

Project:	Optimization of Caisson with ChromX Steel	Designed By:	DK	Date:	8/27/2019
Subject:	Example used in Bon Air Road Bridge Project	Checked By:	AG	Sheet	1 of 12

**Optimization of Caisson with ChromX Steel  
Example Used in  
Bon Air Road Bridge  
Replacement Project  
Larkspur, CA**

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## INTRODUCTION

The purpose of this report is to investigate the possibility of replacing the currently used Grade 60 steel with high-strength reinforcement, ChromX Grade 100 steel, in caissons. The benefits include substantial savings in reinforcing steel weight, reduction in reinforcing steel fabrication, and an improved reinforcement layout. The following section of this report provides a detailed example of the current design vs. the proposed design for both a Cast-in-Drilled-Hole (CIDH) Pile for bridge abutments and a concrete column at bridge piers.

## DESIGN COMPARISON

### ABUTMENT PILE ASSESMENT

The current design for an abutment pile can be seen in Figure 1.

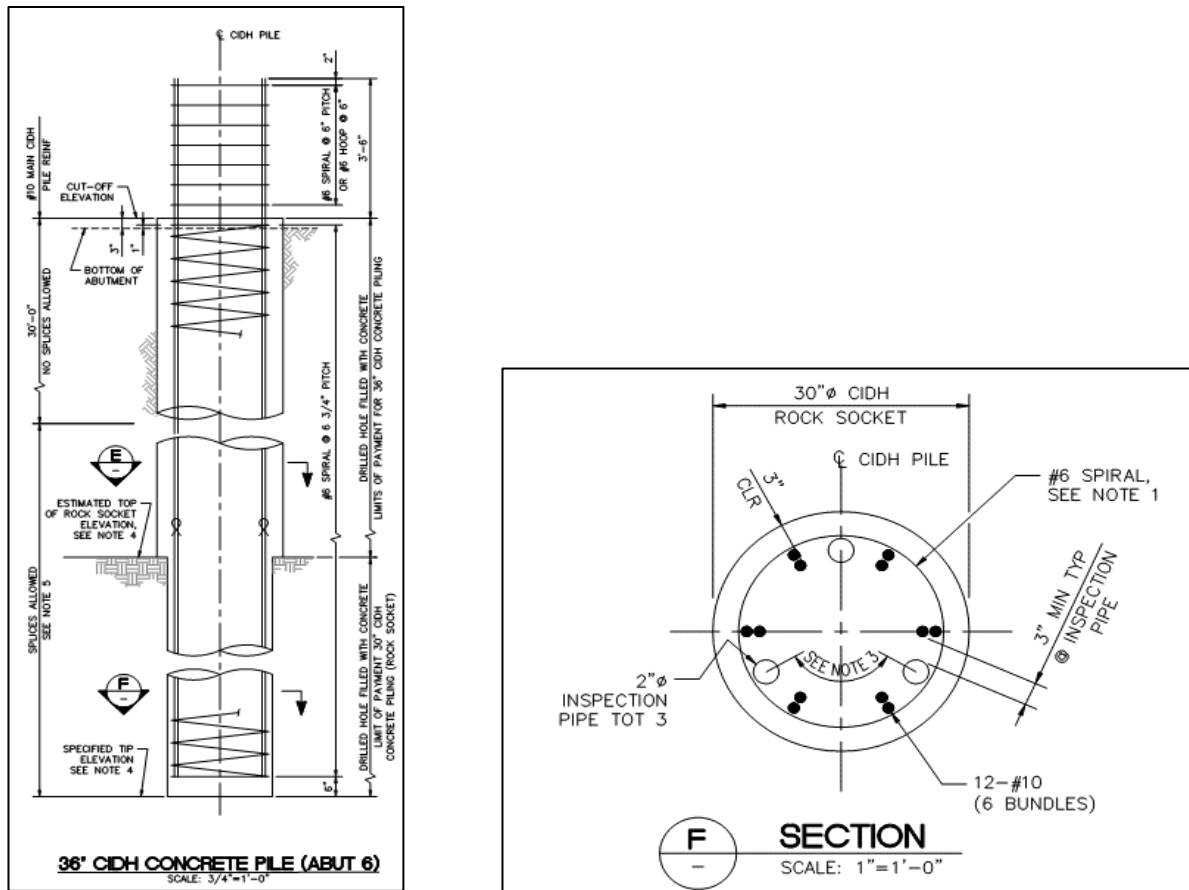
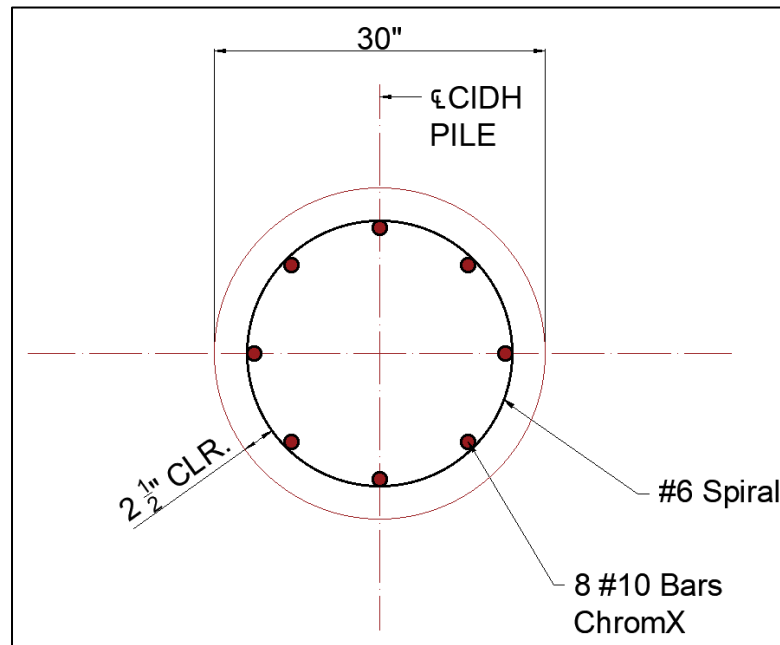


