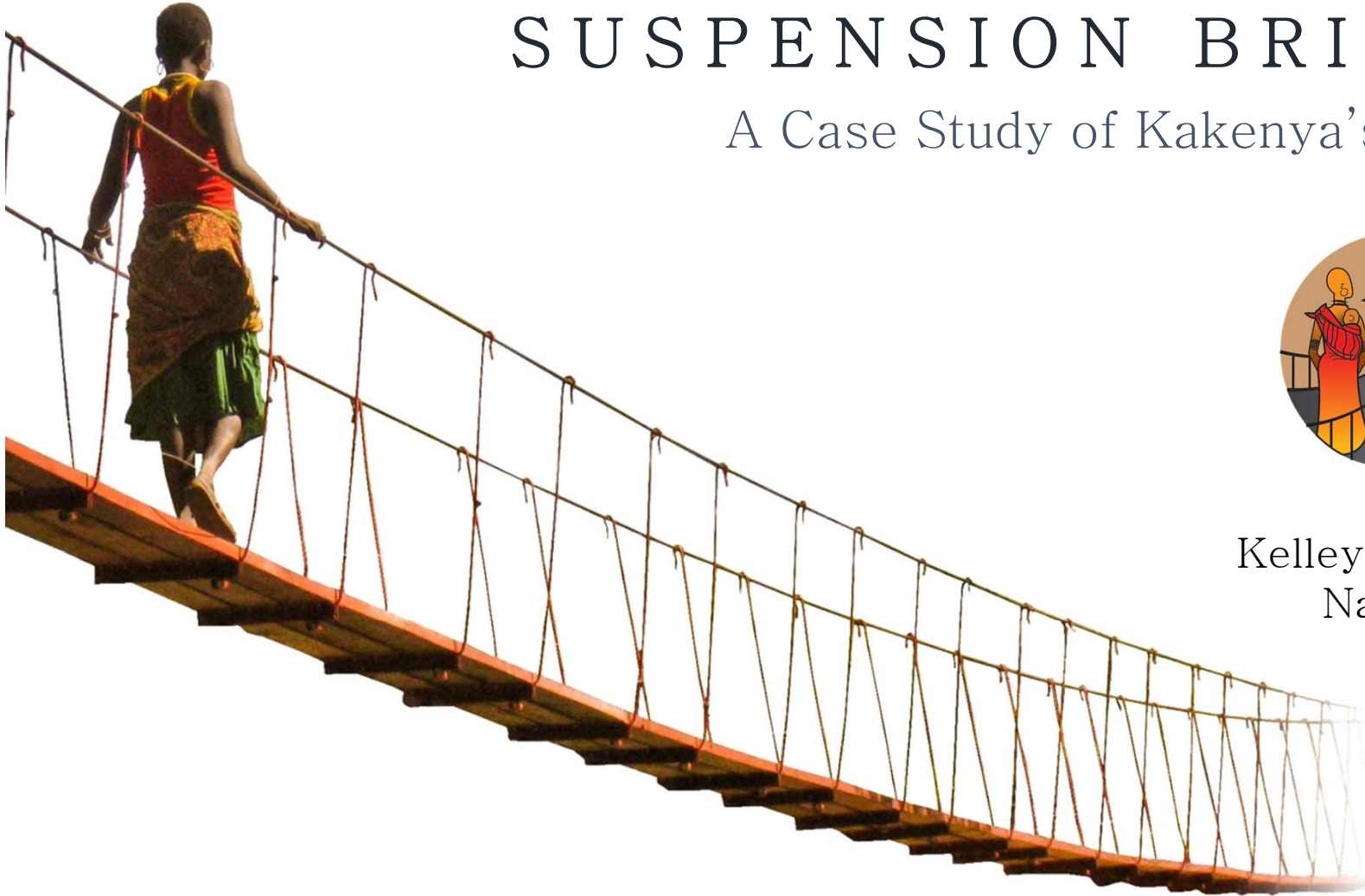


CONSTRUCTION METHODS FOR RURAL PEDESTRIAN SUSPENSION BRIDGES

A Case Study of Kakenya's Crossing



Kelley Severns, PE
Nate Bloss, PE



WALKING WORLD



- ➔ **BACKGROUND**
- SURVEY
- DESIGN
- FABRICATION
- CONSTRUCT., PHASE 1
- CONSTRUCT., PHASE 2

WALKING WORLD



78% of Kenya's
44 million people
live in a
walking world

➔ BACKGROUND

SURVEY

DESIGN

FABRICATION

CONSTRUCT., PHASE 1

CONSTRUCT., PHASE 2

WALKING WORLD



Rivers prevent access to
EDUCATION, HEALTH CARE,
and **MARKETS**



➔ BACKGROUND

SURVEY

DESIGN

FABRICATION

CONSTRUCT., PHASE 1

