Cold-Formed Steel Section with Bolted Connection to Estimate Total Cost and Maintenance

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Abstract

A rise in the use of advisory services to monitor STA construction operations and aging, experienced, and turnover-prone STA construction workforces make it challenging for STAs to manage complex transportation networks. STAs receive construction-related human resources from Construction and Engineering Inspection (CEI) consultants in order to meet project requirements. However, no information has been gathered regarding the impact of CEIs on project schedules or costs. To fill in this information void, data from 305 completed highway construction projects in 16 STAs are being utilized. The study found that projects with CEI consultants had more full-time equivalent construction workers than projects with only agency workers. It had no effect on project costs when compared to programs that only used agency workers. CEI consultants While projects staffed by agencies had an average schedule overrun of 27.7%, CEI projects had an average expense overrun of 20.2%. The project was typically completed earlier than anticipated. There was a difference between the experiment's beginning and end times that was statistically significant.

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1. INTRODUCTION

STAs are building increasingly complex projects under more stringent time constraints. At the same time that this transformation is taking place, STAs are going through a lot of personnel changes. Veteran staff members are retiring from STAs, and younger, less experienced workers who are taking on more responsibility early in their careers are taking their place. In some STAs, retiring employees are not even being considered for replacement. Employees in all STA divisions are noticing the effects of these changes, but those in charge of building infrastructure for roads are particularly affected (1, 2). STA lane kilometers increased by an average of 4.1% between 2000 and 2010, but the number of full-time equivalent employees decreased by 9.7% during the same transit period. STAs' FTE per million dollars of capital investment decreased by an average of 37.3% as a

result of the controlled road system standardizing full-time equivalents (FFE) for responding STAs (3). Due to increasing workloads and decreasing personnel, many services previously performed by STA staff have been outsourced. They are an absolutely necessary resource due to the critical nature of their work and the extensive range of services they provide (4, 5). STAs might gain from receiving guidance from CEI specialists on how to make the most of their construction workforce. Although STAs use CEI consultants to staff agency projects, very little research has been done on the effects on project costs and schedule results of using CEI consultants. This article focuses on how CEI consultants affect staffing levels and performance on highway construction projects. To be more specific, this study enhances our understanding by creating a comprehensive database of information on the accomplishments of highway construction projects in the 18 STAs. For the purpose of this study, individuals representing STA on the AASHTO Technical Committee on Cost Estimation and the AASHTO Subcommittee on Construction were contacted personally. The project's name, type of task, cost performance, schedule performance, and contact information were gathered by the study team. There are a total of 7,154 projects in our database that were substantially completed between 2014 and 2016. The database of completed projects contained 188 projects with a diverse range of project types, sizes, locations, personnel levels, and performance. Based on the information in the database, which included their email addresses, an online survey was sent to 783 project managers/resident engineers. This survey included pre-filled project details for each respondent, including the name, budget, start date, and end date. The following questions were included in the survey

