

# Hydraulic Surge Analysis and Pipe Stress analysis at Khongkuean



Eastern Water Resources Development  
and Management Public Company Limited

22 April , 2020



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Lead Process & Project Engineer

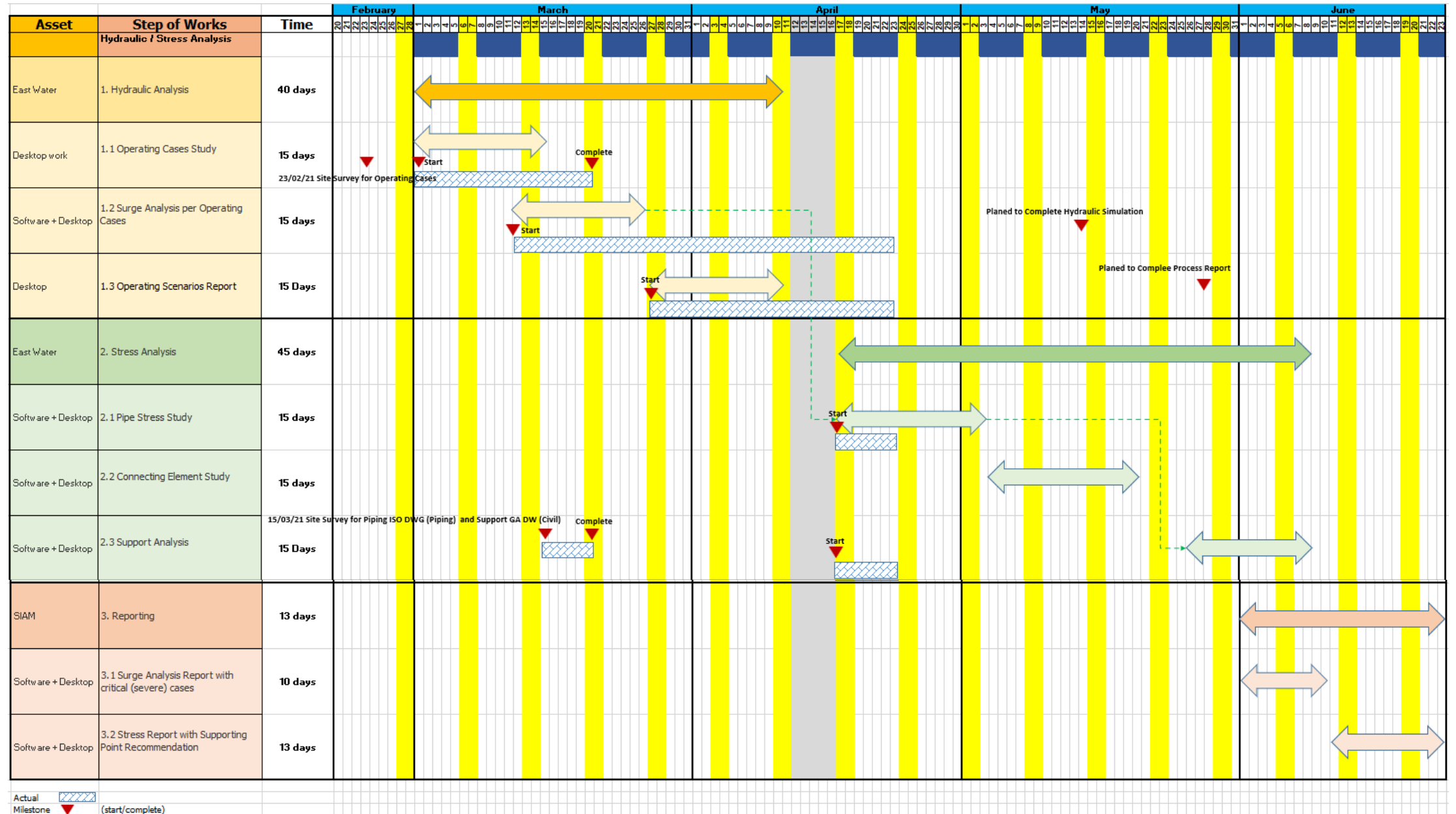
## PROGRESS REPORT



SIAM Operation & Maintenance Co. Ltd.



