# Seismic Analysis of the Oyster Creek Reactor Building Steel Superstructure And Modification

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# Objective

To present the seismic verification and modification of the reactor building steel superstructure for modification of the reactor building crane to single-failure-proof in accordance with NUREG-0612 and NUREG-0554.

# Purpose

The reactor building steel superstructure need to be re-analyzed for upgrade of the reactor building crane.

The upgraded crane is a single-failure-proof 105-Ton capacity crane. The original crane was a non-single-failure-proof 100-Ton capacity crane.

This presentation does not include the seismic verification of the bridge and trolley, these were evaluated in a separate calculation.

# Methodology

- Perform dead load, modal and response spectrum analysis of the reactor building steel superstructure
- A finite element model of the entire RB steel structure was created with a simplified model of the crane and new trolley
- In the model the crane wheels are positioned at the location that produces the worst case stresses in the building structure
- The trolley is modeled at the worst case trolley location on the bridge (see slide)

## Methodology continued:

- A modal evaluation was performed. The program was set to determine 50 modes which excite the structure into the rigid range. This results in approximately 98 to 99 % of mass participation in all three direction and the 47th mode exceeding 33 hertz.

- Modal damping is 4% for OBE and 7% for SSE in accordance with USNRC Regulatory Guide 1.61

- Modal combinations are per USNRC Regulatory Guide 1.92

- Response Spectrum evaluation is performed by combining the 3 direction responses by the SRSS Method.

# Load Combinations and Acceptance Criteria

(1) DL + LL + OBE < Normal allowable stresses from AISC Spec.

(2) DL + LL + SSE < 1.6 x Normal allowable stresses from AISC Spec.

DL: Dead loads includes the building and crane structure, and crane hook load.

LL: Live load due to snow on the building roof

OBE: Operating basis earthquake loads on the operating floor level which is the base of the steel superstructure

SSE: Safe Shutdown Earthquake loads on the operating floor level which is the base of the steel superstructure

# Computer Program Used

Computer and Structures, Inc. Program SAP2000 Plus
Version 7.21

This is a linear finite element analysis program capable of performing static, modal and response spectrum analysis.

This program was verified by EQE (the analysis vendor) under their quality assurance program

# Results

The maximum interaction ratios for the various elements of the steel superstructure:

| **Building Component** | **DL + LL+ OBE < 1.0** | **DL + LL + SSE < 1.6** |
|---|---|---|
| W14 X 74 Columns | 0.94 | 1.16 |
| Column Bracing | 0.77 | 1.05 |
| Crane Rail Girder | 0.96 | 1.15 |
| Roof Truss Cords | 1.00 | 1.37 |
| Roof Truss Bracing | 0.98 | 1.09 |

The maximum computed displacements (NS, EW, VERTICAL) in inches relative to the operating floor:

| **Building Component** | **DL + LL+ OBE** | **DL + LL + SSE** |
|---|---|---|
| Roof Truss Joints | 0.39, 0.44, 0.26 | 0.51, 0.64, 0.37 |
| Crane Runway/Bridge | 0.95, 1.07, 0.48 | 1.22, 1.45, 0.61 |

Results continued:

It was known that the clip connecting the rail girder to the building columns will require modification as such no stresses were computed for this component. The results of this activity are as follows:

1. The analysis results (force magnitude) confirms that the existing bent plate clip will be overstressed and a modification is required at each connection (total = 14)
2. The calculated forces were used to design a modification
3. The modification was installed in July of 2000

The final details of the modification were reconciled in the building analysis.

