

**ENCLOSURE 8**

**GEH Technical Report**

**WG3-U97-ERD-S-0001 Revision 1**

**Fuel Building Structural Design Report**

**HITACHI****WG3-U97-ERD-S-0001**

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**HITACHI**

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**TABLE OF CONTENTS**

1.	SCOPE .....	10
2.	APPLICABLE DOCUMENTS .....	10
2.1	Supporting and Supplemental Documents .....	10
2.1.1	Supporting Documents.....	10
2.1.2	Supplemental Documents .....	10
2.2	Industry Codes and Standards .....	11
2.3	Regulation and Regulatory Requirements.....	12
2.4	References .....	12
3.	STRUCTURAL DESCRIPTION AND GEOMETRY .....	12
3.1	Structural Geometry and Dimensions .....	12
3.2	Key Structural Elements and Descriptions.....	13
3.3	Floor Layout and Elevations .....	13
3.4	Conditions of Vicinity and Support.....	13
3.5	Special Structural Features.....	13
4.	STRUCTURAL MATERIAL REQUIREMENTS.....	14
4.1	Concrete.....	14
4.2	Reinforcement .....	14
4.3	Structural Steel .....	14
4.3.1	Carbon Steel Plate and Shapes.....	14
4.3.2	Stainless Steel Plate .....	14
4.3.3	Steel Decking .....	14
5.	STRUCTURAL LOADS.....	14
5.1	Live Loads and Dead Loads.....	14
5.1.1	Dead Loads .....	14
5.1.2	Live Loads .....	15
5.2	Transient Loads .....	15
5.2.1	Pressure Loads .....	15
5.2.2	Thermal Loads .....	15
5.2.3	Hydrodynamic Loads.....	16
5.2.4	RPV Reactions due to Hydrodynamic Loads .....	16
5.3	Environmental Loads .....	16
5.3.1	Wind Loads.....	16
5.3.2	Tornado Loads .....	17
5.3.3	Seismic Loads .....	17
6.	STRUCTURAL ANALYSIS AND DESIGN .....	18
6.1	General Description.....	18
6.2	Stress Analysis .....	18
6.2.1	Analysis Program.....	18
6.2.2	Analysis Model .....	19
6.2.3	Method of Applying Loads.....	19
6.2.4	Analysis Results.....	19
6.3	Load Combinations .....	19



6.3.1	Code Requirements .....	19
6.3.2	Selection of Design Load Combinations .....	19
6.3.3	Result of Load Combination .....	21
6.4	Section Design Principles .....	22
6.4.1	Section Design of Reinforced Concrete Structures .....	22
6.4.1.1	Walls and Slabs .....	22
6.4.1.2	Columns and Girders .....	25
6.4.2	Section Design of Steel Structures .....	29
6.4.2.1	Section Design for Axial Compression and Bending .....	29
6.4.2.2	Section Design for Axial Tension and Bending .....	30
6.4.2.3	Section Design for Transverse Shear .....	30
6.4.2.4	Allowable Stresses .....	31
7.	SUMMARY OF RESULTS .....	32
7.1	Required Section .....	32
7.2	Provided Section .....	32
7.3	Tabulation of Allowable Stresses versus Calculated Stresses .....	33
7.3.1	Reinforced Concrete Structure .....	33
7.3.1.1	Walls and Slabs .....	33
7.3.1.2	Columns and Beams .....	35
7.3.2	Steel Structure .....	35
8.	CONCLUSIONS .....	35
Appendix A	COMPARISON WITH DCD DATA .....	129
Appendix B	IN-PLANE SHEAR CHECK FOR FB ACCORDING TO ACI 349-01 .....	144
Appendix C	COMPRESSION LIMIT CHECK FOR FB ACCORDING TO ACI 349-01 .....	152



## LIST OF TABLES

Table 3.1-1	Key Dimensions of RB and FB .....	37
Table 5.1.1-1	Dead Loads of Equipment in FB .....	38
Table 5.1.1-2	Miscellaneous Structures, Piping, and Commodities on the Slabs .....	39
Table 5.1.2-1	Floor Live Loads .....	40
Table 5.1.2-2	Design Lateral Soil Pressure at Rest .....	40
Table 5.2.2-1	Steady State Temperature Conditions .....	41
Table 5.2.2-2	Thermal Loads for Shell Elements Normal Operation: Summer .....	42
Table 5.2.2-3	Thermal Loads for Shell Elements Normal Operation: Winter.....	42
Table 5.2.2-4	Design Basis Accident Temperatures in Spent Fuel Pool .....	43
Table 5.2.2-5	Thermal Loads for Shell Elements around Spent Fuel Pool: 72 hr. after DBA: Summer .....	44
Table 5.2.2-6	Thermal Loads for Shell Elements around Spent Fuel Pool: 72 hr. after DBA: Winter .....	44
Table 5.3.1-1	Design Wind Pressure Loads by Floor Level.....	45
Table 5.3.2-1	Design Pressure of Tornado Wind Load .....	45
Table 5.3.3-1	Design Seismic Loads for Horizontal SSE (RB and FB Walls).....	46
Table 5.3.3-2	Maximum Vertical Accelerations (RB and FB Walls and Floor Slab).....	47
Table 5.3.3-3	Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab Oscillators.....	48
Table 5.3.3-4	Soil Pressure Due to an Earthquake .....	50
Table 5.3.3-5	Seismic Hydrodynamic Loads in the Spent Fuel Pool .....	50
Table 5.3.3-6	Enveloping Maximum Horizontal Acceleration: RB/FB Wall Out-of-Plane Oscillators .....	51
Table 6.2.2-1	Material Constants Used in Stress Analysis .....	52
Table 6.2.4-1	Results of NASTRAN Analysis, Dead Load .....	53
Table 6.2.4-2	Results of NASTRAN Analysis, Temperature Load (LOCA after 72 hours: Winter) .....	54
Table 6.2.4-3	Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction) .....	55
Table 6.2.4-4	Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction) .....	56
Table 6.2.4-5	Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)....	57
Table 6.3.1-1	Load Combinations and Acceptance Criteria for Safety-Related Reinforced Concrete Structures .....	58
Table 6.3.1-2	Load Combinations and Acceptance Criteria for Safety-Related Steel Structures.....	59
Table 6.3.1-3	Load Combinations, Load Factors and Acceptance Criteria for Reinforced Concrete Containment .....	60
Table 6.3.2-1	Detail Load Combinations for Reinforced Concrete Structures.....	61
Table 6.3.2-2	Detail Load Combinations for Steel Structures.....	65
Table 6.3.3-1	Combined Forces and Moments, 1.05D + 1.3L + 1.3To + 1.3W: Winter – Load ID = 4021 (Selected Load Combination FB-4) .....	68
Table 6.3.3-2	Combined Forces and Moments, LOCA After 72 hours (1.5Pa): Winter – Load ID = 6441 (Selected Load Combination FB-8) .....	69



Table 6.3.3-3 Combined Forces and Moments, LOCA After 72 hours + SSE: Winter – Load ID = 7441 (Selected Load Combination FB-9).....	71
Table 6.4.1.1-1 Material Constants for Stress Calculations.....	73
Table 6.4.1.1-2 Allowable Stress of Concrete for Membrane Plus Bending.....	73
Table 6.4.1.1-3 Allowable Stress of Reinforcement for Membrane Plus Bending .....	73
Table 6.4.1.1-4 Allowable Stress of Concrete for Membrane Compressive Forces.....	74
Table 7.3.1.1.1-1 Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation .....	75
Table 7.3.1.1.1-2 Rebar and Concrete Stresses of FB, 1.05D+1.3L+1.3To+1.3W: Winter – Load ID = 4021 (Selected Load Combination FB-4) .....	77
Table 7.3.1.1.1-3 Rebar and Concrete Stresses of FB, LOCA After 72 hours (1.5Pa): Winter – Load ID = 6441 (Selected Load Combination FB-8) .....	78
Table 7.3.1.1.1-4 Rebar and Concrete Stresses of FB, LOCA After 72 hours + SSE: Winter – Load ID = 7441 (Selected Load Combination FB-9) .....	79
Table 7.3.1.1.1-5 Maximum Stress Ratios for Flexure and Membrane Forces .....	80
Table 7.3.1.1.2-1 Membrane Compressive Forces of FB .....	81
Table 7.3.1.1.3-1 Transverse Shear of FB .....	82
Table 7.3.1.1.3-2 Transverse Shear of FB for DCD Load Combinations .....	83
Table 7.3.1.2-1 Maximum Stress Ratio of FB Reinforced Concrete Column.....	84
Table 7.3.1.2-2 Maximum Stress Ratio of FB Reinforced Concrete Girder .....	86
Table 7.3.2-1 Maximum Stress Ratio of FB Steel Girder.....	88



## LIST OF FIGURES

Figure 1-1	RB/FB Global FE Analysis Model .....	89
Figure 3.1-1	RB and FB Concrete Outline Plan at EL -11500 .....	90
Figure 3.1-2	RB and FB Concrete Outline Plan at EL 4650 .....	91
Figure 3.1-3	RB and FB Concrete Outline Plan at EL 17500 .....	92
Figure 3.1-4	RB and FB Concrete Outline Plan at EL 27000 .....	93
Figure 3.1-5	RB Concrete Outline Plan at EL 34000 .....	94
Figure 3.1-6	RB and FB Concrete Outline N-S Section .....	95
Figure 3.1-7	RB and FB Concrete Outline E-W Section .....	96
Figure 5.1.2-1	Snow Load Considered Drift Load .....	97
Figure 5.2.2-1	Application of Thermal Load on the External Wall (RA) .....	98
Figure 5.2.2-2	Application of Thermal Load on the External Wall (RG FF) .....	99
Figure 5.2.2-3	Application of Thermal Load on the External Wall (R7/F1) .....	100
Figure 5.2.2-4	Application of Thermal Load on the External Wall (F3) .....	101
Figure 5.2.2-5	Application of Thermal Load on the Basemat .....	102
Figure 5.2.2-6	Application of Thermal Load on the Spent Fuel Pool Wall-1 .....	103
Figure 5.2.2-7	Application of Thermal Load on the Spent Fuel Pool Wall-2 .....	104
Figure 5.2.2-8	Application of Thermal Load on the Spent Fuel Pool Wall-3 .....	105
Figure 5.3.3-1	Dynamic Analysis Model .....	106
Figure 6.2.4-1	Elements Selected for Tabulation (External Wall F3) .....	107
Figure 6.2.4-2	Elements Selected for Tabulation (External Wall RA FA) .....	108
Figure 6.2.4-3	Elements Selected for Tabulation (Basemat) .....	109
Figure 6.2.4-4	Elements Selected for Tabulation (Slab at EL 4,650) .....	110
Figure 6.2.4-5	Elements Selected for Tabulation (Spent Fuel Pool Wall) .....	111
Figure 6.2.4-6	Force and Moment in Shell Element .....	112
Figure 6.4.1-1	Design Flow Chart of Reinforced Concrete Structures .....	113
Figure 6.4.1-2	Comparison of Bending Moment-Axial Force (P-M) Interactions .....	114
Figure 6.4.1.1-1	Calculation of Shear Strength Provided by Concrete .....	115
Figure 6.4.1.2-1	Stress-Strain Relationship Assumed for Strength Check .....	116
Figure 6.4.1.2-2	Calculation Method of Strength Ratios .....	117
Figure 6.4.2-1	Allowable Stress of W-shaped Members (Strong Axis Bending) .....	118
Figure 6.4.2-2	Allowable Stress of W-shaped Members (Weak Axis Bending) .....	119
Figure 6.4.2-3	Allowable Bending Stress of Box Members .....	120
Figure 7.1-1	Reinforcing Steel of Spent Fuel Pool Walls .....	121
Figure 7.1-2	List of FB Wall and Slab Reinforcement .....	122
Figure 7.1-3	FB Reinforced Concrete Column Reinforcing Schedule .....	123
Figure 7.1-4	FB Reinforced Concrete Girder Reinforcing Schedule .....	124
Figure 7.1-5	FB Steel Girder Member .....	125
Figure 7.3.1.1-1	P-M Demand and Capacities for Element 72004 with New Arrangement of Reinforcement .....	126
Figure 7.3.1.2-1	Elements Selected for Tabulation - FB Frame - .....	128

**LIST OF ACRONYM**

CB	Control Building
CH	Chugging
CO	Condensation Oscillation
DBA	Design Basis Accident
DCD	Design Control Document
DLF	Dynamic Load Factor
ESBWR	Economic Simplified Boiling Water Reactor
EW	East-West
FB	Fuel Building
FE	Finite Element
FAPCS	Fuel and Auxiliary Pools Cooling System
FWSC	Firewater Service Complex
GDCS	Gravity-Driven Cooling System
HELB	High Energy Line Break
LOCA	Loss of Coolant Accident
NA3	North Anna Unit 3
NS	North-South
PS	Pool Swell
RB	Reactor Building
RB/FB	Reactor/Fuel Building Complex
RCCV	Reinforced Concrete Containment Vessel
RG	Regulatory Guides
RPV	Reactor Pressure Vessel
SRP	Standard Review Plan
SRSS	Square Root of the Sum of the Squares
SRV	Safety Relief Valve
SSE	Safe Shutdown Earthquake
SSI	Soil-Structure Interaction



## 1. SCOPE

This report describes the section design calculation results of the Fuel Building (FB) for North Anna Unit 3 (NA3) site-specific seismic load demands that exceed the seismic loads used for the standard design of the FB. The scope of the evaluation is the analysis and stress checks of the structure for site-specific seismic loads in combination with other design loads in critical seismic load combinations. The analysis is performed using the same NASTRAN models used for the standard design of the FB, which are further described in Section 6.2.2.1 of Reference 2.1.2-p. The design loads applied to the models are the same as those considered in the standard design, except for the Safe Shutdown Earthquake (SSE) loads that are obtained from Reference 2.1.2-o. The NA3 site-specific SSE loads are combined with non-seismic standard plant loads following the same standard design analysis methodology and acceptance criteria.