CONSTRUCT., PHASE 2

WALKING WORLD



➔ BACKGROUND

SURVEY

DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

WALKING WORLD



A bridge **TRANSFORMS** a village

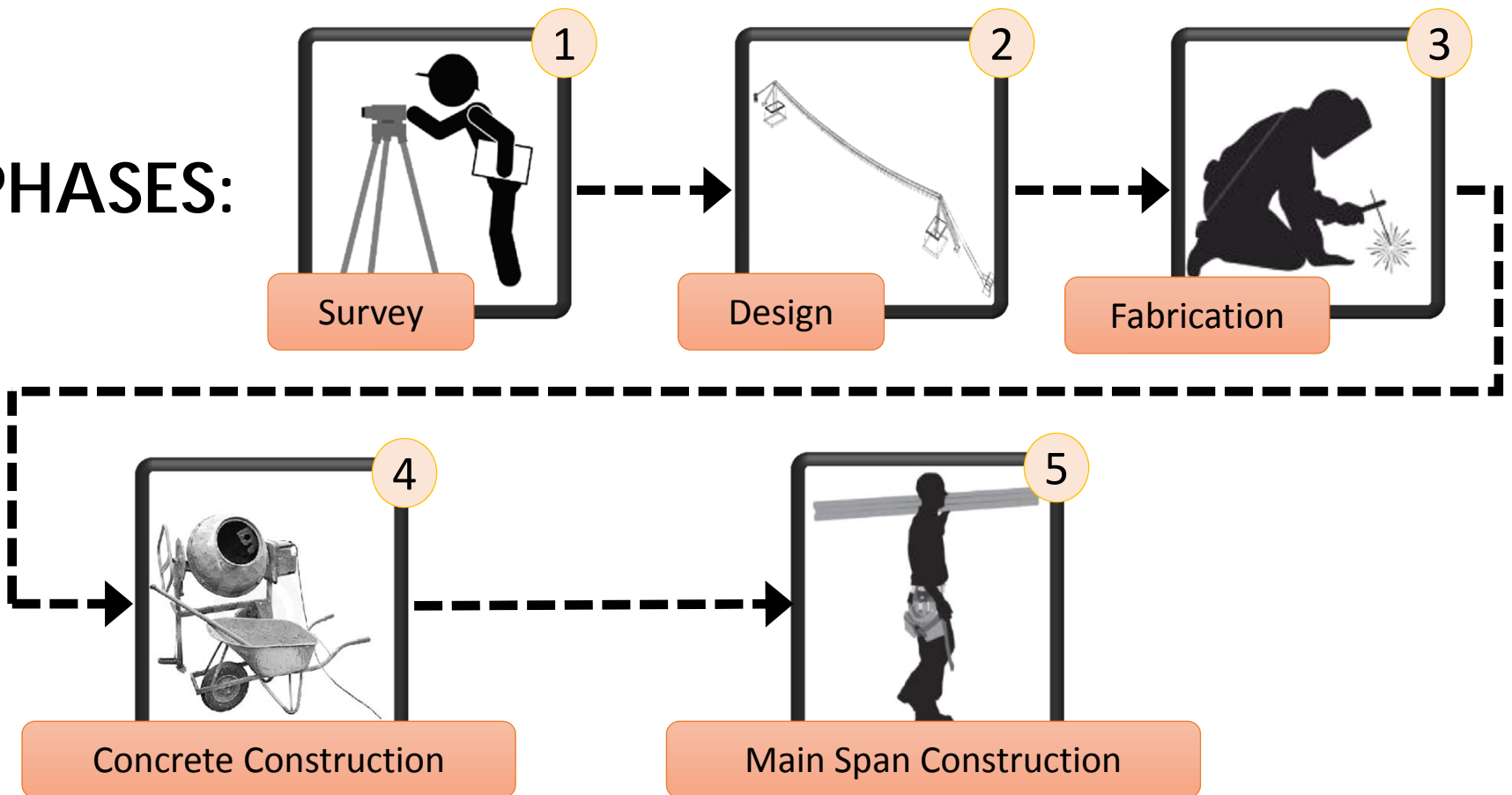
WALKING WORLD



DESIGN AND CONSTRUCTION



5 PHASES:



SURVEY



- Meet with Community Members
- Desirable Site Characteristics:
 - ✓ Rock
 - ✓ Straight section of river
 - ✓ No large trees upstream
 - ✓ Near existing crossings
 - ✓ No significant erosion patterns



BACKGROUND

➔ **SURVEY**

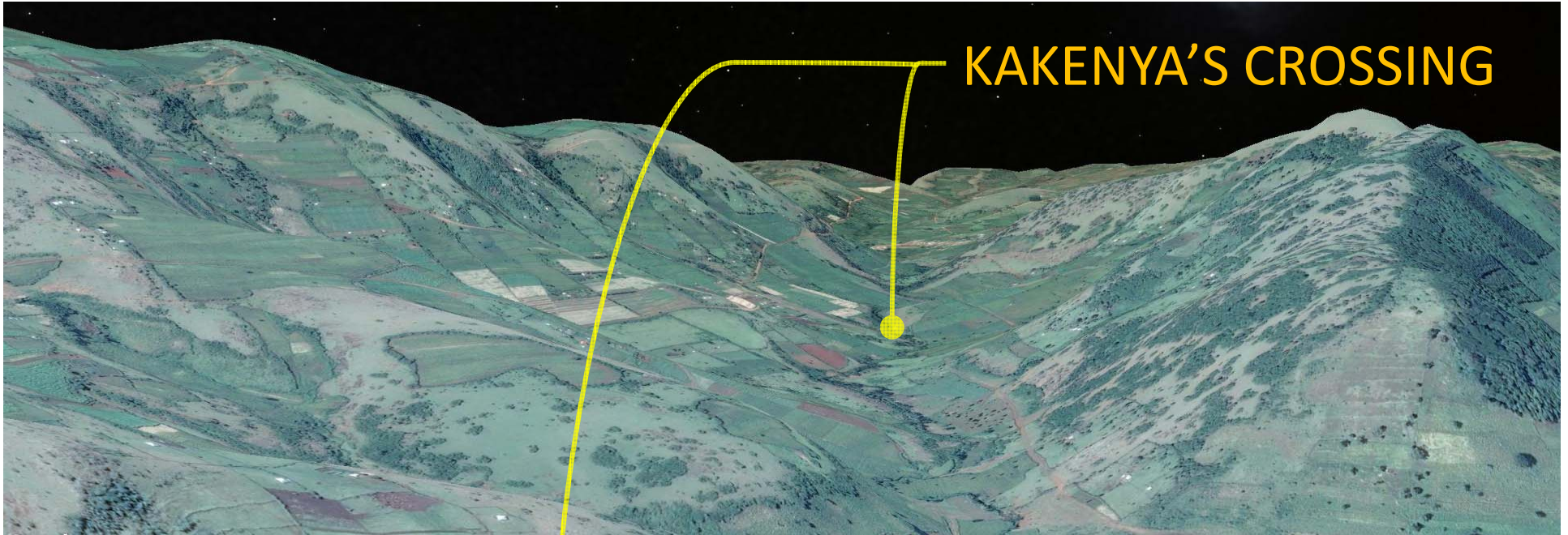
DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

