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CALCULATION COVER SHEET

Calculation No: 59037-C-044

Project: WPPSS IPEEE

Calculation Title: Turbine Building Seismic Evaluation

References: See p. 4

Attachments: Att. A (2 pp.), B (19 pp.), C (4 pp.)

Total Number of Pages (Including Cover Sheet): 34 Excluding attachments

Revision Number	Approval Date	Description of Revision	Originator	Checker	Approver
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P PDR

EQE INTERNATIONAL

SHEET NO. 2/39

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

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REFERENCES

1. Structural drawings S601 to S681.

2. "A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)," Electric Power Research Institute, EPRI NP-6041-SL, Revision 1, August 1991.

3. EQE Engineering Consultants, Calculation No. 59037-C-037, "IPEEE Building Forces", Revision 0.

4. "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-90) and Commentary - ACI 349R-90," American Concrete Institute, 1990.

5. EQE Engineering Consultants, Calculation No. 59037-C-005, "Turbine Building Model", Revision 0.

6. EQE Engineering Consultants, Calculation No. 52182-C-017, "Quality Assurance Document For WALLD Version 1.0," Revision 0.

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SHEET NO. 5/34

JOB NO. 59037 JOB WPPSS IPEEE BY TSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D MC DATE 7-20-94

OBJECTIVE

The objective of this calculation is to evaluate the seismic capacity of the turbine building. A seismic fragility for this building is needed if its median capacity and High Confidence of a Low Probability of Failure (HCLPF) capacity are less than about 1.5g and 0.5g, respectively.

SUMMARY

A preliminary review was performed to identify the more heavily loaded structural components of the turbine building (Reference 1). Based on this preliminary review, a subset of structural components was selected for more detailed evaluation.

High Confidence of a Low Probability of Failure (HCLPF) capacities for the selected components were calculated following the Conservative Deterministic Failure Margins (CDFM) method recommended in EPRI NP-6041-SL (Reference 2). Seismic responses for this evaluation were taken as the 84% values obtained by probabilistic response analyses performed for a peak ground acceleration of 0.50g (Reference 3). The following results were obtained:

Structural Component	HCLPF Capacity
Shear on Column Line 13 wall at EL 441'-0"	0.51g
Overturning moment on Column Line 13 wall at EL 441'-0"	0.60g
Shear on Column Line A wall at EL 441'-0"	0.58g
Overturning moment on Column Line A wall at EL 441'-0"	0.63g
Shear on diaphragm between Column Lines A and B EL 441'-0"	0.57g
Moment on diaphragm between Column Lines A and B EL 441'-0"	0.55g

It is noted that conservative approximations were included to simplify these calculations. More rigorous calculations could be performed to reduce these conservatisms and obtain HCLPF capacities even greater than those listed above.

It is concluded that the HCLPF capacity of the turbine building is greater than 0.50g.

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JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

PRELIMINARY REVIEW

A preliminary review was performed to identify a subset of turbine building structural components for which more detailed evaluations should be performed. This review consisted of (1) review structural drawings (Reference 1) and turbine building seismic responses for IPEEE (Reference 3), and (2) approximate calculations to estimate seismic capacities of certain structural components.

The drawing review was performed to identify the seismic load paths and any potentially significant seismic vulnerabilities. Diaphragm slabs between Column Lines A and B and between Column Lines F and H were observed to have relatively long spans between supporting shear walls. Further investigation of these diaphragms was considered appropriate.

Approximate calculations were performed to further scope the need for more detailed evaluation. These calculations revealed that the diaphragm between Column Lines A and B at Elevation 471'-0" has lower seismic capacity than the diaphragm between Column Lines A and B at Elevation 501'-0" (which has greater flexural reinforcement) and the diaphragm between Column Lines F and H at Elevation 531'-0".

Based on the preliminary review, the following structural components were selected for more detailed evaluation:

- Shear and overturning moment on the shear wall on Column Line 13 at Elevation 441'-0". This wall attracts a significant proportion of the N-S shear, and has less reinforcement than other major N-S shear walls.
- Shear and overturning moment on the shear wall on Column Line A at Elevation 441'-0". This wall attracts a significant proportion of the E-W shear, and has slightly less reinforcement than other major E-W shear walls.
- Shear and moment on the diaphragm between Column Lines A and B at Elevation 471'-0".

Evaluation of the steel superstructure was not performed. There are no essential components attached to this part of the turbine building. Even if the superstructure were to collapse, it would not impact the reactor and radwaste/control buildings.

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CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

TECHNICAL APPROACH

HCLPF capacities for the selected turbine building structural components were calculated following the Conservative Deterministic Failure Margins (CDFM) approach recommended in EPRI NP-6041-SL (Reference 2).

Seismic demands on the structural components were based on 84% responses for a 0.50g peak ground acceleration calculated for use in IPEEE in Reference 3.

Seismic capacities of the structural components were determined following acceptance criteria recommended by EPRI NP-6041-SL. These acceptance criteria are specified in appendices to EPRI NP-6041-SL and provisions of ACI 349-90 (Reference 4).

Following the recommendations of EPRI NP-6041-SL, an inelastic energy absorption factor of 1.25 was conservatively assigned to ductile failure modes in lieu of performing a more rigorous calculation.

Seismic Demands On Col. Line B Wall

Overall seismic loads from the response analysis can be distributed to the walls in proportion of their relative rigidities. The general approach developed in Ref. 6 (see Att. C) will be used. Because shear flexibility is much greater than bending flexibility for these walls, the wall relative rigidities can be based on the shear stiffness (Kx, Ky) listed in Ref. 5 (see Att. B). Wall centroidal locations (x, y) and overall story shear stiffnesses are also listed in Ref. 5 (Att. B). Overall story forces (shear, torsion) are obtained from Ref. 3 (see Att. A). The values listed in Ref. 3 are in units of force/g, and must be factored by 32.2 ft/sec². The torsional moment will be conservatively assumed to be in-phase with the N-S shear.

EL 501' to EL 531'

Wall modeled by Segments 11 and 12. See pp. 40 to 51, Ref. 5 (see Att. B)

Ky_{13} = Shear stiffness of wall on Col. Line 13
= 1.84×10^6 k/ft

X_{13} = -68.0 ft

Ky = Total story stiffness
= 6.62×10^6

Xs = X coordinate of shear center of rigidity
= 19.60 ft

Kzz = Torsional stiffness
= 1.06×10^{11} k-ft

Story modeled by Elmt. 3 of structure model. Use 84% demands, 0.5g PGA.

$V_y = V_3 = 5.46 \times 10^2 (32.2)$
= 17,600 k ... Force component 3

T = Torsional Moment
= $1.75 \times 10^4 (32.2)$ ... Force component 4
= 5.64×10^5 k-ft

M_{xx} = Moment about X (E-W) axis
= $2.94 \times 10^4 (32.2)$ ... Force component 5
= 9.47×10^5 k-ft

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CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

V_{D13} = Direct shear

$= V \frac{K_{y13}}{K_y}$

$= 17,600 \left(\frac{1.84 \times 10^6}{6.62 \times 10^6}\right)$

$= 4,890^k$

V_{T13} = Shear due to torsion

$= T \frac{K_{y13} |X_{13} - X_S|}{K_{zz}}$

$= 5.64 \times 10^5 \frac{1.84 \times 10^6 |-68.0 - 19.6|}{1.06 \times 10^{11}}$

$= 860^k$

V_{13} = Total shear = $V_{D13} + V_{T13}$

$= 4,890 + 860$

$= 5,750^k$

ΔM_{xx} = Total increment'l moment

$= 9.47 \times 10^5 - 0 = 9.47 \times 10^5$ k-ft

$\Delta M_{xxD13} = \Delta M_{xx} \frac{K_{y13}}{K_y}$ Direct moment

$= 9.47 \times 10^5 \left(\frac{1.84 \times 10^6}{6.62 \times 10^6}\right)$

$= 2.63 \times 10^5$ k-ft

ΔM_{xxT13} = Incremental moment due to torsion

$= V_{T13} \Delta h$ Δh = story height = 30 ft

$= 860 (30)$

$= 2.58 \times 10^4$ k-ft

ΔM_{xx13} = Total wall incremental moment

$= \Delta M_{xxD13} + \Delta M_{xxT13}$

$= 2.63 \times 10^5 + 2.58 \times 10^4$

$= 2.89 \times 10^5$ k-ft

EL 471' to EL 501'

Wall modeled by Segments 11 and 18 See pp. 29 to 38, Ref 5 (Att B)

$K_{y13} = 1.34 \times 10^6$ k/ft

$X_{13} = -68.0$ ft

$K_y = 8.69 \times 10^6$ k/ft

$X_S = 19.6$ ft

$K_{ZZ} = 1.74 \times 10^{11}$ k-ft

Story modeled by Elmt 4

$V_y = 1.67 \times 10^3 (32.2)$ Force Comp 3

$= 53,800$ k

$T = 3.28 \times 10^4 (32.2)$ " 4

$= 1.06 \times 10^6$ k-ft

$M_{xx} = 9.36 \times 10^4 (32.2)$ " 5

$= 3.01 \times 10^6$ k-ft

$V_{D13} = 53,800 \left(\frac{1.34 \times 10^6}{8.69 \times 10^6} \right)$

$= 8,300$ k

$V_{T13} = 1.06 \times 10^6 \frac{1.34 \times 10^6 \, |-68.0 - 19.6|}{1.74 \times 10^{11}}$

$= 715$ k

$V_{13} = 8300 + 715$

$= 9,020$ k

$\Delta M_{xx} = 3.01 \times 10^6 - 9.47 \times 10^5$

$= 2.06 \times 10^6$ k-ft

$\Delta M_{xxD13} = 2.06 \times 10^6 \frac{1.34 \times 10^6}{8.69 \times 10^6}$

$= 3.18 \times 10^5$ k-ft

$\Delta M_{xxT13} = 715 (30)$

$= 2.15 \times 10^4$ k-ft

$\Delta M_{xx13} = 3.18 \times 10^5 + 2.15 \times 10^4$

$= 3.40 \times 10^5$ k-ft

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SHEET NO. 11/34

JOB NO. 59037 JOB [illegible]

CALC. NO: C-044 SUBJECT Turbine Bldg

BY [illegible] DATE 7-18-94

CHK'D [illegible] DATE 7-20-94

EL 441' to EL 471'

Wall modeled by Segment 1k. See pp. 19 to 27, Ref. 5 (Att. B)

$K_{y,13} = 1.69 \times 10^6$ k/ft

$X_{13} = -68.0$ ft

$K_y = 1.02 \times 10^7$ k/ft

$X_S = 3.91$ ft

$K_{zz} = 1.36 \times 10^{11}$ k-ft

Story modeled by Elmt. 5

$V_y = 2.84 \times 10^3 (32.2)$ Force Comp. 3

$= 91,500^k$

$T = 9.52 \times 10^4 (32.2)$ " " 4

$= 3.07 \times 10^6$ k-ft

$M_{xx} = 1.96 \times 10^5 (32.2)$ " " 5

$= 6.31 \times 10^6$ k-ft

$$V_{D13} = 91,500 \frac{1.69 \times 10^6}{1.02 \times 10^7}$$

$= 15,200^k$

$$V_{T13} = 3.07 \times 10^6 \frac{1.69 \times 10^6 |-68.0 - 3.91|}{1.36 \times 10^{11}}$$

$= 2,740^k$

$V_{13} = 15,200 + 2,740$

$= 17,900^k$

$\Delta M_{xx} = 6.31 \times 10^6 - 3.01 \times 10^6$

$= 3.30 \times 10^6$ k-ft

$$\Delta M_{xxD13} = 3.30 \times 10^6 \frac{1.69 \times 10^6}{1.02 \times 10^7}$$

$= 5.47 \times 10^5$ k-ft

$\Delta M_{xxT13} = 2,740 (30)$

$= 8.22 \times 10^4$ k-ft

$\Delta M_{xx13} = 5.47 \times 10^5 + 8.22 \times 10^4$

$= 6.29 \times 10^5$ k-ft

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SHEET NO. 12/34

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-95

Net Wall Forces At EL 441'

V = 17,900k

$M = 2.89\times10^5 + 3.40\times10^5 + 6.29\times10^5$

$= 1.26\times10^6$ k-ft

Shear On Column Line 13 Wall At EL 441'-0"

Shear Demand

V = 17,900k

Shear Capacity - See Dwgs S625, S626, S634

Wall thickness = 4'-0

Wall length

Conservatively neglect section at south end which is perforated by openings. Wall angles off at 45° at north end. Conservatively include only half of this section (note, wall taken as being continuous to Col. Line D in developing model properties).

$$\text{Effective length} \approx 4(26.0) - 1.83 - 5.42 - 0.5 - 4.5 - 5 - \frac{14}{2}$$

$$= 79.75 \text{ ft}$$

Wall reinforcement varies along length. Sectns. 357 and 358 on Drg. S626 cover most of length, use typical.

Reinf.: #10 @ 12" EF horiz, #9 @ 12" EF vert.

$$\rho_h = \frac{2(1.27)}{12(48)}$$

$$= 0.00441$$

$$\rho_v = \frac{2(1.0)}{12(48)}$$

$$= 0.00347$$

Wall axial load

Conservatively neglect floor slab. Include only weight of wall conservatively using only 3'-6" thickness and rises up to EL 524'-6". Reduce for vertical acceleration assuming 40% of vertical response acts concurrent with max horizontal response.

$$\sigma_{DL} = \frac{150(3.5)(524.5 - 441)}{48(12)}$$

$$= 76 \text{ psi}$$

Vert. ZPA = 0.55g Node 4

$\sigma_e = 76[1-0.4(0.55)]$

$= 59$ psi

Calculate shear capacity following App. L of EPRI NP-6041-SL, with exception that reinforcement shear strength is also reduced by $e^{-0.20}$ (equivalent to ϕ, strength reduction factor).

Conservatively use total wall height up to El. 531':

$h_w = 531 - 441$

$= 90'$

$\frac{h_w}{l_w} = \frac{90}{79.75}$

$= 1.13$

Effective reinforcement ratio, ρ_{se}

$A = -h_w/l_w + 1.5 = 0.37$

$B = h_w/l_w - 0.5 = 0.63$ (L-2)

$\rho_{se} = A\rho_v + B\rho_h$

$= 0.37(0.00347) + 0.63(0.0044)$

$= 0.00406$

$f'_c = 4{,}000$ psi

$h_w/l_w = 1.13$

$N_A/l_w t_n = \sigma_e = 59$ psi

$\rho_{se} = 0.00406$

$f_y = 60{,}000$ psi

Added term

$v_u = 6.8\sqrt{f'_c} - 2.8\sqrt{f'_c}(h_w/l_w - 0.5) + \frac{N_A}{4 l_w t_n} + \rho_{se} f_y e^{-0.20}$ (L-4)

$= 6.8\sqrt{4000} - 2.8\sqrt{4000}(1.13 - 0.5) + \frac{59}{4} + 0.00406(60{,}000)e^{-0.20}$

$= 533$ psi

Conservatively use d = 0.6 lw (L-6)

= 0.6 (79.75) (12)

= 574 in

$V_u = v_u d t_w$ (L-5)

= 0.533 (48) (574)

= 14,700 k

HCLPF Capacity

F_μ = 1.25

HCLPF Capacity = $\frac{14,700}{17,900}$ (1.25) (0.50g)

= 0.51g

Note: This evaluation contains a number of conservatisms.

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CALC. NO. C-044	SUBJECT Turbine Bldg	CHK'D [initials]	DATE 7-18-99 / DATE 7-20-99

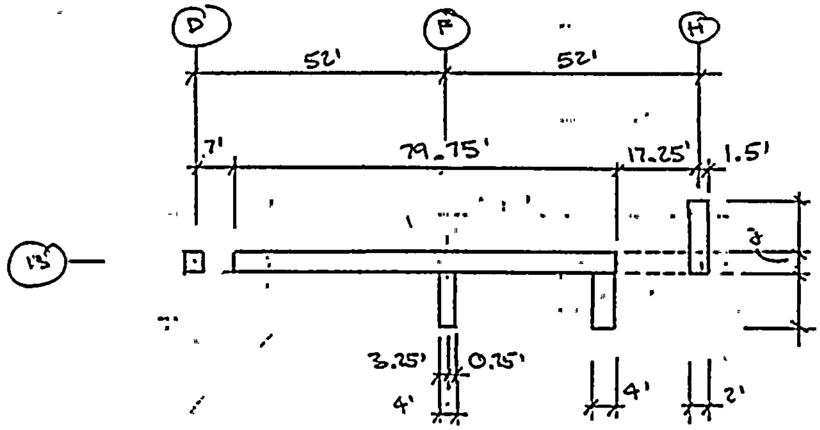
Overturning Moment On Column Line 13 Wall At EL 441'-0"

Moment Demand

$M = 1.26 \times 10^6$ k-ft

Moment Capacity

By inspection, lower bound moment capacity obtained for compression on south end. Include resistance provided by Column D13, and the intersecting Walls on Column Lines F and H.



Compression Flange, Wall On Col. Line H

Determine effective flange width per Sect. 8.10.3 of ACI 349-96 (Ref. ___)

a. Use effective span length for cantilever of 2x wall height

$\frac{1}{2}(2)(531-441) = 15$ ft

b. 6 x slab thickness = 6(2.0) = 12 ft ⟸ Controls

c. ½ clear distance doesn't control.

Total flange width = 12 + 4 ⌒ Web thickness

= 16 ft

Web.

Use typical reinforcement of #9 @ 12" EF vert (see shear capacity calc). Include replacement bars at openings (Dr. S749)

$L_{eff} = 52 + 52 - 7 = 97$ ft

$A_{sw} = 2(1.0)(97) = 194$ in²

$d_W = \frac{97}{2}$ See sketch

$= 48.5$ ft

Wall Just South of Col. Line G. Conservatively neglect shorter wall east of Col. Line 13.