Figure 1. Existing CIDH Pile Elevation and Section

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**Figure 2. Proposed Section for a CIDH Pile**

Figure 2 shows the proposed section for a CIDH pile using ChromX. The total number of bars are reduced when utilizing high-strength steel reinforcement (Grade 100).

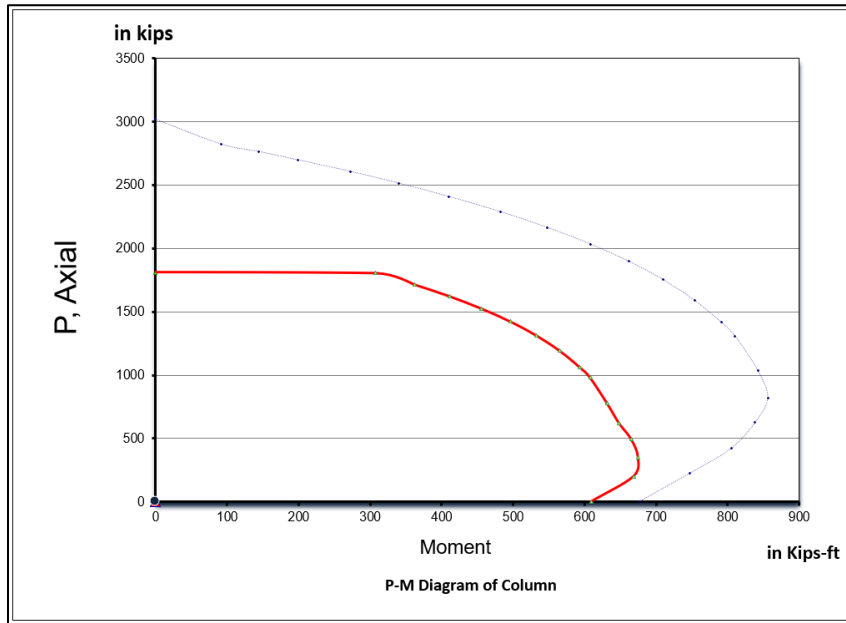
The following spreadsheet was used to analyze the performance of a CIDH pile by using both Grade 60 and ChromX Grade 100 steel. The pile interaction diagrams were then plotted to better represent this comparison. A reduction of 0.5 in. of cover was used in accordance with AASHTO LRFD 8<sup>th</sup> Edition, Chapter 5 provisions.