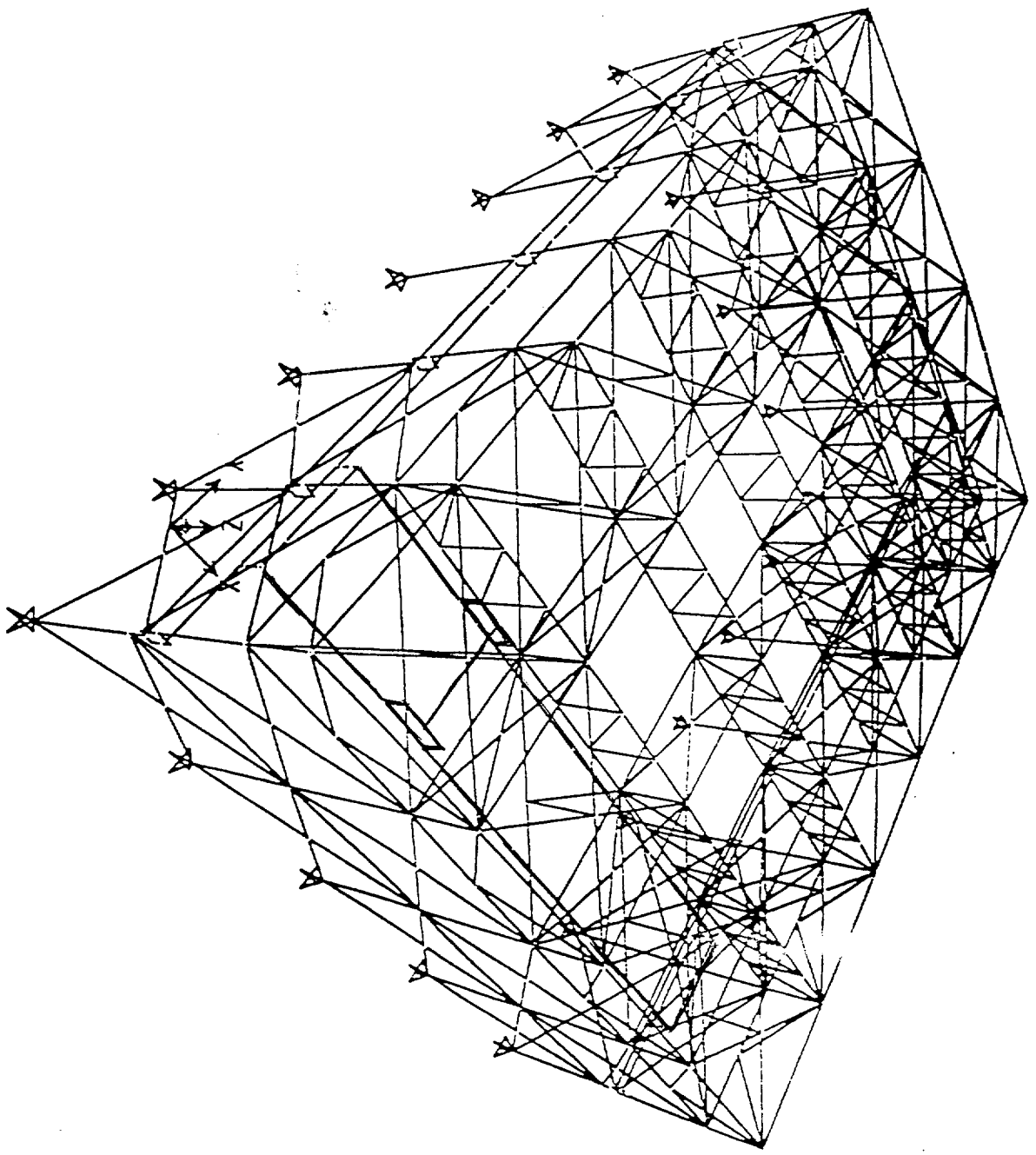
## Summary

The modified reactor building super structure and reactor building crane rail girders are adequate for the Oyster Creek Safe Shutdown and Operating Bases earthquakes for a fully loaded crane with the trolley at any location on the crane bridge.

Job No. 302067 O.C. REACTOR BLDG SUPERSTRUCTURE By: TDA Date: 6-11-00

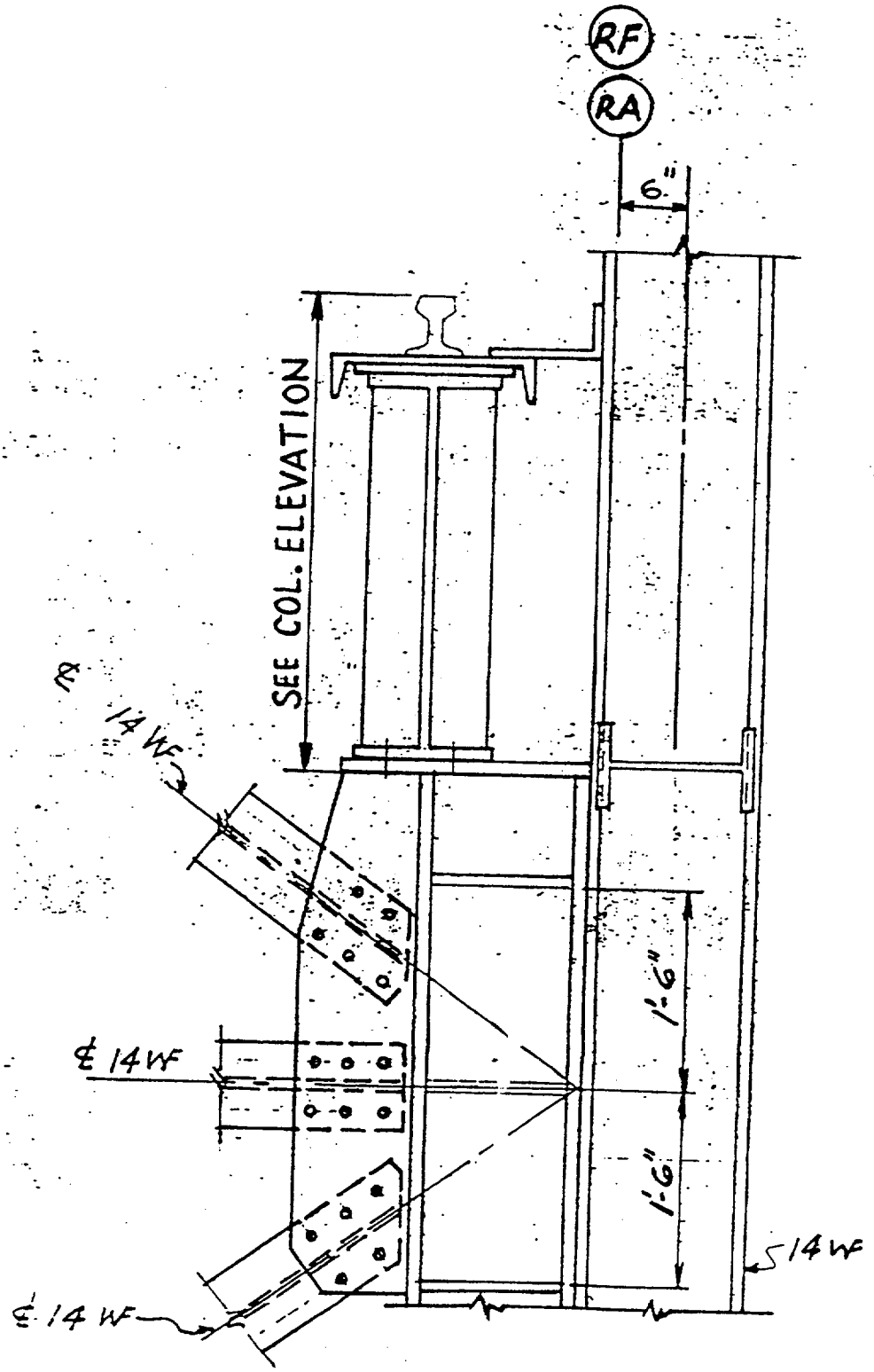
Calc. No.C-002 SEISMIC QUAL. FOR NEW F.P. CRANE Chkd: JVI Date: 6-11-00