Have replacement steel at opening.

Effective tension flange width

$\frac{1}{3}$ of wall height $= \frac{1}{3}(501-441) = 20$ ft

$\frac{1}{2}$ clear distance to next wall $= \frac{1}{2}(20) = 10'$ ⇐ Controls

Wall reinf. — #18 @ 12" EF vert. Sect. 537, Dr. S626

$A_{SG} = 2(4.0)(10)$

$= 80$ in²

$d_G = 17.25 + 1.5 + \frac{9}{2}$

$= 20.75$ ft

Wall On Col. Line F .. Ditto

Wall reinf. — 2-#18 @ 12" EF vert.

$A_S = 4(4.0)(10)$

$= 160$ in²

$d_F = 52 + 1.5 - 0.75 + \frac{4}{2}$

$= 54.75$ ft

Column D13

Have 14-#11, Dr S628

$A_{SD} = 14(1.56)$

$= 22$ in²

$d_D = 52 + 52 + 1.5$

$= 105.5$ ft

Axial Load

Use conservative effective vertical stress from shear capacity calculation.

$\sigma_e = 59$ psi

$L_e = 97$ ft See web steel calc.

$P = 0.059(48)(97)(12)$

$= 3{,}300$ k

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CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D AC DATE 7-20-94

$$a = \frac{(194+80+160+22)(60)+3300}{0.85(4)(16)(12)}$$

$= 47" > \text{Flange thickness} = 2'-0"$

$$a = \frac{(194+80+160+22)(60)+3300 - 0.85(4)(24)[16(12)-48]}{0.85(4)(48)}$$

$= 116"$

Check stress in flange south of Col. Line G

$$c = \frac{116}{0.85}$$

$= 137"$

$= 11.4$ ft

$$f_s = 0.003(29{,}000)\frac{20.75-11.4}{11.4}$$

$= 71.7$ ksi > 60 ksi ok

$$x' = \frac{[16(12)-48](24)(24/2) + 48(116)(116/2)}{[16(12)-48](24)+48(116)}$$

$= 40.4"$

$= 3.4$ ft

$0.1 f'_c A_g = 0.1(4)[48(97)(12)+24(16)(12)]$

$= 24{,}200$ k

$$\frac{P}{0.1 f'_c A_g} = \frac{3300}{24{,}200}$$

$= 0.14$

$\phi = 0.9 - 0.2(0.14)$

$= 0.87$

$\phi M_n = 0.87\{[194(60)+3300](48.5-3.4) + 80(60)(20.75-3.4)$
$+160(60)(54.75-3.4) + 22(60)(105.5-3.4)\}$

$= 1.21 \times 10^6$ k-ft

EQE INTERNATIONAL

SHEET NO. 19/34

JOB NO. 59037 JOB WNPSS IPEEE BY FEH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

HCLPF Capacity

$F_\mu = 1.25$

$$\text{HCLPF Capacity} = \frac{1.21 \times 10^6}{1.36 \times 10^6} (1.25)(0.54g)$$

$$= 0.60g$$

Seismic Demands On Col. Line A Wall

Follow approach for Col. Line B wall

EL 501' to EL 531'

Wall modeled by Segment 2

$K_{x2} = 3.12 \times 10^4$ k/ft

$y_2 = 112.0$ ft

$K_x = 7.86 \times 10^4$ k/ft

$y_s = 11.9$ ft

$K_{zz} = 1.06 \times 10^{11}$ k-ft

Story modeled by Elmt. 3

$V_x = 5.22 \times 10^2 (32.2)$ Force Comp. 2

$= 16,800^k$

$T = 5.64 \times 10^5$ k-ft Col. Line B Wall Calc;

$M_{yy} = 2.68 \times 10^4 (32.2)$ Force Comp. 6

$= 8.63 \times 10^5$ k-ft

$V_{DA} = 16,800 \left(\frac{3.12 \times 10^4}{7.86 \times 10^4}\right)$

$= 6670^k$

$V_{TA} = 5.64 \times 10^5 \frac{3.12 \times 10^4 (112.0 - 11.9)}{1.06 \times 10^{11}}$

$= 1,660^k$

$V_A = 6670 + 1660$

$= 8330^k$

$\Delta M_{yy} = 8.63 \times 10^5$ k-ft

$\Delta M_{yyDA} = 8.63 \times 10^5 \frac{3.12 \times 10^4}{7.86 \times 10^4}$

$= 3.43 \times 10^5$ k-ft

$\Delta M_{yyTA} = 1660 (30)$

$= 4.98 \times 10^4$ k-ft

$\Delta M_{yyA} = 3.43 \times 10^5 + 4.98 \times 10^4$

$= 3.93 \times 10^5$ k-ft

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EL 471' to EL 501'

Wall modeled by Segment 3

$K_{xA} = 3.12 \times 10^4$ k/ft

$y_A = 112.0$ ft

$K_x = 9.12 \times 10^4$ k/ft

$y_s = 4.7$ ft

$K_{zz} = 1.74 \times 10^{11}$ k-ft

Story modeled by Elmt 4

$V_x = 1.66 \times 10^3 (32.2)$ — Force Comp. 2

$= 53{,}500^k$

$T = 1.06 \times 10^6$ k-ft — Col. Line B wall calc.

$M_{yy} = 8.68 \times 10^4 (32.2)$ — Force Comp. 6

$= 2.80 \times 10^6$ k-ft

$V_{DA} = 53{,}500 \dfrac{3.12 \times 10^4}{9.12 \times 10^4}$

$= 18{,}300^k$

$V_{TA} = 1.06 \times 10^6 \dfrac{3.12 \times 10^4 (112.0 - 4.7)}{1.74 \times 10^{11}}$

$= 2040^k$

$V_A = 18{,}300 + 2040$

$= 20{,}300^k$

$\Delta M_{yy} = 2.80 \times 10^6 - 8.63 \times 10^5$

$= 1.94 \times 10^6$ k-ft

$\Delta M_{yy\,DA} = 1.94 \times 10^6 \dfrac{3.12 \times 10^4}{9.12 \times 10^4}$

$= 6.64 \times 10^5$ k-ft

$\Delta M_{yy\,TA} = 2040 (30)$

$= 6.12 \times 10^4$ k-ft

$\Delta M_{yy\,A} = 6.64 \times 10^5 + 6.12 \times 10^4$

$= 7.25 \times 10^5$ k-ft

EQE INTERNATIONAL

SHEET NO. 22/34

JOB NO. 59037 JOB WPPSS BREEZE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

EL 441' to EL 471'

Wall modeled by Segments 3+5

$K_{xA} = 2.82 \times 10^6$ k/ft

$y_A = 112.0$ ft

$K_x = 8.91 \times 10^6$ k/ft

$y_S = 17.2$ ft

$K_{zz} = 1.36 \times 10^{11}$ k-ft

Story modeled by Elmt. 5

$V_x = 2.89 \times 10^3 (32.2)$ — Force Comp. 2

$= 93,100^k$

$T = 3.07 \times 10^6$ k-ft — Col. Line 13 wall calc.

$M_{yy} = 1.85 \times 10^5 (32.2)$ — Force Comp. 6

$= 5.96 \times 10^6$ k-ft

$V_{DA} = 93,100 \dfrac{2.82 \times 10^6}{8.91 \times 10^6}$

$= 29,500^k$

$V_{TA} = 3.07 \times 10^6 \dfrac{2.82 \times 10^6 (112.0 - 17.2)}{1.36 \times 10^{11}}$

$= 6030^k$

$V_A = 29,500 + 6030$

$= 35,500^k$

$\Delta M_{yy} = 5.96 \times 10^6 - 2.80 \times 10^6$

$= 3.16 \times 10^6$ k-ft

$\Delta M_{yyDA} = 3.16 \times 10^6 \dfrac{2.82 \times 10^6}{8.91 \times 10^6}$

$= 1.00 \times 10^6$ k-ft

$\Delta M_{yyTA} = 6030(30)$

$= 1.81 \times 10^5$ k-ft

$\Delta M_{yyA} = 1.00 \times 10^6 + 1.81 \times 10^5$

$= 1.18 \times 10^6$ k-ft

Net Wall Forces At EL 441'

$V = 35{,}500^k$

$M = 3.93\times10^5 + 7.25\times10^5 + 1.18\times10^6$
$= 2.30\times10^6$ k-ft

Shear On Column Line A Wall At EL 441'-0"

Shear Demand

V = 35,500 k

Shear Capacity

Wall thickness = 4'-0"

Wall length = 139'-6" Out-to-out Col. Lines 7 to 13 only. Conservative

Wall height = 83'-6" To top of wall at EL 524'-6". Conservative

Wall reinforcement

Typical: #8@12" EFEW Sect-351, Dr-S625

27'-6" Length at each end: #8@12" EF horiz., #18@12" EF vert. Sect-530, Dr. S626

f'_c = 4000 psi

f_y = 60,000 psi

$$\frac{h_w}{L_w} = \frac{83.5}{139.5}$$

= 0.60

Effective Reinforcement Ratio

Horiz. reinf.

$$\rho_h = \frac{2(0.79)}{12(48)}$$

= 0.00274

Vert. reinf. Use average value weighted by length. Conservatively exclude #18@12 at compression side

Typical reinf.; ρ = 0.00274

At ends: $\rho = \frac{2(4.0)}{12(48)}$

= 0.0139

$$\bar{\rho}_v = \frac{0.00274(139.5-55)+0.0139(27.5)}{(139.5-55)+27.5}$$

= 0.00548

A = −0.60 + 1.5 = 0.90

B = 0.60 − 0.5 = 0.10

ρ_{se} = 0.90(0.00548) + 0.10(0.00274)

= 0.00521

EQE INTERNATIONAL

SHEET NO. 25/34

JOB NO. 59037 JOB USPSS SPEIE BY PSH DATE 7-18-99

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-99

Axial Load. Conservatively use only wall weight.

$\sigma_{DL} = 150(83.5)$

$= 12500 psf$

$\sim 87 psi$

$\sigma_{NET} = 87[1 - 0.4(0.55)]$

$= 68 psi$

$d = 0.6 l_w$

$= 0.6(139.5)(12)$

$= 1000 in$

$v_u = 6.8\sqrt{4000} - 2.8\sqrt{4000}(0.60 - 0.50) + \frac{68}{4} + 0.0052(60,000)e^{-0.8}$

$= 685 psi$

$V_u = 0.685(48)(1000)$

$= 32,900^k$

HCLPF Capacity

$F_\mu = 1.25$

$\text{HCLPF Capacity} = \frac{32,900}{35,500}(1.25)(0.50g)$

$= 0.58g$

EQE INTERNATIONAL

SHEET NO. 26/34

JOB NO. 59037 JOB WPPSS IPEEE BY [illegible] DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

Overturning Moment On Col. Line A Wall At EL 441'-0"

Moment Demand

$M = 2.26 \times 10^4$ k-ft

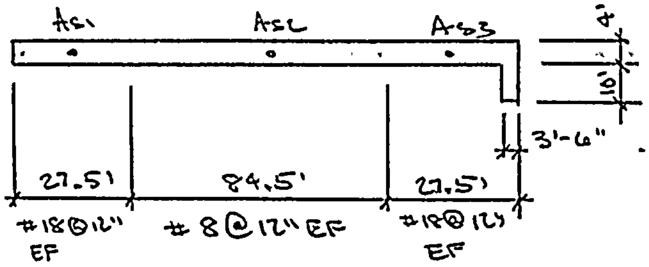
Moment Capacity

Wall thickness = 4'-0"

Wall length = 139'-6"

Effective vertical reinforcement ratio = 0.00675

Effective axial stress = 68 psi



Compression Flange

$\frac{1}{2}$ clear distance ≈ 10'

Total flange width = 14' = 168"

$A_{s1} = 2(4.0)(27.5)$

$= 220 \text{ in}^2$

$d_1 = 139.5 - \frac{27.5}{2}$

$= 126$ ft

$A_{s2} = 2(0.79)(84.5)$

$= 134 \text{ in}^2$

$d_2 = 139.5/2$

$= 69.8'$

$A_{s3} = 220 \text{ in}^2$

$d_3 = 27.5/2$

$= 13.8$ ft

EQE INTERNATIONAL

SHEET NO. 27/39

JOB NO. 59037 JOB [illegible] BY [illegible] DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

$P_{NET} = 0.068(4)(139.5)(144)$
$= 5500^k$

Assume A_{s3} is at yield

$$a = \frac{(220+134+220)(60)+5500}{0.85(4)(168)}$$
$= 70'' > t_f = 42''$

Assume A_{s3} is at $f_{s3} = 32$ ksi

$$a = \frac{(220+134)(60)+5500+220(32)-0.85(4)(42)(168-48)}{0.85(4)(48)}$$
$= 102''$

$$c = \frac{102}{0.85}$$
$= 120'' = 10.0$ ft

$$f_{s3} = 0.003(29{,}000)\frac{13.8-10.0}{10.0}$$
$= 33$ ksi ≈ 32 ksi ok

$0.1 f'_c A_g = 0.1(4)(48)(139.5)(12)$
$= 32{,}100^k$

$$\frac{P}{0.1 f'_c A_g} = \frac{5500}{32{,}100}$$
$= 0.17$

$\phi = 0.90 - 0.2(0.17)$
$= 0.87$

$$\overline{\left(\frac{a}{2}\right)} = \frac{(168-48)(42)(42/2)+(48)(102)(102/2)}{(168-48)(42)+48(102)}$$
$= 35.8''$
$= 3.0$ ft

$\phi M_n = 0.87 [220(60)(126-3.0) + 134(60)(69.8-3.0) + 220(32)(13.8-3.0) + 5500(69.8-3.0)]$

$= 2.27 \times 10^6$ k-ft

$\bar{d} = \frac{220(60)(126) + 134(60)(69.8) + 220(32)(13.8)}{220(60) + 134(60) + 220(32)}$

= 82.1 ft

= 985"

HCLPF Capacity

$F_\mu = 1.25$

HCLPF Capacity $= \frac{2.27 \times 10^6}{2.26 \times 10^6} (1.25)(0.50g)$

~ 0.63g

JOB NO. 59037 JOB WPPSS [illegible] BY [illegible] DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

Diaphragm Between Column Lines A and B At EL 471'-0"

Seismic Demand

Model the diaphragm as a flexible beam subjected to a uniform inertial load, with the following boundary conditions

- Fixed at Col. Line 7, accounting for restraint from walls at Col. Lines 6 & 7
- Singly supported by wall at Col. Line 13
- Singly supported by continuous slab at Col. Line 16; rotational restraint is limited.

Inertial Load

N-S (y-dir'n) ZPA, Node 5 = 0.84 g

Masses

1'-6" floor slab - 150 (1.5) = 225 psf

3'x3'-6 beams (typ) at 24' - 150 (3) (3.5-1.5) ($\frac{1}{24}$) = 38 psf

Col. Line A wall (4' thick) - 150 (4) ($\frac{1}{2}$) (501-441) ($\frac{1}{26}$) = 692 psf

Col. Line B columns (4' sq. typ) - 150 (4)^2 (501-441) ($\frac{1}{24}$) ($\frac{1}{26}$) = 115 psf

Eqmt - Conservatively use 75 psf

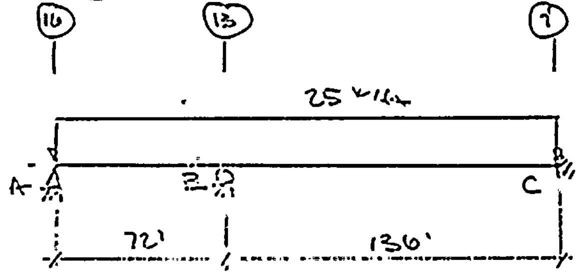
Total - 1150 psf

$q = 1.15 (26) (0.84)$ Col. Line A-B = 26'

$= 25$ k/ft

Diaphragm Internal Forces

Solve by moment distribution



Fixed End moments

Span AB - FEM = $\pm \frac{25(72)^2}{12}$

= ±10,800 k-ft

Span BC - FEM = $\pm \frac{25(136)^2}{12}$

= ± 38,500 k-ft

Stiffness + Distribution Factors

$K = f \frac{I}{L}$ I = 1 nominal

$K_{BA} = 0.75 \frac{1}{72}$ Simple support at A => 0.75 factor

$= 1.04 \times 10^{-2}$

$K_{BC} = \frac{1}{136}$

$= 7.35 \times 10^{-3}$

$\Sigma K = 1.78 \times 10^{-2}$

$DF_{BA} = \frac{1.04 \times 10^{-2}}{1.78 \times 10^{-2}}$

= 0.58

$DF_{BC} = 1 - 0.58$

= 0.42

Solution (Moments × 10^{-3})

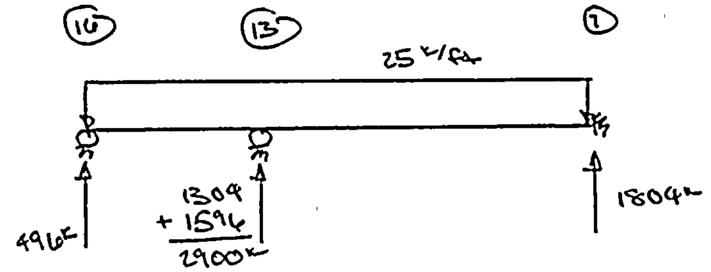
	AB	BA	BC	CB
DF		0.58	0.42	
FEM	-10.8	+10.8	-38.5	+38.5
	+10.8			
		+5.4		
		+12.9	+9.4	
				+4.7
M	0	+29.1	-29.1	+43.2