SURVEY



BACKGROUND

➔ **SURVEY**

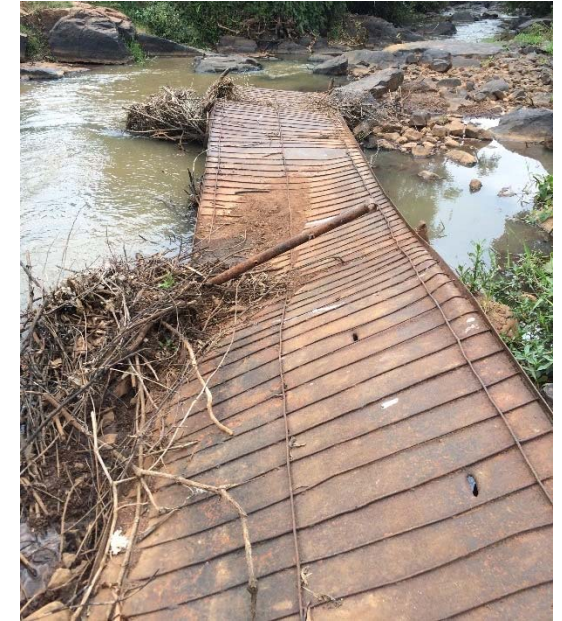
DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

SURVEY



BACKGROUND

➔ **SURVEY**

DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

SURVEY



BACKGROUND

➔ **SURVEY**

DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

SURVEY



BACKGROUND

➔ **SURVEY**

DESIGN

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

OBJECTIVES

- **SIMPLE** PEDESTRIAN FOOTBRIDGE
- EASY TO TRANSPORT
- CAN BE CONSTRUCTED W/O HEAVY MACHINERY
- REQUIRES **LITTLE MAINTENANCE**

BRIDGE TYPES

- SUSPENSION BRIDGE
- SUSPENDED BRIDGE

BACKGROUND

SURVEY

➔ **DESIGN**

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

DESIGN



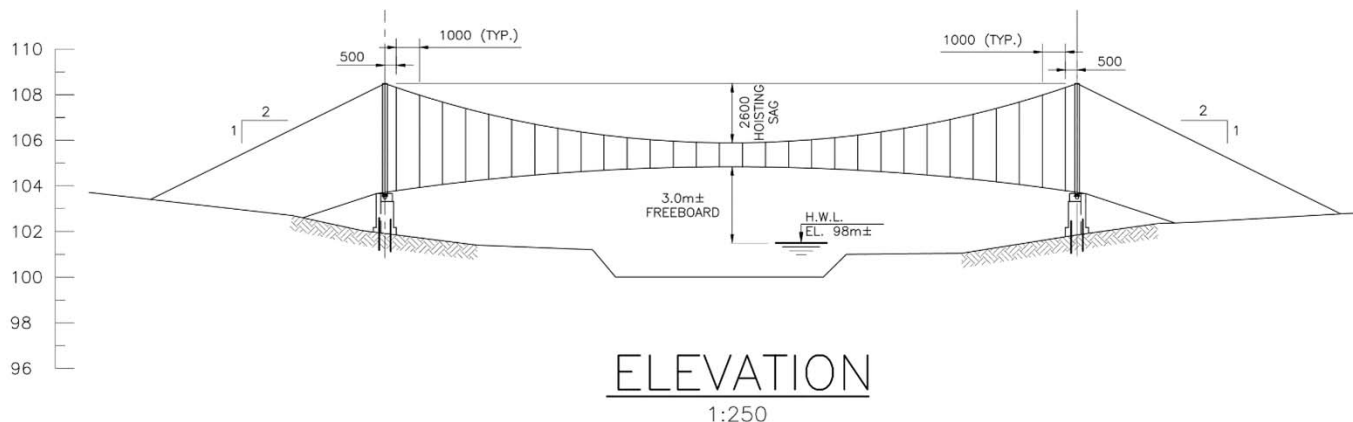
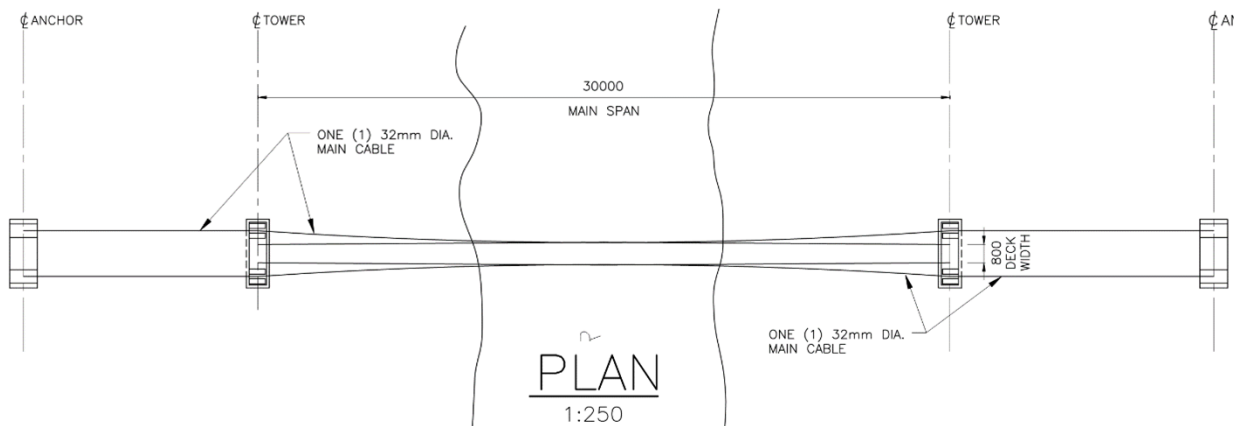
- BACKGROUND
- SURVEY
- ➔ **DESIGN**
- FABRICATION
- CONCRETE CONST.
- MAIN SPAN CONST.