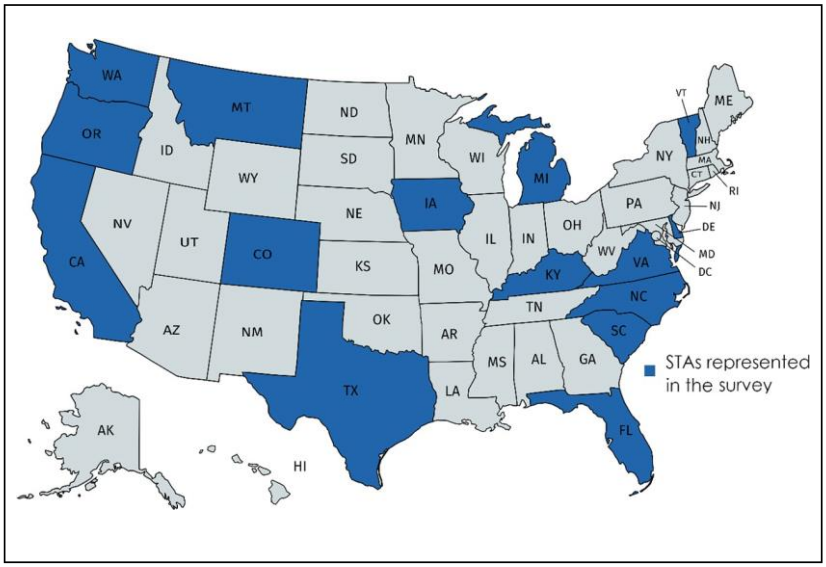

Fig.1 STAsrepresentedintheprojectsurvey

2. LITERATURE REVIEW

Information from the 18 STAs' highway construction projects has been compiled into a comprehensive database. For the purpose of this study, individuals representing STA on the AASHTO Technical Committee on Cost Estimation and the AASHTO Subcommittee on Construction were contacted personally. The project's name, type of task, cost performance, schedule performance, and contact information were gathered by the study team. There are a total of 7,154 projects in our database that were substantially completed between 2014 and 2016. The database of completed projects contained 188 projects with a diverse range of project types, sizes, locations, personnel levels, and performance. Based on the information in the database, which included their email addresses, an online survey was sent to 783 project managers/resident engineers. This survey included pre-filled project details for each respondent, including the name, budget, start date, and end date. The survey included questions about the following subjects:

The survey was completed by project managers/resident engineers from 16 STAs who worked on 305 recent highway construction projects (Figure 1), and the results had a 95% confidence level margin of error of 5.69 percent.

STAs use a variety of approaches to identify the various kinds of construction for transportation. The nine categories outlined in the FHWA reporting categories and the databases of each agency were used to classify the projects under consideration:

Other rehabilitation projects include ramps, curbs, shoulders, sidewalks, drains, retaining walls, and so on.

Other—guardrails/lights/signals/stripes/signs/landscape,andsoforth.

Other structures (such as weigh stations, restareas, and toll stations)

Research: The survey's most popular topic was road resurfacing and restoration. More than half of the comments (148 out of 305) were for road and bridge improvements, while the remaining 33% were for other projects like lighting and signage, drainage, guardrail, sidewalks, ramps, and shoulders (Figure 2).

An online survey revealed that nearly 40% (305 projects) had inadequate staffing. According to DOT policy and procedure manuals (FTEs), there were sufficient full-time workers for 86.7% of the evaluated projects. During a typical work week, full-time employees (FTEs) put in at least 40 hours per week. The most common reason for outsourcing CEI work was a lack of staff. 117 of the 305 projects analyzed had CEI consultants involved, or 39% of the total.

According to Figure 3, the utilization of CEI consultants was higher in projects involving new road/expansion and bridge rehabilitation than in other project types. Despite conflicting evidence, a

staggering 68.3% of the 31 CEI consultants may influence budget and schedule performance. Performance on highway construction projects can vary based on a lot of things, like the characteristics of the project and the expertise and authority levels of CEI consultants. Using information from a survey about the consultants' employment and the finished project performance database, CEI consultants and non-CEI consultants were compared to each other. As a percentage of the anticipated workdays (or calendar days), it was determined that each project had an overrun of the original contract value. With or without significant cost overruns (3.34 percent vs. 3.36 percent, Table 2), CEI consultants were utilized on all projects. Bringing in CEI's assistance certainly improved the project's on-time delivery (p-value = 0.0012).

