Floating Slide Plates for Coke Chutes

A Case Study
Agenda

▪ Who is Structural Group?
▪ Case Study: 2017 Slide Plate Install
  ▪ Scope Development
  ▪ Engineered Solution
  ▪ Preplanning
  ▪ Implementation
▪ Closing remarks
▪ Open floor discussion/ Q&A period
WHO IS STRUCTURAL GROUP?
▪ International Offices (3):
  Abu Dhabi
  Dubai
  Qatar

▪ Corporate HQ:
  Columbia, MD

▪ North America Offices (20):
  Baltimore
  Baton Rouge
  Chicago
  Dallas
  Denver
  Detroit
  Ft. Lauderdale/Miami
  Hartford
  Houston
  Kansas City
  Lake Charles
  Long Island
  Los Angeles
  New York
  Philadelphia
  Pittsburgh
  San Francisco
  Sarasota/West Florida
  Springfield
Case Study Background

- **Background / Customer PROBLEMS**
  - 2- drum, delayed coking unit constructed in 1990.
  - Evident concrete deterioration throughout support structure and coke pit.
  - Coke chutes lined with steel wear plates that were a maintenance burden and required replacement.
  - Replacement planned for 2012 Turnaround deferred due to cost and interference with coke drum replacement.

- **Engineered Solution OBJECTIVES**
  - Undertake structural concrete repairs.
  - Remove and replace the steel wear plates.
Primary Objectives:
- Identify, Quantify and Prioritize Repairs.
- Using NDT, and Visual Observation.

Assessment Area Included:
- Coke Chutes (Hot Face)
- Coke Chutes (Underside)
- Coke Pit Walls
- Fines Settling Basin
Condition Assessment: Deterioration Mapping
Condition Assessment: Core Samples

- Four 3” diameter cores were collected.
- Cores were extracted from the South and East Pit Walls.
- Depths ranged from 2.5” to 8”
Condition Assessment: Field Photographs
Condition Assessment: Conclusions

6.4 Failed Joints

Failure of the existing joints on the coke pit walls was observed. Most joint areas were found that have previous repair attempts that are in a generalized state of failure.

7. RECOMMENDATIONS

- Floor Repair
- Top of Wall Repair
- Expansion Joints
- Weir Wall Modifications
- Coke Pit Wall Extension
- Outside Corner Repair
- Remove and Replace Slide Plates
What is a Wear Plate?
Typical Wear Plate Construction

- Carbon Steel Plate Welded to Embedments
- Mechanical Anchorage to Substrate
Issues with Conventional Wear Plates

- Sections of wear-plate being dislodged over time.
- On-going quarterly inspections and emergency repairs.
- Operational downtime and on-going maintenance costs.
- Inability to inspect concrete structure below.
- Multi-million dollar, intrusive replacement program.
- Cracked welds due to impact from falling material and thermal cycles.
INNOVATION: New “Floating” Slide Plate
DESIGN HIGHLIGHT: Plate Mounting Bracket

- All components were fabricated from 304L Stainless Steel.
- Specialty components required 2+ month lead-time.
Nosing plates were 304L SS and $\frac{1}{2}$ thickness of the new wear plates.

Plates were delivered to site in sections with the studs pre-welded.
Slide plates (20’ x 40’) were made from 304L SS.
Each plate was 4 separate sections welded on-site.
DESIGN HIGHLIGHT: Material Selection

- Continuous issues with CS wear plate corrosion/erosion on slide plates and in coke handling system
DESIGN HIGHLIGHT: Material Selection

- The plant installed a “test plate” in 2011
- ¼” 304 SS plate welded on top of CS in slide zone
DESIGN HIGHLIGHT: Material Selection

- **2013:** Installed CS plate with 0.109” thick 317L SS cladding after major plate failure.
- **Final Decision:** Solid 304 SS material chosen for long term benefits.
Slide Plate Construction: Off-Site Welding
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Slide Plate Construction: Off-Site Welding
Slide Plate Construction: Shipping Plates To Site

Scope Development

Engineered Solution

Preplanning

Implementation

Stainless Steel Plate Lashing Plan

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PURPOSE

This document provides guidance, recommendations, methods and measures for controlling weld distortion during on-site fabrication of the new coke chute wear plates at the Phillips 66 Billings Montana refinery. The project requirements include field fabrication of two 304L Stainless Steel wear plates measuring 1 inch thick by 20 feet wide by 40 feet long. Each plate will be constructed of two plates measuring 1 inch thick by 20 feet wide by 40 feet long, butt welded together along the 40-foot edge with a full penetration double-V groove weld. On-site fabrication is to be performed in a laydown area in the vicinity of the coke pit.

Refer to the attachment at the end of the document for each WPS that may be required for this project.

WELD DISTORTION CONTROL

Weld distortion happens due to expansion and contraction of the weld metal and adjacent base metal caused by the heating and cooling cycle of the welding process. Proper weld design and special fabrication methods are used to control the distortion in the welded parts. Some of the methods to control distortion are listed below:

1. **Design weld size requirement.**

   Correctly sizing a weld minimizes distortion and saves weld metal and time. The amount of weld metal in a fillet weld can be minimized by the use of a flat or slightly convex bead. In a butt joint, proper edge preparation and fit-up will minimize the amount of weld metal needed. In heavy plate welding, beveling or double beveling can save amount of weld metal which translates into much less distortion. The excess weld metal in a highly convex bead does not increase the strength but it increases shrinkage forces in the weld that may cause undesirable distortion.

   Note that the double groove weld for the wear plates is designed to minimize the amount of weld material and is to be ground flat after completion of welding.

2. **Intermittent welding.**

   Intermittent welding reduces the weld metal by as much as 75% while often providing the required strength. Intermittent weld are shown in Figure 1(c) and Figure 3 (d). The intermittent welding is often used in a sequence to minimize distortion if needed. Although intermittent welds (stitch welding) is conducive to limiting distortion, the constraints of the wear plate project do not permit this method as the final weld must be continuous for the full length of the plate.
Slide Plate Construction: On-Site Welding
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Slide Plate Construction: On-Site Welding

10' x 40'

Scope Development ➔ Engineered Solution ➔ Preplanning ➔ Implementation
We developed a comprehensive **Weld Distortion Control Guide** to compliment the WPS to control warping, twisting, and or curling.
Step #1: Layout Slide Plate Mounting Brackets
Drill Bracket Holes On-Site to AVOID Rebar
Step #2: Existing Slide Plate Demolition
Oxygen (Oxy) Lance Cutting
Oxy Lance Cutting Continued…
Step #3: Install Stainless Steel Brackets
Drill, Epoxy, and Set Brackets
Step #4: Install Chute Nosing Plates
Nose Plate Installation - Concrete Removal

Scope Development → Engineered Solution → Preplanning → Implementation
Nose Plate Installation - Concrete Placement
Step #5: Installation of New Slide Plates
Actual Plate Installation (May 2017)
Structural was able to value engineer a solution from the original design that saved Phillips 66 millions.

- Total on-site duration (28 days).
  - Project completed on-time and on-budget.
  - ZERO safety incidents or first-aids.

- NDT inspection in Q4 2017 (6 months after install) revealed NO issues with system performance.
Questions?

Thank You!

Matthew Hickey, P.Eng., PMP
Project Manager
mhickey@structural.net

Stephanie Keeth
Area Mechanical Engineer
stephanie.Keeth@p66.com

COME VISIT US AT BOOTH No.72 FOR MORE INFORMATION!