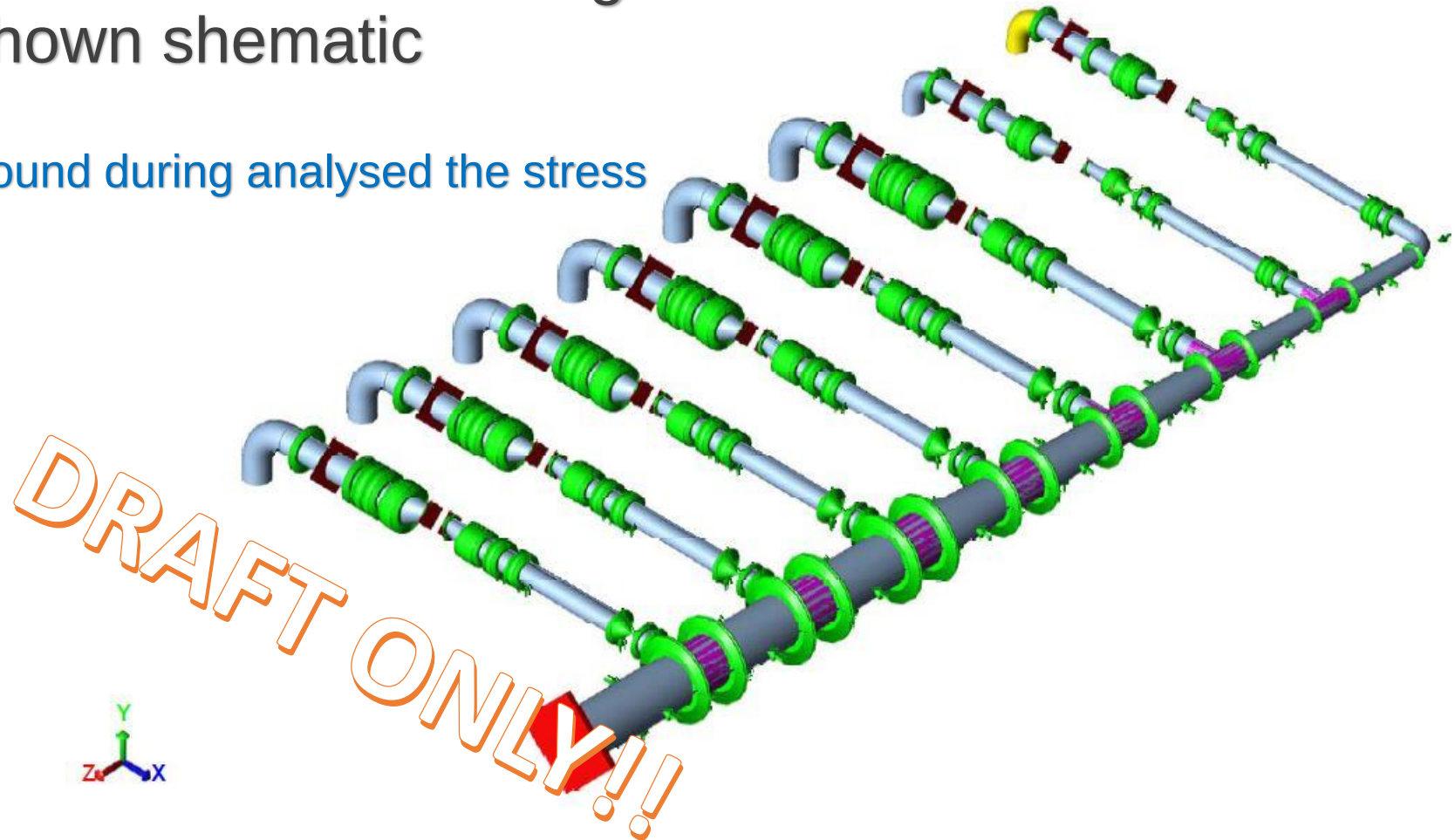
# PROGRESS SCHEDULE



# PIPING Progress

Piping stress analysis has started and modeled, in simulation software in according to Client information as shown shematic

Major concern issue has been found during analysed the stress analysis [SEE NEXT PAGE].