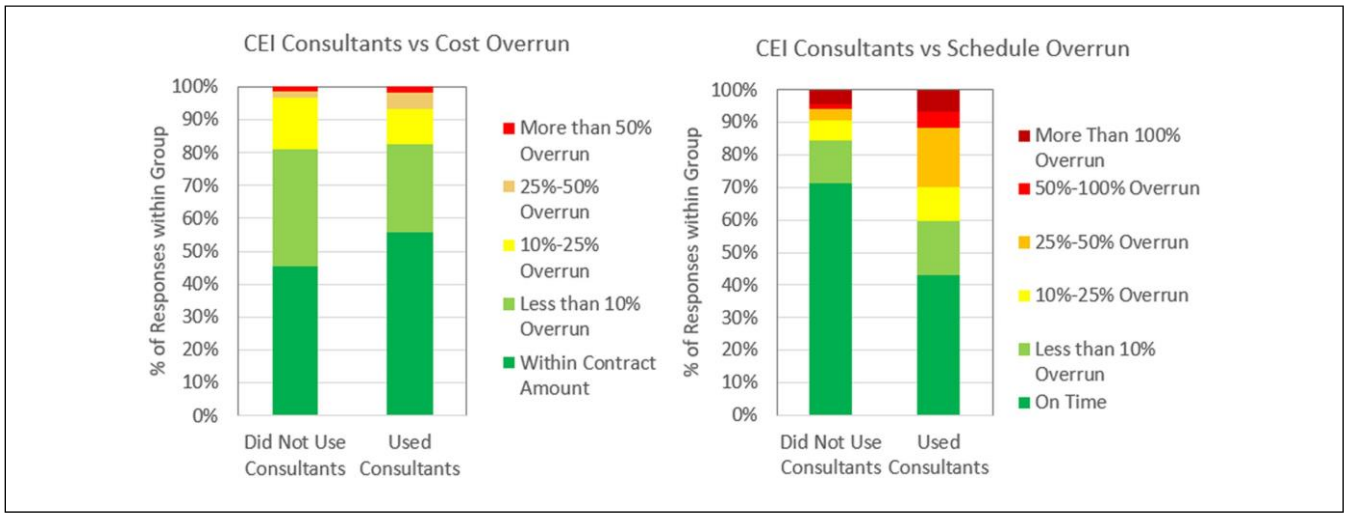

Figure2 .Distributionsofprojectcost andscheduleoverrun.

3. PROPOSED SYSTEM

By constructing buildings with fewer resources, many construction companies these days are striving for more sustainable growth. Steel is the most recyclable material in the world, making it possible to build safer, higher structures and automobiles that use less fuel and are lighter. Compared to competing materials, the superior sustainability performance of steel members reduces environmental impact throughout the entire life cycle. Cold-formed and hot-rolled structural steel are the two most common types [1]. Cold-formed steel is made by rolling or pressing thin sheets of steel into items at room temperature, whereas hot-rolled steel is made in a blast furnace or electric arc furnace[2]. Because hot-rolled and cold-formed steels differ greatly in their strength and structural performance, the production method is important to their performance.

Steel has emerged as a preferred material for a wide range of businesses when it comes to large-scale machinery and equipment, energy, automobiles, and machinery. Steel is a crucial part of the infrastructure for energy, transportation, and water, as well as commercial and residential construction projects. The Industrial Building System (IBS) and other new products and

technologies appear to be gaining industry acceptance. The Malaysian Iron and Steel Industry Federation reports that Malaysia's imports of steel increased by 15.3% in 2016 compared to 2015. MISIF). Bars, cold-rolled steel, and hot-rolled steel account for one quarter of the nation's total steel imports. From 2.3 million tons in 2015 to 2.22 million tons in 2016, ASEAN exported steel goods decreased by 41%, or 2.7%. Products made of cold-rolled steel make up 25% of exports, followed by pipes, tubes, and galvanized sheets, which make up 11% of all steel exports. This data demonstrates that cold-rolled or cold-formed steel sections are still extensively utilized in the manufacturing process of the nation, despite the fact that exports of Malaysian steel are decreasing.

Due to their low density and light weight, cold-formed steel (CFS) sections (such as channels, Z-sections, hat sections, and other open sections) may be useful for building structures. These sections are made by cold-rolling or brake-pressing into various shapes. For cold-formed members made of regular steel, the typical yield stress is 350 MPa, but more recently, it has been as high as 550 MPa for high strength steel [6]. Section thickness typically ranges from one millimeter to three millimeters. Strain hardening increases yield strength more than cold rolling does [7]. 7] The ductility and ultimate strength of a material are both affected by the metallurgical characteristics of that material as a result of strain aging.

Since steel mills began producing flat sheets of steel more than a century ago, there has always been a supply of CFS available for purchase. Members of the CFS worked on building projects in America and Great Britain in the 1850s. Due to a lack of appropriate design standards and inadequate building standards at the time, CFS construction materials were not widely accepted in the early 20th and early 30th centuries. One of the earliest examples of the use of CFS as a building material was the construction of the Virginia Baptist Hospital in Lynchburg, Virginia, in 1925. Since its first use in construction, cold-formed steel has come a long way.

The use of CFS as a structural frame for residential and multi-story commercial structures, such as roof systems, wall studs, girts, and steel-framed houses, has significantly increased over the past few decades. [8]. This is now possible because cold-formed steel has properties that compensate for the shortcomings of conventional goods. Fiber-reinforced plastic (CFS) has become increasingly popular among architects, engineers, and builders as a means of enhancing a structure's structural function and aesthetic appeal at a lower cost and with greater ease of use than conventional materials like concrete. Hot-rolled steel sections are typically used to support claddings on exterior building envelopes, whereas CFS sections serve as secondary structural components.