SAP2000

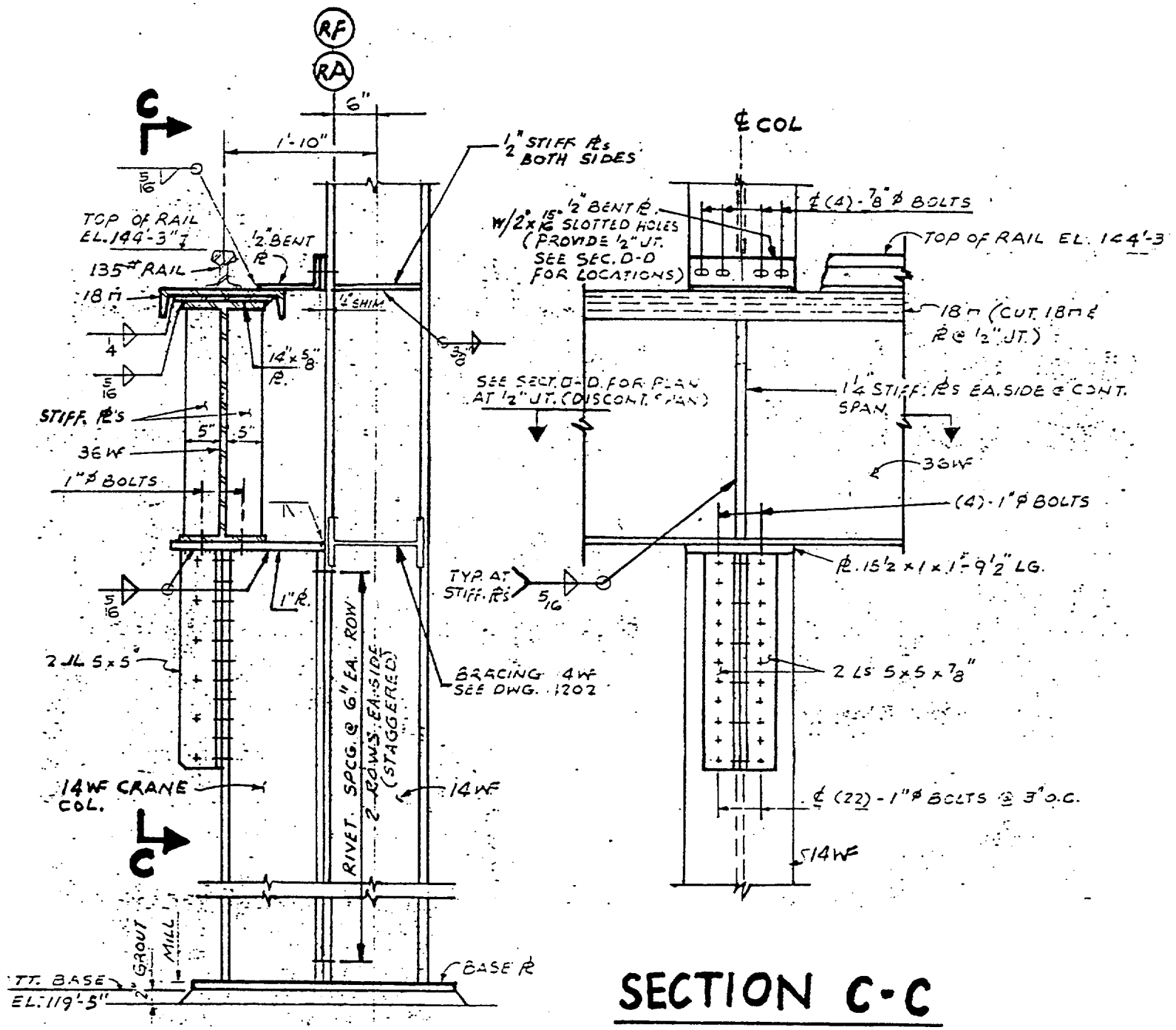


SAP2000 v7.21 - File:Position11 - 3-D View - Kip-in Units

6/9/00 13:48:52

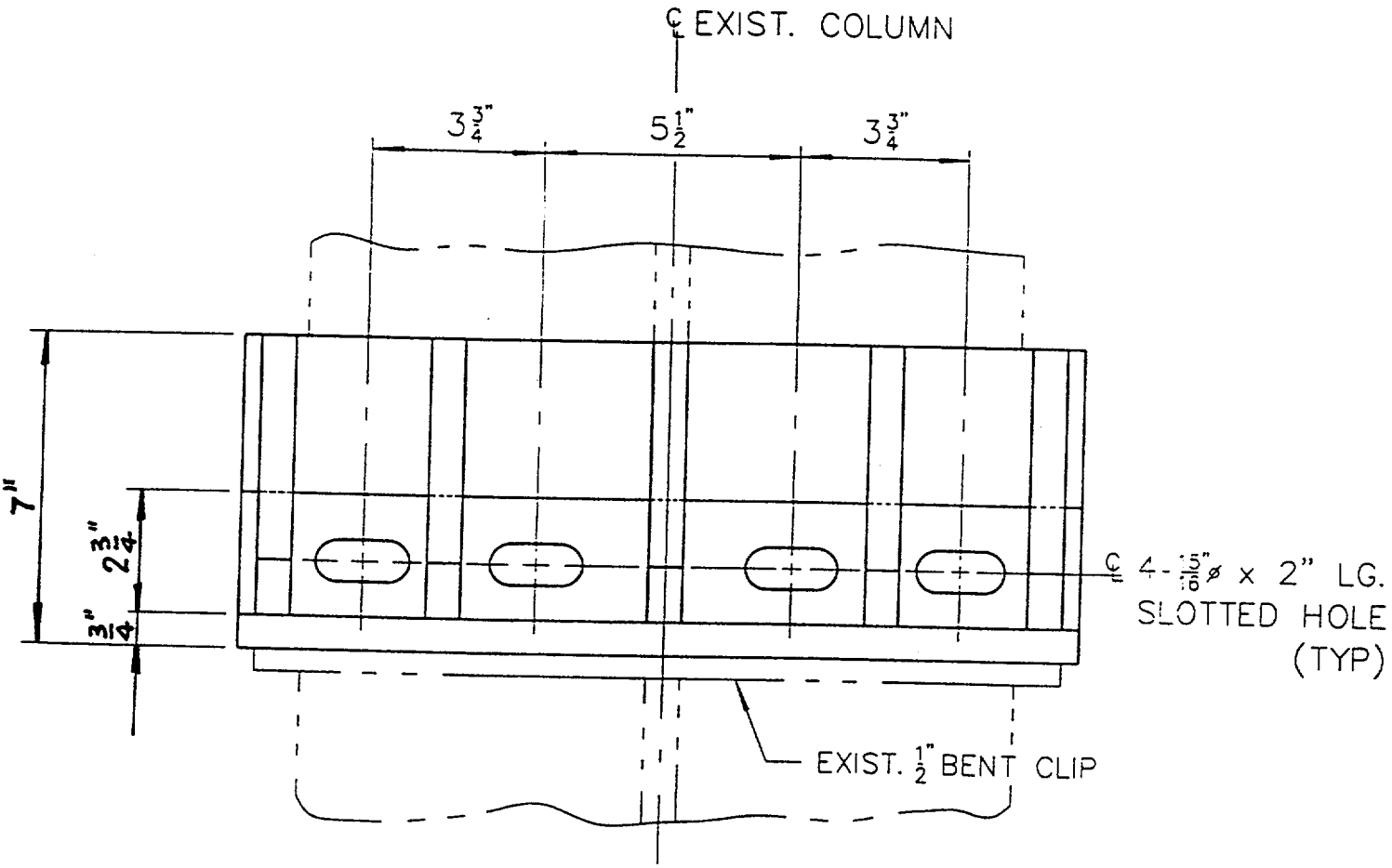