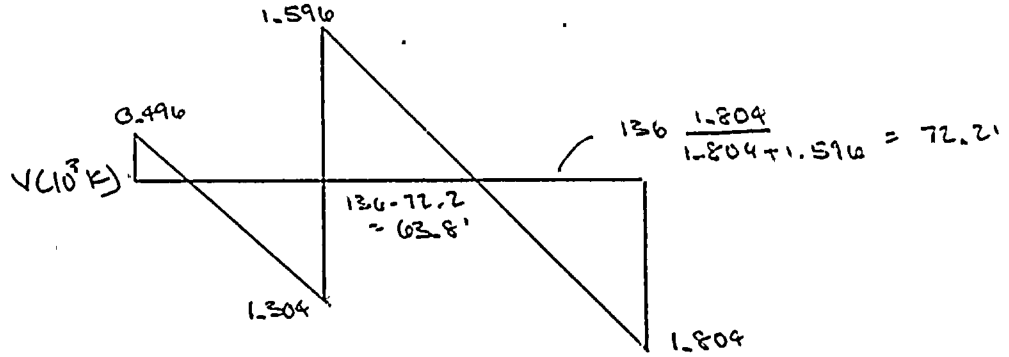
EQE INTERNATIONAL

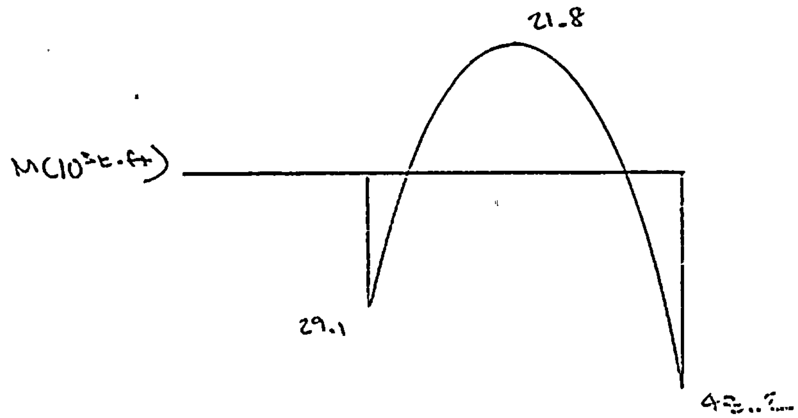
SHEET NO. 31/34

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D DATE 7-20-94







At distance L/2 ≈ 14' from support

V = 18,04 - 25(14)

= 1450 k

M = 43,200 - 1804(14) + ½(25)(14)²

= 20,400 k-ft

EQE INTERNATIONAL

SHEET NO. 32/39

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

Moment Capacity - See Dr. S614; Sect. 798, Dr. S616

Total depth of slab = 29'-8"

Concentrated reinforcement

11-#11 bars

$A_s = 11(1.56)$

$= 17.2 \, in^2$

$d = 29.67 - 0.58$

$= 29.08$ ft

Note: Section at stair opening doesn't control. Add'l 4-#11 bars provided at face of opening

Slab Reinforcement

Slab 2325 - #6 @ 18" T&B E-W

Ok to include both layers since slab is spanning more in N-S dir'n.

$A_s = 2(0.44)\frac{29(12)}{18}$

$= 17.0 \, in^2$

$d = \frac{1}{2}(29.67)$

$= 14.8$ ft

Conservatively neglect any beam reinforcement. Conservative neglect Col. Line A wall acting as a flange.

$a = \frac{(17.2 + 17.0)(60)}{0.85(4)(18)}$

$= 34"$

$= 2.8$ ft

$\phi M_n = 0.90\left[17.2(60)(29.1 - \frac{2.8}{2}) + 17.0(60)(14.8 - \frac{2.8}{2})\right]$

$= 38{,}000$ k-ft

HCLPF Capacity

$F_\mu = 1.25$

HCLPF Capacity $= \frac{38{,}000}{43{,}200}(1.25)(0.50g)$

$= 0.55g$

(Note: Have additional capacity through yielding and redistribution).

EQE INTERNATIONAL

SHEET NO. 33/39

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

Shear Capacity

At distance L/2 = 14' from support (west of Col. Line 7)

V ~ 1450 k

M ~ 20,400 k-ft

At the critical section, the slab is perforated by the stair opening. The diaphragm shear capacity will be determined by applying the approach for shear walls in App. L of EPRI NP-6041. Only the slab section south of the opening will be included. The effective height of the panel will be conservatively taken as the E-W opening dimension (17'-0")

Slab thickness = 1'-6"

Slab length = 29.67' - 8.08' - 4'

= 17.6 ft

Slab "height" = 17'

Slab reinf. - #6@18" T&B E-W, #6@12" T&B N-S Mark No. 2525

$\frac{h_w}{L_w} = \frac{17}{17.6}$

$= 0.97$

Effective reinforcement ratio

$\rho_v \sim \frac{2(0.44)}{18(18)}$

$= 0.00272$

$\rho_n \sim \frac{2(0.44)}{12(18)}$

$= 0.00407$

$A \sim -0.97 + 1.5 = 0.53$

$B = 0.97 - 0.5 = 0.47$

$\rho_{se} \sim 0.53(0.00272) + 0.47(0.00407)$

~ 0.00336

EQE INTERNATIONAL

SHEET NO. 34/34

JOB NO. 59037 JOB WRSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

Added term

$V_u = 6.8\sqrt{4000} - 2.8\sqrt{4000}(0.97-0.50) + 0.00336(60,000)e^{-0.20}$

≈ 512 psi

Effective Section Depth

Slab Reinf. - #6@18" T&B

$\therefore A_s = 2(0.44)\frac{17.6(12)}{18}$

$= 10.3 \text{ in}^2$

$d \approx \frac{1}{2}(17.6)$

$= 8.8'$

Reinf. at stair opening - 4-#11

$A_s = 4(1.56)$

$\approx 6.24 \text{ in}^2$

$d \approx 17'$

$\bar{d} \approx \frac{10.3(8.8) + 6.24(17)}{10.3+6.24}$

$= 11.9 \text{ ft} = 143"$

$= 0.68 l_w$

$V_u = 0.512(18)(143)$

$= 1320^k$

HCLPF Capacity

$F_\mu = 1.25$

$\text{HCLPF Capacity} = \frac{1320}{1450}(1.25)(0.50g)$

$= 0.57g$

HCLPF Capacity

HCLPF Capacity = 0.55g. Controlled by moment

EQE INTERNATIONAL

SHEET NO. A1

JOB NO. 59037	JOB WPPSS IPEEE	BY PSH	DATE 7-18-94
CALC. NO. C-044	SUBJECT Turbine Bldg	CHK'D [illegible]	DATE 7-20-94

ATTACHMENT A

EXCERPTS FROM REFERENCE 3

(2 pp. total)

59037-C-044 - A2

X:\WPPSS\TURBINE\IPEEE\50\SSINO.MSD 94-Jan-27 12:48

```
File: X:\WPPSS\TURBINE\IPEEE\50\SSINO.MSD                        Page: 1
Program: MSOPEAK VER 1.0
Version Date: 12-01-93 12:50

Input File Name: SSINO

--------------- Input File Header ---------------------------------
        PROGRAM SSIN, INTEL-80386/DOS VERSION 1.1P

        Compiler:  SVS C3 FORTRAN-77 Version 2.8.2, Release 1.1
        Compilation Date and Time:  12/17/93  09:08:57
        Execution Date and Time:    01/27/94  12:11:40

        Three-Dimensional Rigid Foundation SSI Response Analysis

        Reference EOE/EEC QA Project Number AA-QA-04


        CALCULATION NUMBER:  59037-C-025

        TITLE:      Turbine Building IPEEE Analysis

        PROBLEM DESCRIPTION:
        Turbine Building, IPEEE PGA=0.50g
-------------------------------------------------------------------

RESPONSE HEADERS

     1:   fdn  1   abs accel   x-translation
     2:   fdn  1   abs accel   y-translation
     3:   fdn  1   abs accel   z-translation
     4:   fdn  1   abs accel   xx-rotation
     5:   fdn  1   abs accel   yy-rotation
     6:   fdn  1   abs accel   zz-rotation
     7:   str  1   base force  x-shear force
     8:   str  1   base force  y-shear force
     9:   str  1   base force  vertical force
    10:   str  1   base force  xx- o.t.moment
    11:   str  1   base force  yy- o.t.moment
    12:   str  1   base force  torsional moment
    13:   str  1   abs accel   node   1  x-tran
    14:   str  1   abs accel   node   1  y-tran
    15:   str  1   abs accel   node   1  z-tran
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    17:   str  1   abs accel   node   2  y-tran
    18:   str  1   abs accel   node   2  z-tran
    19:   str  1   abs accel   node   3  x-tran
    20:   str  1   abs accel   node   3  y-tran
    21:   str  1   abs accel   node   3  z-tran
    22:   str  1   abs accel   node   4  x-tran
    23:   str  1   abs accel   node   4  y-tran
    24:   str  1   abs accel   node   4  z-tran
    25:   str  1   abs accel   node   5  x-tran
    26:   str  1   abs accel   node   5  y-tran
    27:   str  1   abs accel   node   5  z-tran
    28:   str  1   abs accel   node   6  x-tran
    29:   str  1   abs accel   node   6  y-tran
    30:   str  1   abs accel   node   6  z-tran
    31:   str  1   abs accel   node   7  x-tran
    32:   str  1   abs accel   node   7  y-tran
    33:   str  1   abs accel   node   7  z-tran
    34:   str  1   abs accel   node  17  x-tran
    35:   str  1   abs accel   node  17  y-tran
    36:   str  1   abs accel   node  17  z-tran
```

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File: X:\WPPSS\TURBINE\IPEEE\50\SSINO.MSD                        Page: 2
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    38:   str  1   abs accel   node  21  y-tran
    39:   str  1   abs accel   node  21  z-tran
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    46:   str  1   elmt force  elmt   1-11 gp 1
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    87:   str  1   elmt force  elmt   6-12 gp 1
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    94:   str  1   elmt force  elmt   7-11 gp 1
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 CALCULATION RESULT

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     2: 5.65437e-01 6.81042e-01 5.85050e-01 6.54795e-01
     3: 4.07437e-01 4.85691e-01 4.00950e-01 4.84667e-01
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     7: 2.96923e+03 3.71391e+03 2.86750e+03 3.73644e+03
     8: 3.21253e+03 3.93236e+03 3.26000e+03 3.72837e+03
     9: 1.79077e+03 2.14906e+03 1.74800e+03 2.15679e+03
    10: 2.53550e+05 3.11762e+05 2.53750e+05 3.09421e+05
    11: 2.23437e+05 2.85331e+05 2.19250e+05 2.86315e+05
    12: 8.62123e+04 1.14448e+05 8.12100e+04 1.06098e+05
    13: 1.36287e+00 1.93271e+00 1.15050e+00 1.81012e+00
    14: 1.77409e+00 2.40529e+00 1.75250e+00 2.46206e+00
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    17: 1.17512e+00 1.50352e+00 1.14700e+00 1.44396e+00
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    23: 8.21463e-01 1.00122e+00 8.18800e-01 9.54046e-01
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    27: 4.45857e-01 5.31942e-01 4.28300e-01 5.30043e-01
    28: 7.20303e-01 8.72403e-01 6.92550e-01 8.88276e-01
    29: 9.67603e-01 1.22789e+00 9.31600e-01 1.23930e+00
    30: 4.64213e-01 5.57558e-01 4.58600e-01 5.66176e-01
    31: 6.46630e-01 7.76079e-01 6.23150e-01 7.93067e-01
    32: 8.38127e-01 1.05296e+00 8.20600e-01 1.01615e+00
    33: 4.39413e-01 5.25779e-01 4.36350e-01 5.15649e-01
    34: 5.81153e-01 7.02231e-01 5.36550e-01 7.06859e-01
    35: 5.80763e-01 7.04876e-01 5.96800e-01 6.79574e-01
    36: 4.08730e-01 4.89312e-01 3.98350e-01 4.86477e-01
    37: 5.71300e-01 6.83950e-01 5.54700e-01 6.90572e-01
    38: 5.77887e-01 6.94876e-01 5.83600e-01 6.76675e-01
    39: 4.21060e-01 5.03334e-01 4.09650e-01 4.85949e-01
    40: 3.62150e+01 4.37921e+01 3.51300e+01 4.50343e+01
    41: 1.07623e+02 1.57376e+02 9.00600e+01 1.43336e+02
    42: 1.40612e+02 1.90894e+02 1.37800e+02 1.96252e+02
    43: 1.65765e+03 2.87029e+03 1.19000e+03 2.15695e+03
    44: 3.98890e+03 5.33935e+03 3.91450e+03 5.56096e+03
    45: 3.45337e+03 4.88097e+03 3.08100e+03 4.54330e+03
    46: 4.45400e+02 5.24268e+02 4.45050e+02 5.08978e+02
    47: 7.80180e+02 1.00731e+03 7.56950e+02 9.02071e+02
    48: 5.06027e+01 6.10359e+01 4.82000e+01 6.33686e+01
    49: 1.33347e+02 1.90911e+02 1.13500e+02 1.75322e+02
    50: 1.71322e+02 2.29266e+02 1.70850e+02 2.41082e+02
    51: 2.50603e+03 4.15504e+03 1.94300e+03 3.03022e+03
    52: 6.40443e+03 8.47052e+03 6.37300e+03 8.92203e+03
    53: 5.37883e+03 7.49919e+03 4.73300e+03 7.13763e+03
    54: 4.42153e+03 5.80793e+03 4.41600e+03 5.96356e+03
    55: 3.84107e+03 5.30108e+03 3.37750e+03 4.99259e+03
    56: 2.00897e+02 2.40994e+02 1.91900e+02 2.40828e+02
    57: 3.94443e+02 5.22376e+02 3.68150e+02 4.85820e+02
    58: 4.38343e+02 5.45503e+02 4.28200e+02 5.24491e+02
    59: 1.30851e+04 1.75410e+04 1.22900e+04 1.69544e+04
    60: 2.37580e+04 2.94342e+04 2.39450e+04 2.95355e+04
    61: 2.01257e+04 2.67732e+04 1.86550e+04 2.52072e+04
    62: 1.18185e+04 1.44605e+04 1.14750e+04 1.42643e+04
    63: 9.12687e+03 1.18219e+04 8.89650e+03 1.12233e+04
    64: 7.76987e+02 9.32995e+02 7.51200e+02 9.47492e+02
    65: 1.28807e+03 1.65892e+03 1.23950e+03 1.64619e+03
    66: 1.36157e+03 1.67417e+03 1.36400e+03 1.60450e+03
    67: 2.32740e+04 3.27643e+04 2.14700e+04 2.99212e+04
    68: 7.63577e+04 9.36440e+04 7.74600e+04 9.41776e+04
    69: 6.66153e+04 8.68186e+04 6.26400e+04 8.44073e+04
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File: X:\WPPSS\TURBINE\IPEEE\50\SSINO.MSD                        Page: 4
    70: 3.87687e+04 4.68842e+04 3.93500e+04 4.65876e+04
    71: 3.08167e+04 3.96757e+04 2.94800e+04 3.68818e+04
    72: 1.32916e+03 1.59321e+03 1.27600e+03 1.59056e+03
    73: 2.28347e+03 2.89213e+03 2.21300e+03 2.89847e+03
    74: 2.32630e+03 2.86174e+03 2.36350e+03 2.72141e+03
    75: 7.20507e+04 9.51737e+04 6.66650e+04 8.87716e+04
    76: 1.58869e+05 1.96482e+05 1.59700e+05 1.95248e+05
    77: 1.43366e+05 1.84920e+05 1.36000e+05 1.84832e+05
    78: 9.53340e+04 1.18126e+05 9.93050e+04 1.14640e+05
    79: 7.75647e+04 1.00269e+05 6.90950e+04 9.84446e+04
    80: 3.27917e+02 3.92825e+02 3.24350e+02 3.94230e+02
    81: 4.60930e+02 5.57918e+02 4.43700e+02 5.68678e+02
    82: 6.19080e+02 7.85149e+02 5.93150e+02 7.86427e+02
    83: 1.12959e+04 1.59862e+04 1.00620e+04 1.39284e+04
    84: 1.95495e+04 2.48602e+04 1.85000e+04 2.49886e+04
    85: 1.64510e+04 2.01854e+04 1.56700e+04 2.08705e+04
    86: 1.36051e+03 1.75348e+03 1.33550e+03 1.56443e+03
    87: 5.57913e+03 6.96149e+03 5.43650e+03 7.21688e+03
    88: 4.27980e+02 5.12780e+02 4.24050e+02 5.13964e+02
    89: 6.86943e+02 8.28995e+02 6.60250e+02 8.53036e+02
    90: 9.11577e+02 1.15127e+03 8.74950e+02 1.14063e+03
    91: 1.96529e+04 2.74608e+04 1.78100e+04 2.42852e+04
    92: 4.72870e+04 5.98925e+04 4.49700e+04 5.97692e+04
    93: 3.78587e+04 4.61915e+04 3.66350e+04 4.68922e+04
    94: 2.00537e+04 2.55264e+04 1.90300e+04 2.56986e+04
    95: 1.84783e+04 2.26984e+04 1.74000e+04 2.32587e+04
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59037-C-044

EQE INTERNATIONAL

SHEET NO. B1

JOB NO. 59037 JOB WPPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. C-044 SUBJECT Turbine Bldg CHK'D [illegible] DATE 7-20-94

ATTACHMENT B

EXCERPTS FROM REFERENCE 5

(19 pp. total)