DESIGN



LAYOUT CONSIDERATIONS:

- SPAN AND SAG ($L/11$)
- FREEBOARD (2 TO 5 METERS)
- TOWER HEIGHTS ($\leq 6m$)
- FREEBOARD (2 TO 5 METERS)
- DECK WIDTH (DEPENDS ON TRAFFIC)



BACKGROUND

SURVEY

➔ **DESIGN**

FABRICATION

CONCRETE CONST.

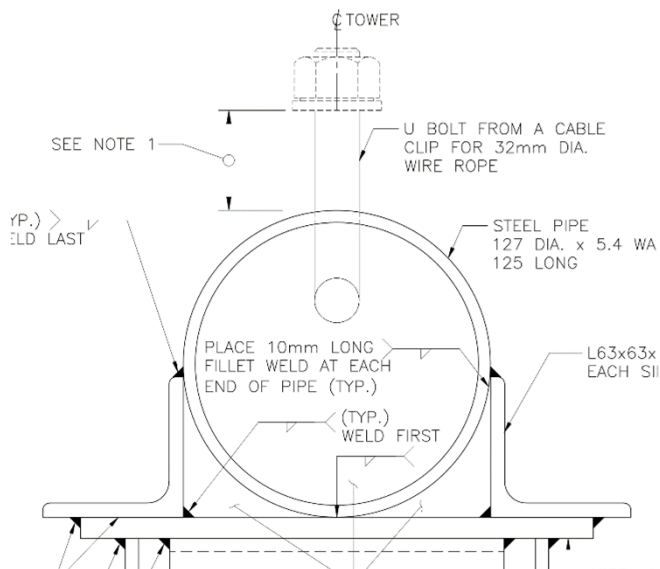
MAIN SPAN CONST.

DESIGN



DESIGN CONSIDERATIONS:

- **PINNED** AT TOWER BASE / SADDLE
 - ELLIMINATES FLEXURE IN FOOTINGS
 - CREATES DETERMINATE STRUCTURE
- **SIMPLE CONNECTIONS** EMPHASIZED
 - NO TENSION WELDS
 - **BOLTS** USED WHEN POSSIBLE
 - **RECTANGULAR HSS** USED OVER CIRCULAR



BACKGROUND
SURVEY

➔ **DESIGN**

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

BASIC MATERIALS:

- DONATED **WIRE ROPE** (A603, 1¼" DIAMETER)
- **STEEL** SECTIONS ($F_y = 40 \text{ ksi}$) / REBAR ($F_y = 60 \text{ ksi}$)
- 2.2 ksi **CONCRETE** (1:2:4 MIX WITH ~3" SLUMP)
- LOCAL, ROUGH CUT **TIMBER** (CYPRUS, BENDING STRENGTH ~15 ksi)

BACKGROUND

SURVEY

➔ **DESIGN**

FABRICATION

CONCRETE CONST.

MAIN SPAN CONST.

FABRICATION



BACKGROUND

SURVEY

DESIGN

➔ **FABRICATION**

CONCRETE CONST.

MAIN SPAN CONST.

FABRICATION



BACKGROUND
SURVEY
DESIGN

➔ **FABRICATION**

CONCRETE CONST.
MAIN SPAN CONST.

FABRICATION



BACKGROUND

SURVEY

DESIGN

➔ **FABRICATION**

CONCRETE CONST.

MAIN SPAN CONST.

FABRICATION



BACKGROUND

SURVEY

DESIGN

➔ **FABRICATION**

CONCRETE CONST.

MAIN SPAN CONST.

FABRICATION



BACKGROUND

SURVEY

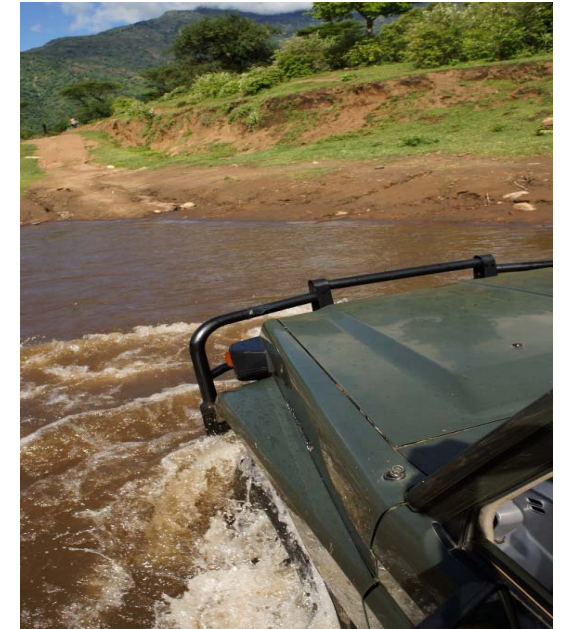
DESIGN

➔ **FABRICATION**

CONCRETE CONST.