AT COL. LINES (R1) & (R7) ONLY

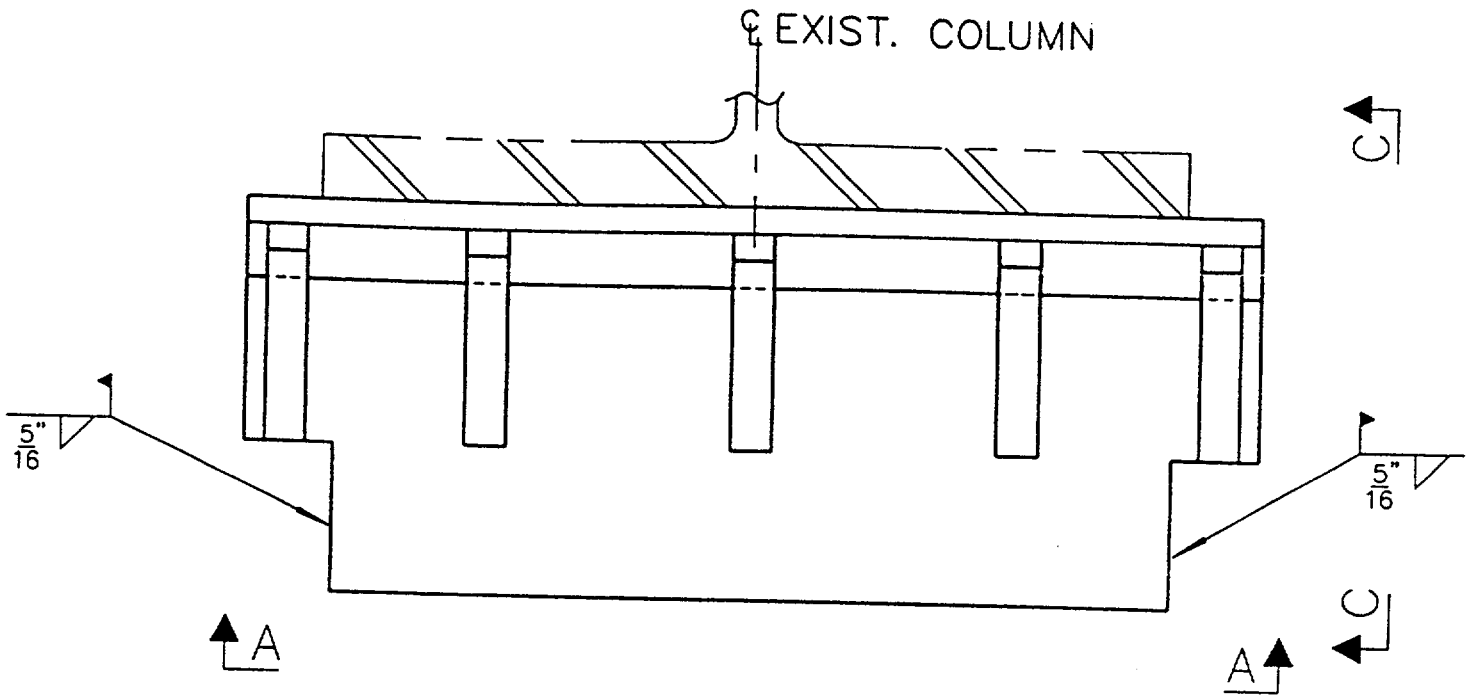



## SECTION C-C

## COL. ELEVATION

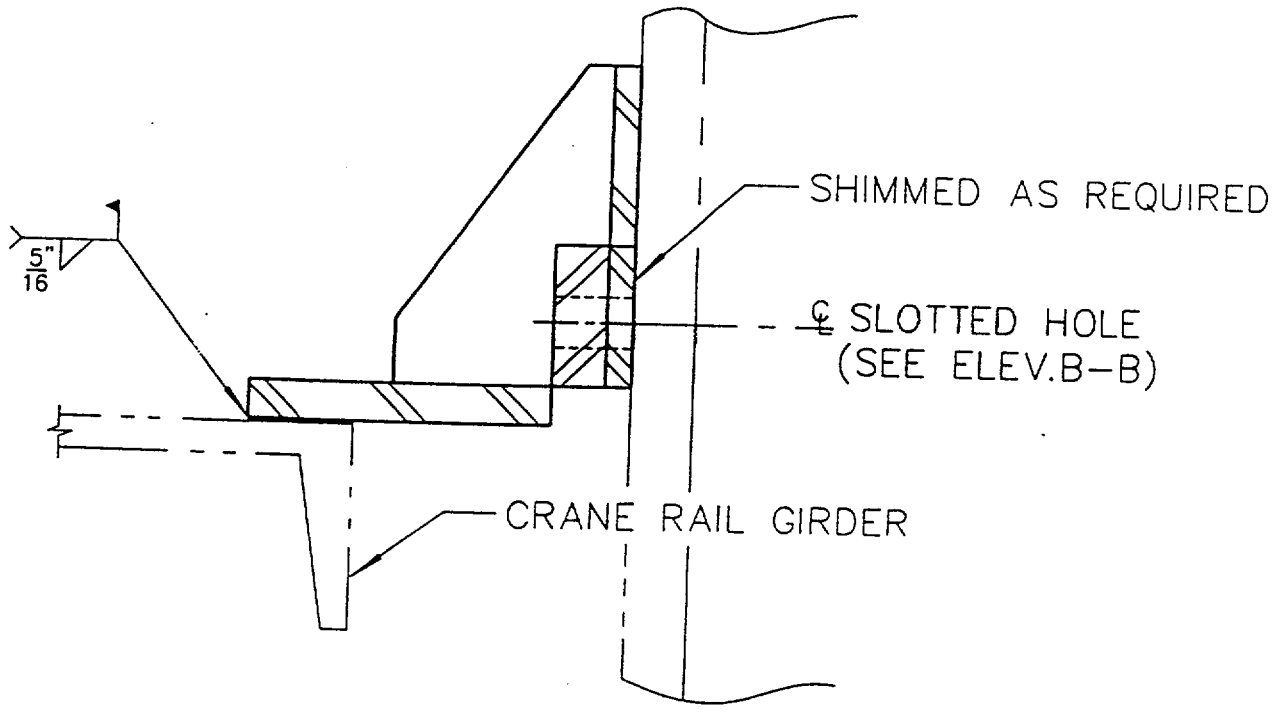



ELEVATION A–A

