        - This area of Montana has one of the highest recreational sites in the US Northern Rockies
    - These partnerships can act as significant economic generators for local communities
- A national infrastructure bill to cover some costs
- Other innovative funding mechanisms discussed include:
    - State and local bonds;
    - Speciality license plates;
    - YNP conservation fees;
    - Crowdsourcing;
    - Ecotours; and,
    - Books

NEXT STEPS AND OPPORTUNITIES FOR ONGOING COLLABORATION

The Ecological Design Lab and ARC Solutions are interested in ongoing collaboration with the Western Transportation Institute as well as the Montana State University team. Both organizations support the implementation of the Bozeman Canyon and the potential Hyalite Canyon Road wildlife crossing.

Future collaboration between these organizations can consider the development of prototyping efforts amongst other resource development, including but not limited to: reports and data presentation, best practice manuals, and overarching design guidelines.

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