MAIN SPAN CONST.

FABRICATION



BACKGROUND

SURVEY

DESIGN

➔ **FABRICATION**

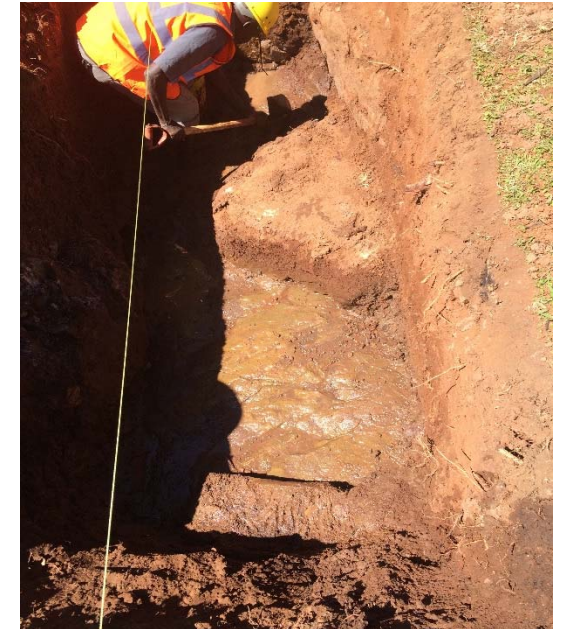
CONCRETE CONST.

MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- EXCAVATE FOR ANCHORS AND ABUTMENTS



BACKGROUND

SURVEY

DESIGN

FABRICATION

➔ **CONCRETE CONST.**

MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- DRILL DOWELS INTO ROCK



BACKGROUND

SURVEY

DESIGN

FABRICATION

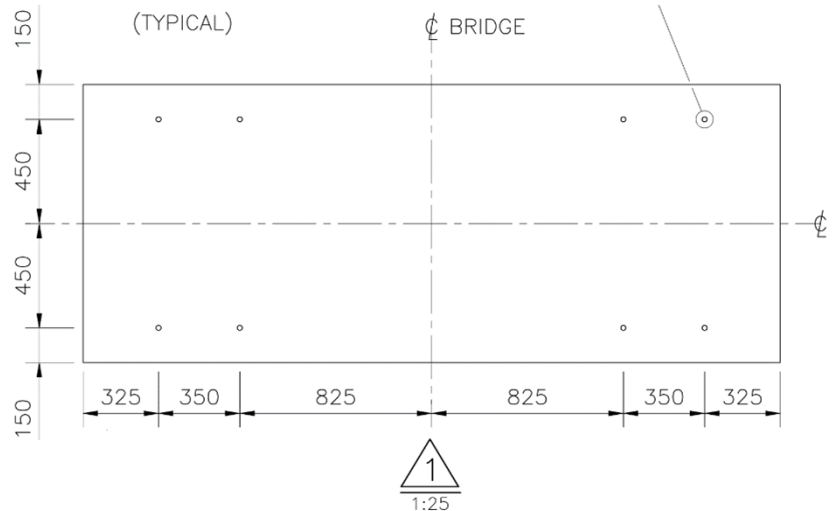
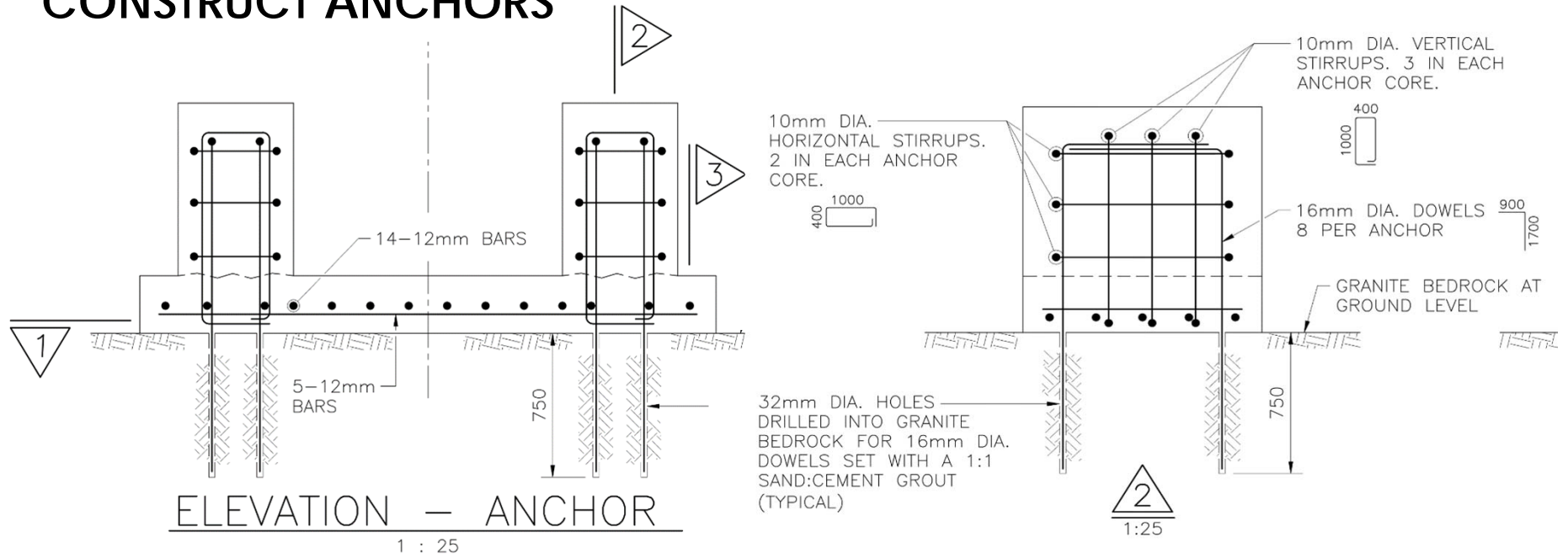
➔ **CONCRETE CONST.**

MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- **CONSTRUCT ANCHORS**



- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- ➔ **CONCRETE CONST.**
- MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- FORM CONCRETE AROUND ANCHOR DOWELS



- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- ➔ **CONCRETE CONST.**
- MAIN SPAN CONST.