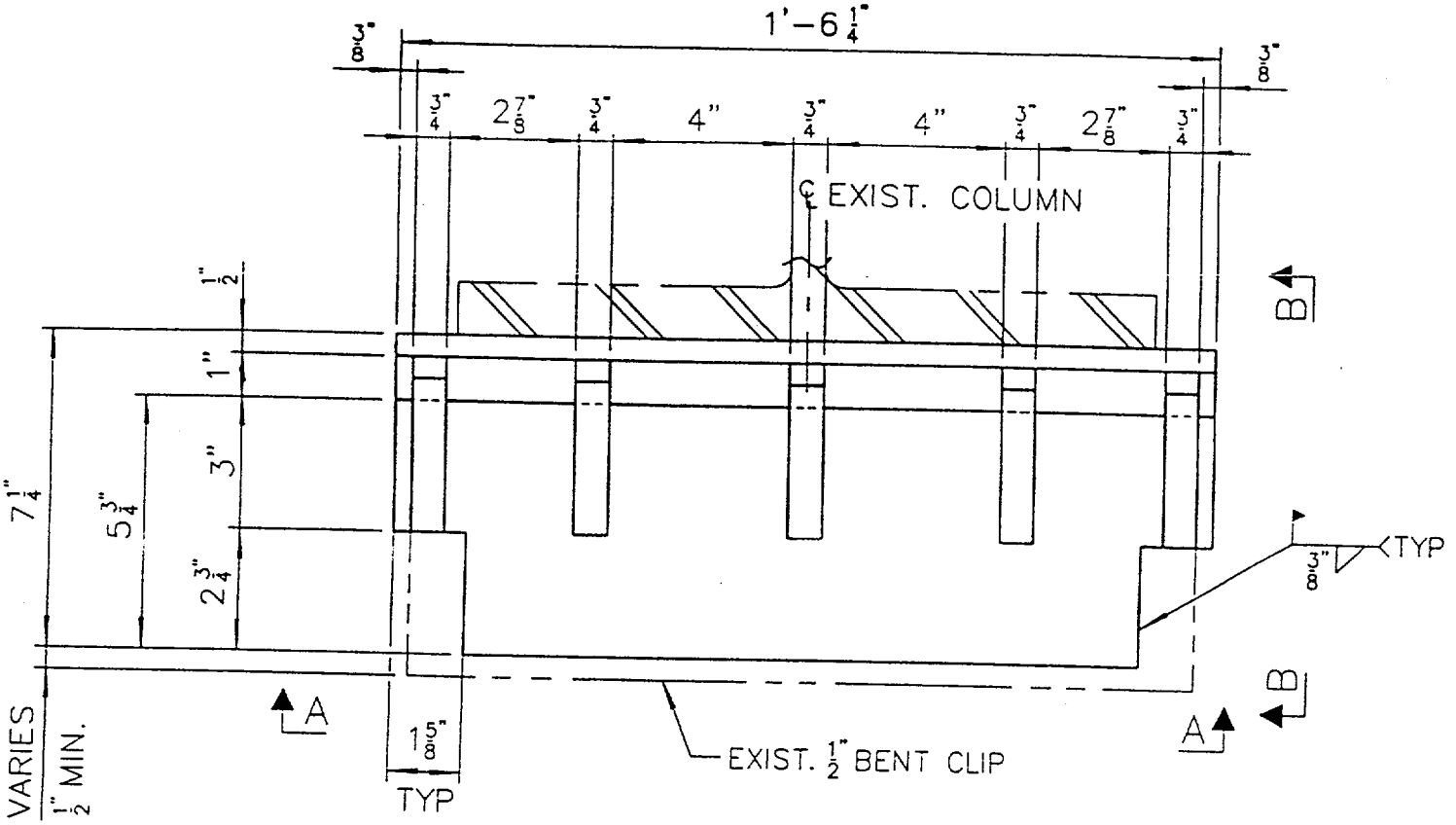



## P L A N – END COLUMN

RA/R1; RA/R7; RF/R1; RF/R7

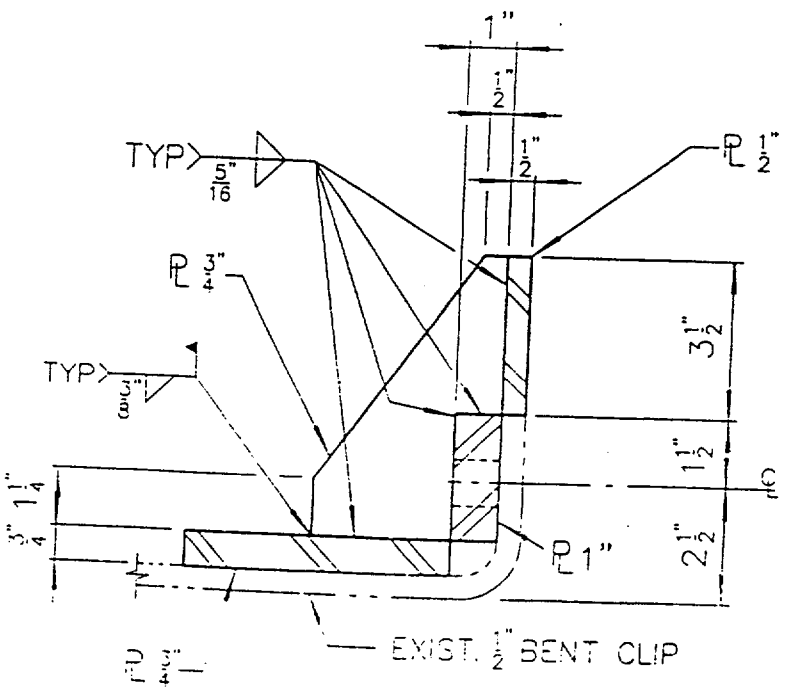



## E L E V A T I O N C–C




## P L A N – INTERIOR COLUMN

RA/R2 to RA/R6 & RF/R2 to RF/R6




4-15/16"ø x 2" LG. SLOTTED HOLE FOR 7/8"ø HVY. HEX. BOLT WITH HEX.NUT & HARDENED WASHER (SEE NOTE-3)