The FB is integrated with the Reactor Building (RB), including the Reinforced Concrete Containment Vessel (RCCV), sharing a large common foundation mat. In the structural design of the FB, RB, and RCCV, stresses are evaluated using one Finite Element (FE) analysis model (RB/FB global model), which is shown in Figure 1-1. As described later in Chapter 6, the details of the FE analysis methods, such as analysis model and load application methods, are included in WG3-U71-ERD-S-0004, "North Anna 3 Reactor Building Structural Design Report", Reference 2.1.2-p. Therefore, this report describes mainly the results of FE analyses and section design calculations of the FB.

## 2. APPLICABLE DOCUMENTS

### 2.1 Supporting and Supplemental Documents

The following documents form a part of this document:

#### 2.1.1 Supporting Documents

Supporting documents are those documents that complete the requirements of this document and are referred to herein.

#### Designation

- a. 105E4059, Fuel Building Concrete Drawings, Revision 3 U97-2010
- b. eDRF Section 0000-0102-0965, "Deliverable to Structural Group for Steady State Heat Transfer and Stress Analysis", Revision 0

#### 2.1.2 Supplemental Documents

Supplemental documents are those documents that are to be used in conjunction with this document.

#### Designation

- a. SR3-1-A11-TRD-5201, Standard Review Plans and Regulatory Guides Design Specification, Revision 0 A11-5201
- b. 105E3908, "ESBWR Nuclear Island General Arrangement Drawing", Revision 5



- c. 26A6642AL, "ESBWR Design Control Document Tier 2 Chapter 3 Appendices 3A – 3F", Revision 10
- d. 26A6642AN, "ESBWR Design Control Document Tier 2 Chapter 3 Appendices 3G – 3L", Revision 10
- e. DE-ES-0083, "Seismic Load Data for North Anna 3 from HGNE Analysis", Revision 0
- f. 26A6650, "ESBWR RCCV Structural Design Report", Revision 5
- g. 26A6651, "ESBWR Reactor Building Structural Design Report", Revision 5
- h. 26A6655, "ESBWR Fuel Building Structural Design Report", Revision 5
- i. 26A6605, "Design Specification for Concrete Containment", Revision 4
- j. 26A6606, "Design Specification for Reactor Building", Revision 2
- k. WG3-U71-ERD-S-0001, "North Anna 3 Reactor/Fuel Building Complex Seismic Analysis Report", Revision 4
- l. WG3-U71-ERD-S-0003, "North Anna 3 Reactor/Fuel Building Complex Stability Analysis Report", Revision 1
- m. SER-DMN-011, "Benchmarking of SASSI2010 MSM Results from NA3 Site-Specific SSI Analysis", Revision 1
- n. TODI WG3-A25-TDI-S-0004, "North Anna 3 RB/FB, CB & FWSC SSI Analyses EPRI 2013 GMPE Based Inputs", Revision 0
- o. SER-DMN-019 "RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra", Revision 1
- p. WG3-U71-ERD-S-0004, "North Anna 3 Reactor Building Structural Design Report", Revision 1
- q. WG3-T11-DRD-S-0001, "North Anna 3 RCCV Structural Design Report", Revision 1
- r. SR3-1-A11-TRD-5202, Industry Codes and Standards Design Specification, Revision 0  
A11-5202
- s. 26A6558, General Civil Design Criteria, Revision 4  
A40-4010
- t. 26A6649, Reactor/Fuel Building Complex Heat Transfer Analysis Report, Revision 3  
U71-5060
- u. 26A6608, Design Specification for Fuel Building, Revision 2  
U97-4010

## 2.2 Industry Codes and Standards

The following industry codes and standards shall form a part of this document to the extent specified herein. Unless otherwise specified, the applicable revision of the industry codes and





standards as indicated in the Industry Codes and Standards Design Specification (Reference 2.1.2-r) shall be used.

- a. ACI 349-01: "Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-01) and Commentary (ACI 349R-01)"
- b. ASME-2004: Boiler and Pressure Vessel Code, Section III, Rules for Construction of Nuclear Power Plant Components, Division 2, Subsection CC, "Code for Concrete Reactor Vessels and Containments"
- c. AISC N690-1994: "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities," with the Supplements No.1 (2002) and No.2 (2004)
- d. ASCE 7-02: "Minimum Design Loads for Buildings and Other Structures"
- e. ASCE 4-98: "Seismic Analysis of Safety-Related Nuclear Structures"

### **2.3 Regulation and Regulatory Requirements**

The following regulations and regulatory requirements shall form a part of this document to the extent specified herein. Unless otherwise specified, the applicable revision of the Standard Review Plans (SRP) and Regulatory Guides (RG) as indicated in the Standard Review Plans and Regulatory Guides Design Specification (Reference 2.1.2-a) shall be used.

- a. NUREG-0800, "USNRC Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants-Light Water Reactor Edition" Revision 4

### **2.4 References**

- a. A Review of Procedures for the Analysis and Design of Concrete Structures to Resist Missile Impact Effects, R.P. Kennedy, Holmes and Narver, Inc. (Nuclear Engineering and Design article Vol. 37 1976, pages 183-203)
- b. Topical Report, Design of Structures for Missile Impact, Bechtel Power Corp., BC-TOP-9A Revision 2, September 1974

## **3. STRUCTURAL DESCRIPTION AND GEOMETRY**

### **3.1 Structural Geometry and Dimensions**

The FB is integrated with the RB, sharing a common wall between the RB and the FB and a large common foundation mat. The FB houses the Spent Fuel Pool facilities and their supporting system, and HVAC equipment. The FB is a Seismic Category I structure except for the penthouse that houses HVAC equipment. The penthouse is a Seismic Category II structure, and the design of the penthouse is not included in this report.

The FB is a rigid box shape building, and its key dimensions are summarized in Table 3.1-1. Table 3.1-1 includes the key dimensions of the RB for reference. Floor plans and sections of the FB and RB are shown in Figures 3.1-1 through 3.1-7.



The NA3 site-specific seismic demands for sliding stability can be solved without shear key as shown in the NA3 RB/FB Stability Analysis Report, Reference 2.1.2-1. Therefore, shear key design is not contained in this report. The same shear keys as described in Reference 2.1.2-g are provided under the basemat for NA3.

### **3.2 Key Structural Elements and Descriptions**

The FB is a reinforced concrete shear wall structure consisting of walls and slabs and is supported by a foundation mat. Concrete framing is composite with concrete slab and used to support the slabs for vertical loads. As for the floor slab at EL 22,500, it is supported by steel girders.

The FB is a shear wall structure designed to accommodate all seismic loads with its walls and the connected floors. Therefore, frame members such as beams or columns are designed to accommodate deformations of the walls in case of earthquake conditions.

The Spent Fuel Pool is composed with thick walls and a bottom slab to satisfy the requirements of radiation shielding and to bear pressure loads of the contained water. The bottom slab of the Spent Fuel Pool is a part of the FB basemat. The thickness of the basemat is increased to 5.5 m, whereas it is 4.0 m in other regions. The steel liner plates are installed at the inside surfaces of the Spent Fuel Pool to prevent leakage, but the design of the steel liners is out of scope of this report.

### **3.3 Floor Layout and Elevations**

Floor layouts and sections of the FB are shown in Figures 3.1-1 through 3.1-7. The FB is a four-story (excluding the penthouse) building with rectangular-shaped floor plans. The FB structure is partially embedded with the top of basemat 16.0 meters below the finished ground level grade.

### **3.4 Conditions of Vicinity and Support**

In the Economic Simplified Boiling Water Reactor (ESBWR) NA3 site-specific design, the buildings including the RB are designed under the condition that they are supported by the foundation soil that has the following properties corresponding to the Soft Site conditions described in Reference 2.1.2-p. The soft site conditions are conservative for the NA3 rock site because softer soils lead to larger structural deformations.

- Shear wave velocity: 300 m/s
- Unit weight:  $0.0196 \text{ MN/m}^3$  ( $2.00 \text{ t/m}^3$ )
- Shear modulus:  $180 \text{ MN/m}^2$  ( $1.835 \times 10^4 \text{ t/m}^2$ )
- Poisson's Ratio: 0.478

### **3.5 Special Structural Features**

The FB has the following structural feature:

- Steel girders supporting the slabs at EL 22,500 are connected with pinned joints at their both ends.



#### **4. STRUCTURAL MATERIAL REQUIREMENTS**

##### **4.1 Concrete**

The specified compressive strengths,  $f'_c$ , of the concrete at 28 days, or earlier, are as follows:

- basemat: 27.6 MPa (4,000 psi)
- others: 34.5 MPa (5,000 psi)

##### **4.2 Reinforcement**

Reinforcing steel is deformed billet steel conforming to ASTM A-615 grade 60. Minimum yield strength,  $F_y$ , is 413.6 MPa (60,000 psi).

##### **4.3 Structural Steel**

###### **4.3.1 Carbon Steel Plate and Shapes**

Structural steel and fasteners of the FB conform to the following:

- Structural Steel: A572 Gr.50 (for girders)
- High strength bolts: ASTM A325 or A490
- Anchor bolts (rods): ASTM A36 or A307
- Steel floor decking: ASTM A446 with minimum  $f_y = 228$  MPa (33 ksi)
- Studs: ASTM A 108
- Pipe material: ASTM A-333 Gr. 1 or 6, and A312 tp 304L or 316L
- Forgings: ASTM A 350 Gr. LF1 or LF2, and A182 Type F304L/316L

###### **4.3.2 Stainless Steel Plate**

N/A.

###### **4.3.3 Steel Decking**

Steel floor and roof decks conform to ASTM A446, Grade A, galvanized.

#### **5. STRUCTURAL LOADS**

The structural loads considered in the design are described in detail in Reference 2.1.2-p. They are summarized below.

##### **5.1 Live Loads and Dead Loads**

###### **5.1.1 Dead Loads**

Dead loads under normal operating conditions are considered in the design. The following loads are included in the dead loads:

- Structural weight:



- Equipment weights: Refer to Table 5.1.1-1.
- Weight of miscellaneous structures, piping, and commodities: Refer to Table 5.1.1-2.
- Pool water hydrostatic loads  
Hydrostatic pressure loads due to the SPF pool water of 14.35 m deep is considered in the design.

### **5.1.2 Live Loads**

The following live loads are considered:

- Floor live loads: Refer to Table 5.1.2-1. Floor live loads for roofs are enveloping snow load.
- Snow loads: Refer to Figure 5.1.2-1.
- Static soil pressure: Refer to Table 5.1.2-2.

The at-rest lateral pressures are for generic sites considered in the standard design and they are larger than the NA3 site-specific static lateral pressures and conservatively used for NA3.

## **5.2 Transient Loads**

### **5.2.1 Pressure Loads**

Pressure loads include the following loads:

- Containment pressure loads
- High Energy Line Break (HELB) loads

These loads are not applied to the FB structures directly. However, because the FB is integrated with the RB and RCCV, the loads applied to the RCCV are transferred to the FB through the RB floor slabs. Therefore, the containment pressure load at the following event is considered in the FB design among the pressure loads considered in the RCCV and RB design.

1. Normal operation
2. LOCA – 5 seconds after Design Basis Accident (DBA)
3. LOCA – 6 minutes after DBA
4. LOCA – 10 hours after DBA
5. LOCA – 72 hours after DBA

Details of pressure loads are described in References 2.1.2-q and 2.1.2-p.

### **5.2.2 Thermal Loads**

Thermal loads during normal operation, Loss of Coolant Accident (LOCA) and DBA in the Spent Fuel Pool due to loss of Fuel and Auxiliary Pools Cooling System (FAPCS) cooling function are considered. Both the summer and winter conditions are included in each phenomenon.



Tables 5.2.2-1 and 5.2.2-4 show the temperature conditions during normal operation and DBA in the FB, respectively. LOCA thermal loads at the following event are considered in the FB design with the same reason as pressure loads:

1. Normal operation, Summer and Winter
2. LOCA – 5 seconds after DBA, Summer and Winter
3. LOCA – 6 minutes after DBA, Summer and Winter
4. LOCA – 10 hours after DBA, Summer and Winter
5. LOCA – 72 hours after DBA, Summer and Winter

The thermal loads in the Spent Fuel Pool are considered for the following cases in combination with No.1 and No.5 of the above RCCV conditions:

1. Normal operation
2. DBA – 72hours after DBA due to loss of FAPCS cooling function

Tables 5.2.2-2 and 5.2.2-3, based on Reference 2.1.2-t, show the average temperature,  $T_d$ , and the surface temperature difference,  $T_g$ , at the normal operation in the FB regions that are shown in Figures 5.2.2-1 through 5.2.2-8. The thermal loads at 72 hours after DBA in the Spent Fuel Pool are shown in Tables 5.2.2-5 and 5.2.2-6.

The stress-free design temperature used in the stress analyses is 15.5 °C.

### **5.2.3 Hydrodynamic Loads**

Hydrodynamic loads are not applied to the FB structures directly. However, because the FB is integrated with the RB and RCCV, the loads applied to the RCCV are transferred to the FB through the RB floor slabs. Therefore, the following hydrodynamic loads are considered in the FB design among the hydrodynamic loads considered in the RCCV and RB design.