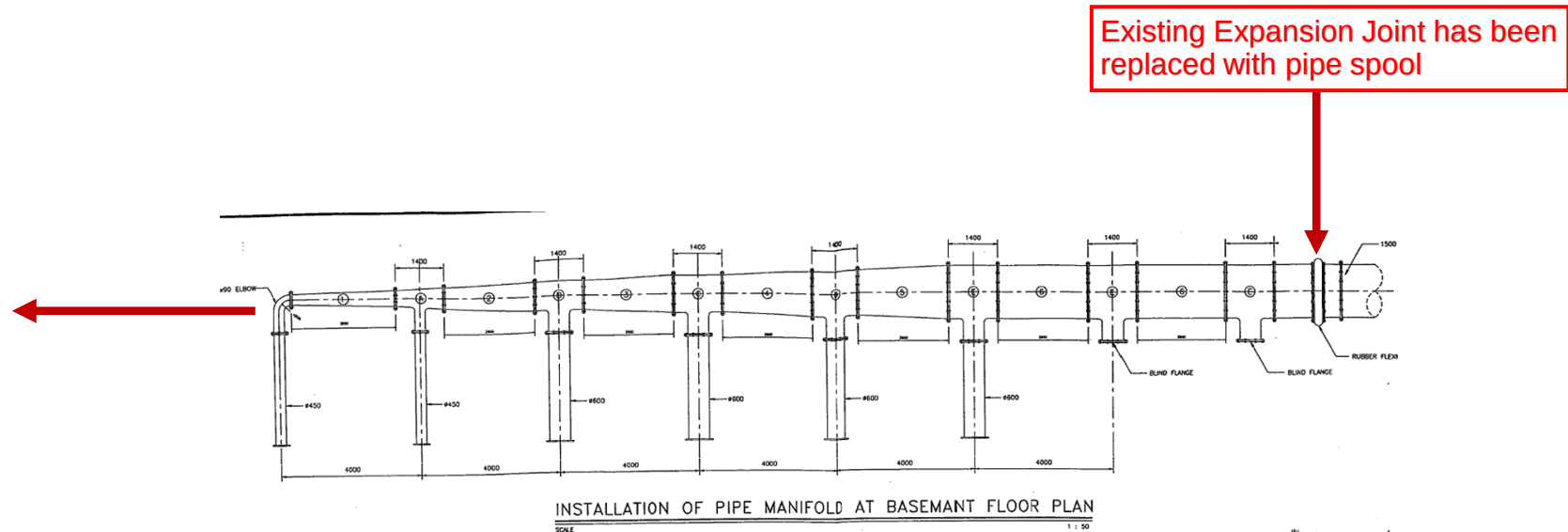
# PIPING Progress

## Major Concerned Issue

## 1) Concept of Anchor Support at Elbow

Based on the good engineering practice including vendor recommendation, this anchor support is required to withstand the pressure thrust load from expansion joint (no tie-rod).

**NOTE** According to visual survey, the existing expansion joint has been replaced with pipe spool.



# PIPING Progress

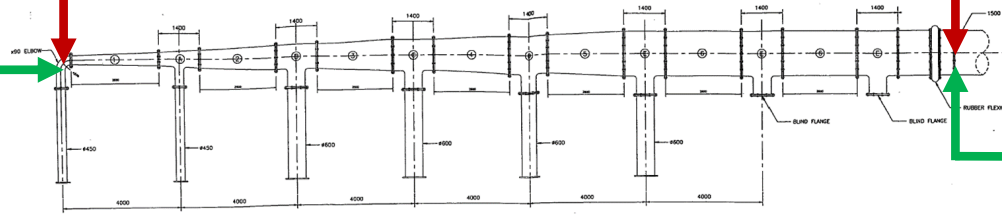
## Major Concerned Issue

### 1) (Continued) Concept of Anchor Support at Elbow

Therefore, the anchor support location of main discharge header as shown below:

(New) Anchor

Anchor (Building Wall)



INSTALLATION OF PIPE MANIFOLD AT BASEMENT FLOOR PLAN  
SCALE 1:100

This is not a good engineering practice if pipe expands even a little bit (let assume; installation temp.= 28C and operating temp. =35C in summer season), the axial loads at both anchors will be:

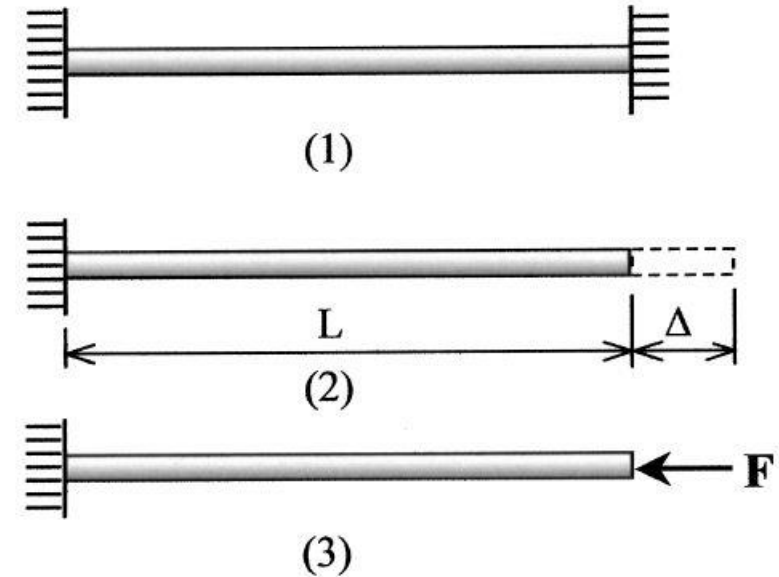
| Node | Load Case | FX<br>N. | FY<br>N. | FZ<br>N. |
|------|-----------|----------|----------|----------|
| 699  | 1 (OPE)   | Rigid Z  | 0        | 0        |
|      |           |          |          | -334659  |

| Node | Load Case | FX<br>N.  | FY<br>N. | FZ<br>N. |
|------|-----------|-----------|----------|----------|
| 1300 | 1 (OPE)   | Rigid ANC | -2021    | -25177   |
|      |           |           |          | 606190   |