CONCRETE CONSTRUCTION



BACKGROUND

SURVEY

DESIGN

FABRICATION

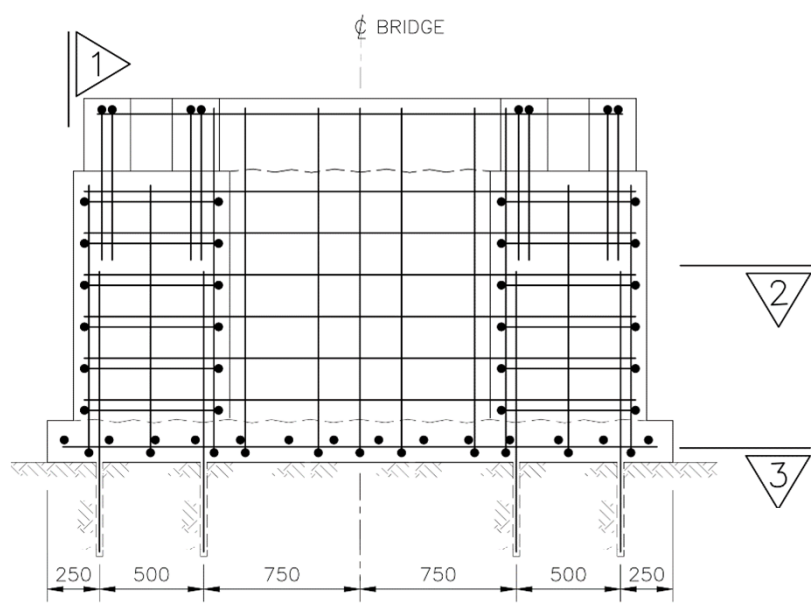
➔ **CONCRETE CONST.**

MAIN SPAN CONST.

CONCRETE CONSTRUCTION

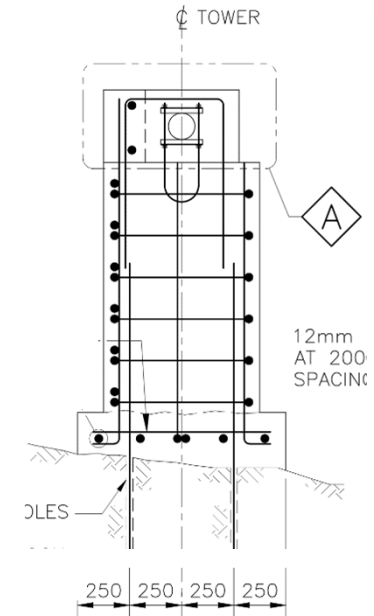


- CONSTRUCT ABUTMENTS

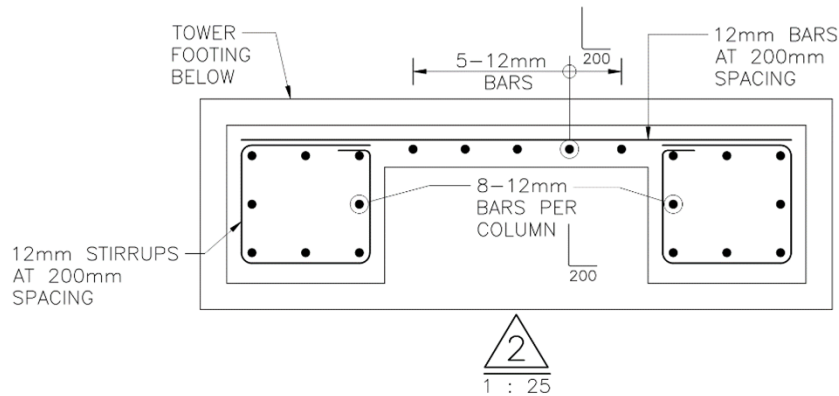


ELEVATION — TOWER FOUNDATION

1 : 25



1
1 : 25



2
1 : 25

BACKGROUND

SURVEY

DESIGN

FABRICATION

➔ **CONCRETE CONST.**

MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- ➔ **CONCRETE CONST.**
- MAIN SPAN CONST.

CONCRETE CONSTRUCTION



- BACKGROUND
- SURVEY
- DESIGN
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- ➔ **CONCRETE CONST.**
- MAIN SPAN CONST.