1. Safety-Relief Valve (SRV) Loads
2. Chugging (CH) Load
3. Condensation Oscillation (CO) Load
4. Pool Swell

Details of hydrodynamic loads are described in References 2.1.2-q and 2.1.2-p.

### **5.2.4 RPV Reactions due to Hydrodynamic Loads**

RPV reactions due to hydrodynamic loads considered for the FB design are described in Reference 2.1.2-p.

## **5.3 Environmental Loads**

### **5.3.1 Wind Loads**

Design conditions for calculating the basic wind loads are as follows:



Basic wind speed (50 year recurrence interval), m/s (mph)	62.6 (140)
Importance Factors (safety-related structures)	1.15
Exposure Category	Exposure D

Wind load values at each floor level are shown in Table 5.3.1-1. The evaluation of design wind loads is described in Reference 2.1.2-g.

### 5.3.2 Tornado Loads

Design conditions for calculating the tornado wind load are as follows:

Maximum Tornado wind speed, m/s (mph)	147.5 (330)
Maximum Rotational Speed, m/s (mph)	116.2 (260)
Maximum Translational Speed, m/s (mph)	31.3 (70)
Radius, m (ft)	45.7 (150)
Maximum Pressure Drop, kPa (psi)	16.6 (2.4)
Maximum Rate of Pressure Drop, kPa/s (psi/s)	11.7 (1.7)

Tornado load values at each floor level are shown in Table 5.3.2-1. The evaluation of design tornado loads is described in Reference 2.1.2-g.

### 5.3.3 Seismic Loads

The seismic loads considered in the FB design are those generated by the site-specific SSE.

The design seismic loads are determined from the site-specific Soil-Structure Interaction (SSI) analysis results, which are described in Reference 2.1.2-k. Four components - two horizontal, one vertical, and one torsional - of the seismic loads are evaluated following the methodology used for the standard design of the FB in Reference 2.1.2-h. The out-of-plane loads due to horizontal SSE acceleration are considered as one of the horizontal components at walls, whose out-of-plane natural frequency is less than 50 Hz.

The design loads applied to the FB are shown in the following tables. Node numbers in the tables are described in Figure 5.3.3-1.

- Horizontal seismic loads and torsion: Table 5.3.3-1.
- Vertical seismic loads: Tables 5.3.3-2 and 5.3.3-3
- Out-of-plane accelerations at walls: Table 5.3.3-6

The equivalent out-of-plane acceleration loads on slabs and walls are based on Tables 4.5-1 and 4.5-2 of Reference 2.1.2-o. The details of calculation of the equivalent out-of-plane acceleration loads on slabs and walls are shown in Appendix D of Reference 2.1.2-k.



The following loads are also regarded as seismic loads, which are described in Reference 2.1.2-p, and are considered in the FB design:

- Soil pressure due to an earthquake: Refer to Table 5.3.3-4.
- Seismic hydrodynamic loads in pools

Seismic hydrodynamic loads in the Spent Fuel Pool due to SSE are shown in Table 5.3.3-5. The convective (sloshing) pressures considered in the standard plant design are conservatively used for NA3. As additional conservatism, the pressure component associated with impulsive (rigid) mode is based on the NA3 seismic demand or standard plant demand, whichever is larger.

## **6. STRUCTURAL ANALYSIS AND DESIGN**

### **6.1 General Description**

The structural analysis and design of the FB are performed according to the following procedure:

1. Prepare a FE model for stress analyses considering structural characteristics and materials.  
As stated in Section 3.1, the RB including RCCV and the FB are integrated into one building in the ESBWR plant. Therefore, the FE model includes the RCCV, RB, and FB (RB/FB global FE model).
2. Perform stress analyses for the design loads described in Chapter 5, and calculate the section forces.
3. Select the basic and critical load combinations as the selected design load combinations for the FB design.
4. Combine the section forces according to the selected design load combinations mentioned in Step 3 above, which are described later in Section 6.3.
5. Perform structural design calculations using the section forces for the selected design load combinations.

The design/evaluation is essentially performed using ASME, Section III, Division 2. The details of the design/evaluations and the exceptions to the use of ASME, Section III, Division 2 are described in Section 6.4.1.1.

The design of steel structures in the FB is performed in accordance with AISC N690-1994.

### **6.2 Stress Analysis**

An outline of the RB/FB global FE model analysis is summarized below since it is described in detail in Reference 2.1.2-p.

#### **6.2.1 Analysis Program**

The computer program used for the stress analysis calculations is NASTRAN Version 2013.0.0. It is a general-purpose stress analysis program, which is technically based on the



FE method. Analysis calculations are executed on the Red Hat Enterprise Linux Server release 5.7 OS.

### **6.2.2 Analysis Model**

Figure 1-1 shows the global FE model, which consists of SHELL elements for plane members such as the basemat, the RCCV, walls, and slabs and BAR elements for linear members such as beams and columns.

Table 6.2.2-1 shows the material constants for the concrete and steel used in the analysis.

The Young's modulus for concrete used in the thermal load analysis is reduced depending on the average temperature of each element, as described in Note 2 of Table 6.2.2-1. Young's modulus for the RCCV steel liners is set to a small value, 1/10000 of the normal value, in analysis calculations for non-thermal loads so that they do not bear any stresses.

### **6.2.3 Method of Applying Loads**

Refer to Reference 2.1.2-p.

### **6.2.4 Analysis Results**

Tables 6.2.4-1 through 6.2.4-5 show the element forces and moments of the selected elements. The locations of the selected elements are illustrated in Figures 6.2.4-1 through 6.2.4-5. The elements for tabulation are selected, in principle, from the center and both ends of the wall and slab, where it is reasonably expected that the critical stresses appear based on engineering experience and judgment. Element forces and moments listed in the tables are defined with relation to the element coordinate system shown in Figure 6.2.4-6.

## **6.3 Load Combinations**

### **6.3.1 Code Requirements**

#### **Reinforced Concrete Structures**

The load combinations and associated load factors and acceptance criteria for reinforced concrete structures outside the containment are summarized in Table 6.3.1-1, which is in compliance with ACI 349-01 and SRP 3.8.4.

For the design of any structures which are integrated with the RCCV structures, the load combinations and associated load factors and acceptance criteria for the RCCV design are also considered. Therefore, Table 6.3.1-3, which is the load combination table for the RCCV design, is considered for the FB structures in addition to Table 6.3.1-1. Table 6.3.1-3 complies with ASME-2004.

#### **Steel Structures**

The load combinations and associated load factors and acceptance criteria for steel structures outside the containment are summarized in Table 6.3.1-2, which is in compliance with AISC N690-1994 Code and SRP 3.8.4.

### **6.3.2 Selection of Design Load Combinations**

#### **Reinforced Concrete Structures**





The following load combinations given in Tables 6.3.1-1 and 6.3.1-3 need not be considered, because of the reasons described for each of the load combinations in common with the RB.

No.	Reason
FB-C5	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination FB-C3 covers these combinations.
FB-C6 FB-C8	These combinations are almost identical to CV-5, CV-7, respectively.
FB-C9	This combination is almost identical to CV-11.
CV-2	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination CV-3 covers CV-2.
CV-4, 6	Stresses in the basemat and pool due to wind loads W or tornado loads Wt are negligibly small, and these combinations are not critical for their design.
CV-5	This combination is covered by CV-11.
CV-8, 9	These combinations are covered by CV-7.
CV-10	Stresses in the basemat and pool due to wind loads W are negligibly small, and the combination CV-7 covers CV-10.

Finally, the following load combinations are selected for reinforced concrete structures.

- FB-C1, FB-C2, FB-C3, FB-C4, FB-C7, CV-1, CV-3, CV-7, CV-11

Detailed design load combinations are determined in terms of load patterns for the selected load combinations. Load patterns include time of year for temperature loads, time after an accident for LOCA pressure/temperature loads, and load application patterns for hydrodynamic loads. The determined detail design combinations are shown in Table 6.3.2-1. The acceptance criteria for the selected combinations are also included in the tables. In addition, the load combinations selected as critical combinations in Appendix 3G of the ESBWR Design Control Document (DCD) are identified in the table.

#### Steel Structures

Among the load combinations listed in Table 6.3.1-2, the following combination is negligible:

No.	Reason
FB-S1	This combination is covered by FB-S3.
FB-S2	This combination is covered by FB-S4.

The detail design combinations for the steel structures are shown in Table 6.3.2-2 together with the acceptance criteria.



Some remarks concerning the determination of the detailed load combinations are mentioned below:

- Two kinds of thermal loads, summer and winter, are considered. Because of the uncertainties in the thermal loads, two combinations which differ only in including the thermal load or not are always included in the detailed load combinations.
- Seismic loads include the following:
  - Seismic hydrodynamic load of the Spent Fuel Pool water
  - Dynamic increment of soil pressure
- Dynamic loads, i.e. seismic loads and hydrodynamic loads, are combined according to the SRSS method, as specified in Section 6.3.2 of Reference 2.1.2-q.
- For the tornado loads, the following combinations are considered in accordance with SRP 3.3.2:

$$W_t = W_w$$

$$W_t = W_p$$

$$W_t = W_w + 0.5W_p$$

where,

$W_w$ : Tornado wind load

$W_p$ : Tornado differential pressure load

### **6.3.3 Result of Load Combination**

Tables 6.3.3-1 through 6.3.3-3 show the resultant combined forces and moments for the selected elements shown in Figures 6.2.4-1 through 6.2.4-5, which are calculated for several typical design load combinations selected from the combinations in Table 6.3.2-1.

Section forces due to the following loads are shown independently in the tables.

- OTHR: Loads other than temperature and seismic loads
- TEMP: Temperature loads
- SEIS: Seismic loads
- HYDR: Hydrodynamic loads

Element forces and moments listed in the tables are defined with relation to the element coordinate system shown in Figure 6.2.4-6.



## **6.4 Section Design Principles**

### **6.4.1 Section Design of Reinforced Concrete Structures**

The design/evaluation is essentially performed using ASME, Section III, Division 2. The details of the design/evaluations and the exceptions to the use of ASME, Section III, Division 2 are described in the following Sections. The design flow chart is shown in Figure 6.4.1-1.

#### **6.4.1.1 Walls and Slabs**

Section design calculations for reinforced concrete walls and slabs are carried out for the following section forces, and it is confirmed that the results satisfy code requirements.

- Flexure and Membrane Forces
- Membrane Axial Forces
- Transverse Shear
- In-plane Shear Force

The evaluation method for each of the section forces is described in the following subsections:

##### **6.4.1.1.1 Section Design for Flexure and Membrane Forces**

Stress conditions of the FB structure sections are actually very complicated since the various forces, such as axial forces, in-plane shear, bending moments, and torsional moments, are applied simultaneously. It is difficult to estimate the section strength of the section under such a complicated stress condition by the equations which are normally used in the design calculation.

Therefore, stress calculations for flexure and membrane forces are performed by a computer program SSDP-2D. The program has the following characteristics:

- It calculates concrete and rebar stresses under two-dimensional equilibrium conditions for six components of the section forces in a shell element – two axial forces, two bending moments, in-plane shear, and torsional moment.
- It takes concrete cracks into account in the stress calculation. Cracked concrete is assumed not to bear tensile forces.
- It assumes concrete and rebars to be perfectly elastic.
- It considers the reduction of thermal stresses due to the decreased stiffness of a cracked concrete section.
- Transverse shear is generated in an element but is not considered in the equilibrium conditions. Stresses of shear ties are not calculated with SSDP-2D. The design method for transverse shear is described in Section 6.4.1.1.3.

In calculations with SSDP-2D, section forces including in-plane shear force, axial forces and bending moments are considered simultaneously. In SSDP-2D, the compressive stress distribution of concrete is based on the linear distribution which is proportional to the strain



distribution at the section. Moment capacity based on this condition is more conservative than the moment capacity specified in ACI 349-01 which is based on the stress block for the compressive stress distribution of concrete. Therefore, the wall design with SSDP-2D is considered to be more conservative than the design specified in ACI 349-01. Figure 6.4.1-2 shows the comparison of bending moment-axial force (P-M) interactions which define the relationships between allowable bending moments and axial forces calculated according to ACI 349-01 and SSDP with ASME-2004 acceptance criteria. As shown in the figure, the ASME-2004 allowable values are more conservative than ACI 349-01 except in the high axial force (compression) region. This is addressed in Appendix C by performing additional compression check per ACI 349-01. Additionally, in-plane shear check per ACI 349-01 is performed in Appendix B.

As for the thermal effects, section forces due to thermal loads, which are evaluated by NASTRAN analyses using uncracked concrete stiffness, are reduced considering the depth and direction of cracking in calculations with SSDP-2D. The cracked section properties are used in the calculation only for the cracked sections. Furthermore, compatibility between strain distribution in a section and internal forces including reduced thermal stress is examined under an assumed cracked condition in calculations with SSDP-2D. The calculations are continued until the compatibility of strain and internal forces are satisfied. During the iterative calculations, redistribution of internal forces and strains are considered adequately.

Table 6.4.1.1-1 shows the material properties used for the stress calculation. Allowable stresses specified in CC-3420 of ASME-2004 are used in the design, since they are not defined in ACI 349-01. Tables 6.4.1.1-2 and 6.4.1.1-3 show the allowable stresses of concrete and rebar.

As specified in Reference 2.1.2-u, strengths of concrete and rebars are reduced taking effects of elevated temperatures into consideration.