2HD 289/wpstb

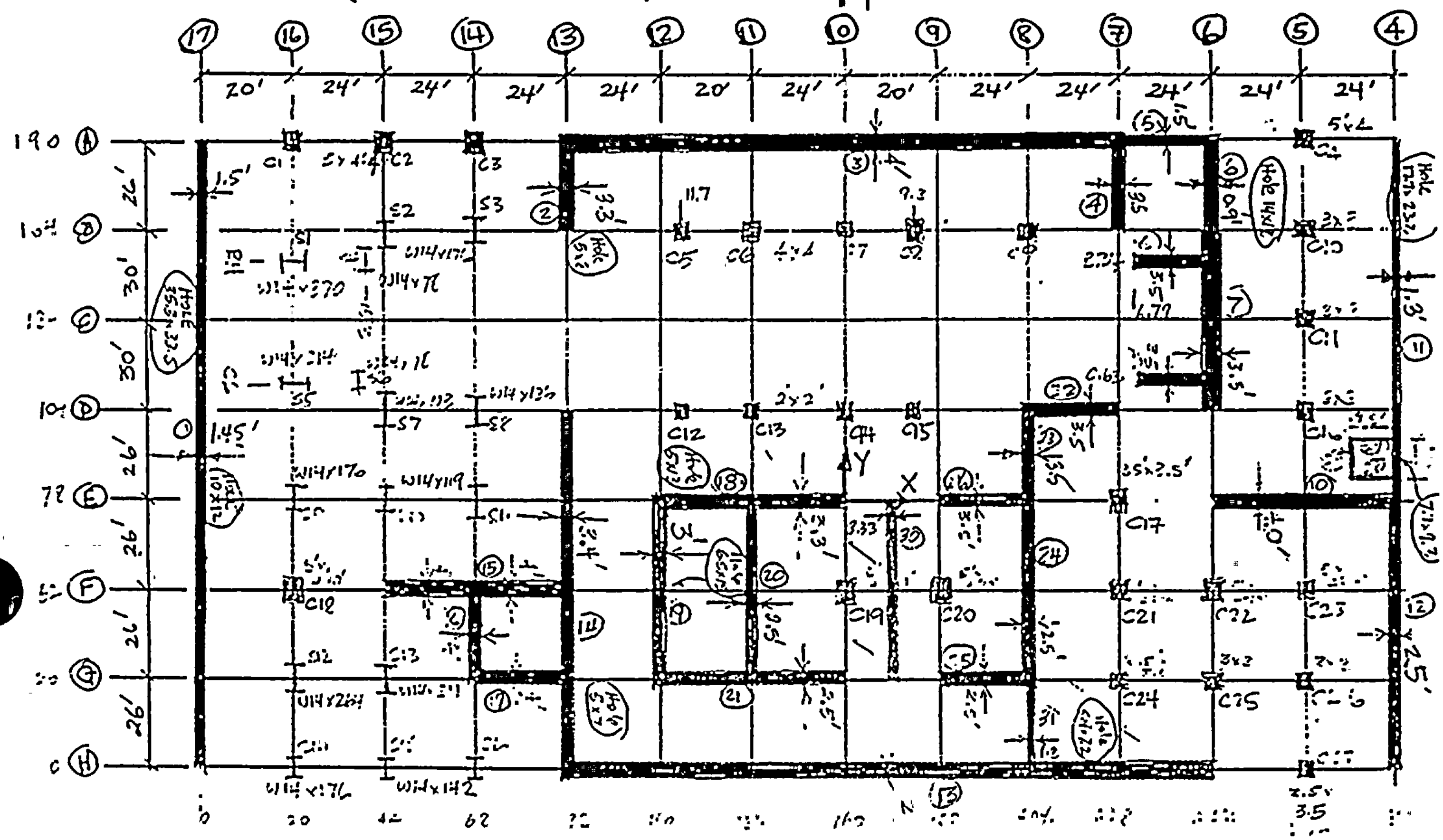
EQE
EQE ENGINEERING

59037-C-044 B2

SHEET NO. 14

JOB NO. 59037.01 JOB Seismic Analysis of WNP-2 BY JMB DATE 5/15/93
CALC. NO. C-006 SUBJECT STIFFNESS CALCULATION CHK'D [illegible] DATE 6/22/93

BELOW MEZZ. FLOOR (ELEV. 471'-0") - Wall & Column Geometry
(X-Y reference at (E)(10))



W14x370	W14x176	W14x78	W14x214	W14x103	W14x136	W14x119
A = 0.76 ft²	= 0.26	A = 0.16 ft²	= 0.63	= 0.20	= 0.27	= 0.25
A_x = 0.61 ft²	= 0.28	A_x = 0.11	= 0.51	= 0.16	= 0.21	= 0.19
A_y = 0.14 ft²	= 0.07	A_y = 0.04	= 0.12	= 0.04	= 0.06	= 0.05
I_x = 0.76 ft⁴	= 0.10	I_x = 0.04	= 0.21	= 0.05	= 0.07	= 0.07
I_y = 0.10 ft⁴	= 0.04	I_y = 0.01	= 0.02	= 0.02	= 0.03	= 0.02

W14x264	W14x211	W14x142
A = 0.53	= 0.43	= 0.30
A_x = 0.42	= 0.34	= 0.24
A_y = 0.10	= 0.09	= 0.06
I_x = 0.16	= 0.13	= 0.08
I_y = 0.06	= 0.05	= 0.03

see drawings S601-602 + S633-634 S628, S676

*Note: Closest section according to AISC 8th Edition

* See pages 16-17 for wall holes

WPPSS SSI ANALYSIS
TURBINE BUILDING MODEL
FINITE ELEMENT ANALYSIS TEST
ELEV. 471'-0"

Calculation 59037-C-006

By JMB

Checked [signature]

Page 24 59037-C-044 B3

Date 6/10/93

Date 6/23/93

3. Calculation of Center of Rigidity

Story ht= 30 ft

E = 415295.601 ksf
G = 177476.8 ksf

Wall or Column		L (Y,N-S) (ft)	T (X,E-W) (ft)	Ixxo (ft4)	Iyyo (ft4)	kx (k/ft)	ky (k/ft)	X (ft)	Y (ft)	kx*Y (k)	ky*X (k)
w1a	y	39.4	1.50	7.65E+03	1.11E+01	2.05E+03	2.41E+05	-160.00	92.30	1.89E+05	-3.86E+07
w1b	y	115.3	1.45	1.85E+05	2.93E+01	5.41E+03	8.06E+05	-160.00	-20.30	-1.10E+05	-1.29E+08
w2	y	26.0	3.30	4.83E+03	7.79E+01	1.44E+04	2.87E+05	-68.00	99.00	1.42E+06	-1.95E+07
w3,5	x	160.0	3.63	7.32E+02	1.06E+06	2.82E+06	1.35E+05	4.97	112.00	3.16E+08	6.72E+05
w4	y	26.0	3.50	5.13E+03	9.29E+01	1.71E+04	3.04E+05	68.00	99.00	1.70E+06	2.07E+07
w6,7	y	86.0	2.71	1.03E+05	2.16E+02	3.98E+04	1.09E+06	92.00	60.31	2.40E+06	9.98E+07
w8	x	19.0	3.50	6.79E+01	2.00E+03	1.74E+05	1.25E+04	82.50	75.00	1.30E+07	1.03E+06
w9	x	19.0	3.50	6.79E+01	2.00E+03	1.74E+05	1.25E+04	82.50	37.00	6.43E+06	1.03E+06
w10	x	48.0	4.00	2.56E+02	3.69E+04	8.31E+05	4.73E+04	116.00	0.00	0.00E+00	5.48E+06
w11,12	y	190.0	1.79	1.00E+06	1.22E+02	2.25E+04	1.66E+06	140.00	1.61	3.63E+04	2.33E+08
w13	x	160.0	2.00	1.07E+02	6.83E+05	1.56E+06	1.97E+04	12.00	-78.00	-1.22E+08	2.36E+05
w14	y	104.0	3.40	3.19E+05	3.41E+02	6.29E+04	1.69E+06	-68.00	-26.00	-1.63E+06	-1.15E+08
w15	x	48.0	4.00	2.56E+02	3.69E+04	8.31E+05	4.73E+04	-92.00	-26.00	-2.16E+07	-4.35E+06
w16	y	26.0	4.00	5.86E+03	1.39E+02	2.56E+04	3.48E+05	-92.00	-39.00	-9.98E+05	-3.20E+07
w17	x	24.0	4.00	1.28E+02	4.61E+03	3.04E+05	2.36E+04	-80.00	-52.00	-1.58E+07	-1.89E+06
w18	x	44.0	3.30	1.32E+02	2.34E+04	6.14E+05	2.43E+04	-22.00	0.00	0.00E+00	-5.35E+05
w19	y	52.0	3.00	3.52E+04	1.17E+02	2.16E+04	6.88E+05	-44.00	-26.00	-5.61E+05	-3.03E+07
w20	y	52.0	2.50	2.93E+04	6.77E+01	1.25E+04	5.73E+05	-24.00	-26.00	-3.25E+05	-1.38E+07
w21	x	44.0	2.50	5.73E+01	1.77E+04	4.65E+05	1.06E+04	-22.00	-52.00	-2.42E+07	-2.33E+05
w22	x	24.0	3.50	8.58E+01	4.03E+03	2.66E+05	1.58E+04	56.00	26.00	6.92E+06	8.86E+05
w23,24,31	y	104.0	2.45	2.07E+05	1.65E+02	3.05E+04	1.22E+06	44.00	-17.24	-5.26E+05	5.35E+07
w25	x	24.0	2.50	3.13E+01	2.88E+03	1.90E+05	5.77E+03	32.00	-52.00	-9.88E+06	1.85E+05
w26	x	24.0	3.50	8.58E+01	4.03E+03	2.66E+05	1.58E+04	32.00	0.00	0.00E+00	5.06E+05
w27	x	9.5	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.30	15.80	1.63E+05	1.98E+04
w28	x	9.5	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.30	7.80	8.03E+04	1.98E+04
w30	y	52.0	3.33	3.90E+04	1.60E+02	2.95E+04	7.63E+05	10.00	-26.00	-7.68E+05	7.63E+06
c1		5.0	4.33	4.51E+01	3.39E+01	6.26E+03	8.33E+03	-140.00	112.00	7.01E+05	-1.17E+06
c2		5.0	4.33	4.51E+01	3.39E+01	6.26E+03	8.33E+03	-116.00	112.00	7.01E+05	-9.66E+05
c3		5.0	4.33	4.51E+01	3.39E+01	6.26E+03	8.33E+03	-92.00	112.00	7.01E+05	-7.66E+05
c4		5.0	4.00	4.17E+01	2.67E+01	4.92E+03	7.69E+03	116.00	112.00	5.51E+05	8.92E+05
c5		4.0	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	-38.00	86.00	3.39E+05	-1.50E+05
c6		4.0	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	-24.00	86.00	3.39E+05	-9.45E+04
c7		4.0	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	0.00	86.00	3.39E+05	0.00E+00
c8		4.0	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	14.00	86.00	3.39E+05	5.51E+04
c9		4.0	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	44.00	86.00	3.39E+05	1.73E+05
c10		3.0	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.00	86.00	1.07E+05	1.45E+05
c11		3.0	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.00	56.00	6.98E+04	1.45E+05
c12		2.0	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	-38.00	26.00	6.40E+03	-9.35E+03
c13		2.0	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	-24.00	26.00	6.40E+03	-5.91E+03
c14		2.0	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	0.00	26.00	6.40E+03	0.00E+00
c15		2.0	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	14.00	26.00	6.40E+03	3.45E+03
c16		3.0	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.00	26.00	3.24E+04	1.45E+05
c17		3.5	3.50	1.25E+01	1.25E+01	2.31E+03	2.31E+03	68.00	0.00	0.00E+00	1.57E+05
c18		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-140.00	-26.00	-2.26E+05	-1.30E+06
c19		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	0.00	-26.00	-2.26E+05	0.00E+00
c20		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	20.00	-26.00	-2.26E+05	1.86E+05
c21		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	68.00	-26.00	-2.26E+05	6.32E+05
c22		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	92.00	-26.00	-2.26E+05	8.55E+05
c23		5.0	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	116.00	-26.00	-2.26E+05	1.08E+06
c24		3.5	3.50	1.25E+01	1.25E+01	2.31E+03	2.31E+03	68.00	-52.00	-1.20E+05	1.57E+05
c25		3.0	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	92.00	-52.00	-6.48E+04	1.15E+05
c26		3.0	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.00	-52.00	-6.48E+04	1.45E+05
c27		3.5	3.50	1.25E+01	1.25E+01	2.31E+03	2.31E+03	116.00	-78.00	-1.80E+05	2.68E+05
s1				1.00E-01	2.60E-01	4.80E+02	1.85E+02	-140.00	74.00	3.55E+04	-2.58E+04
s2				1.00E-01	4.00E-02	7.39E+01	1.85E+02	-116.00	86.00	6.35E+03	-2.14E+04
s3				1.00E-01	4.00E-02	7.38E+01	1.85E+02	-92.00	86.00	6.35E+03	-1.70E+04
s4				4.00E-02	1.00E-02	1.85E+01	7.38E+01	-123.20	74.00	1.37E+03	-9.10E+03
s5				8.00E-02	2.10E-01	3.88E+02	1.48E+02	-140.00	38.00	1.47E+04	-2.07E+04
s6				4.00E-02	1.00E-02	1.85E+01	7.38E+01	-123.20	38.00	7.01E+02	-9.10E+03
s7				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-116.00	26.00	9.60E+02	-1.07E+04
s8				7.00E-02	3.00E-02	5.54E+01	1.29E+02	-92.00	26.00	1.44E+03	-1.19E+04
s9				1.00E-01	4.00E-02	7.38E+01	1.85E+02	-140.00	0.00	0.00E+00	-2.58E+04
s10				7.00E-02	2.00E-02	3.69E+01	1.29E+02	-116.00	0.00	0.00E+00	-1.50E+04
s11				7.00E-02	2.00E-02	3.69E+01	1.29E+02	-92.00	0.00	0.00E+00	-1.19E+04
s12				1.60E-01	6.00E-02	1.11E+02	2.95E+02	-140.00	-52.00	-5.76E+03	-4.13E+04
s13				1.30E-01	5.00E-02	9.23E+01	2.40E+02	-116.00	-52.00	-4.80E+03	-2.78E+04
s14				1.0E-01	4.0E-02	7.38E+01	1.85E+02	-140.00	-78.00	-5.76E+03	-2.58E+04
s15				8.0E-02	3.0E-02	5.54E+01	1.48E+02	-116.00	-78.00	-4.32E+03	-1.71E+04
s16				8.00E-02	3.00E-02	5.54E+01	1.48E+02	-92.00	-78.00	-4.32E+03	-1.30E+04
Sum						8.91E+06	1.02E+07			1.53E+08	3.97E+07

Xs = 3.91 ft
Ys = 17.16 ft

Center of Rigidity

4. Calculation of the Torsional Constant

Wall		kx (k/ft)	ky (k/ft)	xs (ft)	ys (ft)	kzz (k-ft)	Iz (ft^4)
w1a	y	2.05E+03	2.41E+05	-163.91	75.14	6.50E+09	1.10E+06
w1b	y	5.41E+03	8.05E+05	-163.91	-37.46	2.16E+10	3.66E+06
w2	y	1.44E+04	2.87E+05	-71.91	81.84	1.58E+09	2.67E+05
w3,5	x	2.82E+06	1.35E+05	1.06	94.84	2.53E+10	4.28E+06
w4	y	1.71E+04	3.04E+05	64.09	81.84	1.36E+09	2.31E+05
w6,7	y	3.98E+04	1.09E+06	88.09	43.15	8.50E+09	1.44E+06
w8	x	1.74E+05	1.25E+04	78.59	57.84	6.58E+08	1.11E+05
w9	x	1.74E+05	1.25E+04	78.59	19.84	1.46E+08	2.46E+04
w10	x	8.31E+05	4.73E+04	112.09	-17.16	8.38E+08	1.42E+05
w11,12	y	2.25E+04	1.66E+06	136.09	-15.55	3.08E+10	5.20E+06
w13	x	1.56E+06	1.97E+04	8.09	-95.16	1.41E+10	2.39E+06
w14	y	6.29E+04	1.69E+06	-71.91	-43.16	8.87E+09	1.50E+06
w15	x	8.31E+05	4.73E+04	-95.91	-43.16	1.98E+09	3.35E+05
w16	y	2.56E+04	3.48E+05	-95.91	-56.16	3.28E+09	5.54E+05
w17	x	3.04E+05	2.36E+04	-83.91	-69.16	1.62E+09	2.74E+05
w18	x	6.14E+05	2.43E+04	-25.91	-17.16	1.97E+08	3.33E+04
w19	y	2.16E+04	6.88E+05	-47.91	-43.16	1.62E+09	2.74E+05
w20	y	1.25E+04	5.73E+05	-27.91	-43.16	4.70E+08	7.94E+04
w21	x	4.65E+05	1.06E+04	-25.91	-69.16	2.23E+09	3.77E+05
w22	x	2.66E+05	1.58E+04	52.09	8.84	6.37E+07	1.08E+04
w23,24,31	y	3.05E+04	1.22E+06	40.09	-34.40	1.99E+09	3.37E+05
w25	x	1.90E+05	5.77E+03	28.09	-69.16	9.14E+08	1.54E+05
w26	x	2.66E+05	1.58E+04	28.09	-17.16	9.09E+07	1.54E+04
w27	x	1.03E+04	1.46E+02	131.39	-1.36	2.54E+06	4.30E+02
w28	x	1.03E+04	1.46E+02	131.39	-9.36	3.42E+06	5.79E+02
w30	y	2.95E+04	7.63E+05	6.09	-43.16	8.34E+07	1.41E+04
c1		6.26E+03	8.33E+03	-143.91	94.84	2.29E+08	3.87E+04
c2		6.26E+03	8.33E+03	-119.91	94.84	1.76E+08	2.98E+04
c3		6.26E+03	8.33E+03	-95.91	94.84	1.33E+08	2.25E+04
c4		4.92E+03	7.69E+03	112.09	94.84	1.41E+08	2.38E+04
c5		3.94E+03	3.94E+03	-41.91	68.84	2.56E+07	4.32E+03
c6		3.94E+03	3.94E+03	-27.91	68.84	2.17E+07	3.67E+03
c7		3.94E+03	3.94E+03	-3.91	68.84	1.87E+07	3.16E+03
c8		3.94E+03	3.94E+03	10.09	68.84	1.91E+07	3.22E+03
c9		3.94E+03	3.94E+03	40.09	68.84	2.50E+07	4.22E+03
c10		1.25E+03	1.25E+03	112.09	68.84	2.16E+07	3.64E+03
c11		1.25E+03	1.25E+03	112.09	38.84	1.75E+07	2.96E+03
c12		2.46E+02	2.46E+02	-41.91	8.84	4.51E+05	7.63E+01
c13		2.46E+02	2.46E+02	-27.91	8.84	2.11E+05	3.56E+01
c14		2.46E+02	2.46E+02	-3.91	8.84	2.30E+04	3.88E+00