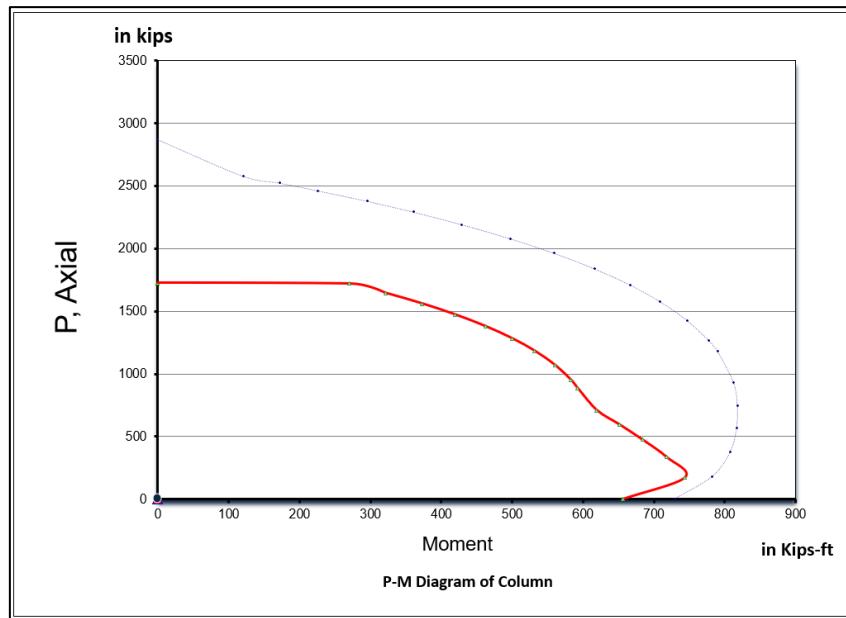


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Below, Figures 5 & 6 show the interaction diagrams, P-M, for both the current and the proposed column sections.



**Figure 5. P-M Interaction Diagram for the Current Column Design (Grade 60)**



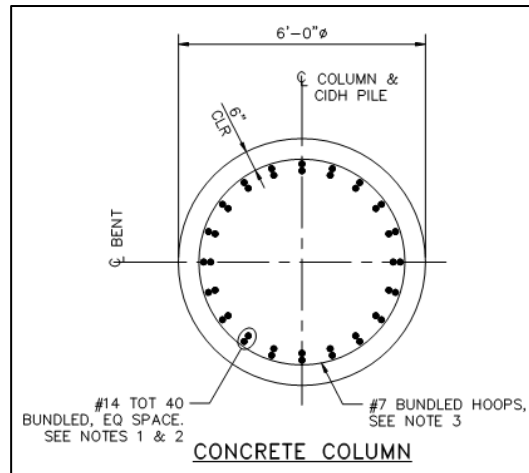
**Figure 6. P-M Interaction Diagram for the Proposed Column Design (Grade 100)**

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A reinforcement reduction of 33% can be achieved by using ChromX rebar while maintaining the same flexural strength.

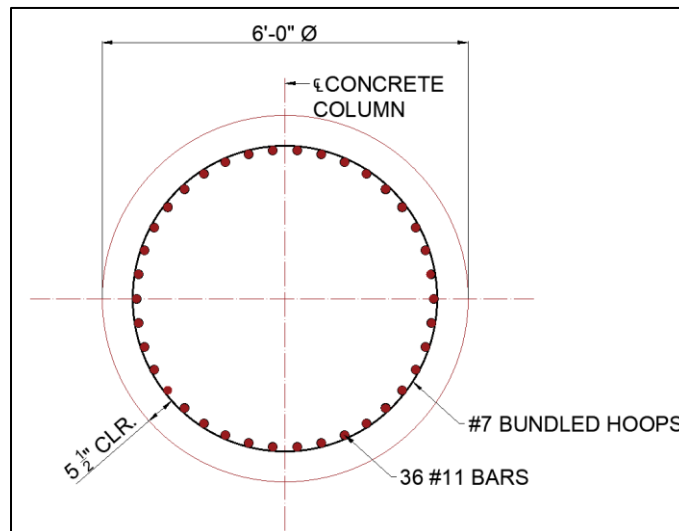
### PIER COLUMN ASSESMENT

The current design for a concrete column can be seen in Figure 7:



**Figure 7. Current Section for a Concrete Column**

The proposed section for a concrete column is shown in Figure 8. A reduction of 0.5 in. of cover was used in accordance with AASHTO LRFD 8<sup>th</sup> Edition, Chapter 5 provisions.