CONCRETE CONSTRUCTION



BACKGROUND

SURVEY

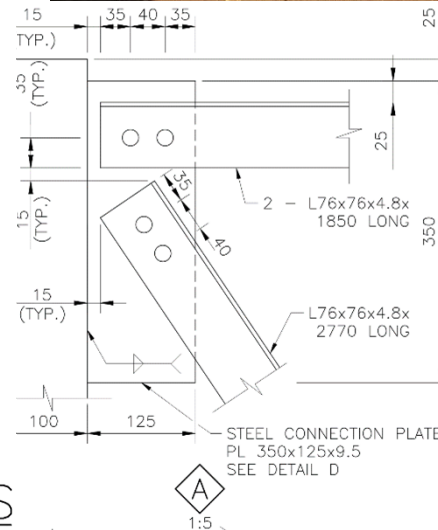
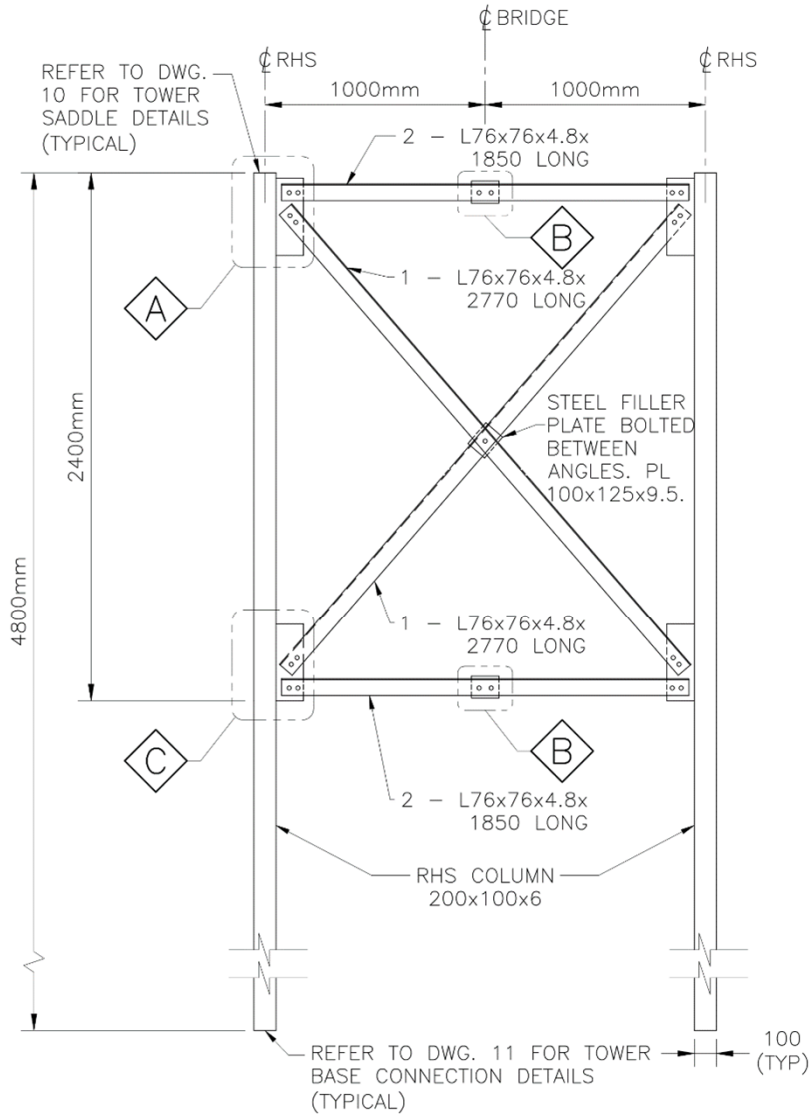
DESIGN

FABRICATION

➔ **CONCRETE CONST.**

MAIN SPAN CONST.

MAIN SPAN CONSTRUCTION



ELEVATION — TOWER DETAILS

1 : 25

BACKGROUND
SURVEY
DESIGN
FABRICATION
CONCRETE CONST.

➔ MAIN SPAN CONST.

MAIN SPAN CONSTRUCTION



- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- CONCRETE CONST.
- ➔ **MAIN SPAN CONST.**

MAIN SPAN CONSTRUCTION



BACKGROUND
SURVEY
DESIGN
FABRICATION
CONCRETE CONST.

➔ **MAIN SPAN CONST.**

MAIN SPAN CONSTRUCTION



BACKGROUND

SURVEY

DESIGN

FABRICATION

CONCRETE CONST.