94051-C-044 (2 of 2) ~~pg~~ 26 B5

c15	2.46E+02	2.46E+02	10.09	8.84	4.43E+04	7.49E+00
c16	1.25E+03	1.25E+03	112.09	8.84	1.58E+07	2.66E+03
c17	2.31E+03	2.31E+03	64.09	-17.16	1.02E+07	1.72E+03
c18	8.68E+03	9.29E+03	-143.91	-43.16	2.09E+08	3.53E+04
c19	8.68E+03	9.29E+03	-3.91	-43.16	1.63E+07	2.76E+03
c20	8.68E+03	9.29E+03	16.09	-43.16	1.86E+07	3.14E+03
c21	8.68E+03	9.29E+03	64.09	-43.16	5.44E+07	9.19E+03
c22	8.68E+03	9.29E+03	88.09	-43.16	8.83E+07	1.49E+04
c23	8.68E+03	9.29E+03	112.09	-43.16	1.33E+08	2.25E+04
c24	2.31E+03	2.31E+03	64.09	-69.16	2.05E+07	3.47E+03
c25	1.25E+03	1.25E+03	88.09	-69.16	1.56E+07	2.64E+03
c26	1.25E+03	1.25E+03	112.09	-69.16	2.16E+07	3.65E+03
c27	2.31E+03	2.31E+03	112.09	-95.16	4.99E+07	8.44E+03
s1	4.80E+02	1.85E+02	-143.91	56.84	5.37E+06	9.08E+02
s2	7.38E+01	1.85E+02	-119.91	68.84	3.00E+06	5.08E+02
s3	7.38E+01	1.85E+02	-95.91	68.84	2.05E+06	3.46E+02
s4	1.85E+01	7.38E+01	-127.11	56.84	1.25E+06	2.12E+02
s5	3.88E+02	1.48E+02	-143.91	20.84	3.23E+06	5.45E+02
s6	1.85E+01	7.38E+01	-127.11	20.84	1.20E+06	2.03E+02
s7	3.69E+01	9.23E+01	-119.91	8.84	1.33E+06	2.25E+02
s8	5.54E+01	1.29E+02	-95.91	8.84	1.19E+06	2.02E+02
s9	7.38E+01	1.85E+02	-143.91	-17.16	3.84E+06	6.50E+02
s10	3.69E+01	1.29E+02	-119.91	-17.16	1.87E+06	3.16E+02
s11	3.69E+01	1.29E+02	-95.91	-17.16	1.20E+06	2.03E+02
s12	1.11E+02	2.95E+02	-143.91	-69.16	6.65E+06	1.12E+03
s13	9.23E+01	2.40E+02	-119.91	-69.16	3.89E+06	6.58E+02
s14	5.54E+01	1.48E+02	-95.91	-95.16	1.86E+06	3.14E+02
Sum	8.91E+06	1.02E+07			1.36E+11	2.31E+07

Ax = 1505.6 ft^2
Ay = 1717.4 ft^2
Iz = 2.31E+07 ft^4

EQE

EQE ENGINEERING

SHEET NO. 27

JOB NO. 59037.01 JOB Seismic Analysis of WPN-2 BY JMB DATE 6/10/93

CALC. NO. C-006 SUBJECT CHK'D [illegible] DATE 6/23/93

Properties below Mezz. Floor (ELEV 471'-0")

$A = 4628.2\ ft^2$

$A_x = 1505.6\ ft^2$

$A_y = 1717.4\ ft^2$

$I_{zz} = 2.31 \times 10^7\ ft^4$

$I_{xx} = 1.82 \times 10^7\ ft^4$

$I_{yy} = 3.12 \times 10^7\ ft^4$

$X_{CR} = 3.91\ ft$

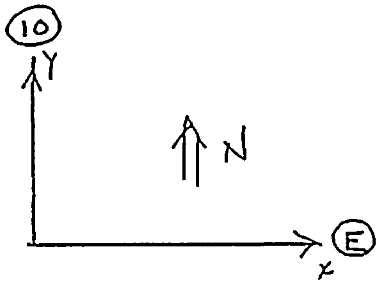
$Y_{CR} = 17.16\ ft$

CONCRETE:

E = 415,295.6 ksf

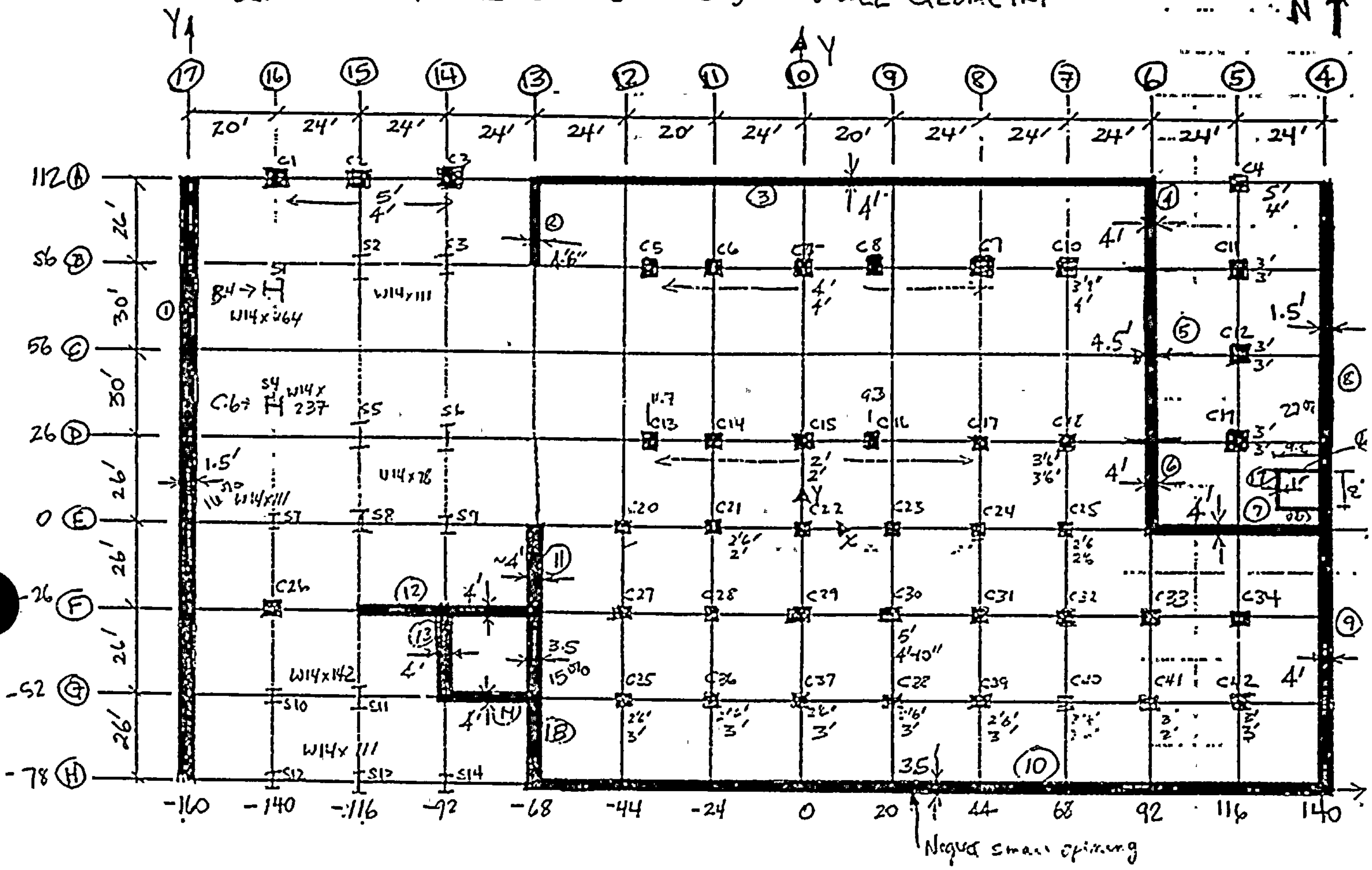
G = 177,476.8 ksf

$\nu = 0.17$



Note: The center of wall area for vertical deformation will coincide with the center of rigidity in the structural model, since the differences are small.

BELOW OPER. FLOOR (EL 501'-0") - WALL GEOMETRY



W14x111 $A_x = 0.174\ ft^2$
W14x127 $A_y = 0.046\ ft^2$
$I_x = 1240\ in^4 = 0.06\ ft^4$
$I_y = 447\ in^4 = 0.022\ ft^4$
$A \approx 32\ in^2 = 0.22\ ft^2$

[AISC Manual of Steel Construction, 9th Ed.]
Sections are approximate (similar) to existing.

W14x264 $A_x = 0.42\ ft^2$
W14x257 $A_y = 0.103\ ft^2$
$I_x = 3400\ in^4 = 0.164\ ft^4$
$I_y = 1290\ in^4 = 0.062\ ft^4$
$A = 756\ in^2 = 0.525\ ft^2$

W14x237 $A_x = 0.38\ ft^2$
W14x233 $A_y = 0.094\ ft^2$
$I_{xx} = 3010\ in^4 = 0.145\ ft^4$
$I_y = 1150\ in^4 = 0.055\ ft^4$
$A = 68.5\ in^2 = 0.476\ ft^2$

W14x142 $A_y = 0.235\ ft^2$
W14x145 $A_y = 0.06\ ft^2$
$I_x = 0.083\ ft^4$
$I_y = 0.033\ ft^4$
$A = 0.3\ ft^2$

W14x78 $A_x = 0.11\ ft^2$
W14x74 $A_y = 0.04\ ft^2$
$I_x = 0.038\ ft^4$
$I_y = 0.006\ ft^4$
$A = 0.15\ ft^2$

See drawings S614-615 + S637-638, 628, 676, 625

WPPSS SSI ANALYSIS
TURBINE BUILDING MODEL
FINITE ELEMENT ANALYSIS TEST
BELOW ELEV. 501'-0"

Calculation 59037-C-006

By JMB

Checked [signature]

Page 35 59037-C-044

Date 6/16/93

Date 6/23/93

B8

3. Calculation of Center of Rigidity

Story ht= 30 ft
E = 415295.601 ksf
G = 177476.8 ksf

Wall or Column		L (ft)	T (ft)	Ixxo (ft4)	Iyyo (ft4)	kx (k/ft)	ky (k/ft)	X (ft)	Y (ft)	kx*Y (k)	ky*x (k)
w1	y	190.00	1.50	8.57E+05	5.34E+01	9.86E+03	1.39E+06	-160.0	17.0	1.68E+05	-2.23E+08
w2	y	26.00	4.50	6.59E+03	1.97E+02	3.64E+04	3.91E+05	-68.0	99.0	3.61E+06	-2.66E+07
w3	x	160.00	4.00	8.53E+02	1.37E+06	3.12E+06	1.58E+05	12.0	112.0	3.49E+08	1.89E+06
w4,5,6	y	112.00	4.27	5.00E+05	7.26E+02	1.34E+05	2.30E+06	92.0	56.0	7.50E+06	2.11E+08
w7	x	48.00	4.00	2.56E+02	3.69E+04	8.31E+05	4.73E+04	116.0	0.0	0.00E+00	5.48E+06
w8,9	y	190.00	2.53	1.44E+06	2.55E+02	4.71E+04	2.35E+06	140.0	-5.8	-2.71E+05	3.28E+08
w10	x	208.00	3.50	7.43E+02	2.62E+06	3.56E+06	1.37E+05	36.0	-78.0	-2.78E+08	4.94E+06
w11,18	y	78.00	3.67	1.45E+05	3.21E+02	5.93E+04	1.34E+06	-68.0	-37.8	-2.24E+06	-9.12E+07
w12	x	48.00	4.00	2.56E+02	3.69E+04	8.31E+05	4.73E+04	-92.0	-26.0	-2.16E+07	-4.35E+06
w13	y	26.00	4.00	5.86E+03	1.39E+02	2.56E+04	3.48E+05	-92.0	-39.0	-9.98E+05	-3.20E+07
w14	x	24.00	4.00	1.28E+02	4.61E+03	3.04E+05	2.36E+04	-80.0	-52.0	-1.58E+07	-1.89E+06
w15	x	9.50	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.3	15.8	1.63E+05	1.98E+04
w16	x	9.50	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.3	7.8	8.03E+04	1.98E+04
w17	y	8.00	1.00	4.27E+01	6.67E-01	1.23E+02	6.56E+03	130.5	11.8	1.45E+03	8.57E+05
c1		5.00	4.00	4.17E+01	2.67E+01	4.92E+03	7.69E+03	-140.0	112.0	-1.28E+05	2.77E+05
c2		5.00	4.00	4.17E+01	2.67E+01	4.92E+03	7.69E+03	-116.0	112.0	-1.92E+05	-5.23E+05
c3		5.00	4.00	4.17E+01	2.67E+01	4.92E+03	7.69E+03	-92.0	112.0	-2.56E+05	-7.08E+05
c4		5.00	4.00	4.17E+01	2.67E+01	4.92E+03	7.69E+03	116.0	112.0	5.51E+05	-7.08E+05
c5		4.00	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	-38.0	86.0	4.41E+05	-2.15E+05
c6		4.00	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	-24.0	86.0	4.41E+05	-5.51E+05
c7		4.00	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	0.0	86.0	4.41E+05	-4.57E+05
c8		4.00	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	14.0	86.0	3.39E+05	-3.62E+05
c9		4.00	4.00	2.13E+01	2.13E+01	3.94E+03	3.94E+03	44.0	86.0	3.39E+05	4.57E+05
c10		3.75	4.00	1.76E+01	2.00E+01	3.69E+03	3.24E+03	68.0	86.0	3.17E+05	-1.23E+05
c11		3.00	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.0	86.0	1.07E+05	-2.99E+04
c12		3.00	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.0	56.0	1.07E+05	0.00E+00
c13		2.00	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	-38.0	26.0	2.12E+04	3.45E+03
c14		2.00	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	-24.0	26.0	2.12E+04	1.08E+04
c15		2.00	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	0.0	26.0	1.38E+04	1.67E+04
c16		2.00	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	14.0	26.0	6.40E+03	2.85E+04
c17		2.00	2.00	1.33E+00	1.33E+00	2.46E+02	2.46E+02	44.0	26.0	6.40E+03	2.85E+04
c18		3.50	3.50	1.25E+01	1.25E+01	2.31E+03	2.31E+03	68.0	26.0	6.00E+04	-8.77E+04
c19		3.00	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.0	26.0	3.24E+04	-2.99E+04
c20		2.50	2.00	2.60E+00	1.67E+00	3.08E+02	4.81E+02	-44.0	0.0	8.00E+03	0.00E+00
c21		2.50	2.00	2.60E+00	1.67E+00	3.08E+02	4.81E+02	-24.0	0.0	8.00E+03	6.73E+03
c22		2.50	2.00	2.60E+00	1.67E+00	3.08E+02	4.81E+02	0.0	0.0	8.00E+03	2.11E+04
c23		2.50	2.00	2.60E+00	1.67E+00	3.08E+02	4.81E+02	20.0	0.0	0.00E+00	3.27E+04
c24		2.50	2.00	2.60E+00	1.67E+00	3.08E+02	4.81E+02	44.0	0.0	0.00E+00	5.58E+04
c25		2.50	2.50	3.26E+00	3.26E+00	6.01E+02	6.01E+02	68.0	0.0	0.00E+00	-2.64E+04
c26		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-140.0	-26.0	0.00E+00	-2.23E+05
c27		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-44.0	-26.0	0.00E+00	0.00E+00
c28		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-24.0	-26.0	0.00E+00	1.86E+05
c29		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	0.0	-26.0	-2.26E+05	4.09E+05
c30		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	20.0	-26.0	-2.26E+05	6.32E+05
c31		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	44.0	-26.0	-2.26E+05	-1.30E+06
c32		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	68.0	-26.0	-2.26E+05	-4.09E+05
c33		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	92.0	-26.0	-2.26E+05	-2.23E+05
c34		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	116.0	-26.0	-2.26E+05	0.00E+00
c35		2.50	3.00	3.91E+00	5.63E+00	1.04E+03	7.21E+02	-44.0	-52.0	-2.70E+04	1.44E+04
c36		2.50	3.00	3.91E+00	5.63E+00	1.04E+03	7.21E+02	-24.0	-52.0	-2.70E+04	3.17E+04
c37		2.50	3.00	3.91E+00	5.63E+00	1.04E+03	7.21E+02	0.0	-52.0	-2.70E+04	4.90E+04
c38		2.50	3.00	3.91E+00	5.63E+00	1.04E+03	7.21E+02	20.0	-52.0	-5.40E+04	6.63E+04
c39		2.50	3.00	3.91E+00	5.63E+00	1.04E+03	7.21E+02	44.0	-52.0	-5.40E+04	8.36E+04
c40		3.50	3.50	1.25E+01	1.25E+01	2.31E+03	2.31E+03	68.0	-52.0	-1.20E+05	-1.02E+05
c41		3.00	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	92.0	-52.0	-6.48E+04	-2.99E+04
c42		3.00	3.00	6.75E+00	6.75E+00	1.25E+03	1.25E+03	116.0	-52.0	-6.48E+04	0.00E+00
s1				6.20E-02	1.64E-01	3.03E+02	1.14E+02	-140.0	74.0	-1.57E+04	2.29E+03
s2				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-116.0	86.0	-2.11E+03	4.87E+03
s3				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-92.0	86.0	-2.11E+03	7.53E+03
s4				5.50E-02	1.45E-01	2.68E+02	1.02E+02	-140.0	38.0	1.98E+04	9.34E+03
s5				3.80E-02	6.00E-03	1.11E+01	7.01E+01	-116.0	26.0	9.52E+02	8.14E+03
s6				3.80E-02	6.00E-03	1.11E+01	7.01E+01	-92.0	26.0	9.52E+02	-9.82E+03
s7				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-140.0	0.0	1.54E+03	-1.28E+04
s8				3.80E-02	6.00E-03	1.11E+01	7.01E+01	-116.0	0.0	2.88E+02	-6.45E+03
s9				3.80E-02	6.00E-03	1.11E+01	7.01E+01	-92.0	0.0	2.88E+02	-9.82E+03
s10				8.30E-02	3.30E-02	6.09E+01	1.53E+02	-140.0	-52.0	0.00E+00	-1.78E+04
s11				8.30E-02	3.30E-02	6.09E+01	1.53E+02	-116.0	-52.0	0.00E+00	-1.41E+04
s12				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-140.0	-78.0	0.00E+00	-1.55E+04
s13				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-116.0	-78.0	-2.11E+03	-1.28E+04
s14				6.00E-02	2.20E-02	4.06E+01	1.11E+02	-92.0	-78.0	-2.11E+03	-1.02E+04
Sum						9.12E+06	8.69E+06			4.26E+07	1.70E+08