“Design codes for structures made of cold-formed steel are available, such as those issued by AISI (1996), the British Standard (1998), and Eurocode 3: For typical use of cold-formed steel sections, parts 1-3 On the other hand, comments and design guidelines for cold-formed steel buildings can be

accessed. While the American Iron and Steel Institute (AISI) is utilized by researchers in the United States, Eurocode 3 (EN 1993-1-3) and Eurocode 8 (EN 1993-1-8) are utilized in the design of CFS members in Europe. Concerns about the structural integrity as a whole are raised by members made of cold-formed steel that have unusually high width-to-thickness ratios. 9] In contrast to hot-rolled steel joints, the design guidelines for cold-formed steel connections are limited to their fundamental behavior. Cold-formed steel joint profiles rarely require elaborate design strategies due to the wide range of configurations that are possible and the specific nature of their intended use. Since cold-formed steel (CFS) is a common building material, this study compares and contrasts the bolted connections between CFS sections. Malaysia's design standards are BS EN 1993-1-3 and BS EN 1993-1-8, and the design guidelines from these two standards will be the focus of this study. 3rd Eurocode: Cold-formed components and sheets are subject to additional requirements in BS EN 1993-1-3:2006, whereas Eurocode 3: Connection-related design guidelines can be found in BS EN 1993-1-8.

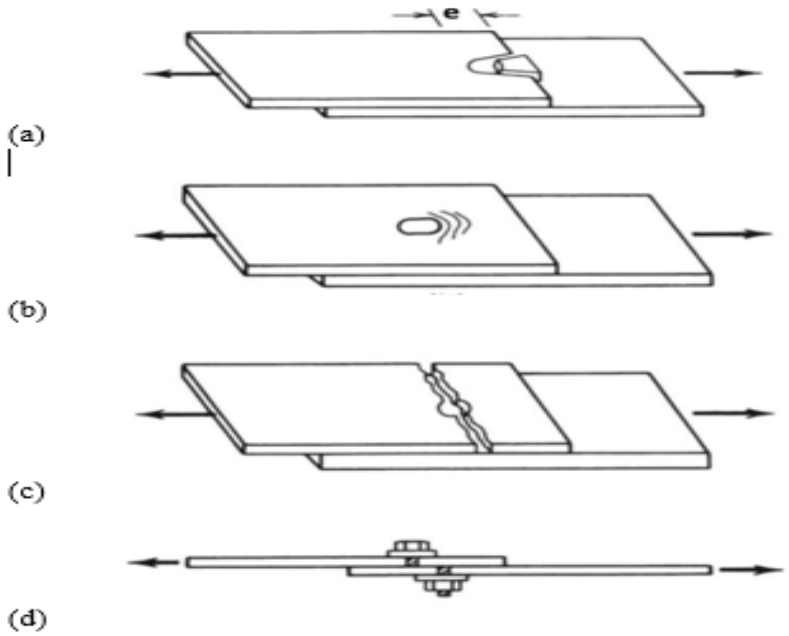

Fig.3 Proposed Methodology

4.CONCLUSION

Products made of cold-formed steel are increasingly being utilized by engineers and contractors due to their improved strength, light weight, non-combustibility, and ease of manufacture. Products made of cold-formed steel may reduce construction costs while enhancing structural functionality, in addition to enhancing the aesthetics and structural performance of buildings. There are a number of factors to take into account when designing a bolted connection in accordance with Eurocode 3

Part 1-8. Due to its thin walls, cold-formed steel has a distinct failure mechanism and significant deformation as buckling, which is the primary challenge in structural analysis. Because they were initially developed for hot-rolled steel joints, the formulas in Eurocode may be incorrect when designing bolted cold-formed steel connections. Consequently, extensive research into the dependability of connection design in accordance with CFS practice rules is required. Researchers may use numerical modeling instead of costly and time-consuming laboratory testing to determine the behavior of bolted connections in cold form steel sections without incurring additional costs. However, it is still necessary to conduct laboratory tests in order to verify the numerical modeling data.

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