Reduction of concrete strength due to high temperature, which is based on averaged temperature,  $T_d$ , obtained from the heat transfer analysis, is determined based upon the average value of the following upper bound and lower bound equations:

- Lower bound reduction factor
  - $\phi = 1.0 - 0.0030 (T - 21.1)$   $21.1^\circ\text{C} (70^\circ\text{F}) \leq T \leq 121.1^\circ\text{C} (250^\circ\text{F})$
  - $\phi = 0.70 - 0.00083 (T - 121.1)$   $121.1^\circ\text{C} (250^\circ\text{F}) \leq T$
- Upper bound reduction factor
  - $\phi = 1.0$   $T \leq 260.0^\circ\text{C} (500^\circ\text{F})$
  - $\phi = 1.0 - 0.00081 (T - 260.0)$   $260.0^\circ\text{C} (500^\circ\text{F}) \leq T$

Reduction of reinforcing steel strength is based upon the following equation:

- Reduction Factor
  - $\phi = 1.0 - 0.000873 (T - 21.1)$   $21.1^\circ\text{C} (70^\circ\text{F}) \leq T \leq 204.4^\circ\text{C} (400^\circ\text{F})$



Allowable stresses listed in Tables 6.4.1.1-2 and 6.4.1.1-3 are reduced using these factors in the calculations for load combinations, including thermal loads.

#### 6.4.1.1.2 Section Design for Membrane Compressive Forces

ASME-2004 specifies the allowable concrete stresses for membrane forces. It is necessary to confirm that the compressive stresses of the concrete due to membrane forces do not exceed the allowable stresses specified in CC-3420 of ASME-2004. Examinations for membrane compressive forces are also performed in the FB design in addition to examinations for flexure and membrane forces.

The principal membrane compressive stress  $\sigma_c$ , which is calculated by the following equation, is used for the evaluation.

$$\sigma_c = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} \quad (- \text{ for compression, } + \text{ for tension})$$

$$\sigma_x = \frac{N_x}{h}$$

$$\sigma_y = \frac{N_y}{h}$$

$$\tau_{xy} = \frac{N_{xy}}{h}$$

where  $N_x$ : x-direction axial force per unit length (tension is positive.)

$N_y$ : y-direction axial force per unit length (tension is positive.)

$N_{xy}$ : in-plane shear force per unit length

$h$ : element thickness

Table 6.4.1.1-4 shows the allowable membrane compressive stress of concrete. Reductions due to elevated temperatures described in Subsection 6.4.1.1.1 are applicable to these allowables.

#### 6.4.1.1.3 Section Design for Transverse Shear

Section design calculations for transverse shear are performed according to ACI 349-01, Chapter 11. It requires that the shear force at a section and section strength satisfy the following equation:

$$V_u \leq \phi(V_c + V_s)$$

where  $V_u$ : factored shear force at section per unit length

$V_c$ : nominal shear strength provided by concrete per unit length

$V_s$ : nominal shear strength provided by shear reinforcement per unit length



$\phi$ : strength reduction factor (=0.85)

The nominal shear strength provided by concrete,  $V_c$ , is calculated in accordance with Section 11.3.2 of ACI 349-01. The calculation method is shown in Figure 6.4.1.1-1. The nominal shear strength provided by shear reinforcement,  $V_s$ , is calculated by the following equation:

$$V_s = \rho_v f_y d, \quad V_s \leq 8\sqrt{f'_c}d \quad (\text{in English units})$$

where  $\rho_v$ : shear reinforcement ratio

$f_y$ : specified yield strength of rebar

$d$ : distance from extreme compression fiber to centroid of tension reinforcement

$f'_c$ : specified compressive strength of concrete

The transverse shear stress is evaluated in the direction of the maximum shear force, and the section forces for evaluation are calculated by the following equations:

$$V_u = \sqrt{Q_x^2 + Q_y^2}$$

$$M_u = M_x \sin^2 \theta + M_y \cos^2 \theta + 2M_{xy} \sin \theta \cos \theta$$

$$N_u = N_x \sin^2 \theta + N_y \cos^2 \theta + 2N_{xy} \sin \theta \cos \theta$$

$$\theta = \tan^{-1}(Q_x/Q_y)$$

In NASTRAN analyses, the transverse shear forces, i.e.,  $Q_x$  and  $Q_y$ , are calculated independently in X and Y directions, respectively. The resultant transverse shear forces, i.e. the maximum transverse shear force ( $V_u$ ), is calculated with the SRSS method in order to consider transverse shear forces in two directions simultaneously. The value,  $\theta$  means the direction of the maximum shear force. The values  $N_u$  and  $M_u$  are also evaluated in the direction of the maximum shear force.

#### 6.4.1.2 Columns and Girders

Structural design of reinforced concrete columns and girders is performed according to the following principles:

- Section design is performed by confirming that strength ratios are less than 1.0 for each component of section forces, i.e., axial force, bending moment and shear force. Strength ratios are calculated by dividing section forces by corresponding section strengths that include the strength reduction factors defined in ACI 349-01.
- Rebar arrangements are determined based on the results of section design calculations and according to structural specifications on rebar arrangements described in ACI 349-01.
- Section forces due to thermal loads are reduced considering concrete cracking.



- Section forces are evaluated at both ends of bar elements, which are used to model frame members in the FE stress analyses.
- Columns are designed in two principal directions. Bending moments and shear forces are assumed to act in each independent direction. Effects of the bi-axial bending shown in Section 10.11.6 in ACI 349-01 are neglected in the design due to the presence of shear walls minimizing the effects of the flexural deformation of the columns. Therefore, the columns are subjected to small flexural moment as described in Section 7.3.1-2 and are mainly resisting to the lateral load.
- Girders with slabs are designed only in the out-of-plane direction with regard to the slabs, since in-plane deformations are restricted. For the in-plane direction (weak-axis direction), skin rebars are arranged according to ACI standards, but section strengths are, in principle, not examined.

#### 6.4.1.2.1 Strength Reduction Factor

Strength reduction factor  $\phi$  is defined in ACI 349-01 as follows:

- Axial force with bending moment:

$$\begin{aligned}
 {}_p\phi &= \begin{cases} 0.90 & ({}_p\phi \cdot P_n \leq 0) \\ 0.70 + 0.20 \left( 1 + \frac{{}_p\phi \cdot P_n}{P_m} \right) & (0 < {}_p\phi \cdot P_n < 0.1f'_c A_g) \\ 0.70 & ({}_p\phi \cdot P_n \geq 0.1f'_c A_g) \end{cases} \\
 P_m &= \begin{cases} 0.1f'_c A_g & (f_y \leq 60,000 \text{ psi and } (h-d'-d_s)/h \geq 0.70) \\ \min(0.1f'_c A_g, {}_p\phi \cdot P_b) & (\text{others}) \end{cases}
 \end{aligned}$$

where:

$P_n$  : nominal strength for axial force at given eccentricity

$P_b$  : nominal axial load strength at balanced strain conditions

$f'_c$  : specified compressive strength of concrete

$A_g$  : gross area of section

$f_y$  : specified yield strength of reinforcement

$h$  : overall thickness of member

$d'$  : distance from extreme compression fiber to centroid of compression reinforcement

$d_s$  : distance from extreme tension fiber to centroid of tension reinforcement

- Shear force

$${}_v\phi = 0.85$$

**6.4.1.2.2 Section Design for Axial Forces and Bending Moments**

Section strengths for axial forces and bending moments are calculated based on the following assumptions, which conform to ACI 349-01, and on equilibrium conditions of section forces and conformity conditions of strains.

- Tensile strength and stiffness of concrete are ignored.
- Stress-strain relationship of concrete is perfectly elasto-plastic and based on Whitney rectangular stress distribution in which design compressive strength is  $0.85 f'_c$  (See Figure 6.4.1.2-1).
- Section forces due to thermal loads are reduced considering concrete cracks. The reduction method is in accordance with SSDP-2D, which is described in Subsection 6.4.1.1.1.
- Design section strengths are obtained from section strengths and strength reduction factor  $\phi$ . Strength ratios are calculated, as illustrated in Figure 6.4.1.2-2, by dividing design section forces by design section strengths. Section design for axial force and bending moment is completed by confirming that strength ratios are less than 1.0 as follows:

$$P_u / \phi P_n < 1.0 \text{ and } M_u / \phi M_n < 1.0$$

**6.4.1.2.3 Section Design for Shear Forces**

It is confirmed that the following equation is satisfied in the section design for shear forces.

$$V_u \leq \phi (V_c + V_s)$$

where

$V_u$ : factored shear force at section

$V_c$ : nominal shear strength provided by concrete

$V_s$ : nominal shear strength provided by shear reinforcement

$\phi$ : strength reduction factor (=0.85)

Nominal shear strength provided by concrete,  $V_c$ , is evaluated as follows:

$$N_u < 0 \quad (\text{compression})$$





$$V_c = \min(V_{c1}, V_{c2})$$

$$V_{c1} = \left( 1.9\sqrt{f'_c} + 2500\rho_w \frac{V_u \cdot d}{M_m} \right) b_w d$$

$$V_{c2} = 3.5\sqrt{f'_c} \cdot b_w d \sqrt{1 - \frac{N_u}{500A_g}}$$

$$M_m = M_u + N_u \frac{(4h - d)}{8}$$

$$\text{if } M_m < 0, V_c = V_{c2}$$

$$N_u > 0 \quad (\text{tension})$$

$$V_c = 2 \left( 1 - \frac{N_u}{500A_g} \right) \sqrt{f'_c} \cdot b_w d$$

where:

$V_c$  : nominal shear strength provided by concrete

$f'_c$  : specified compressive strength of concrete

$M_u$  : factored moment at section

$N_u$  : factored axial load normal to cross section occurring simultaneously with  $V_u$

$V_u$  : factored shear force at section

$\rho_w$  : ratio of shear reinforcement

$b_w$  : width of section

$d$  : distance from extreme compression fiber to centroid of longitudinal tension rebar

$h$  : overall thickness of member

$A_g$  : gross area of section

Nominal shear strength provided by shear reinforcement,  $V_s$ , is evaluated as follows:

$$V_s = \rho_w r f_y \cdot b_w \cdot d \quad \text{and} \quad V_s \leq 8\sqrt{f'_c} \cdot b_w \cdot d$$

where:

$V_s$  : nominal shear strength provided by shear reinforcement

$\rho_w$  : ratio of shear reinforcement

$f_y$  : specified yield strength of shear reinforcement

$b_w$  : width of section

$d$  : distance from extreme compression fiber to centroid of longitudinal tension rebar

$f'_c$  : specified compressive strength of concrete



### 6.4.2 Section Design of Steel Structures

Section design of steel member is performed according to AISC N690-1994, Reference 2.2-c. Steel members are examined by the evaluation method described in the following subsections.

The design flow of steel structures is almost the same as the flow of reinforced concrete structures which is shown in Figure 6.4.1-1. However, reductions of thermal stresses are not considered for the steel design.

#### 6.4.2.1 Section Design for Axial Compression and Bending

Steel members subjected to both axial compression and bending stresses shall be proportioned to satisfy the following requirements:

$$\frac{f_a}{F_a} + \frac{C_{mx}f_{bx}}{\left(1 - \frac{f_a}{F'_{ex}}\right)F_{bx}} + \frac{C_{my}f_{by}}{\left(1 - \frac{f_a}{F'_{ey}}\right)F_{by}} \leq 1.0 \quad (6.4.2-1)$$

$$\frac{f_a}{0.60F_y} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0 \quad (6.4.2-2)$$

When  $f_a/F_a \leq 0.15$ , Equation (6.4.2-3) is permitted in lieu of Equation (6.4.2-1) and (6.4.2-2):

$$\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0 \quad (6.4.2-3)$$

In Equations (6.4.2-1), (6.4.2-2) and (6.4.2-3), the subscripts  $x$  and  $y$ , combined with subscripts  $b$ ,  $m$ , and  $e$ , indicate the axis of bending about which a particular stress or design property applies, and

$F_a$  = Axial compressive stress that would be permitted if axial force alone existed, ksi

$F_b$  = Compressive bending stress that would be permitted if bending moment alone existed, ksi

$$F'_e = \frac{12\pi^2 E}{23(Kl_b / r_b)^2}$$

= Euler stress divided by a factor of safety, ksi (In the expression for  $F'_e$ ,  $l_b$  is the actual unbraced length in the plane of bending and  $r_b$  is the corresponding radius of gyration.  $K$  is the effective length factor in the plane of bending.)

$f_a$  = Computed axial stress, ksi

$f_b$  = Computed compressive bending stress at the point under consideration, ksi

$C_m$  = Coefficient whose value shall be taken as follows:



- a. For compression members in frames subject to joint translation (sidesway),  
 $C_m = 0.85$ .
- b. For rotationally restrained compression members in frames braced against joint translation and not subject to transverse loading between their supports in the plane of bending,

$$C_m = 0.6 - 0.4 (M_1/M_2).$$

where  $M_1/M_2$  is the ratio of the smaller to larger moments at the ends of that portion of the member unbraced in the plane of bending under consideration.  $M_1/M_2$  is positive when the member is bent in reverse curvature, negative when bent in single curvature.

- c. For compression members in frames braced against joint translation in the plane of loading and subjected to transverse loading between their supports, the value of  $C_m$  may be determined by an analysis. However, in lieu of such analysis, the following values are permitted:
  - i. For members whose ends are restrained against rotation in the plane of bending .....  $C_m = 0.85$
  - ii. For members whose ends are unrestrained against rotation in the plane of bending .....  $C_m = 1.0$

#### 6.4.2.2 Section Design for Axial Tension and Bending

Steel members subjected to both axial tension and bending stresses shall be proportioned at all points along their length to satisfy the following requirement:

$$\frac{f_a}{F_t} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}} \leq 1.0 \quad (6.4.2-4)$$

where  $f_b$  is the computed bending tensile stress,  $f_a$  is the computed axial tensile stress,  $F_b$  is the allowable bending stress and  $F_t$  is the governing allowable tensile stress.