Xs = 19.56 ft
Ys = 4.67 ft

Center of Rigidity

59037-C-044

B9

WPPSS SSI ANALYSIS
TURBINE BUILDING MODEL
FINITE ELEMENT ANALYSIS TEST
BELOW ELEV. 501'-0"

Calculation 59037-C-006

By JMB

Checked Jr

Date 6/16/93

Date 6/23/93

(1 of 2)

4. Calculation of the Moments of Inertia

Wall		kx (k/ft)	ky (k/ft)	xs (ft)	ys (ft)	kzz (k-ft)	Izz (ft^4)
w1	y	9.9E+03	1.4E+06	-179.59	12.33	4.49E+10	7.59E+06
w2	y	3.6E+04	3.9E+05	-87.59	94.33	3.33E+09	5.62E+05
w3	x	3.1E+06	1.6E+05	-7.59	107.33	3.59E+10	6.07E+06
w4,5,6	y	1.3E+05	2.3E+06	72.41	51.33	1.24E+10	2.10E+06
w7	x	8.3E+05	4.7E+04	96.41	-4.67	4.57E+08	7.73E+04
w8,9	y	4.7E+04	2.3E+06	120.41	-10.42	3.40E+10	5.75E+06
w10	x	3.6E+06	1.4E+05	16.41	-82.67	2.44E+10	4.12E+06
w11,18	y	5.9E+04	1.3E+06	-87.59	-42.47	1.04E+10	1.76E+06
w12	x	8.3E+05	4.7E+04	-111.59	-30.67	1.37E+09	2.32E+05
w13	y	2.6E+04	3.5E+05	-111.59	-43.67	4.38E+09	7.40E+05
w14	x	3.0E+05	2.4E+04	-99.59	-56.67	1.21E+09	2.05E+05
w15	x	1.0E+04	1.5E+02	115.71	11.13	3.23E+06	5.46E+02
w16	x	1.0E+04	1.5E+02	115.71	3.13	2.06E+06	3.48E+02
w17	y	1.2E+02	6.6E+03	110.91	7.13	8.08E+07	1.37E+04
c1		4.9E+03	7.7E+03	-159.59	107.33	2.53E+08	4.27E+04
c2		4.9E+03	7.7E+03	-135.59	107.33	1.98E+08	3.35E+04
c3		4.9E+03	7.7E+03	-111.59	107.33	1.52E+08	2.58E+04
c4		4.9E+03	7.7E+03	96.41	107.33	1.28E+08	2.17E+04
c5		3.9E+03	3.9E+03	-57.59	81.33	3.91E+07	6.61E+03
c6		3.9E+03	3.9E+03	-43.59	81.33	3.35E+07	5.67E+03
c7		3.9E+03	3.9E+03	-19.59	81.33	2.76E+07	4.66E+03
c8		3.9E+03	3.9E+03	-5.59	81.33	2.62E+07	4.42E+03
c9		3.9E+03	3.9E+03	24.41	81.33	2.84E+07	4.80E+03
c10		3.7E+03	3.2E+03	48.41	81.33	3.20E+07	5.41E+03
c11		1.2E+03	1.2E+03	96.41	81.33	1.98E+07	3.35E+03
c12		1.2E+03	1.2E+03	96.41	51.33	1.49E+07	2.51E+03
c13		2.5E+02	2.5E+02	-57.59	21.33	9.28E+05	1.57E+02
c14		2.5E+02	2.5E+02	-43.59	21.33	5.79E+05	9.80E+01
c15		2.5E+02	2.5E+02	-19.59	21.33	2.06E+05	3.49E+01
c16		2.5E+02	2.5E+02	-5.59	21.33	1.20E+05	2.02E+01
c17		2.5E+02	2.5E+02	24.41	21.33	2.59E+05	4.37E+01
c18		2.3E+03	2.3E+03	48.41	21.33	6.46E+06	1.09E+03
c19		1.2E+03	1.2E+03	96.41	21.33	1.21E+07	2.05E+03
c20		3.1E+02	4.8E+02	-63.59	-4.67	1.95E+06	3.30E+02
c21		3.1E+02	4.8E+02	-43.59	-4.67	9.20E+05	1.55E+02
c22		3.1E+02	4.8E+02	-19.59	-4.67	1.91E+05	3.23E+01
c23		3.1E+02	4.8E+02	0.41	-4.67	6.80E+03	1.15E+00
c24		3.1E+02	4.8E+02	24.41	-4.67	2.93E+05	4.96E+01
c25		6.0E+02	6.0E+02	48.41	-4.67	1.42E+06	2.40E+02

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c26	8.7E+03	9.3E+03	-159.59	-30.67	2.45E+08	4.14E+04
c27	8.7E+03	9.3E+03	-63.59	-30.67	4.57E+07	7.73E+03
c28	8.7E+03	9.3E+03	-43.59	-30.67	2.58E+07	4.37E+03
c29	8.7E+03	9.3E+03	-19.59	-30.67	1.17E+07	1.98E+03
c30	8.7E+03	9.3E+03	0.41	-30.67	8.17E+06	1.38E+03
c31	8.7E+03	9.3E+03	24.41	-30.67	1.37E+07	2.32E+03
c32	8.7E+03	9.3E+03	48.41	-30.67	3.00E+07	5.06E+03
c33	8.7E+03	9.3E+03	72.41	-30.67	5.69E+07	9.62E+03
c34	8.7E+03	9.3E+03	96.41	-30.67	9.46E+07	1.60E+04
c35	1.0E+03	7.2E+02	-63.59	-56.67	6.25E+06	1.06E+03
c36	1.0E+03	7.2E+02	-43.59	-56.67	4.70E+06	7.95E+02
c37	1.0E+03	7.2E+02	-19.59	-56.67	3.61E+06	6.10E+02
c38	1.0E+03	7.2E+02	0.41	-56.67	3.33E+06	5.64E+02
c39	1.0E+03	7.2E+02	24.41	-56.67	3.76E+06	6.36E+02
c40	2.3E+03	2.3E+03	48.41	-56.67	1.28E+07	2.17E+03
c41	1.2E+03	1.2E+03	72.41	-56.67	1.05E+07	1.78E+03
c42	1.2E+03	1.2E+03	96.41	-56.67	1.56E+07	2.63E+03
s1	3.0E+02	1.1E+02	-159.59	69.33	4.37E+06	7.39E+02
s2	4.1E+01	1.1E+02	-135.59	81.33	2.30E+06	3.90E+02
s3	4.1E+01	1.1E+02	-111.59	81.33	1.65E+06	2.78E+02
s4	2.7E+02	1.0E+02	-159.59	33.33	2.88E+06	4.87E+02
s5	1.1E+01	7.0E+01	-135.59	21.33	1.29E+06	2.19E+02
s6	1.1E+01	7.0E+01	-111.59	21.33	8.78E+05	1.48E+02
s7	4.1E+01	1.1E+02	-159.59	-4.67	2.82E+06	4.77E+02
s8	1.1E+01	7.0E+01	-135.59	-4.67	1.29E+06	2.18E+02
s9	1.1E+01	7.0E+01	-111.59	-4.67	8.74E+05	1.48E+02
s10	6.1E+01	1.5E+02	-159.59	-56.67	4.10E+06	6.93E+02
s11	6.1E+01	1.5E+02	-135.59	-56.67	3.01E+06	5.09E+02
s12	4.1E+01	1.1E+02	-159.59	-82.67	3.10E+06	5.24E+02
s13	4.1E+01	1.1E+02	-135.59	-82.67	2.31E+06	3.91E+02
s14	4.1E+01	1.1E+02	-111.59	-82.67	1.66E+06	2.80E+02
Sum	9.12E+06	8.69E+06			1.74E+11	2.95E+07

Ax = 1541.5 ft^2
Ay = 1469.4 ft^2
Iz = 2.95E+07 ft^4

EQE

EQE ENGINEERING

SHEET NO: 38

JOB NO. 59037.01 JOB WPPSS BY JMB DATE 5/10/93

CALC. NO. C-006 SUBJECT CHK'D [initials] DATE 6/23/93

Properties Below Operational Floor (EL. 501'-0")

$A = 4211.0 \text{ ft}^2$

$A_x = 1541.5 \text{ ft}^2$

$A_y = 1469.4 \text{ ft}^2$

$I_{zz} = 2.95 \times 10^7 \text{ ft}^4$

$I_{xx} = 2.09 \times 10^7 \text{ ft}^4$

$I_{yy} = 3.67 \times 10^7 \text{ ft}^4$

Concrete:

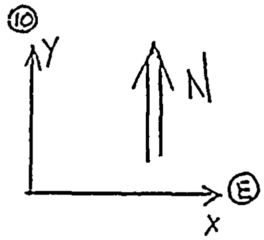
E = 415,295.6 Ksf

G = 177,476.8 Ksf

ν = 0.17

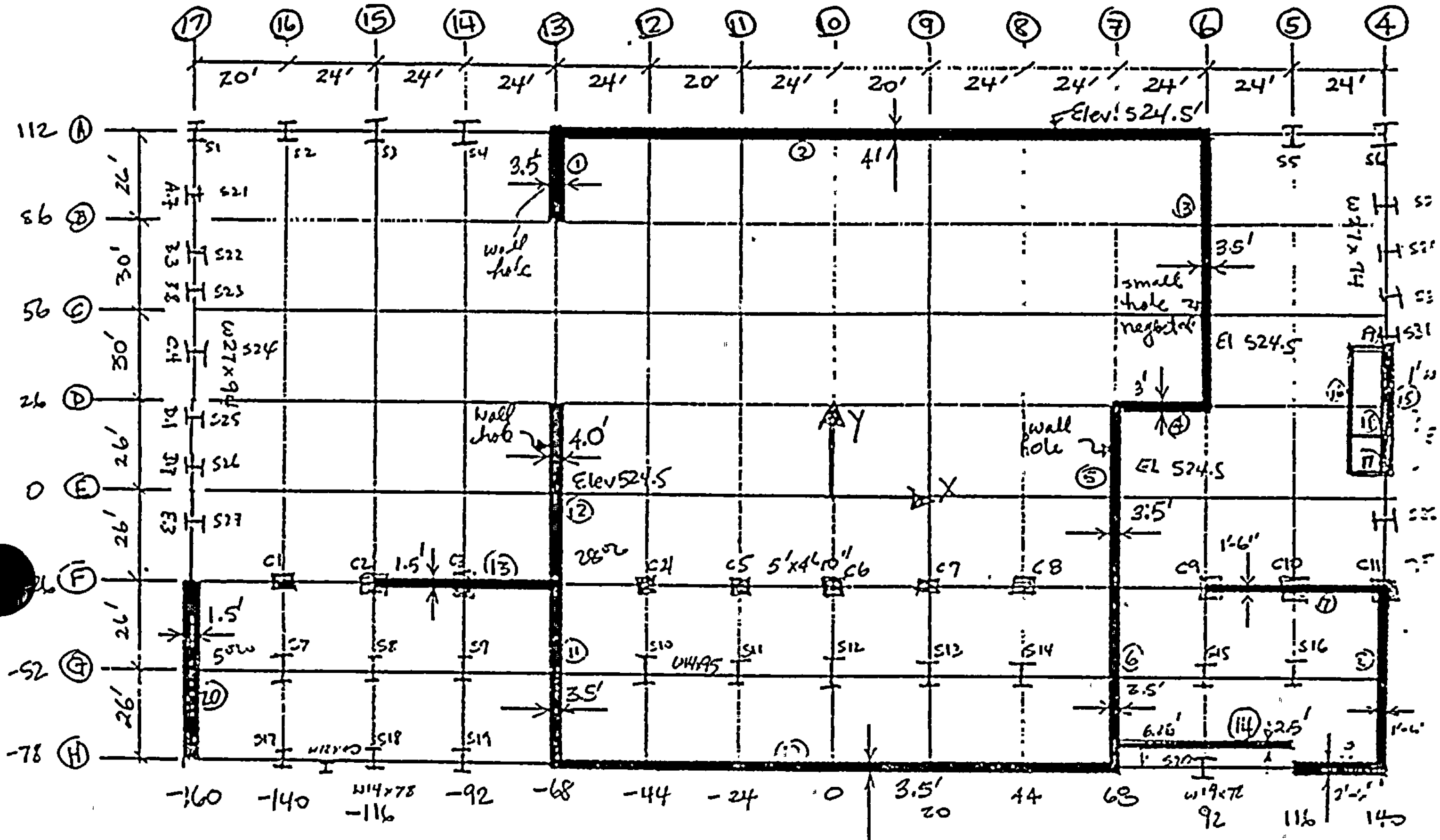
X_{CR} = 19.59 ft

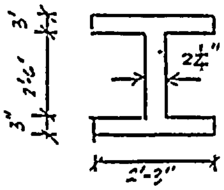
Y_{CR} = 4.67 ft



Note: Axial center of wall and column areas are taken at center of rigidity (X_{CR}, Y_{CR}), because the difference is small.

Below Elev 531'-0" — WALL & COLUMN Geometry





COLUMNS ALONG Line A

$A = 2\left[(2.25)\left(\frac{3}{12}\right)\right] + \frac{2.25}{12}(2.5) = 1.59\ ft^2$

$A_x = 2\left(\frac{3}{12}\right)(2.25) = 1.125\ ft^2$

$A_y = (2.25/12)(2.5) = 0.47\ ft^2$

$I_{xx} = \frac{1}{12}\left(\frac{2.25}{12}\right)(2.5)^3 + 2\left[\frac{1}{12}(2.25)(0.25)^3 + (2.25)(0.25)(1.375)^2\right]$

$= 2.38\ ft^4$

$I_{yy} = \frac{1}{12}(2.5)(2.25/12)^3 + 2\left[\frac{1}{12}\left(\frac{3}{12}\right)(2.25)^3\right]$

$= 0.48\ ft^4$

See drawing Numbers S619-624, S640-S641, 627, 672, 675, 676, 628

COLUMN Line 17 & 4

W27x94:
$A = \frac{27.7}{144} = 0.19\ ft^2$
$A_x = 0.10\ ft^2$
$A_y = 0.09\ ft^2$
$I_{xx} = 3270/(144)^2 = 0.16\ ft^4$
$I_{yy} = 124/(144)^2 = 0.006\ ft^4$

W14x95 (Approx):
$A = 26.5/144 = 0.18\ ft^2$
$A_x = 0.14\ ft^2$
$A_y = 0.04\ ft^2$
$I_{xx} = 199/(144)^2 = 0.05\ ft^4$
$I_{yy} = 362/(144)^2 = 0.02\ ft^4$

W14x78:
$A = 0.15\ ft^2$
$A_x = 0.11\ ft^2$
$A_y = 0.04\ ft^2$
$I_{xx} = 0.04\ ft^4$
$I_{yy} = 0.006\ ft^4$

{AISC Manual of Steel Construction, 9th Ed.} Sections are similar to existing.