**Figure 8. Proposed Section for a Concrete Column**

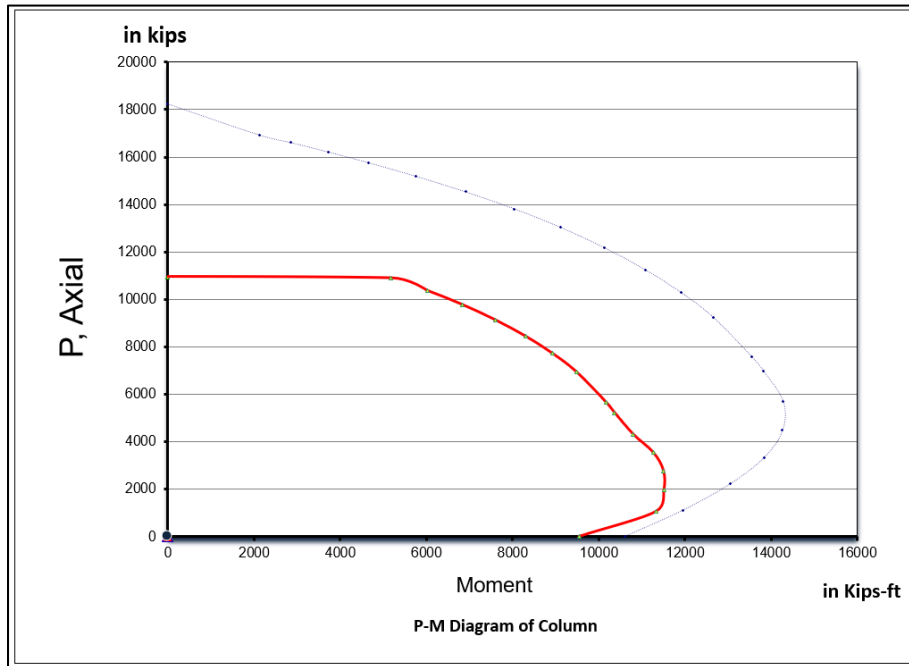




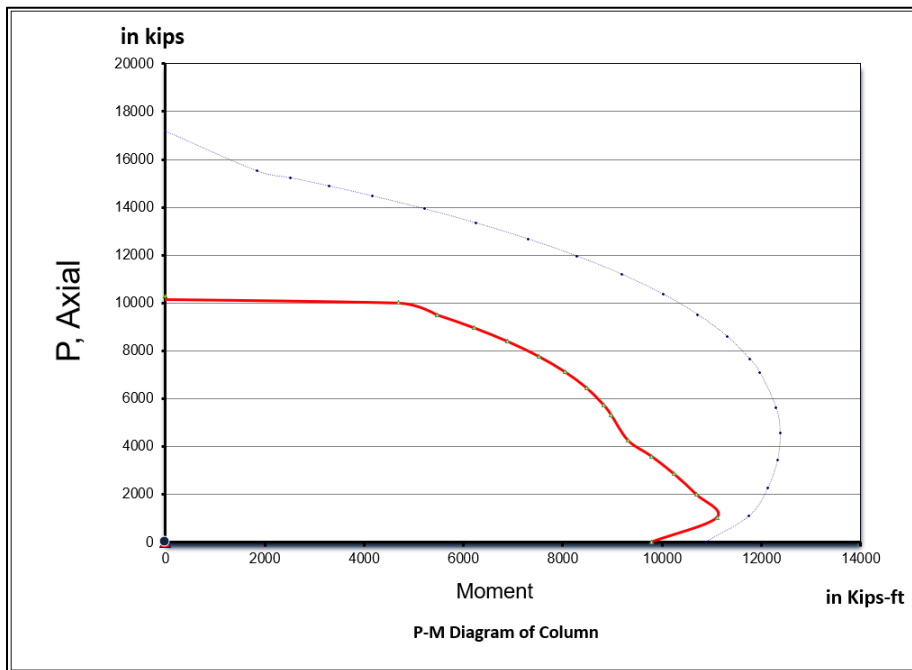


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Figures 11 & 12 show the interaction diagrams P-M for both the current and the proposed column sections.