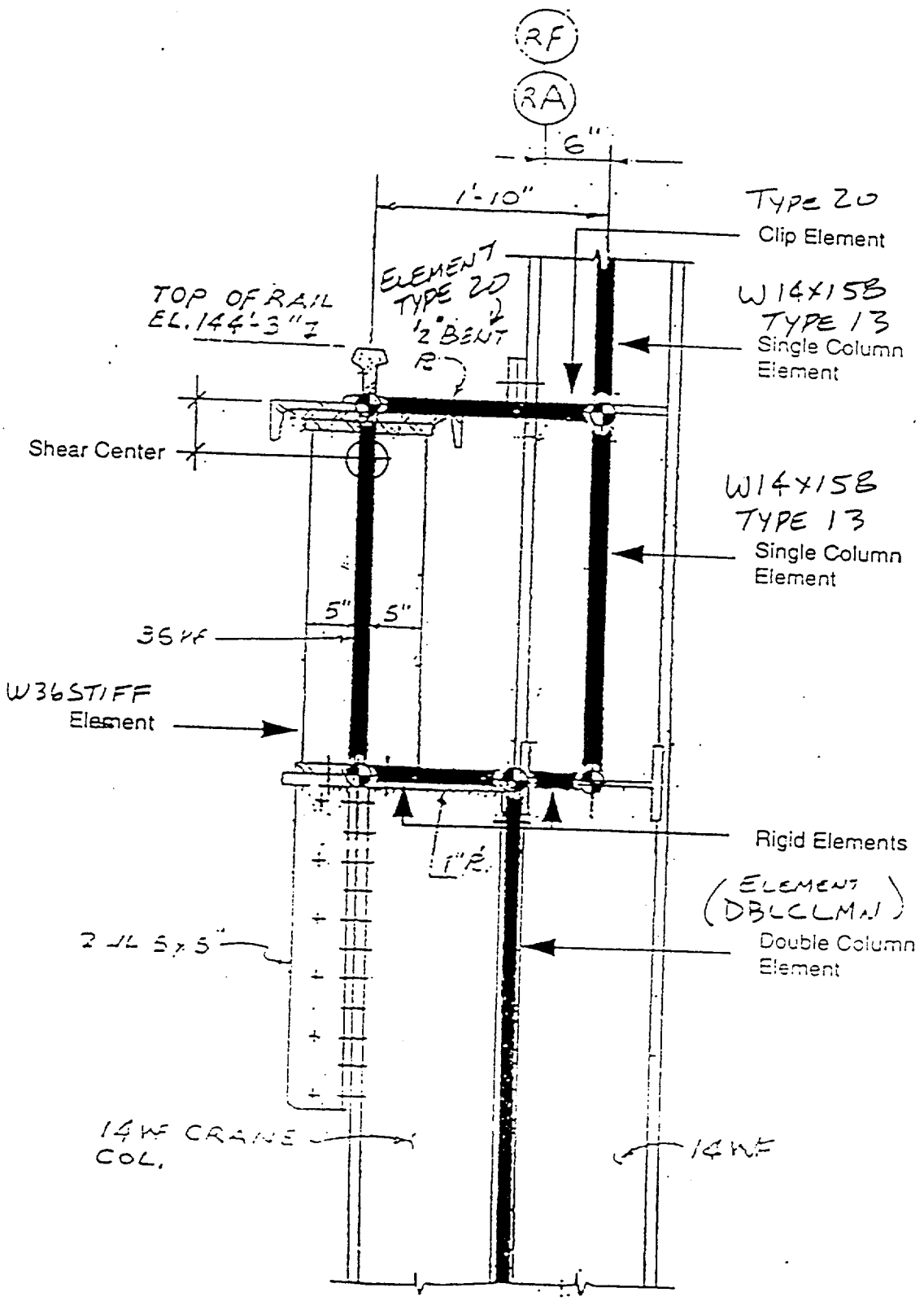
## E L E V A T I O N B–B

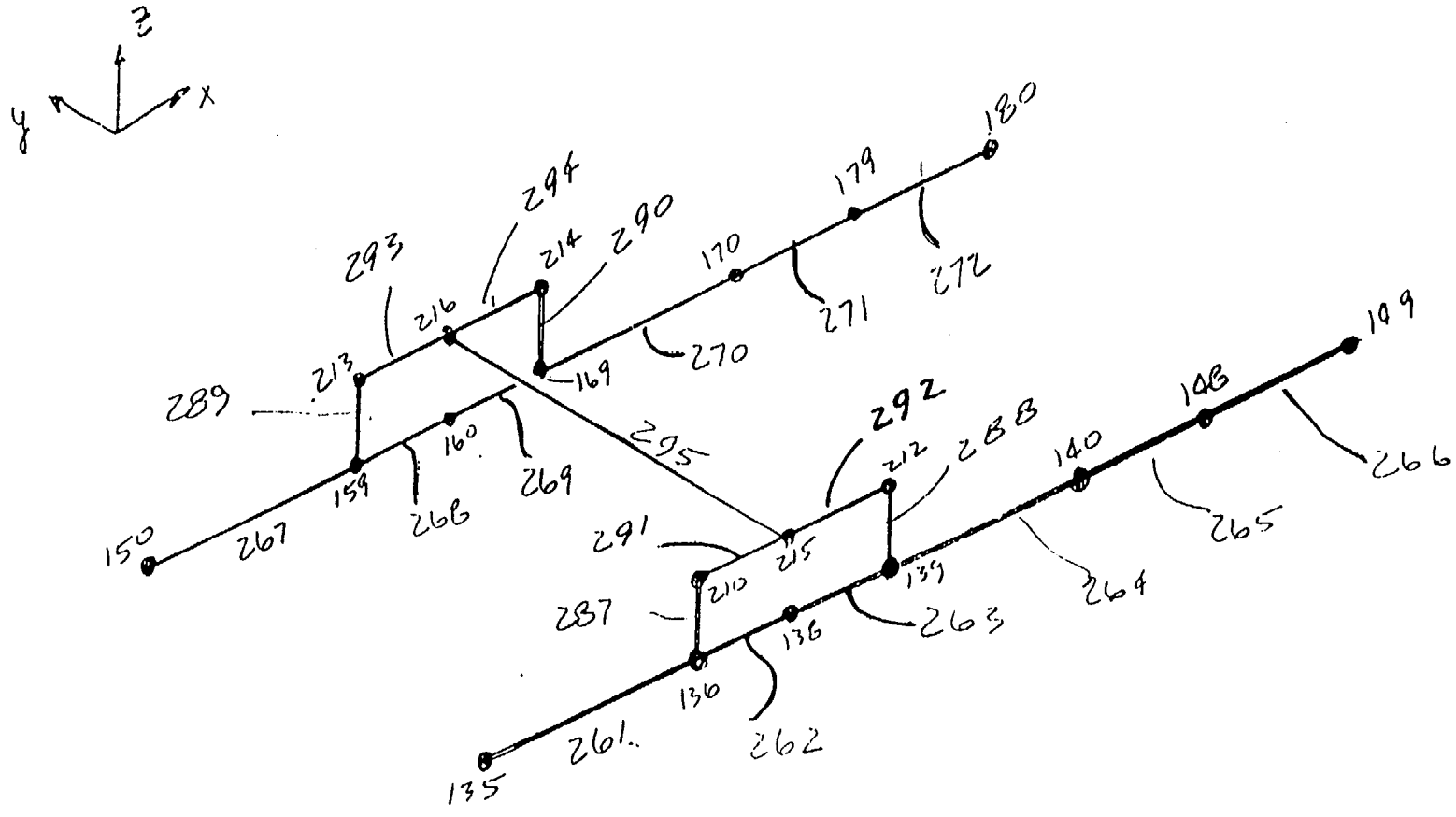
EQE INTERNATIONAL

JOB NO. 302067 JOB O.C. REACTOR BLDG SUPERSTRUCTURE BY TDA DATE 6/11/