#### 6.4.2.3 Section Design for Transverse Shear

Steel members subjected to transverse shear stress shall be proportioned to satisfy the following requirement:

$$\frac{f_v}{F_v} \leq 1.0 \quad (6.4.2-5)$$

where  $f_v$  is the computed shear stress and  $F_v$  is the governing allowable shear stress.

**6.4.2.4 Allowable Stresses****6.4.2.4.1 Allowable Axial Tensile Stress**

On the gross section of axially loaded tension members, the allowable stress is:

$$F_t = 0.60F_y \quad (6.4.2-6)$$

where  $F_y$  is the specified minimum yield stress of the type of steel being used, ksi.

**6.4.2.4.2 Allowable Axial Compressive Stress**

On the gross section of axially loaded compression members, when  $Kl/r$ , the largest effective slenderness ratio of any unbraced segment is less than  $C_c$ , the allowable stress is:

$$F_a = \frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right] F_y}{\frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}} \quad (6.4.2-7)$$

where

$$C_c = \sqrt{\frac{2\pi^2 E}{F_y}}$$

$E$  = Modulus of elasticity of steel, ksi

On the gross section of axially loaded compression members, when  $Kl/r$  exceeds  $C_c$ , the allowable stress is:

$$F_a = \frac{12\pi^2 E}{23(Kl/r)^2} \quad (6.4.2-8)$$

**6.4.2.4.3 Allowable Bending Stress of W-shaped Members (Strong Axis Bending)**

The allowable stress for the strong axis bending of W-shaped members is given according to the procedure shown in Figure 6.4.2-1.

**6.4.2.4.4 Allowable Bending Stress of W-shaped Members (Weak Axis Bending)**

The allowable stress for the weak axis bending of W-shaped members is given according to the procedure shown in Figure 6.4.2-2.

**6.4.2.4.5 Allowable Bending Stress of Box Members**

The allowable bending stress of box members is given according to the procedure shown in Figure 6.4.2-3.

**6.4.2.4.6 Allowable Shear Stress**

For  $h/t_w \leq 380/\sqrt{F_y}$ , on the overall depth times the web thickness, the allowable shear stress is:

$$F_v = 0.40F_y \quad (6.4.2-9)$$

For  $h/t_w > 380/\sqrt{F_y}$ , the allowable shear stress on the clear distance between flanges times the web thickness is:

$$F_v = \frac{F_y}{2.89}(C_v) \leq 0.40F_y \quad (6.4.2-10)$$

where

$$C_v = \frac{45000k_v}{F_y(h/t_w)^2} \quad \text{when } C_v \text{ is less than } 0.8$$

$$= \frac{190}{h/t_w} \sqrt{\frac{k_v}{F_y}} \quad \text{when } C_v \text{ is more than } 0.8$$

$$k_v = 4.00 + \frac{5.34}{(a/h)^2} \quad \text{when } a/h \text{ is less than } 1.0$$

$$= 5.34 + \frac{4.00}{(a/h)^2} \quad \text{when } a/h \text{ is more than } 1.0$$

$t_w$  = thickness of web, in.

$a$  = clear distance between transverse stiffeners, in.

$h$  = clear distance between flanges at the section under investigation, in.

**7. SUMMARY OF RESULTS****7.1 Required Section**

Figures 7.1-1 through 7.1-4 show typical sections of the FB concrete structures.

The steel members, i.e., steel girders at EL 22,500, are shown in Figure 7.1-5.

**7.2 Provided Section**

The sections of the FB structures that have been provided are identical to the required sections described in Section 7.1.



### 7.3 Tabulation of Allowable Stresses versus Calculated Stresses

#### 7.3.1 Reinforced Concrete Structure

##### 7.3.1.1 Walls and Slabs

###### 7.3.1.1.1 Calculations for Flexure and Membrane Forces

The stresses of the concrete and reinforcing steel are calculated for flexure and membrane forces. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that all values are less than their allowable stresses, except for the exterior wall at EL 4,650 to EL 6,600 with 3% exceedance. The 3% exceedance calculated from the SSDP-2D program is due to conservatisms used in the SSDP-2D program. The first conservatism in the SSDP-2D program is the use of the linear concrete compressive stress-strain relationship to calculate the internal forces of a section. As permitted in Section CC-3511.1(e) of ASME, Section III, Division 2, a parabolic distribution of concrete compressive stress can be used in the section analysis for factored loads.

The second conservatism is the use of the principal stress for the concrete stress demand, rather than the axial stress on the plane perpendicular to the direction of rebar. The use of the principal stress for the concrete significantly overestimates the concrete stress demand as the in-plane shear membrane force as well as the axial membrane forces and bending moments are input to the SSDP-2D program.

Due to these unnecessary conservatisms, refined stress evaluations were performed for one element using the axial-flexural (P-M) capacity curves constructed in accordance to ASME 2004 and ACI 349-01. P-M curves were constructed for the planes perpendicular to longitudinal rebar, and the ASME P-M curve was constructed using a parabolic concrete stress-strain relationship and the primary-plus-secondary allowable stresses for factored loads. The site-specific total axial-flexural demands associated with the exceedances were compared to the ASME and ACI 349-01 axial-flexural capacity curves.

Figure 7.3.1.1-1 compares the axial-flexural demands associated with the 3% exceedance to three axial-flexural capacity curves: (1) ASME capacity with linear concrete compressive stress distribution; (2) ASME capacity with parabolic concrete compressive stress distribution; and (3) ACI 349-01. Since the 3% exceedance using SSDP-2D occurs only for primary-plus-secondary condition, therefore for the ASME capacities, the primary-plus-secondary allowable stresses for factored load in Tables 6.4.1.1-2 through 6.4.1.1-4 are used.

As shown in Figure 7.3.1.1-1, the ASME capacity with linear concrete compressive stress distribution (used in the SSDP-2D program) is very conservative. All the axial-flexural demands associated with 3% exceedance stay inside of the limiting capacity of curves (2) and (3). Therefore, it is concluded that the wall is structurally adequate at the NA3 site. It is also noted that the ASME capacity with parabolic concrete compressive stress distribution bounds the ACI 349-01 capacity.

The calculation results for the selected elements shown in Figures 6.2.4-1 through 6.2.4-5 are given in this report. The thicknesses and the rebar arrangements of selected elements are shown in Table 7.3.1.1.1-1. The arrangements of reinforcements and shear ties at the exterior



wall on columns FA and FF at EL 4,650 to EL 6,600 are updated from standard design as shown in red in Table 7.3.1.1.1-1.

Calculated stresses and allowable stresses are compared in Tables 7.3.1.1.1-2 through 7.3.1.1.1-4 for several load combinations.

Table 7.3.1.1.1-5 shows a summary of the maximum stress ratios, which are ratios of the maximum stresses to the allowable stresses.

For shear walls and Spent Fuel Pool walls, the maximum stress of vertical rebar is found to be 257.3 MPa (37.30 ksi) at Section 2 due to the load combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum stress of horizontal rebar is found to be 333.3 MPa (48.33 ksi) at Section 2 for the combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -22.1 MPa (-3.20 ksi), which occurs at Section 3 due to load combination FB-9 against the allowable stress of -29.3 MPa (-4.25 ksi), as shown in Table 7.3.1.1.1-4.

For floor slabs, the maximum rebar stress of 133.5 MPa (19.36 ksi) is found due to the load combination FB-9 against the allowable stress of 372.2 MPa (53.97 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -8.7 MPa (-1.26 ksi) due to load combination FB-9 against the allowable stress of -29.3 MPa (-4.25 ksi), as shown in Table 7.3.1.1.1-4.

For foundation mat, the maximum rebar stress is found to be 111.5 MPa (16.17 ksi) due to the load combination FB-9 against the allowable stress of 367.2 MPa (53.24 ksi) as shown in Table 7.3.1.1.1-4. The maximum concrete stress is found to be -7.0 MPa (-1.02 ksi) due to load combination FB-9 against the allowable stress of -22.9 MPa (-3.32 ksi), as shown in Table 7.3.1.1.1-4.

#### **7.3.1.1.2 Calculations for Membrane Compressive Forces**

The compressive stress of concrete is calculated for membrane forces. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that the values are less than the allowable stress.

Table 7.3.1.1.2-1 gives a summary of the maximum compressive stresses for selected elements shown in Figures 6.2.4-1 through 6.2.4-5.

For shear walls and Spent Fuel Pool walls, the maximum compressive stress of -9.094 MPa (-1.319 ksi) is found at Section 1 against the allowable stress of -25.9 MPa (-3.756 ksi) as shown in Table 7.3.1.1.2-1.

For floor slabs, the maximum compressive stress of -3.689 MPa (-0.535 ksi) is found against the allowable stress of -25.9 MPa (-3.756 ksi) as shown in Table 7.3.1.1.2-1.

For foundation mat, the maximum compressive stress of -2.576 MPa (-0.374 ksi) is found against the allowable stress of -16.6 MPa (-2.407 ksi) as shown in Table 7.3.1.1.2-1.



#### **7.3.1.1.3 Calculations for Transverse Shear**

The transverse shear strength is calculated and compared with shear forces generated by design loads. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed section forces are less than the shear strength of sections.

Table 7.3.1.1.3-1 gives a summary of the examinations for selected elements shown in Figures 6.2.4-1 through 6.2.4-5. Table 7.3.1.1.3-2 shows the calculation results for the load combinations selected for the DCD that are indicated in Table 6.3.2-1.

For shear walls and Spent Fuel Pool walls, the maximum transverse shear force is found to be 4.04 MN/m (23.1 kips/in) against the shear strength of 11.08 MN/m (63.25 kips/in) at Section 1, Exterior Wall and Pool Wall as shown in Table 7.3.1.1.3-2.

For floor slabs, the maximum transverse shear force is found to be 0.97 MN/m (5.54 kips/in) against the shear strength of 4.35 MN/m (24.8 kips/in) as shown in Table 7.3.1.1.3-2.

For foundation mat, the maximum transverse shear force is found to be 5.35 MN/m (30.54 kips/in) against the shear strength of 16.05 MN/m (91.62 kips/in) as shown in Table 7.3.1.1.3-2.

#### **7.3.1.2 Columns and Beams**

Design section strengths for axial forces, bending moments, and shear forces are calculated, and compared with section forces and moments generated by design loads. The calculations are performed for the selected design load combinations shown in Table 6.3.2-1, and it is confirmed that all design section forces and moments are less than design section strengths.

The calculation results for the selected elements shown in Figure 7.3.1.2-1 are given in this report.

Tables 7.3.1.2-1 and 7.3.1.2-2 give a summary of the maximum strength ratios, which are defined in Subsection 6.4.1.2. Since the design margin of flexural moment is at least 43% for columns as shown in Table 7.3.1.2-1, the flexural deformation of these columns is considered to be sufficiently small and consistent with the assumption made in Section 6.4.1.2.

#### **7.3.2 Steel Structure**

The stresses of the steel members are combined in accordance with Table 6.3.2-2, and it is confirmed that all values are less than the allowable stresses.

Table 7.3.2-1 lists the calculation results of the selected sections included in Figure 7.3.1.2-1. The stress ratios of the design stresses against their allowable stresses shown in the tables are the maximum ratios among all the load combinations.

### **8. CONCLUSIONS**

The site-specific stress check calculations for the FB structure are performed to evaluate the structural integrity of the FB at the NA3 site per the specifications of ACI 349-01, ASME-2004, and AISC N690-1994, following the same methodology as that used for the standard design. The stress checks are based on the results of the RB/FB global model analyses for the





site-specific seismic loads combined together with the non-seismic load results according to site-specific seismic load combinations. The conclusions from the site-specific stress checks are summarized as follows:

- Reinforced concrete walls and slabs
  - The stresses of the concrete and rebar are less than the allowable stresses specified in the code, except for the exterior wall at EL 4,650 to EL 6,600 with 3% exceedance. As discussed in Section 7.3.1.1.1, the 3% exceedance is due to the conservative assumption used in the SSDP program which is the linear concrete compressive stress distribution. It is confirmed that the axial-flexural demands associated with 3% exceedance stay inside the limiting of ASME capacity with parabolic concrete compressive stress distribution and ACI 349-01, as shown in Figure 7.3.1.1-1. Therefore, the wall is structurally adequate at the NA3 site. The arrangements of reinforcement at the exterior wall at EL 4,650 to EL 6,600 are updated from the standard design as shown in red in Table 7.3.1.1.1-1.
  - The sections have enough strength to bear transverse shear forces generated by design loads. The arrangements of shear ties at the exterior wall at EL 4,650 to EL 6,600 are updated from the standard design as shown in red in Table 7.3.1.1.1-1.
- Reinforced concrete columns and girders
  - The sections have enough strength to bear axial forces, bending moments, and shear forces generated by design loads.
- Steel structures
  - The stresses of steel members are less than the allowable stresses specified in the code.

The comparison between NA3 and the standard design is shown in Appendix A.

In addition, the following structural evaluations are performed for the FB separately:

- The stability of the RB/FB at the NA3 site is demonstrated to resist the dynamic load demand without the shear keys that are part of the standard design of the RB/FB, as described in "Reactor/Fuel Building Complex Stability Analysis Report," Reference 2.1.2-1.
- Tornado missile impact assessment is shown in Reference 2.1.2-g.