### Simplified Diagram:

(New) Anchor

Anchor (Building Wall)



$$F = EA\alpha(T_2 - T_1), \quad S = E\alpha(T_2 - T_1)$$

# PIPING Progress

## Major Concerned Issue

- 1) (Continued) Concept of Anchor Support at Elbow  
and the expansion stress of piping system exceed the allowable stress:

```
CODE STRESS CHECK FAILED      : LOADCASE 9 (EXP) L9=L1-L8

Highest Stresses: (KPa        ) LOADCASE 9 (EXP) L9=L1-L8
Ratio (%):                146.9      @Node    770
Code Stress:              419402.5    Allowable Stress:    285482.3
Axial Stress:             38728.7     @Node    700
Bending Stress:           88585.2     @Node    770
Torsion Stress:           133.9       @Node   5520
Hoop Stress:              0.0         @Node    19
Max Stress Intensity:     89908.3     @Node    770
```

Solution: Horizontal dummy (new anchor) support at elbow need to be removed or add gap

# PIPING Progress

## Major Concerned Issue

### 1) (Continued) Concept of Anchor Support at Elbow

Vendor recommendation for expansion joint (no tie-rod) and anchor support arrangement:

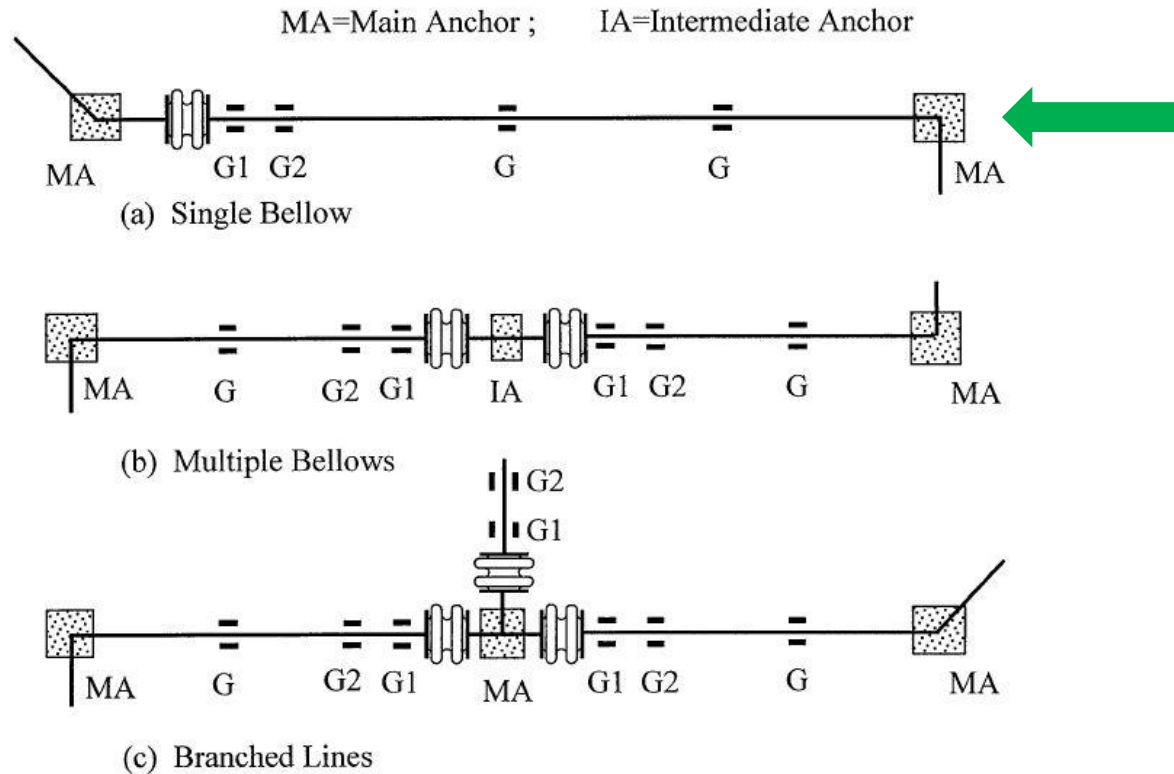


FIG. 7.9

TYPICAL ANCHOR AND GUIDE ARRANGEMENTS ON STRAIGHT LINES

# PIPING Progress

## Minor Concerned Issue

### 2) Design Pressure

เนื่องจากเป็นระบบท่อของเก่าและไม่แน่ใจว่าคอนอกแบบเดิมนั้นได้ตั้งค่า Design Pressure ตาม Rating ของ Flange 150# หรือไม่ (ซึ่งค่า Design Pressure จะเป็นเท่าไรก็ได้ อย่างเช่นโครงการนี้ทางคอนอกแบบเดิมอาจจะใช้วิธีการเอา Shutoff Head ของปั๊ม + %Factor ก็ได้ โดยค่านี้จะต้องไม่เกิน Rating ของ Flange 150#)