CALC NO. C-002 SUBJECT SEISMIC QUAL FOR NEW E.P. CRANE CHK'D VMM DATE 6/11/

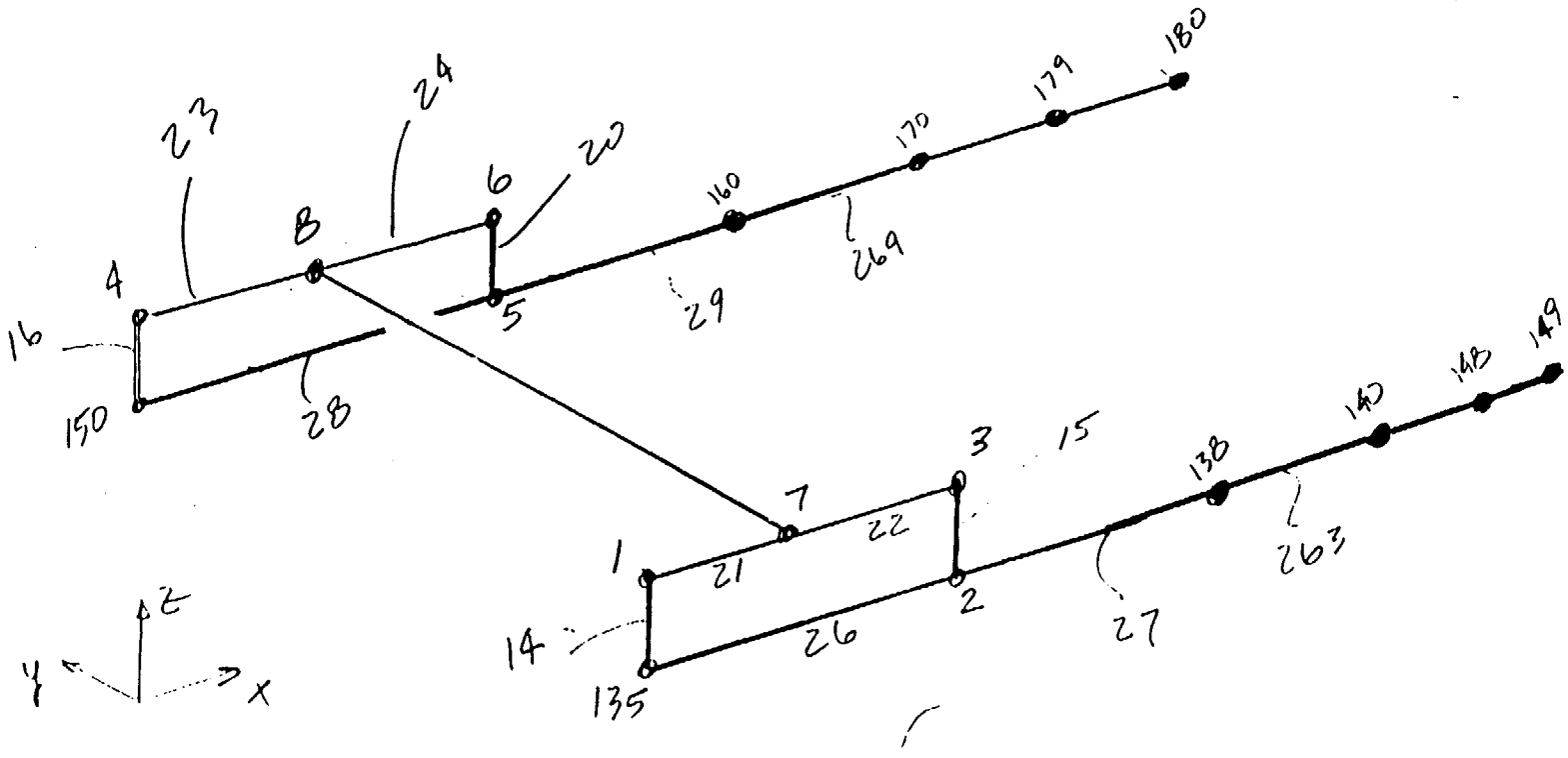
SHEET NO. 45

# Runway Girder to Column Connection






TROLLEY POSITION II




TROLLEY POSITION 12