WPPSS SSI ANALYSIS
TURBINE BUILDING MODEL
FINITE ELEMENT ANALYSIS TEST
BELOW ELEV. 531'-0"

Calculation 59037-C-006

Page 48 59037-C-044 B13

By JMB Date 6/17/93

Checked [signature] Date 6/23/93

3. Calculation of Center of Rigidity

Story ht= 30 ft
E = 415295.601 ksf
G = 177476.8 ksf

Wall or Column		L (ft)	T (ft)	Ixxo (ft4)	Iyyo (ft4)	kx (k/ft)	ky (k/ft)	X (ft)	Y (ft)	kx*Y (k)	ky*x (k)
w1	y	26.00	3.50	5.13E+03	9.29E+01	1.71E+04	3.04E+05	-68.0	99.0	1.70E+06	-2.07E+07
w2	x	160.00	4.00	8.53E+02	1.37E+06	3.12E+06	1.58E+05	12.0	112.0	3.49E+08	1.89E+06
w3	y	86.00	3.50	1.86E+05	3.07E+02	5.67E+04	1.42E+06	92.0	69.0	3.91E+06	1.31E+08
w4	x	24.00	3.00	5.40E+01	3.46E+03	2.28E+05	9.97E+03	80.0	26.0	5.93E+06	7.97E+05
w5,6	y	104.00	3.50	3.28E+05	3.72E+02	6.86E+04	1.74E+06	68.0	-26.0	-1.78E+06	1.19E+08
w7,c9-11	x	48.00	3.00	1.64E+02	4.18E+04	6.50E+05	3.03E+04	116.0	-26.0	-1.69E+07	3.52E+06
w8	y	52.00	1.50	1.76E+04	1.46E+01	2.70E+03	3.44E+05	140.0	-52.0	-1.40E+05	4.81E+07
w9	x	24.00	2.50	3.13E+01	2.88E+03	1.90E+05	5.77E+03	128.0	-78.0	-1.48E+07	7.38E+05
w10	x	136.00	3.50	4.86E+02	7.34E+05	2.31E+06	8.97E+04	0.0	-78.0	-1.80E+08	0.00E+00
w11,12	y	104.00	3.75	2.28E+05	4.63E+02	8.55E+04	1.84E+06	-68.0	-24.3	-2.08E+06	-1.25E+08
w13,c2-3	x	48.00	2.51	1.14E+02	2.50E+04	5.26E+05	2.11E+04	-96.8	-26.0	-1.37E+07	-2.04E+06
w14	x	48.00	2.50	6.25E+01	2.30E+04	5.19E+05	1.15E+04	92.0	-71.8	-3.73E+07	1.06E+06
w15	y	30.00	1.00	2.25E+03	2.50E+00	4.61E+02	1.09E+05	140.0	22.8	1.05E+04	1.53E+07
w16	y	30.00	1.00	2.25E+03	2.50E+00	4.61E+02	1.09E+05	130.5	22.8	1.05E+04	1.42E+07
w17	x	9.50	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.3	7.8	8.03E+04	1.98E+04
w18	x	9.50	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.3	15.8	1.63E+05	1.98E+04
w19	x	9.50	1.00	7.92E-01	7.14E+01	1.03E+04	1.46E+02	135.3	37.8	3.89E+05	1.98E+04
w20	y	52.00	1.50	1.76E+04	1.46E+01	2.70E+03	3.44E+05	-160.0	-52.0	-1.40E+05	-5.50E+07
c1		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-140.0	-26.0	-2.26E+05	-1.30E+06
c4		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-44.0	-26.0	-2.26E+05	-4.09E+05
c5		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	-24.0	-26.0	-2.26E+05	-2.23E+05
c6		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	0.0	-26.0	-2.26E+05	0.00E+00
c7		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	20.0	-26.0	-2.26E+05	1.86E+05
c8		5.00	4.83	5.03E+01	4.70E+01	8.68E+03	9.29E+03	44.0	-26.0	-2.26E+05	4.09E+05
s1				2.38E+00	4.80E-01	8.86E+02	4.39E+03	-160.0	112.0	9.92E+04	-7.03E+05
s2				2.38E+00	4.80E-01	8.86E+02	4.39E+03	-140.0	112.0	9.92E+04	-6.15E+05
s3				2.38E+00	4.80E-01	8.86E+02	4.39E+03	-116.0	112.0	9.92E+04	-5.10E+05
s4				2.38E+00	4.80E-01	8.86E+02	4.39E+03	-92.0	112.0	9.92E+04	-4.04E+05
s5				2.38E+00	4.80E-01	8.86E+02	4.39E+03	116.0	112.0	9.92E+04	5.10E+05
s6				2.38E+00	4.80E-01	8.86E+02	4.39E+03	140.0	112.0	9.92E+04	6.15E+05
s7				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-140.0	-52.0	-1.92E+03	-1.29E+04
s8				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-116.0	-52.0	-1.92E+03	-1.07E+04
s9				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-92.0	-52.0	-1.92E+03	-8.49E+03
s10				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-44.0	-52.0	-1.92E+03	-4.06E+03
s11				5.00E-02	2.00E-02	3.69E+01	9.23E+01	-24.0	-52.0	-1.92E+03	-2.21E+03
s12				5.00E-02	2.00E-02	3.69E+01	9.23E+01	0.0	-52.0	-1.92E+03	0.00E+00
s13				5.00E-02	2.00E-02	3.69E+01	9.23E+01	20.0	-52.0	-1.92E+03	1.85E+03
s14				5.00E-02	2.00E-02	3.69E+01	9.23E+01	44.0	-52.0	-1.92E+03	4.06E+03
s15				5.00E-02	2.00E-02	3.69E+01	9.23E+01	92.0	-52.0	-1.92E+03	8.49E+03
s16				5.00E-02	2.00E-02	3.69E+01	9.23E+01	116.0	-52.0	-1.92E+03	1.07E+04
s17				4.00E-02	6.00E-03	1.11E+01	7.38E+01	-140.0	-78.0	-8.64E+02	-1.03E+04
s18				4.00E-02	6.00E-03	1.11E+01	7.38E+01	-116.0	-78.0	-8.64E+02	-8.56E+03
s19				4.00E-02	6.00E-03	1.11E+01	7.38E+01	-92.0	-78.0	-8.64E+02	-6.79E+03
s20				4.00E-02	6.00E-03	1.11E+01	7.38E+01	92.0	-78.0	-8.64E+02	6.79E+03
s21				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	93.8	2.77E+04	-1.77E+03
s22				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	77.0	2.27E+04	-1.77E+03
s23				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	62.0	1.83E+04	-1.77E+03
s24				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	44.0	1.30E+04	-1.77E+03
s25				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	23.4	6.91E+03	-1.77E+03
s26				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	7.8	2.30E+03	-1.77E+03
s27				6.00E-03	1.60E-01	2.95E+02	1.11E+01	-160.0	-7.8	-2.30E+03	-1.77E+03
s28				6.00E-03	1.60E-01	2.95E+02	1.11E+01	140.0	93.8	2.77E+04	1.55E+03
s29				6.00E-03	1.60E-01	2.95E+02	1.11E+01	140.0	77.0	2.27E+04	1.55E+03
s30				6.00E-03	1.60E-01	2.95E+02	1.11E+01	140.0	62.0	1.83E+04	1.55E+03
s31				6.00E-03	1.60E-01	2.95E+02	1.11E+01	140.0	44.0	1.30E+04	1.55E+03
s32				6.00E-03	1.60E-01	2.95E+02	1.11E+01	140.0	-7.8	-2.30E+03	1.55E+03
SUM						7.86E+06	6.62E+06			9.39E+07	1.30E+08

Xs = 19.60 ft Center of Rigidity
Ys = 11.94 ft

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WPPSS SSI ANALYSIS
TURBINE BUILDING MODEL
FINITE ELEMENT ANALYSIS TEST
BELOW ELEV. 531'-0"

Calculation 59037-C-006

By JMB

Checked J

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Date 6/17/93 (1 of 2)

Date 6/23/93

4. Calculation of the Moments of Inertia

Wall		kx (k/ft)	ky (k/ft)	xs (ft)	ys (ft)	kzz (k-ft)	Izz (ft^4)
w1	y	1.7E+04	3.0E+05	-87.60	87.06	2.47E+09	4.17E+05
w2	x	3.1E+06	1.6E+05	-7.60	100.06	3.12E+10	5.28E+06
w3	y	5.7E+04	1.4E+06	72.40	57.06	7.64E+09	1.29E+06
w4	x	2.3E+05	1.0E+04	60.40	14.06	8.15E+07	1.38E+04
w5,6	y	6.9E+04	1.7E+06	48.40	-37.94	4.18E+09	7.07E+05
w7,c9-11	x	6.5E+05	3.0E+04	96.40	-37.94	1.22E+09	2.06E+05
w8	y	2.7E+03	3.4E+05	120.40	-63.94	4.99E+09	8.44E+05
w9	x	1.9E+05	5.8E+03	108.40	-89.94	1.60E+09	2.71E+05
w10	x	2.3E+06	9.0E+04	-19.60	-89.94	1.87E+10	3.16E+06
w11,12	y	8.5E+04	1.8E+06	-87.60	-36.24	1.42E+10	2.40E+06
w13,c2-3	x	5.3E+05	2.1E+04	-116.40	-37.94	1.04E+09	1.76E+05
w14	x	5.2E+05	1.2E+04	72.40	-83.69	3.70E+09	6.25E+05
w15	y	4.6E+02	1.1E+05	120.40	10.86	1.58E+09	2.67E+05
w16	y	4.6E+02	1.1E+05	110.90	10.86	1.34E+09	2.27E+05
w17	x	1.0E+04	1.5E+02	115.70	-4.14	2.13E+06	3.60E+02
w18	x	1.0E+04	1.5E+02	115.70	3.86	2.11E+06	3.57E+02
w19	x	1.0E+04	1.5E+02	115.70	25.86	8.84E+06	1.49E+03
w20	y	2.7E+03	3.4E+05	-179.60	-63.94	1.11E+10	1.88E+06
c1		8.7E+03	9.3E+03	-159.60	-37.94	2.49E+08	4.21E+04
c4		8.7E+03	9.3E+03	-63.60	-37.94	5.01E+07	8.47E+03
c5		8.7E+03	9.3E+03	-43.60	-37.94	3.02E+07	5.10E+03
c6		8.7E+03	9.3E+03	-19.60	-37.94	1.61E+07	2.72E+03
c7		8.7E+03	9.3E+03	0.40	-37.94	1.25E+07	2.11E+03
c8		8.7E+03	9.3E+03	24.40	-37.94	1.80E+07	3.05E+03
s1		8.9E+02	4.4E+03	-179.60	100.06	1.51E+08	2.55E+04
s2		8.9E+02	4.4E+03	-159.60	100.06	1.21E+08	2.04E+04
s3		8.9E+02	4.4E+03	-135.60	100.06	8.96E+07	1.52E+04
s4		8.9E+02	4.4E+03	-111.60	100.06	6.36E+07	1.07E+04
s5		8.9E+02	4.4E+03	96.40	100.06	4.97E+07	8.40E+03
s6		8.9E+02	4.4E+03	120.40	100.06	7.26E+07	1.23E+04
s7		3.7E+01	9.2E+01	-159.60	-63.94	2.50E+06	4.23E+02
s8		3.7E+01	9.2E+01	-135.60	-63.94	1.85E+06	3.12E+02
s9		3.7E+01	9.2E+01	-111.60	-63.94	1.30E+06	2.20E+02
s10		3.7E+01	9.2E+01	-63.60	-63.94	5.24E+05	8.86E+01
s11		3.7E+01	9.2E+01	-43.60	-63.94	3.26E+05	5.52E+01
s12		3.7E+01	9.2E+01	-19.60	-63.94	1.86E+05	3.15E+01
s13		3.7E+01	9.2E+01	0.40	-63.94	1.51E+05	2.55E+01
s14		3.7E+01	9.2E+01	24.40	-63.94	2.06E+05	3.48E+01
s15		3.7E+01	9.2E+01	72.40	-63.94	6.35E+05	1.07E+02

s16	3.7E+01	9.2E+01	96.40	-63.94	1.01E+06	1.70E+02
s17	1.1E+01	7.4E+01	-159.60	-89.94	1.97E+06	3.33E+02
s18	1.1E+01	7.4E+01	-135.60	-89.94	1.45E+06	2.45E+02
s19	1.1E+01	7.4E+01	-111.60	-89.94	1.01E+06	1.71E+02
s20	1.1E+01	7.4E+01	72.40	-89.94	4.77E+05	8.06E+01
s21	3.0E+02	1.1E+01	-179.60	81.86	2.34E+06	3.95E+02
s22	3.0E+02	1.1E+01	-179.60	65.06	1.61E+06	2.72E+02
s23	3.0E+02	1.1E+01	-179.60	50.06	1.10E+06	1.85E+02
s24	3.0E+02	1.1E+01	-179.60	32.06	6.61E+05	1.12E+02
s25	3.0E+02	1.1E+01	-179.60	11.46	3.96E+05	6.69E+01
s26	3.0E+02	1.1E+01	-179.60	-4.14	3.62E+05	6.12E+01
s27	3.0E+02	1.1E+01	-179.60	-19.74	4.72E+05	7.98E+01
s28	3.0E+02	1.1E+01	120.40	81.86	2.14E+06	3.62E+02
s29	3.0E+02	1.1E+01	120.40	65.06	1.41E+06	2.38E+02
s30	3.0E+02	1.1E+01	120.40	50.06	9.01E+05	1.52E+02
s31	3.0E+02	1.1E+01	120.40	32.06	4.64E+05	7.85E+01
s32	3.0E+02	1.1E+01	120.40	-19.74	2.76E+05	4.66E+01
	7.86E+06	6.62E+06			1.06E+11	1.79E+07

Ax = 1329.10 ft^2
Ay = 1119.63 ft^2
Iz = 1.79E+07 ft^4

JOB NO. 59037.01 JOB Seismic Analysis of WPN-2 BY JMB DATE 5/27/93

CALC. NO. C-006 SUBJECT CHK'D [illegible] DATE 6/23/93

Properties below Elev. 531'-0"

$A = 3310.5\ ft^2$

$A_x = 1329.1\ ft^2$

$A_y = 1119.6\ ft^2$

$I_{zz} = 1.79 \times 10^7\ ft^4$

$I_{xx} = 1.75 \times 10^7\ ft^4$

$I_{yy} = 2.13 \times 10^7\ ft^4$

$X_{CR} = 19.60\ ft$

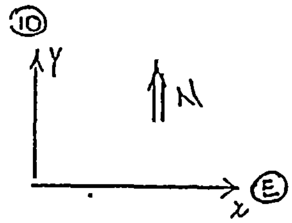
$Y_{CR} = 11.94\ ft$

Concrete:

E = 415,295.6 ksf

G = 177,476.8 ksf

ν = 0.17



Note: Axial center of wall and column areas are taken at center of rigidity (Xcr, Ycr), because the difference is small.

EQE

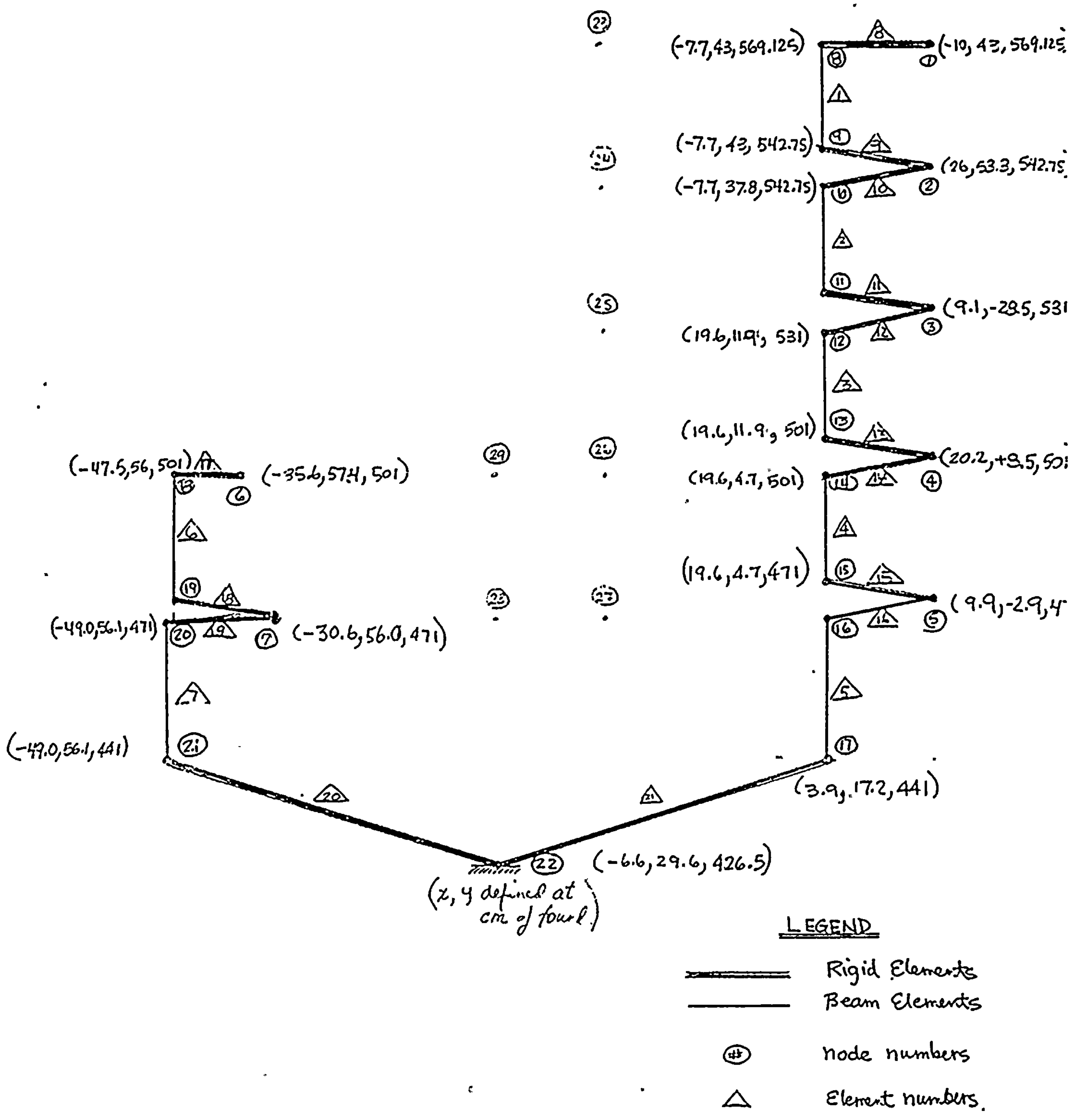
EQE ENGINEERING

SHEET NO. 200

JOB NO. 59037.01 JOB Seismic Analysis of WPN-2 BY GMB DATE 6/22/93

CALC. NO. C-006 SUBJECT CHK'D [illegible] DATE 6/23/93

Turbine Building Stick Model Representation



1**** Algor (c) Dynamic Modal Analysis SSAP1 05/03/91 ver 9.20/387

DATE: JUNE 23,1993
TIME: 04:46 PM
INPUT FILE.............turbine

Seismic Analysis of WPN-2 - Turbine Building

1**** CONTROL INFORMATION

number of node points	(NUMNP)	=	29
number of element types	(NELTYP)	=	1
number of load cases	(LL)	=	0
number of frequencies	(NF)	=	30
geometric stiffness flag	(GEOSTF)	=	0
analysis type code	(NDYN)	=	1
solution mode	(MODEX)	=	0
equations per block	(KEQB)	=	0
weight and c.g. flag	(IWTCG)	=	0
bandwidth minimization flag	(MINBND)	=	0
gravitational constant	(GRAV)	=	3.2200E+01