ดังนั้นเมื่อไม่มีเอกสารเก่ายืนยันจึงพยายามหาข้อมูลจากแบบ As-Built ที่ให้มา เลยไปเจอข้อมูลนี้

| ITEM | MARKS | DESCRIPTION                                | SERIAL NUMBER                                                                                                                                      | QUANTITY | SPECIFICATION                              |
|------|-------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------|
| 1    | 100   | SUCTION ELBOW DIA.600                      |                                                                                                                                                    | 2        |                                            |
| 2    | 101   | SUCTION ELBOW DIA.800                      |                                                                                                                                                    | 6        |                                            |
| 3    | 102   | BUTTERFLY VALVE DIA.600(MANUAL)            | 00/5186-005-005/A(P1)<br>00/5186-005-004/A(P2)<br>00/5186-003-001/B(P3)<br>00/5186-003-002/B(P4)<br>00/5186-003-003/B(P5)<br>00/5186-003-004/B(P6) | 2        | PN.6(Metal seat)                           |
| 4    | 103   | BUTTERFLY VALVE DIA.800(MANUAL)            |                                                                                                                                                    | 4        | PN.6 (Metal seat)                          |
| 5    |       | PUMP 0.29 CMS. 280 kW.                     | E239 C852 (P1)<br>E239 C853 (P2)<br>E239 C854-1(P3)<br>E239 C854-2(P4)<br>E239 C854-3(P5)<br>E239 C855 (P6)                                        | 2        |                                            |
| 6    |       | PUMP 0.52 CMS. 480 kW.                     |                                                                                                                                                    | 4        |                                            |
| 7    | 105   | RUBBER FLEX. DIA.600                       | N/A<br>N/A                                                                                                                                         | 2        | PN.6                                       |
| 8    | 106   | RUBBER FLEX. DIA.800                       | 19856 (P3)<br>19858 (P4)<br>19855 (P5)<br>19854 (P6)                                                                                               | 4        | PN.6                                       |
| 9    | 107   | ECCENTRIC REDUCER DIA.600x350              |                                                                                                                                                    | 2        |                                            |
| 10   | 108   | ECCENTRIC REDUCER DIA.800x400              |                                                                                                                                                    | 4        |                                            |
| 11   | 109   | CONICAL ADAPTOR DIA.450x250                |                                                                                                                                                    | 2        |                                            |
| 12   | 110   | CONICAL ADAPTOR DIA.600x300                |                                                                                                                                                    | 4        |                                            |
| 13   | 111   | RUBBER FLEX. DIA.450                       |                                                                                                                                                    | 2        | PN.16                                      |
| 14   | 112   | RUBBER FLEX. DIA.600                       |                                                                                                                                                    | 4        | PN.16                                      |
| 15   | 113   | CHECK VALVE DIA.450                        | 95-18160 (P1)<br>95-18161 (P2)<br>95-24213 (P3)<br>95-24215 (P4)<br>95-24214 (P5)<br>95-24210 (P6)                                                 | 2        | Tilted disc.Metal seat                     |
| 16   | 114   | CHECK VALVE DIA.600                        |                                                                                                                                                    | 4        | Tilted disc.Metal seat                     |
| 17   | 115   | MOTORIZED ACTUATOR BUTTERFLY VALVE DIA.450 | 00/5186-007-001/A(P1)<br>00/5186-007-002/A(P2)<br>00/5186-006-003/A(P3)<br>00/5186-002-001/A(P4)<br>00/5186-006-002/A(P5)<br>00/5186-005-003/A(P6) | 2        | Non-rising stem type<br>PN.16 (Metal seat) |
| 18   | 116   | MOTORIZED ACTUATOR BUTTERFLY VALVE DIA.600 |                                                                                                                                                    | 4        | Non-rising stem type<br>PN.16 (Metal seat) |
| 19   | 117   | BUTTERFLY VALVE DIA.450(MANUAL)            | 00/5186-003-001/A(P1)<br>00/5186-003-002/A(P2)<br>00/5186-006-001/A(P3)<br>00/5186-005-006/A(P4)<br>00/5186-005-002/A(P5)<br>00/5186-005-001/A(P6) | 2        | PN.16 (Metal seat)                         |
| 20   | 118   | BUTTERFLY VALVE DIA.600(MANUAL)            |                                                                                                                                                    | 4        | PN.16 (Metal seat)                         |

