Climate change could hasten deterioration of US bridge infrastructure

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A steel girder bridge representative of the close to 80,000 Hussam Mahmoud's team studied in their analysis of how climate change is impacting bridge infrastructure. Credit: Hussam Mahmoud/Colorado State University

When most people think of climate change, they think of rising sea levels and more intense heat waves. Engineers like Colorado State University's Hussam Mahmoud think of bridges.

The associate professor in the Department of Civil and Environmental Engineering is studying the toll climate change may take on aging U.S. infrastructure, which includes over 600,000 bridges. Now, he is co-author of a new study linking the potential impacts of climate change with the structural integrity of thousands of bridges transecting America's highways and towns. Mahmoud's analysis demonstrates a need to rethink the nation's priority order of bridge repair, as climate change looms and infrastructure funding remains limited.

The research is published Oct. 23 in *PLOS ONE*, and its lead author is Susan Palu, who recently graduated from CSU with a master's degree in civil engineering.

Mahmoud and Palu focused their analysis on about 80,000 "simply supported steel girder bridges," a design common since World War II that consists of longitudinal beams spanning two piers. These bridges suffer frequently from expansion joints clogging with debris and require regular maintenance to clean the joints. Expansion joints connect bridge spans and allow the structure to expand and contract as the air heats or cools.

When joints become clogged, they prevent the bridge from expanding normally in response to higher temperatures. The researchers reasoned that higher average temperatures in the future, not accounted for when such bridges were first built, could lead to unpredicted thermal stress. Heat stress can cause buckling and cracking, which are exacerbated by both bending from the weight of trucks and cars, and axial loading from the expansion restriction. The researchers' study is the first to quantify the impact of potential temperature changes in conjunction with normal

expected clogging of expansion joints.

The researchers considered four different seasonal scenarios for temperature at the time of each bridge's construction, along with projected average temperatures for the years 2040, 2060, 2080 and 2100. The projected temperature rises are the "radiative concentration pathway" greenhouse gas warming scenarios adopted by the International Panel on Climate Change in 2014.

Results indicate that bridges located in the northern portion of the United States, including the Northern Rockies and Plains, Northwest and Upper Midwest, are the most vulnerable to more pronounced increases in temperatures. Less susceptible regions were the Southeast and Northeast.

The engineers' aim was to rank bridges in order of needed maintenance after accounting for the new normal of climate change.

"We as engineers must start to look beyond what we have initially been taught on how to analyze systems and start to think about what climate change is going to do to our understanding of component-level behavior and system-level performance," Mahmoud said.

Provided by Colorado State University