bandwidth minimization specified

1**** NODAL DATA

NODE NO.	BOUNDARY CONDITION CODES DX	DY	DZ	RX	RY	RZ	NODAL POINT COORDINATES X	Y	Z	T
1	0	0	0	0	0	0	-1.000E+01	4.300E+01	5.691E+02	0.000E+00
2	0	0	0	0	0	0	2.600E+01	5.330E+01	5.427E+02	0.000E+00
3	0	0	0	0	0	0	9.100E+00	-2.850E+01	5.310E+02	0.000E+00
4	0	0	0	0	0	0	2.020E+01	8.500E+00	5.010E+02	0.000E+00
5	0	0	0	0	0	0	9.900E+00	-2.900E+00	4.710E+02	0.000E+00
6	0	0	0	0	0	0	-3.560E+01	5.740E+01	5.010E+02	0.000E+00
7	0	0	0	0	0	0	-3.060E+01	5.600E+01	4.710E+02	0.000E+00
8	0	0	0	0	0	0	-7.700E+00	4.300E+01	5.691E+02	0.000E+00
9	0	0	0	0	0	0	-7.700E+00	4.300E+01	5.427E+02	0.000E+00
10	0	0	0	0	0	0	-7.700E+00	3.780E+01	5.427E+02	0.000E+00
11	0	0	0	0	0	0	-7.700E+00	3.780E+01	5.310E+02	0.000E+00
12	0	0	0	0	0	0	1.960E+01	1.190E+01	5.310E+02	0.000E+00
13	0	0	0	0	0	0	1.960E+01	1.190E+01	5.010E+02	0.000E+00
14	0	0	0	0	0	0	1.960E+01	4.700E+00	5.010E+02	0.000E+00
15	0	0	0	0	0	0	1.960E+01	4.700E+00	4.710E+02	0.000E+00
16	0	0	0	0	0	0	3.900E+00	1.720E+01	4.710E+02	0.000E+00
17	0	0	0	0	0	0	3.900E+00	1.720E+01	4.410E+02	0.000E+00
18	0	0	0	0	0	0	-4.750E+01	5.600E+01	5.010E+02	0.000E+00
19	0	0	0	0	0	0	-4.750E+01	5.600E+01	4.710E+02	0.000E+00
20	0	0	0	0	0	0	-4.900E+01	5.610E+01	4.710E+02	0.000E+00
21	0	0	0	0	0	0	-4.900E+01	5.610E+01	4.410E+02	0.000E+00
22	1	1	1	1	1	1	-6.600E+00	2.960E+01	4.265E+02	0.000E+00
23	1	1	1	1	1	1	-6.700E+00	4.300E+01	5.691E+02	0.000E+00
24	1	1	1	1	1	1	-6.700E+00	3.780E+01	5.427E+02	0.000E+00
25	1	1	1	1	1	1	2.060E+01	1.190E+01	5.310E+02	0.000E+00
26	1	1	1	1	1	1	2.060E+01	4.700E+00	5.010E+02	0.000E+00
27	1	1	1	1	1	1	4.900E+00	1.720E+01	4.710E+02	0.000E+00
28	1	1	1	1	1	1	-4.800E+01	5.610E+01	4.710E+02	0.000E+00
29	1	1	1	1	1	1	-4.650E+01	5.600E+01	5.010E+02	0.000E+00

**** PRINT OF EQUATION NUMBERS SUPPRESSED

1**** BEAM ELEMENTS

number of beam elements	=	21
number of area property sets	=	9

number of fixed end force sets	=	0
number of materials	=	2
number of intermediate load sets	=	0

1**** MATERIAL PROPERTIES

INDEX	E	MU	MASS DENSITY	WEIGHT DENSITY	THERMAL EXPANSION X.	Y	Z	REFERENCE TEMPERATURE
1	4.15E+05	.170	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000E+00
2	4.18E+06	.300	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000E+00

1**** AREA PROPERTIES

INDEX	AREAS AXIAL A(1)	SHEAR A(2)	SHEAR A(3)	TORSION J(1)	FLEXURAL INERTIAS I(2)	I(3)
1	3.430E+01	4.100E+00	2.490E+00	3.740E+04	1.520E+05	3.350E+05
2	3.140E+01	4.210E+00	2.490E+00	3.770E+04	1.370E+05	3.090E+05
3	3.311E+03	1.329E+03	1.120E+03	1.790E+07	1.750E+07	2.130E+07
4	4.211E+03	1.542E+03	1.469E+03	2.950E+07	2.090E+07	3.670E+07
5	4.628E+03	1.506E+03	1.717E+03	2.310E+07	1.820E+07	3.120E+07
6	1.703E+03	8.627E+02	1.273E+03	7.550E+06	7.290E+05	6.690E+06
7	1.808E+03	8.104E+02	2.813E+02	1.840E+06	8.810E+05	7.250E+06
8	1.000E+06	1.000E+06	1.000E+06	1.000E+12	1.000E+12	1.000E+12
9	2.000E+06	2.000E+06	2.000E+06	2.000E+12	2.000E+12	2.000E+12

1**** STRESS PROPERTIES

INDEX	SECTION MODULI S(2)	S(3)
1	0.000E+00	0.000E+00
2	0.000E+00	0.000E+00
3	0.000E+00	0.000E+00
4	0.000E+00	0.000E+00
5	0.000E+00	0.000E+00
6	0.000E+00	0.000E+00
7	0.000E+00	0.000E+00
8	0.000E+00	0.000E+00
9	0.000E+00	0.000E+00

1**** ELEMENT LOAD MULTIPLIERS

	CASE A	CASE B	CASE C	CASE D
X-DIR	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-DIR	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Z-DIR	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1**** ELEMENT CONNECTIVITY DATA

ELEMENT NO.	NODE I	NODE J	NODE K	MAT'L INDEX	SECTN INDEX	ELEMENT LOADS A	B	C	D	RELEASE CODES I-END	J-END	MEMBER NO.
1	9	8	23	2	1	0	0	0	0	0	0	
2	11	10	24	2	2	0	0	0	0	0	0	
3	13	12	25	1	3	0	0	0	0	0	0	
4	15	14	26	1	4	0	0	0	0	0	0	
5	17	16	27	1	5	0	0	0	0	0	0	
6	19	18	29	1	6	0	0	0	0	0	0	
7	21	20	28	1	7	0	0	0	0	0	0	
8	1	8	9	2	8	0	0	0	0	0	0	
9	2	9	8	2	8	0	0	0	0	0	0	
10	2	10	11	2	8	0	0	0	0	0	0	

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11	3	11	10	1	8	0	0	0	0	0	0
12	3	12	13	1	8	0	0	0	0	0	0
13	4	13	12	1	8	0	0	0	0	0	0
14	4	14	15	1	8	0	0	0	0	0	0
15	5	15	14	1	8	0	0	0	0	0	0
16	5	16	17	1	8	0	0	0	0	0	0
17	6	18	19	1	8	0	0	0	0	0	0
18	7	19	18	1	8	0	0	0	0	0	0
19	7	20	21	1	8	0	0	0	0	0	0
20	22	21	20	1	9	0	0	0	0	0	0
21	22	17	16	1	9	0	0	0	0	0	0

1**** BANDWIDTH MINIMIZATION

minbnd (bandwidth control parameter) = 1
bandwidth before resequencing = 84
bandwidth after resequencing = 12

**** EQUATION PARAMETERS

total number of equations = 126
bandwidth 12
number of equations in a block = 125
number of blocks = 2
blocking memory (kilobytes) = 2793
available memory (kilobytes) = 2793

**** Hard disk file size information for processor:

Available hard disk space on C drive = 116.232 megabytes
Estimated required hard disk space = .293 megabytes

1**** NODAL LOADS (STATIC) OR MASSES (DYNAMIC)

NODE NUMBER	LOAD CASE	X-AXIS FORCE	Y-AXIS FORCE	Z-AXIS FORCE	X-AXIS MOMENT	Y-AXIS MOMENT	Z-AXIS MOMENT
1	0	7.940E+01	7.940E+01	7.940E+01	1.090E+05	6.030E+05	7.120E+05
2	0	2.790E+01	2.790E+01	2.790E+01	9.860E+04	2.720E+05	3.130E+05
3	0	3.172E+02	3.172E+02	3.172E+02	1.160E+06	2.330E+06	3.450E+06
4	0	1.143E+03	1.143E+03	1.143E+03	5.030E+06	7.730E+06	1.320E+07
5	0	1.442E+03	1.442E+03	1.442E+03	5.410E+06	9.860E+06	1.470E+07
6	0	6.424E+02	6.424E+02	6.424E+02	2.330E+05	2.290E+06	2.460E+06
7	0	3.546E+02	3.546E+02	3.546E+02	1.730E+05	1.420E+06	1.560E+06

1**** ELEMENT LOAD MULTIPLIERS

load case	case A	case B	case C	case D
1	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1**** STIFFNESS MATRIX PARAMETERS

minimum non-zero diagonal element = 2.6056E+09
maximum diagonal element = 1.8157E+18
maximum/minimum = 6.9682E+08
average diagonal element = 9.3139E+16
density of the matrix = 2.2367E+01

1**** EIGENVALUE ANALYSIS

**** SUBSPACE ITERATION ALGORITHM EXECUTED

1**** MODAL ANALYSIS CONTROL INFORMATION

flag for additional printing (IFPR) = 0
sturm sequence check flag (IFSS) = 0
maximum iteration cycles (NITEM) = 32
convergence tolerance (RTOL) = 1.0000E-05
cut-off frequency (hertz) (COFQ) = 5.0000E+01
no. of starting iteration vectors (NFO) = 0
est. no. of rigid body modes (NSF) = 0
eigen value shift (given) (SHIFT) = 0.0000E+00
orthogonality check flag (NORTH) = 0

**** SOLUTION SOUGHT FOR FOLLOWING EIGENPROBLEM

number of equations = 126
half bandwidth of stiffness matrix = 12
number of equation blocks = 2
number of equations per block = 125
number of eigenvalues required = 30

1**** ITERATION NUMBER............................ 1
sweep number in jacobi = 10

relative tolerance reached on eigenvalues:

.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01
.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01	.1000D+01

1**** ITERATION NUMBER............................ 2
sweep number in jacobi = 8

relative tolerance reached on eigenvalues:

.1959D-15	.7541D-15	.1903D-14	.1909D-14	.3678D-15	.2637D-14
.2593D-14	.1170D-14	.1208D-15	.1440D-13	.2545D-14	.5289D-15
.9067D-15	.6172D-14	.4515D-14	.1267D-14	.6443D-13	.1177D-14
.1751D-14	.2740D-15	.2027D-13	.5994D-14	.3053D-14	.1449D-13
.4280D-14	.1124D-14	.4158D-14	.2210D-13	.2100D-13	.5749D-11
.3390D-10	.2997D-14	.7175D-10	.8751D-10	.3065D-13	.1879D-10
.1697D-14	.1431D-11	.1459D-09	.7896D-12	.7771D-09	.4839D-09

**** CONVERGENCE ACHIEVED IN EIGSOL

number of eigenvalues = 30
relative tolerance = 1.0000E-05

1**** WE SOLVED.FOR THE FOLLOWING EIGENVALUES:

1.16054D+03	1.20610D+03	1.67294D+03	1.90581D+03	2.47284D+03	2.58721D+03
2.63053D+03	3.10910D+03	3.76481D+03	1.16236D+04	1.28671D+04	1.37575D+04
1.40427D+04	1.50295D+04	1.57124D+04	1.72268D+04	1.86340D+04	2.16327D+04
2.28528D+04	2.65515D+04	3.05167D+04	3.27730D+04	3.33668D+04	3.71684D+04
4.42035D+04	4.53108D+04	5.24902D+04	5.53031D+04	6.16825D+04	7.88087D+04

**** UPPER BOUNDS ON EIGENVALUE CLUSTERS

1.16634D+03	1.21213D+03	1.68130D+03	1.91534D+03	2.48520D+03	2.60014D+03
2.64368D+03	3.12464D+03	3.78363D+03	1.16817D+04	1.29314D+04	1.38263D+04
1.41130D+04	1.51046D+04	1.57910D+04	1.73129D+04	1.87272D+04	2.17408D+04
2.29671D+04	2.66843D+04	3.06693D+04	3.29368D+04	3.35337D+04	3.73543D+04

B19

59037-C-044

EQE INTERNATIONAL

SHEET NO. C1

JOB NO. 59037 JOB WNPSS IPEEE BY PSH DATE 7-18-94

CALC. NO. ____ SUBJECT Turbine Bldg CHK'D [initials] DATE 7-20-94

ATTACHMENT C

EXCERPTS FROM REFERENCE 6

(4 pp. total)

E = Modulus of elasticity

ν = Poisson's ratio

G = Shear modulus

t_i = Wall thickness

L_i = Wall length

h = Story height

x_i = X-coordinate of wall centroid

z_i = Z- "   "

K_{Vi} = Wall shear stiffness

$$= \frac{A_i G}{h}$$

A_i = Wall cross-sectional area

$= t_i L_i$

K_{Bi} = Wall bending stiffness

$$= \frac{12 E I_i}{h^3}$$ fixed fixed

I_i = Wall moment of inertia

$$= \frac{1}{12} t_i L_i^3$$

K_i = Wall stiffness

$$= \frac{K_{Vi} K_{Bi}}{K_{Vi} + K_{Bi}}$$

K_x = Story lateral stiffness in X-direction

$$= \sum_i K_{ix}$$

K_z = Story lateral stiffness in Z-direction

$$= \sum_i K_{iz}$$

K_{ix}, K_{iz} = Wall stiffnesses in X, Z directions

X_{cr} = X-coordinate of center of rigidity

$$= \frac{\sum_i K_{iz} X_i}{K_z}$$

Z_{cr} = Z-coordinate of center of rigidity

$$= \frac{\sum_i K_{ix} Z_i}{K_x}$$

K_ϕ = Story torsional stiffness

$$= \sum_i \left[K_{ix} (Z_i - Z_{cr})^2 + K_{iz} (X_i - X_{cr})^2 \right]$$

For ground motion excitation direction j

V_x^j, V_z^j = Overall story shears in x, z directions

T^j = Overall story torsional moment

$M_{xx,t}^j$, $M_{zz,t}^j$ = Overall OT moments at top of story about x, z axes.

$M_{xx,b}^j$, $M_{zz,b}^j$ = Overall OT moments at bottom of story about x, z axes

$V_{ix,d}^j$ = Wall shear in X-direction due to direct shear

$$= V_x^j \frac{K_{ix}}{K_x}$$

$V_{ix,t}^j$ = Wall shear in X-direction due to torsional moment

$$= \left| T^j \cdot \frac{K_{ix}(Z_i - Z_{cr})}{K_\phi} \right| \quad \text{(absolute value)}$$

V_{ix}^j = Total wall shear in X-direction

$$= V_{ix,d}^j + V_{ix,t}^j$$

Wall shears in Z-direction are calculated similarly

ΔM_{xx}^{j} = Incremental OT moment about X-axis

$= M_{xx,b}^{j} - M_{xx,t}^{j}$

ΔM_{zz}^{j} = Incremental OT moment about Z-axis

$= M_{zz,b}^{j} - M_{zz,t}^{j}$

$\Delta M_{i\,xx,d}^{j}$ = Wall incremental OT moment about X-axis due to (direct) incremental OT moment

$$= \Delta M_{xx}^{j} \frac{K_{iz}}{K_z}$$

$\Delta M_{i\,xx,t}^{j}$ = Wall incremental OT moment about X-axis due to torsional moment

$= V_{i\,z,t}^{j}\ h$

$\Delta M_{i\,xx}^{j}$ = Total wall incremental OT moment about X-axis

$= \Delta M_{i\,xx,d}^{j} + \Delta M_{i\,xx,t}^{j}$