### สรุป

Valve กับ Expansion Joint ของเดิมซื้อไว้ที่ Rating PN6 (6 bar) และ PN16 (16 bar) ซึ่งต่ำกว่า Rating ของ Flange 150# (ประมาณ 19.6 bar)

ดังนั้นจะนำค่า Rating Flange มาเป็นค่า Design Pressure ก็จะไม่เหมาะสม

# PIPING Progress

## Minor Concerned Issue

### 2) (continued) Design Pressure

ดังนั้นเพื่อพิสูจน์ว่าค่า Design Pressure น่าจะเป็น 16 bar นั้นจึงนำค่า Pressure นี้ พร้อมกับ Pipe Wall Thickness ที่ระบุไว้ในแบบ As-Built ตามรูปข้างล่าง ไปทำการคำนวณอีกครั้งตามมาตรฐาน AWWA M11 เพื่อ Verify

| SCHEDULE OF PIPE THICKNESS & DIAMETER |                  |                |
|---------------------------------------|------------------|----------------|
| NOMINAL DIAMETER                      | OUTSIDE DIAMETER | WALL THICKNESS |
| 450                                   | 457.0 ± 1.6      | 6.0            |
| 500                                   | 508.0 ± 1.6      | 6.0            |
| 600                                   | 609.6 ± 1.6      | 6.0            |
| 700                                   | 711.2 ± 1.6      | 7.0            |
| 800                                   | 812.8 ± 1.6      | 8.0            |
| 825                                   | 838.0 ± 1.6      | 8.0            |
| 900                                   | 914.4 ± 1.6      | 8.0            |
| 1050                                  | 1066.2 ± 1.6     | 9.0            |
| 1275                                  | 1293 ± 1.6       | 9.0            |
| 1500                                  | 1524.0 ± 1.6     | 12.7           |

### PIPE WALL THICKNESS CALCULATION

|                         |              |                         |                        |                                                                                                                                                         |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
|-------------------------|--------------|-------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|------------|-----------------------------|-----------------------------|------------------------------|----------------------------------------|---------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| Design Data             |              |                         |                        | DESIGN CODE                                                                                                                                             |            |                             |                             | Corrosion Allowance, C1 (mm) |                                        | 0       |                         | (Note 1.)                                                                                                                                                                                                                                                  |            |
| Design Pressure (barg)  |              |                         |                        | 16                                                                                                                                                      |            |                             |                             | AWWA Manual M11              |                                        | SERVICE |                         | Water                                                                                                                                                                                                                                                      |            |
| Design Temperature (°C) |              |                         |                        | 40                                                                                                                                                      |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
| Equation:               |              |                         |                        |                                                                                                                                                         |            |                             |                             |                              |                                        |         |                         | <b>Notes:</b><br>1. All pipes used in this Project have been internally lined, then it shall be assumed that no corrosion allowance is required.<br>2. Minus tolerance = 0.25mm per TIS 427.<br>3. Minimum Selected Wall Thickness > t <sub>m</sub> => OK. |            |
| $t = \frac{PD}{2S}$     |              |                         |                        | $t$ : Calculated Wall Thickness (mm)<br>$P$ : Design Pressure (kPa)<br>$D$ : Pipe Outside Diameter (mm)<br>$S$ : Design Stress Value for Material (kPa) |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
| $t_m = t + C1$          |              |                         |                        | $t_m$ : min. required wall thickness (inch)<br>$C$ : corrosion allowances (inch)                                                                        |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
| Size Range:             |              |                         |                        | 10" - 60"                                                                                                                                               |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
| Material:               |              |                         |                        | TIS 427 Class Kor                                                                                                                                       |            |                             |                             | Yield Strength:              |                                        |         |                         | 230000 kPa                                                                                                                                                                                                                                                 |            |
|                         |              |                         |                        |                                                                                                                                                         |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
| NPS                     | O.D.<br>(mm) | Yield Strength<br>(kPa) | Design Stress<br>(kPa) |                                                                                                                                                         | P<br>(kPa) | Calculated Thickness<br>(t) | Corrosion Allowance<br>(C1) | t <sub>m</sub> =t+C<br>(mm)  | Existing Pipe Wall Thk.<br>SCH.   (mm) |         | Minus Tolerance<br>(mm) | Min Existing Thk.                                                                                                                                                                                                                                          | Acceptable |
| 10"                     | 273.1        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 1.899                       | 0.000                       | 1.899                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 12"                     | 323.9        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 2.253                       | 0.000                       | 2.253                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 14"                     | 355.6        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 2.474                       | 0.000                       | 2.474                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 16"                     | 406.4        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 2.827                       | 0.000                       | 2.827                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 18"                     | 457.2        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 3.181                       | 0.000                       | 3.181                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 20"                     | 508.0        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 3.534                       | 0.000                       | 3.534                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 24"                     | 609.6        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 4.241                       | 0.000                       | 4.241                        |                                        | 6.000   | 0.25                    | 5.750                                                                                                                                                                                                                                                      | Yes        |
| 28"                     | 711.2        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 4.947                       | 0.000                       | 4.947                        |                                        | 7.000   | 0.25                    | 6.750                                                                                                                                                                                                                                                      | Yes        |
| 32"                     | 812.8        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 5.654                       | 0.000                       | 5.654                        |                                        | 8.000   | 0.25                    | 7.750                                                                                                                                                                                                                                                      | Yes        |
| 33"                     | 838.2        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 5.831                       | 0.000                       | 5.831                        |                                        | 8.000   | 0.25                    | 7.750                                                                                                                                                                                                                                                      | Yes        |
| 36"                     | 914.4        | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 6.361                       | 0.000                       | 6.361                        |                                        | 8.000   | 0.25                    | 7.750                                                                                                                                                                                                                                                      | Yes        |
| 42"                     | 1066.8       | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 7.421                       | 0.000                       | 7.421                        |                                        | 9.000   | 0.25                    | 8.750                                                                                                                                                                                                                                                      | Yes        |
| 51"                     | 1293.0       | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 8.995                       | 0.000                       | 8.995                        |                                        | 9.000   | 0.25                    | 8.750                                                                                                                                                                                                                                                      | No         |
| 60"                     | 1524.0       | 230000                  | 115000                 |                                                                                                                                                         | 1600       | 10.602                      | 0.000                       | 10.602                       |                                        | 12.700  | 0.25                    | 12.450                                                                                                                                                                                                                                                     | Yes        |
|                         |              |                         |                        |                                                                                                                                                         |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |
|                         |              |                         |                        |                                                                                                                                                         |            |                             |                             |                              |                                        |         |                         |                                                                                                                                                                                                                                                            |            |