Therefore, it can be concluded that the FB structure is adequately designed to resist the NA3 site-specific SSE loads in combination with non-seismic standard plant loads. And, it is confirmed that the standard design of FB is verified to be acceptable for NA3 sites-specific loads.

**Table 3.1-1 Key Dimensions of RB and FB**

Building	Dimension		Notes
Reactor Building	Story	six stories (above grade) three stories (below grade)	The design plant grade is 16.15 m from the top of the basemat
	Plan	49.0 m × 49.0 m (below EL 34.0 m) 49.0 m × 39.0 m (above EL 34.0 m)	
	Height	64.2 m	From the top of the basemat
Fuel Building	Story	one story (above grade) three stories (below grade)	(excluding the penthouse) The design plant grade is 16.15 m from the top of the basemat
	Plan	21.0 m × 49.0 m	
	Height	34.0 m	From the top of the basemat (excluding the penthouse)
Common	Thickness of Basemat	4.0 m	The thickness is increased to 5.1 m inside of the RPV Pedestal and 5.5 m at the bottom of the Spent Fuel Pool.



Table 5.1.1-1 Dead Loads of Equipment in FB

Elevation (m)	Item No.*	Description	Weight				Area Load (kN/m <sup>2</sup> )
			unit (kN)	qt.	margin	Sum up (kN)	
-11.50	F-1	Skimmer Tank	353	1	0.2	424	-
	F-2	Spent Fuel Racks	16,239	1	0.2	19487	-
	F-3	Spent Fuel Cask	-	-	-	-	120
	F-4	Fuel and Auxiliary Pools Cooling Backwash Tank Room	353	1	0.2	424	-
	F-5	Fuel and Auxiliary Pools Cooling Heat Exchange Room	236	1	0.2	284	-
	F-6	Sump Room	95	1	0.2	114	-
	F-7	Fuel and Auxiliary Pools Cooling Transfer Pump Room	17	2	0.2	41	-
	F-8	Fuel and Auxiliary Pools Cooling Pump Room	112	1	0.2	134	-
-6.40	F-11	Fuel and Auxiliary Pools Cooling Filter/Demineralizer Vault	142	2	0.2	341	-
	F-12	FAPC Holding Pump Room	37	1	0.2	45	-
	F-13	Control Rod Drive Maintenance Area	49	1	0.2	59	-
	F-14	Control Rod Drive Maintenance Control Panel Room	38	1	0.2	46	-
	F-15	Control Rod Drive Motor Test Room	98	1	0.2	118	-
-1.00	F-21	New Fuel Prep Machine Pit	12	1	0.2	15	-
4.65	CR-1	Fuel Handling Machine	343	1	0.2	412	-
13.57	CR-2	Fuel Building Crane	1079	1	0.2	1295	-
	CR-3	Lifted Load	1750	1	-	1750	-
22.50	F-61a	HVAC Penthouse	112	2	0.2	269	-
	F-61b	HVAC Penthouse	112	2	0.2	269	-
	F-61c	HVAC Penthouse	174	2	0.2	416	-
	F-61d	HVAC Penthouse	322	2	0.2	772	-
	F-61e	HVAC Penthouse	292	2	0.2	701	-

General Note: The values shown in this table are based on, 26A6608, Design Specification for Fuel Building, Rev.1

Note \*: Refer to Figures 5.1.1-1 through 5.1.1-9 of Reference 2.1.2-p



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 39

REV. 1 of 155

**Table 5.1.1-2 Miscellaneous Structures, Piping, and Commodities on the Slabs**

<b>Elevation (m)</b>	<b>Piping Area Load (kN/m<sup>2</sup>)</b>	<b>Note</b>
27.50	0.0	FB roof slab of penthouse
22.50	2.4	
4.65	2.4	
-1.00	2.4	
-6.40	2.4	
-11.50	2.4	

**Table 5.1.2-1 Floor Live Loads**

<b>Elevation (m)</b>	<b>Area Load (kN/m<sup>2</sup>)</b>	<b>Note</b>
27.50	2.9	FB roof slab of penthouse
22.50	2.9	
4.65	4.8	
-1.00	4.8	
-6.40	4.8	
-11.50	4.8	

**Table 5.1.2-2 Design Lateral Soil Pressure at Rest**

<b>Elevation (m)</b>	<b>Soil Pressure (kN/m<sup>2</sup>)</b>			<b>Note</b>
	<b>RB on R1 column-row Wall</b>	<b>FB on FA column-row Wall</b>	<b>Other Walls</b>	
4.65	11.0	175.4	11.0	Design plant grade
4.04	21.9	186.3	21.9	Water level
-1.00	127.7	292.1	127.7	
-4.20	194.9			Bottom level of basemat of TB
-4.20	457.9	359.3	194.9	
-6.40	504.1	405.5	241.0	
-11.50	611.1	512.5	348.1	
-15.50	695.1	596.5	432.0	Bottom level of basemat



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 41

REV. 1 of 155

**Table 5.2.2-1 Steady State Temperature Conditions**

Region	Temperature (°C)		Note
	Summer	Winter	
Rooms	40.0	10.0	
Spent Fuel Pool	48.9	48.9	
Air	46.1	-40.0	
Ground	15.5	15.5	

**Table 5.2.2-2 Thermal Loads for Shell Elements Normal Operation: Summer**

Location	Index*	Boundary**		Thickness (mm)	Td (°C)	Tg (°C)	Note
		1	2				
Basemat	BM1	RM	GR	4000	27.07	23.15	General
	BM6	FP	GR	5500	32.20	33.40	Below Spent Fuel Pool
	BM7	FP	GR	4000	32.20	33.40	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	45.05	7.70	
	FP8	FP	RM	1900	44.94	7.92	
	FP9	FP	RM	1750	44.97	7.85	Around Skimmer Surge Tank
	FP10	FP	RM	2000	44.91	-7.96	
	FP11	FP	FP	1900	48.90	0.00	
	FP12	FP	FP	1750	48.90	0.00	Between Skimmer Surge Tanks
Outer Wall	BW1	RM	GR	2000	26.47	21.94	Below Grade General
	BW5	FP	GR	2000	32.19	33.39	Below Grade Spent Fuel Pool
	BW6	FP	GR	3600	32.20	33.39	
	GW9	RM	AT	1000	43.49	-4.77	EL 27,000 to Room
Inner Wall	IW1	RM	RM	-	40.00	0.00	General
Slab	SL1	RM	RM	-	40.00	0.00	General
	SL8	RM	AT	700	43.63	-4.36	FB Roof at EL 22,500

\*: See Figures 5.2.2-1 through 5.2.2-8

\*\* : RM: Room                      FP: Spent Fuel Pool  
      GR: Ground                  AT: Outside Air

**Table 5.2.2-3 Thermal Loads for Shell Elements Normal Operation: Winter**

Location	Index*	Boundary**		Thickness (mm)	Td (°C)	Tg (°C)	Note
		1	2				
Basemat	BM1	RM	GR	4000	12.90	-5.20	General
	BM6	FP	GR	5500	32.20	33.40	Below Spent Fuel Pool
	BM7	FP	GR	4000	32.20	33.40	Skimmer Surge Tank
Spent Fuel Pool Wall**	FP7	FP	RM	1500	32.07	33.63	
	FP8	FP	RM	1900	31.58	34.62	
	FP9	FP	RM	1750	31.74	34.30	Around Skimmer Surge Tank
	FP10	FP	RM	2000	31.48	-34.82	
	FP11	FP	FP	1900	48.90	0.00	
	FP12	FP	FP	1750	48.90	0.00	Between Skimmer Surge Tanks
Outer Wall	BW1	RM	GR	2000	13.04	-4.93	Below Grade General
	BW5	FP	GR	2000	32.19	33.39	Below Grade Spent Fuel Pool
	BW6	FP	GR	3600	32.20	33.39	
	GW9	RM	AT	1000	-18.80	39.27	EL 27000 ~ Room
Inner Wall	IW1	RM	RM	-	10.00	0.00	General
Slab	SL1	RM	RM	-	10.00	0.00	General
	SL8	RM	AT	700	-19.97	35.96	FB Roof at EL 22500

\*: See Figures 5.2.2-1 through 5.2.2-8

\*\* : RM: Room                      FP: Spent Fuel Pool  
      GR: Ground                  AT: Outside Air

**Table 5.2.2-4 Design Basis Accident Temperatures in Spent Fuel Pool**

Time		Temperature (°C)
(hr.)	(sec)	
0.00	0	48.9
0.06	200	49.2
0.28	1000	50.5
0.50	1800	51.8
1.00	3600	54.7
5.00	18000	77.7
8.86	31900	100.0
10.00	36000	100.0
20.00	72000	100.0
72.00	259200	100.0

Note: DBA for the Spent Fuel Pool is due to the loss of the FAPCS cooling function.

The temperature after 8.86 hrs. correspond to the Spent Fuel Pool temperature at 100 °C (212 °F), which is slightly less than the 104 °C (219 °F) water boiling temperature. The slight 4% increase in the Spent Fuel Pool temperature is negligible to the design of the Spent Fuel Pool structure. This is because there are sufficient stress margins in accordance with Tables 7.3.1.1.1-5, 7.3.1.1.2-1, and 7.3.1.1.3-1 and Figure 7.3.1.1-1, even if the total combined stresses were increased by 4%, which would be very conservative since stresses other than thermal in the load combination do not increase.





**Table 5.2.2-5 Thermal Loads for Shell Elements around Spent Fuel Pool:  
72 hr. after DBA: Summer**

Location	Index*	Boundary**		Thickness (mm)	Td (°C)	Tg (°C)	Note
		1	2				
Basemat	BM6	FP	GR	5500	36.74	56.83	Below Spent Fuel Pool
	BM7	FP	GR	4000	38.45	63.68	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	61.65	57.12	
	FP8	FP	RM	1900	58.10	54.97	
	FP9	FP	RM	1750	59.26	56.04	Around Skimmer Surge Tank
	FP10	FP	RM	2000	57.42	54.16	
	FP11	FP	FP	1900	75.29	0.00	
	FP12	FP	FP	1750	77.51	0.00	Between Skimmer Surge Tanks
Outer Wall	BW5	FP	GR	2000	44.70	79.61	Below Grade Spent Fuel Pool
	BW6	FP	GR	3600	39.14	66.16	

\*: See Figures 5.2.2-1 through 5.2.2-8

\*\*:

RM: Room	FP: Spent Fuel Pool
GR: Ground	AT: Outside Air

**Table 5.2.2-6 Thermal Loads for Shell Elements around Spent Fuel Pool:  
72 hr. after DBA: Winter**

Location	Index*	Boundary**		Thickness (mm)	Td (°C)	Tg (°C)	Note
		1	2				
Basemat	BM6	FP	GR	5500	36.74	56.83	Below Spent Fuel Pool
	BM7	FP	GR	4000	38.45	63.68	Skimmer Surge Tank
Spent Fuel Pool Wall	FP7	FP	RM	1500	48.67	83.06	
	FP8	FP	RM	1900	44.74	81.67	
	FP9	FP	RM	1750	46.02	82.49	Around Skimmer Surge Tank
	FP10	FP	RM	2000	43.99	81.01	
	FP11	FP	FP	1900	75.29	0.00	
	FP12	FP	FP	1750	77.51	0.00	Between Skimmer Surge Tanks
Outer Wall	BW5	FP	GR	2000	44.70	79.61	Below Grade Spent Fuel Pool
	BW6	FP	GR	3600	39.14	66.16	

\*: See Figures 5.2.2-1 through 5.2.2-8

\*\*:

RM: Room	FP: Spent Fuel Pool
GR: Ground	AT: Outside Air



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 45

REV. 1

of 155

**Table 5.3.1-1 Design Wind Pressure Loads by Floor Level**

Height (m)		Design Wind Load (kN/m <sup>2</sup> )			
EL	Z	Windward Wall	Leeward Wall	Side Wall	Roof
52.40	47.75	3.13	-2.20	-2.82	-3.87
34.00	29.35	2.93	-2.20	-2.82	-3.87
27.00	22.35	2.82	-2.20	-2.82	
17.50	12.85	2.62	-2.20	-2.82	
13.57	8.92	2.50	-2.20	-2.82	
9.22	4.57	2.30	-2.20	-2.82	
9.06	4.41	2.30	-2.20	-2.82	
4.65	0.00	2.30	-2.20	-2.82	

zg 700 ft  
 α 11.5  
 Importance factor I 1.15  
 Basic wind speed V 62.59 m/s  
 Wind directionality factor Kd 0.85

Coef.	Wall			Roof
	Windward	Leeward	Side	
G	0.85			
Cp	0.8	-0.5	-0.7	-1.04
GCpi	-0.18	0.18	0.18	0.18

**Table 5.3.2-1 Design Pressure of Tornado Wind Load**

Wind Direction	Building	p (kN/m <sup>2</sup> )			
		Wall			Roof
		Windward	Leeward	Side	
All	RB/FB	5.6	-3.5	-4.9	-7.3
Differential		16.5	16.5	16.5	16.5

**Table 5.3.3-1 Design Seismic Loads for Horizontal SSE (RB and FB Walls)**

Elev. (m)	Elem No.	Node No.	Shear		Moment		Calculated	Accidental	Design
			X-Dir. (MN)	Y-Dir. (MN)	X-Dir. (MN-m)	Y-Dir. (MN-m)	Torsion (MN-m)	Torsion (MN-m)	Torsion (MN-m)
52.40*	1110	110	192.2	140.0	2724 5838	2143 4488	1284	471	1755
34.00	1109	109	173.2	113.9	8196 8719	5821 6389	1938	424	2362
27.00	1108	108	396.0	259.4	9400 9599	7162 7958	2799	1321	4120
22.50	1107	107	436.4	291.8	11216 11424	8328 9227	4678	1486	6164
17.50	1106	106	438.4	343.5	12105 12349	9408 10195	4023	1535	5557
13.57	1105	105	450.7	363.7	12839 13651	10255 11216	4211	1578	5788
9.06	1104	104	454.6	383.4	13904 15231	11338 12506	4694	1591	6285
4.65	1103	103	454.7	360.1	9392 10952	6302 7759	5248	1591	6839
-1.00	1102	102	240.0	226.6	6545 7303	4819 5358	2718	840	3558
-6.40 -11.50	1101	101 2	237.7	200.4	4748 5053	3351 3356	2079	832	2910

Note: RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.1-1 of Reference 2.1.2-o)

The node numbers in this table are described in Figure 5.3.3-1.

\* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

**Table 5.3.3-2 Maximum Vertical Accelerations (RB and FB Walls and Floor Slab)**

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.4*	110	RBFB	1.56
34.00	109	RBFB	1.20
27.00	108	RBFB	1.02
22.50	107	RBFB	0.92
17.50	106	RBFB	0.80
13.57	105	RBFB	0.72
9.06	104	RBFB	0.62
4.65	103	RBFB	0.56
-1.00	102	RBFB	0.57
-6.40	101	RBFB	0.52
-11.50	2	RBFB	0.51
-15.50	1	RBFB	0.52

Note: RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)

The node numbers in this table are described in Figure 5.3.3-1.

\* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.



**Table 5.3.3-3 Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab Oscillators**

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
52.4*	9101	Oscillator	0.33
	9102	Oscillator	1.33
	9103	Oscillator	6.27
	9104	Oscillator	2.62
	9105	Oscillator	2.42
	9106	Oscillator	3.74
	9107	Oscillator	3.22
	9108	Oscillator	2.50
	9109	Oscillator	1.53
34.00	9091	Oscillator	1.61
	9092	Oscillator	1.61
	9093	Oscillator	1.12
27.00	9081	Oscillator	1.64
	9082	Oscillator	1.52
	9083	Oscillator	1.30
	9084	Oscillator	1.67
	9085	Oscillator	1.46
	9086	Oscillator	1.12
	9087	Oscillator	1.03
22.50	9071	Oscillator	1.15
	9072	Oscillator	1.79
	9073	Oscillator	4.47
	9074	Oscillator	1.67
	9075	Oscillator	1.51
	9076	Oscillator	1.65
17.50	9061	Oscillator	3.65
	9062	Oscillator	2.62
	9063	Oscillator	1.17
	9064	Oscillator	2.56
	9065	Oscillator	1.28
	99064	Oscillator	0.99
	9066	Oscillator	1.09
	9067	Oscillator	0.91

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Slabs are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)

\* The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

**Table 5.3.3-3 Enveloping Maximum Vertical Acceleration: RB/FB Flexible Slab  
Oscillators (Continued)**

Elev. (m)	Node No.	Stick Model	Max. Vertical Acceleration (g)
13.57	9051	Oscillator	1.11
	9052	Oscillator	1.25
	9053	Oscillator	0.99
	9054	Oscillator	0.83
9.06	9041	Oscillator	1.02
	9042	Oscillator	1.26
	9043	Oscillator	0.93
	9044	Oscillator	0.80
4.65	9031	Oscillator	1.62
	9032	Oscillator	0.89
	9033	Oscillator	1.12
	9034	Oscillator	1.81
	9035	Oscillator	1.09
	9036	Oscillator	0.94
	9037	Oscillator	0.82
-1.00	9021	Oscillator	0.97
	9022	Oscillator	2.07
	9023	Oscillator	0.98
	9024	Oscillator	1.12
	9025	Oscillator	1.21
	9026	Oscillator	1.63
	9027	Oscillator	0.93
	9028	Oscillator	0.96
	9029	Oscillator	1.30
	9030	Oscillator	0.87
-6.40	9011	Oscillator	0.84
	9012	Oscillator	1.17
	9013	Oscillator	1.52
	9014	Oscillator	1.19
	9015	Oscillator	1.03

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Slabs are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.2-1 of Reference 2.1.2-o)



Table 5.3.3-4 Soil Pressure Due to an Earthquake

Elevation (m)	Soil Pressure (MPa)		Note
	F3 Wall	FA and FF Wall	
4.65			Grade
	0.56	0.45	
-1.00			
	0.28	0.29	
-6.40			
	0.24	0.22	
-11.50			
	0.94	0.76	
-15.50			

Table 5.3.3-5 Seismic Hydrodynamic Loads in the Spent Fuel Pool

NS Motion				EW Motion				Vertical Motion		
Wall		Floor		Wall		Floor		Wall		Floor
Depth d/H	Pressure (kN/m <sup>2</sup> )	Distance x/(L/2)	Pressure (kN/m <sup>2</sup> )	Depth d/H	Pressure (kN/m <sup>2</sup> )	Distance x/(L/2)	Pressure (kN/m <sup>2</sup> )	Depth d/H	Pressure (kN/m <sup>2</sup> )	Pressure (kN/m <sup>2</sup> )
0.0	12.3	0.0	0.0	0.0	11.8	0.0	0.0	0.0	0.0	98.5  for all floor area
0.2	23.6	0.2	7.4	0.2	24.2	0.2	8.5	0.2	19.7	
0.4	37.8	0.4	15.2	0.4	40.0	0.4	17.5	0.4	39.4	
0.6	44.6	0.6	23.7	0.6	49.4	0.6	27.4	0.6	59.1	
0.8	45.2	0.8	33.6	0.8	52.2	0.8	38.7	0.8	78.8	
1.0	45.2	1.0	45.2	1.0	52.2	1.0	52.2	1.0	98.5	

Note 1: "d" is a depth from the top of water. "H" is water height of the pool (14.35 m).

2: "x" is a distance from the center of the pool. "L" is width of the pool.

3: Floor pressure due to vertical motion is reference only. It is already included in vertical seismic loads for the floor.

**Table 5.3.3-6 Enveloping Maximum Horizontal Acceleration: RB/FB Wall Out-of-Plane Oscillators**

Elev. (m)	Node No.	Stick Model	Max. Horizontal Acceleration (g)	Portion
42.00 (X-dir)	99981	Oscillator	2.71	R1 and R7 walls
	99982	Oscillator	1.54	
	99986	Oscillator	0.89	
42.00 (Y-dir)	99983	Oscillator	1.86	RB and RF walls
	99984	Oscillator	1.02	
	99985	Oscillator	1.00	
	99987	Oscillator	0.59	
30.50 (X-dir)	99991	Oscillator	0.58	R1 and R7 walls
30.50 (Y-dir)	99992	Oscillator	0.56	RB and RF walls
13.57 (X-dir)	99971	Oscillator	2.11	F3 walls
	99972	Oscillator	2.29	
	99973	Oscillator	1.88	
	99974	Oscillator	1.13	
	99977	Oscillator	0.89	
13.57 (Y-dir)	99975	Oscillator	2.16	FA and FF walls
	99976	Oscillator	0.93	
	99978	Oscillator	0.97	

Note: Bounding Equivalent Out-of-plane Acceleration Loads on Walls are shown in RB/FB Seismic Analyses Bounding Results and In-Structure Response Spectra. (Table 4.5-2 of Reference 2.1.2-o)





Table 6.2.2-1 Material Constants Used in Stress Analysis

			Reinforced Concrete		Steel			Note
			Basemat	Others	Carbon Steel Liner	Stainless Steel Liner	Structural Steel	
		Temperature (°C)	f'c=4000psi 27.6MPa	f'c=5000psi 34.5MPa				
Young's Modulus (MPa)	Thermal Loads *2	<21	2.49E+04	2.78E+04	2.00E+05			Concrete: See Notes 1 & 2.
		93	1.81E+04	2.03E+04				
		204	1.62E+04	1.81E+04				
	Other Loads *1		2.49E+04	2.78E+04	2.00E+01		2.00E+05	
Poisson's Ratio			0.17		0.3			
Thermal Expansion (m/m°C)			9.90E-06		1.17E-05	1.52E-05	1.17E-05	
Weight Density (MN/m³)			0.0235		0.0770			

Note \*1: Young's modulus of concrete is calculated in accordance with ACI 349-01, Section 8.5.1.

$$E_c = 57,000 \sqrt{f'_c}$$

\*2: Reduction factors of Young's modulus for concrete are determined based upon the average values of the following upper bound and lower bound equations.

Lower bound:

$$\phi = 1.0 - 0.0038(T - 70) \quad 70^\circ F \leq T \leq 200^\circ F$$

$$= 0.50 - 0.0005(T - 200) \quad 200^\circ F \leq T$$

Upper bound:

$$\phi = 1.0 - 0.00031(T - 70) \quad 70^\circ F \leq T \leq 400^\circ F$$

$$= 0.90 - 0.00084(T - 400) \quad 400^\circ F \leq T$$



Table 6.2.4-1 Results of NASTRAN Analysis, Dead Load

Location	Element ID	N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-0.483	-1.787	-0.532	-0.161	-1.151	-0.028	-0.097	-0.367
	60219	0.334	-1.569	-0.302	-0.653	-0.827	-0.170	0.032	0.289
	70201	0.298	-0.173	0.000	0.499	-0.014	0.116	-0.273	0.073
	70204	0.425	-1.009	0.028	-0.227	-0.053	0.122	-0.003	-0.358
	110718	0.325	-1.358	-0.067	-0.050	0.085	0.008	0.036	0.190
2 Exterior Wall @ EL4.65 ~-6.60m	62011	0.088	-1.040	0.070	0.043	0.145	0.010	0.010	0.056
	62019	0.125	-0.628	-0.192	-0.032	0.047	-0.031	-0.001	0.021
	72001	0.110	-0.170	0.106	0.106	0.020	-0.006	-0.015	-0.005
	72004	0.146	-0.452	0.196	-0.038	0.004	0.001	-0.016	0.014
3 Exterior Wall @ EL22.50 ~-24.60m	64011	0.093	-0.287	-0.091	-0.110	-0.533	-0.004	-0.005	0.075
	64019	-0.109	-0.369	-0.067	-0.061	-0.371	0.053	0.063	0.063
	74001	-0.016	-0.049	0.093	0.049	-0.045	-0.046	-0.020	-0.029
	74004	-0.054	-0.212	0.089	-0.078	-0.336	-0.061	0.019	-0.069
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	0.603	-1.255	-0.494	-1.105	-0.819	-0.250	-0.006	-0.070
	70801	0.676	-0.155	0.010	1.075	0.074	-0.015	-0.548	0.031
	70804	0.581	-0.753	0.130	-0.561	-0.466	0.064	-0.097	0.045
	110748	0.225	-1.010	-0.442	-0.184	-0.081	-0.008	0.073	-0.025
5 Basemat	90306	-1.088	-0.435	0.523	0.940	-0.124	0.178	-0.539	1.189
	90310	-0.133	-0.122	-0.042	-0.153	-0.153	-0.696	0.169	-0.067
	90410	-0.454	-0.926	0.533	-0.714	0.165	1.501	1.398	-0.065
5 Basemat @ Spent Fuel Pool	90486	0.294	0.018	0.092	3.622	2.380	0.281	-0.180	0.125
	90490	0.429	0.186	0.284	1.433	1.263	0.508	1.201	0.262
	90526	0.518	0.486	0.013	1.991	2.124	0.124	-0.229	-0.799
6 Slab EL4.65m	93306	0.191	0.019	0.024	0.048	-0.004	0.005	0.031	-0.099
	93310	0.039	0.054	0.232	0.032	0.008	0.034	-0.024	0.006
	93410	0.313	0.318	-0.450	0.012	0.013	-0.069	0.002	-0.010

Note: Results are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.