**Figure 11. P-M Interaction Diagram For the Current Column Section (Grade 60)**



**Figure 12. P-M Interaction Diagram for the Proposed Column Section (Grade 100)**

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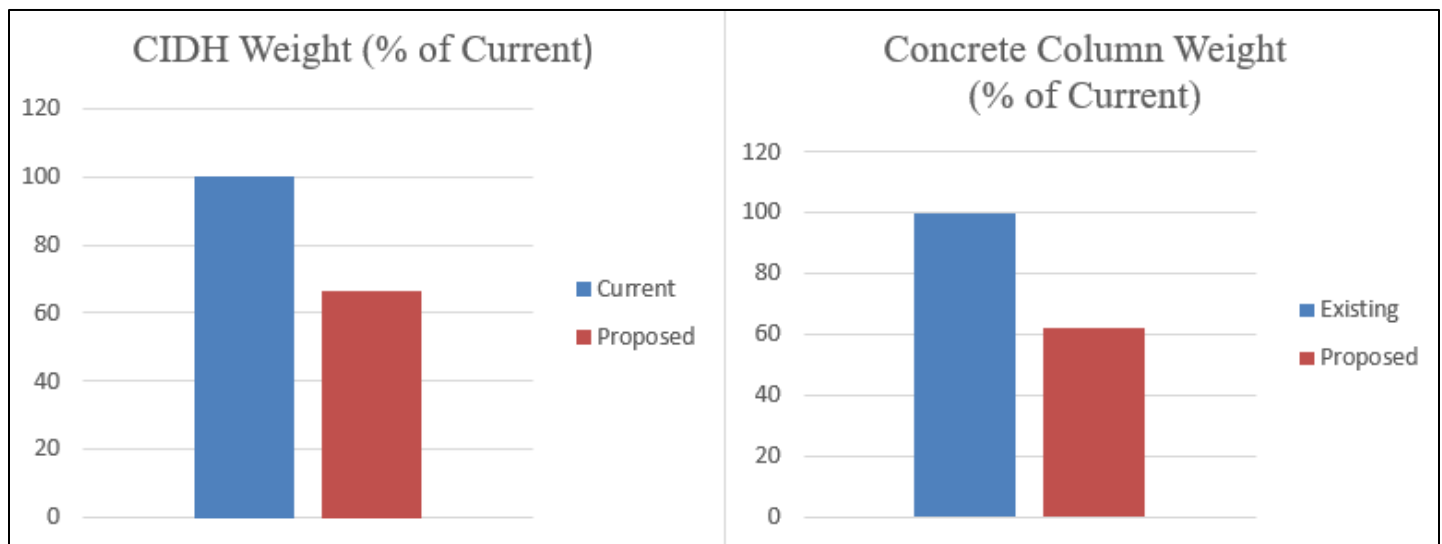
A reinforcement reduction of 38% can be achieved by using ChromX rebar while maintaining the same flexural strength.

## SUMMARY

The results of this investigation demonstrate that ChromX Grade 100 Steel can be effectively implemented in this project. The benefits include substantial savings in reinforcing steel weight, reduction in reinforcing steel fabrication and an improved reinforcement layout. Table 1 and Figure 13 summarize the achieved weight reduction.

**Table 1. Weight Comparison Between Current and Proposed Column Sections**

Element	Current Area of Longitudinal Steel (in <sup>2</sup> ) Grade 60	Proposed Area of Longitudinal Steel (in <sup>2</sup> ) Grade 100
CIDH Pile	15.24	10.16
Concrete Column (6')	90.0	56.16



**Figure 13. Weight comparison between current and proposed column sections.**

A reduction in the total amount of reinforcement and weight per element will simplify the column construction and could lead to reduced labor and an improved quality of the structural element.