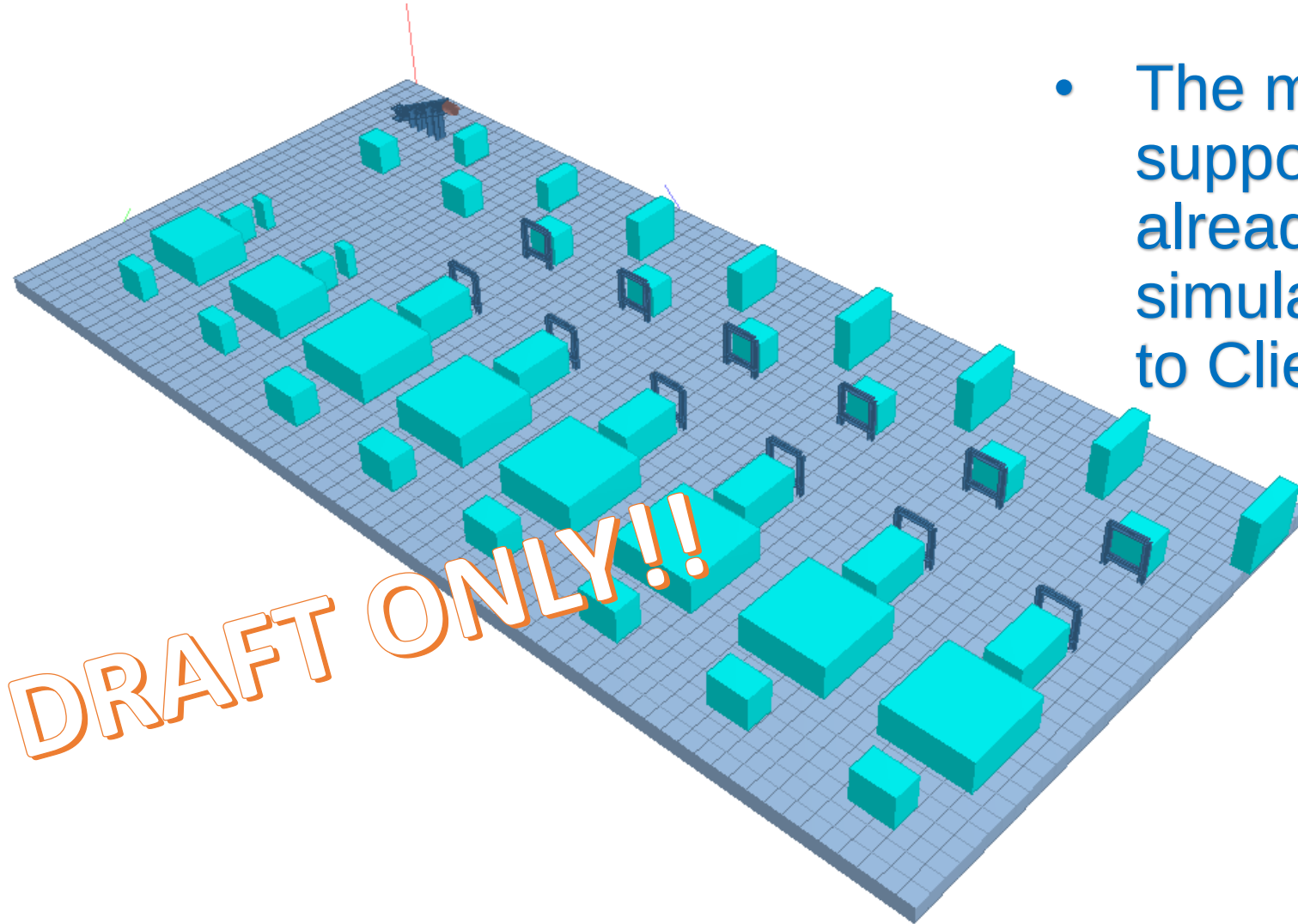
สรุป คือ จะได้ผลตามตาราง ซึ่งดูแล้วมีความเป็นไปได้สูงที่ Design Pressure จะใช้ที่ 16 bar เพราะเมื่อลองเปลี่ยนค่ามาใช้ Design Pressure ที่ 19.6 bar แล้วท่อ Size ใหญ่จะมีความหนาไม่เพียงพอครับ (Fail) จากที่ได้กล่าวมาก็เป็นเพียงสมมุติฐานที่มีความเป็นไปได้สูงนะครับ