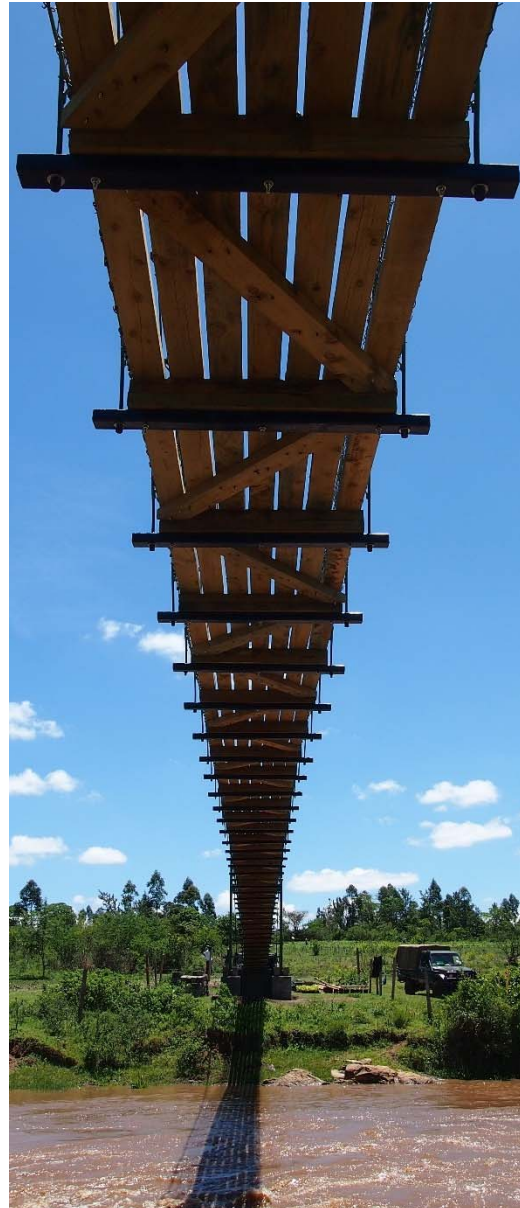
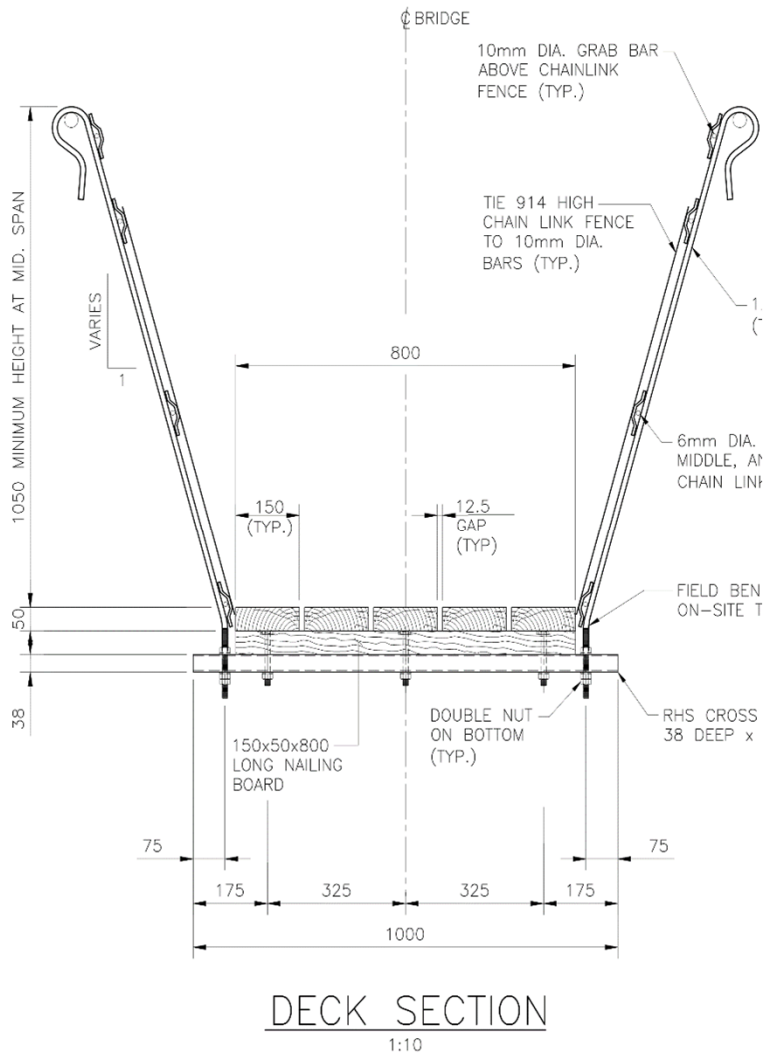
➔ **MAIN SPAN CONST.**

MAIN SPAN CONSTRUCTION



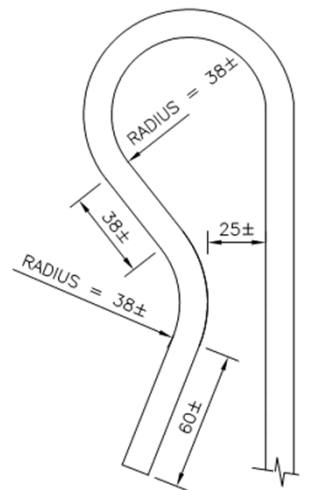
- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- CONCRETE CONST.
- ➔ **MAIN SPAN CONST.**

MAIN SPAN CONSTRUCTION

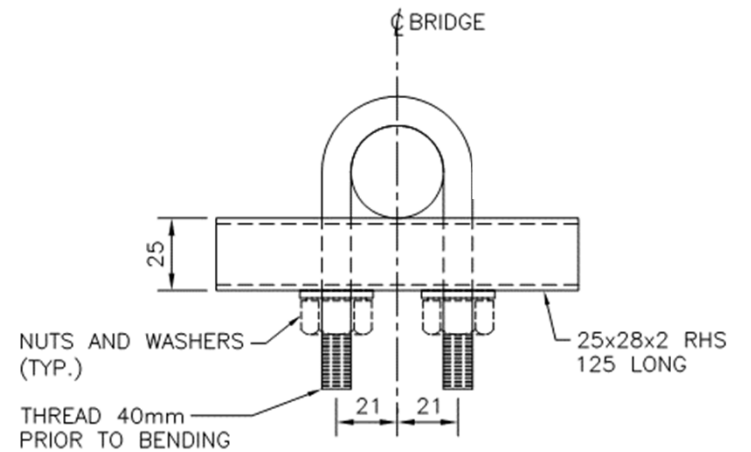


- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- CONCRETE CONST.
- ➔ MAIN SPAN CONST.

MAIN SPAN CONSTRUCTION



HOOK DETAILS
1:2



SUSPENDER STOPPER
1:2
(46 REQUIRED)

- BACKGROUND
- SURVEY
- DESIGN
- FABRICATION
- CONCRETE CONST.

➔ MAIN SPAN CONST.

MAIN SPAN CONSTRUCTION



KAKENYA'S BRIDGE



KAKENYA'S BRIDGE



KAKENYA'S BRIDGE



KAKENYA'S BRIDGE



Questions?



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