ถ้าต้องใช้ค่าอื่นแนะนำมาได้ครับ

# CIVIL & STRUCTURE Progress

## FEM Structural Model

- The model for modified pipe support and existing slab has already been modelled in simulation software in according to Client information.

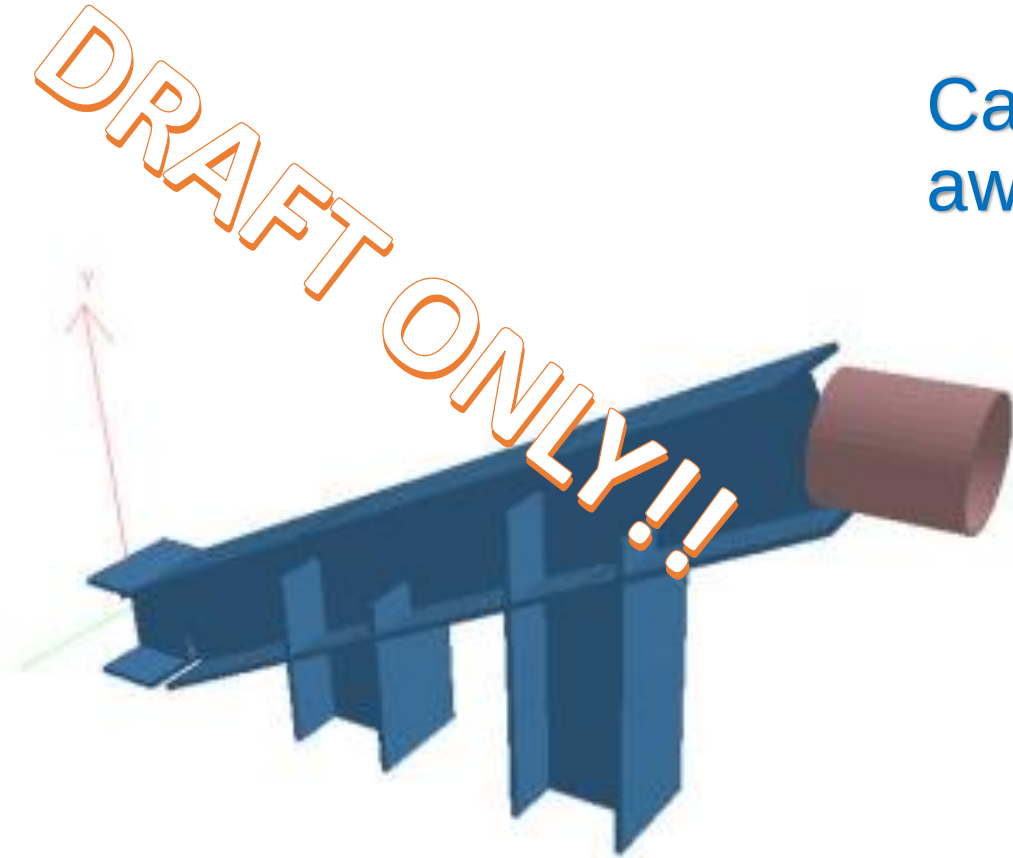


DRAFT ONLY!!!

# CIVIL & STRUCTURE Progress

## FEM Structural Model

Calculation Check for Pipe Support:  
awaiting for pipe support load



**THANK YOU FOR YOUR ATTENTION**