**HITACHI**

WG3-U97-ERD-S-0001 SH NO.54

REV. 1

of 155

**Table 6.2.4-2 Results of NASTRAN Analysis, Temperature Load  
(LOCA after 72 hours: Winter)**

Location	Element ID	N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
	60219	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
	70201	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
	70204	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
	110718	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
2 Exterior Wall @ EL4.65 ~-6.60m	62011	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
	62019	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
	72001	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
	72004	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
3 Exterior Wall @ EL22.50 ~-24.60m	64011	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
	64019	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
	74001	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
	74004	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
	70801	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
	70804	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
	110748	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
5 Basemat	90306	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
	90310	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
	90410	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
5 Basemat @ Spent Fuel Pool	90486	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
	90490	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
	90526	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
6 Slab EL4.65m	93306	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
	93310	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
	93410	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032

**Table 6.2.4-3 Results of NASTRAN Analysis, Seismic Load (Horizontal: North to South Direction)**

Location	Element ID	N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	-2.527	-0.242	0.003	0.047	0.600	-0.044	0.182	0.250
	60219	-3.014	-0.410	-0.969	1.178	1.359	0.655	-0.168	0.104
	70201	0.104	-0.513	-2.050	-0.332	-0.161	-0.003	-0.008	-0.040
	70204	0.894	-0.953	-3.264	-0.222	-0.234	-0.136	0.010	0.024
	110718	0.541	0.223	0.570	0.024	0.004	-0.044	0.041	-0.064
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.623	-0.113	-0.372	0.013	0.227	0.003	-0.029	0.022
	62019	0.413	-0.851	-1.324	0.066	0.226	0.003	0.012	0.031
	72001	-0.541	-1.875	-3.594	-0.164	-0.068	0.013	0.015	0.044
	72004	-0.759	-1.467	-4.289	-0.040	-0.030	-0.001	0.024	0.004
3 Exterior Wall @ EL22.50 ~24.60m	64011	2.978	-0.129	-0.106	-0.055	-0.191	0.022	0.012	0.035
	64019	2.526	0.030	-0.323	-0.057	-0.149	-0.058	-0.032	0.031
	74001	0.086	-0.118	-1.096	0.044	0.049	-0.051	0.031	-0.014
	74004	-1.294	-0.175	-1.774	0.030	0.027	-0.030	0.013	0.011
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-1.022	0.127	-1.375	1.221	0.842	0.921	0.121	0.038
	70801	-0.358	-0.817	-3.068	-0.657	-0.131	0.005	0.054	0.014
	70804	-0.103	-0.726	-3.437	-0.274	-0.078	-0.167	0.069	0.007
	110748	0.267	0.681	0.555	0.189	0.101	-0.145	-0.026	-0.036
5 Basemat	90306	1.633	-0.406	2.341	0.219	-0.150	2.426	-1.962	0.880
	90310	0.445	-0.957	0.030	0.506	-0.204	-0.171	-0.708	1.380
	90410	0.195	-4.795	-0.653	1.554	0.524	0.164	0.151	-0.109
5 Basemat @ Spent Fuel Pool	90486	0.407	-1.009	-1.091	2.026	1.996	-1.743	-0.995	-0.035
	90490	-0.049	-5.644	0.507	2.336	2.835	-0.175	0.538	-0.900
	90526	2.798	-0.137	-3.221	0.443	0.361	-3.693	-1.172	-0.748
6 Slab EL4.65m	93306	1.355	0.182	-0.860	0.288	-0.056	0.008	-0.077	-0.073
	93310	0.483	0.194	0.424	0.404	-0.225	0.053	-0.306	0.355
	93410	-0.409	0.459	1.304	0.362	0.100	0.081	-0.200	-0.005

Note: Results are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.

**Table 6.2.4-4 Results of NASTRAN Analysis, Seismic Load (Horizontal: East to West Direction)**

Location	Element ID	N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	0.127	0.100	1.432	-0.003	0.182	0.017	0.004	0.053
	60219	-0.749	-0.811	0.748	0.095	-0.120	0.002	0.003	-0.021
	70201	-0.041	-0.396	-0.366	-0.035	-0.084	0.006	-0.007	0.029
	70204	-0.066	-1.134	-1.147	-0.038	-0.137	0.027	0.007	0.050
	110718	0.154	-0.450	0.179	-0.057	-0.133	-0.006	0.011	-0.070
2 Exterior Wall @ EL4.65 ~-6.60m	62011	-0.188	0.141	2.379	-0.025	-0.022	0.000	0.009	-0.009
	62019	-0.067	-1.025	1.859	0.004	0.007	0.001	-0.001	0.001
	72001	-0.092	-2.116	-0.080	-0.005	0.032	-0.001	0.033	-0.020
	72004	-0.211	-1.815	-0.919	0.026	0.082	0.012	0.006	-0.011
3 Exterior Wall @ EL22.50 ~-24.60m	64011	-0.040	0.012	1.635	0.000	0.005	-0.001	0.001	-0.001
	64019	0.503	-0.082	1.246	0.000	-0.011	0.006	0.001	0.003
	74001	0.176	-0.213	-0.277	0.054	0.003	0.004	-0.038	-0.022
	74004	0.865	-0.137	-0.920	-0.003	-0.035	-0.001	-0.002	-0.008
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-0.330	-0.421	0.955	0.078	-0.002	-0.011	0.002	-0.010
	70801	-0.029	-0.942	-0.470	0.031	0.055	0.009	0.010	0.045
	70804	-0.138	-0.873	-1.039	0.005	0.078	0.019	0.005	0.031
	110748	0.152	-0.207	0.175	0.065	0.006	-0.029	-0.014	-0.032
5 Basemat	90306	1.386	0.424	-1.243	-0.964	-0.175	-0.848	1.116	-1.018
	90310	0.146	0.278	-0.141	-0.069	-0.051	0.230	-0.169	-0.269
	90410	0.038	0.191	-1.179	0.159	0.269	-1.639	-0.055	1.018
5 Basemat @ Spent Fuel Pool	90486	-0.256	-0.281	-0.615	2.848	2.976	0.734	-0.251	0.291
	90490	-0.129	-1.702	-0.739	0.644	1.838	-0.546	0.905	0.419
	90526	-0.573	-0.169	-1.355	2.088	0.837	-0.745	-0.977	-1.038
6 Slab EL4.65m	93306	-0.987	-0.072	0.755	-0.210	-0.092	-0.005	-0.050	0.040
	93310	-0.191	-0.199	0.082	-0.011	-0.082	-0.026	-0.067	-0.004
	93410	0.009	-0.598	0.036	-0.030	0.020	-0.015	0.054	0.020

Note: Results are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.

**Table 6.2.4-5 Results of NASTRAN Analysis, Seismic Load (Vertical: Upward Direction)**

Location	Element ID	N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	-0.394	-1.290	-0.294	-0.134	-0.824	-0.025	-0.052	-0.250
	60219	-0.106	-1.323	-0.197	-0.253	-0.663	-0.117	0.020	-0.118
	70201	0.031	-0.236	0.012	0.103	-0.108	0.000	-0.076	0.057
	70204	0.089	-0.958	-0.058	-0.078	-0.237	0.031	-0.008	0.062
	110718	0.169	-0.999	-0.239	0.000	0.035	0.008	-0.001	0.004
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.069	-0.913	0.081	0.046	0.204	0.011	0.008	0.068
	62019	0.057	-0.638	-0.092	-0.006	0.097	-0.035	0.001	0.033
	72001	0.038	-0.262	-0.010	0.045	0.006	0.001	-0.001	0.004
	72004	0.025	-0.510	0.010	0.004	0.023	0.012	-0.004	-0.004
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.075	-0.351	-0.041	-0.146	-0.706	-0.004	-0.004	0.097
	64019	-0.055	-0.438	-0.042	-0.084	-0.497	0.064	0.079	0.080
	74001	-0.011	-0.045	0.075	0.066	-0.058	-0.060	-0.029	-0.039
	74004	-0.063	-0.265	0.023	-0.103	-0.442	-0.078	0.023	-0.089
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	0.091	-1.085	-0.333	-0.280	-0.075	-0.164	-0.005	-0.055
	70801	0.090	-0.331	-0.055	0.194	0.026	-0.027	-0.048	-0.005
	70804	0.114	-0.703	-0.012	-0.023	-0.011	0.018	-0.020	0.027
	110748	0.106	-0.671	-0.295	-0.025	0.003	0.003	0.003	0.010
5 Basemat	90306	-0.712	-0.334	0.447	0.682	-0.086	0.181	-0.461	0.901
	90310	-0.084	-0.104	-0.026	-0.102	-0.113	-0.505	0.098	-0.027
	90410	-0.309	-0.785	0.302	-0.474	0.139	1.025	1.008	0.036
5 Basemat @ Spent Fuel Pool	90486	-0.081	-0.369	-0.055	2.628	1.776	0.248	-0.136	0.099
	90490	-0.119	-0.339	0.155	-0.009	0.762	0.334	1.083	0.177
	90526	-0.003	-0.102	-0.124	1.279	0.419	0.034	-0.234	-0.829
6 Slab EL4.65m	93306	0.165	-0.003	0.027	0.048	0.051	0.009	0.026	-0.126
	93310	0.034	0.044	0.206	0.046	0.020	0.041	-0.025	0.006
	93410	0.237	0.287	-0.238	0.075	0.018	-0.068	-0.046	-0.016

Note: Results are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.



Table 6.3.1-1 Load Combinations and Acceptance Criteria for Safety-Related Reinforced Concrete Structures

Category	Combination <sup>*2</sup> No.	Load <sup>*1,7</sup>													Acceptance Criteria <sup>*5</sup>
		D	F	L <sup>*6</sup>	H	Pa <sup>*3</sup>	To	Ta <sup>*3</sup>	E'	W	Wt	Ro	Ra	Y <sup>*4</sup>	
Normal	FB-C1	1.4	1.4	1.7	1.7	-	-	-	-	-	-	1.7	-	-	U
	FB-C2	1.05	1.05	1.3	1.3	-	1.3	-	-	-	-	1.3	-	-	U
Severe Environmental	FB-C3	1.4	1.4	1.7	1.7	-	-	-	-	1.7	-	1.7	-	-	U
	FB-C4	1.05	1.05	1.3	1.3	-	1.3	-	-	1.3	-	1.3	-	-	U
	FB-C5	1.2	1.2	-	-	-	-	-	-	1.7	-	-	-	-	U
Extreme Environmental	FB-C6	1.0	1.0	1.0	1.0	-	1.0	-	1.0	-	-	1.0	-	-	U
	FB-C7	1.0	1.0	1.0	1.0	-	1.0	-	-	-	1.0	1.0	-	-	U
Abnormal	FB-C8	1.0	1.0	1.0	1.0	1.5	-	1.0	-	-	-	-	1.0	-	U
Abnormal/Extreme Environmental	FB-C9	1.0	1.0	1.0	1.0	1.0	-	1.0	1.0	-	-	-	1.0	1.0	U

Note :

\*1: D = Dead loads

F = Hydrostatic pressure loads

L = Live loads (For the roof, Roof Live loads or Snow loads or Rain loads each acting independently.)

H = Lateral soil pressure loads

Pa = Pressure loads during LOCA

To = Thermal loads during the normal operation

Ta = Thermal loads during LOCA

E' = Seismic loads (SSE)

W = Wind loads (basic wind)

Wt = Wind loads (tornado wind)

Ro = Pipe reaction loads during the normal operation

Ra = Pipe reaction loads during LOCA

Y = High energy pipe rupture

\*2: For any load combination, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occurs simultaneously with the other loads. Otherwise, the coefficient for that load shall be taken as zero.

\*3: Because Pa and Ta are time-dependent loads, their effects are superimposed accordingly.

\*4: Y includes Yj, Ym and Yr. The maximum value of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise.

\*5: U = Section strength required to resist design loads based on the strength design method per ACI 349-01 and in SRP 3.8.4 Section II.3.

\*6: Check L using LL Building, LL Roof (Lr), LL Roof Snow (S), or LL Roof Rain (R) as defined in Section 6.2.3.2 of Reference 2.1.2-p. These are independent load cases that are checked independently using the Load Factors for the appropriate categories.

\*7: The effect of SRV and LOCA dynamic loads originating inside the containment shall be considered as applicable.

**Table 6.3.1-2 Load Combinations and Acceptance Criteria for Safety-Related Steel Structures**

Category	Combination No.	Load <sup>*1</sup>											Acceptance Criteria <sup>*3</sup>
		D	L	Pa	To	Ta	E'	W	Wt	Ro	Ra	Y <sup>*2</sup>	
Normal	FB-S1	1.0	1.0	-	-	-	-	-	-	-	-	-	S
	FB-S2	1.0	1.0	-	1.0	-	-	-	-	1.0	-	-	S (a)
Severe Environmental	FB-S3	1.0	1.0	-	-	-	-	1.0	-	-	-	-	S
	FB-S4	1.0	1.0	-	1.0	-	-	1.0	-	1.0	-	-	S (a)
Extreme Environmental	FB-S5	1.0	1.0	-	1.0	-	1.0	-	-	1.0	-	-	1.6S (b)(c)
	FB-S6	1.0	1.0	-	1.0	-	-	-	1.0	1.0	-	-	1.6S (b)(c)
Abnormal	FB-S7	1.0	1.0	1.0	-	1.0	-	-	-	-	1.0	-	1.6S (b)(c)
Abnormal/Extreme Environmental	FB-S8	1.0	1.0	1.0	-	1.0	1.0	-	-	-	1.0	1.0	1.7S (b)(c)

Note :

\*1 : D = Dead loads

L = Live loads (For the roof, Roof Live loads or Snow loads or Rain loads each acting independently.)

Pa = Pressure loads during LOCA

To = Temperature loads during the normal operation

Ta = Temperature loads during LOCA

E' = Seismic loads (SSE)

W = Wind loads (basic wind)

Wt = Wind loads (tornado wind)

Ro = Pipe reaction loads during the normal operation

Ra = Pipe reaction loads during LOCA

Y = High energy pipe rupture

\*2: Y includes  $Y_j$ ,  $Y_m$  and  $Y_r$ . The maximum values of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise.

\*3: Allowable elastic working stress (S) is the allowable stress limit specified in Part 1 of AISC N690-1994-s2 (2004).

(a) For primary plus secondary stress, the allowable limits are increased by a factor of 1.5.

(b) Stress limit coefficient in shear shall not exceed 1.4 in members and bolts.

(c) Stress limit coefficient where axial compression exceeds 20% of nominal allowable, shall be 1.5 for load combination 5, 6, 7, and be 1.6 for load combination 8.





**Table 6.3.1-3 Load Combinations, Load Factors and Acceptance Criteria for Reinforced Concrete Containment**

Description	No. *2	Load Conditions*1																Acceptance Criteria*6
		D	L	Pt	Po	Pa*3	Tt	To	Ta*3	E*7	W	W'	Ro	Ra	Y*4	SRV*7	LOCA**7	
<b>Service</b>																		
Test	CV-1	1.0	1.0	1.0	-	-	1.0	-	-	-	-	-	-	-	-	-	-	S
Construction	CV-2	1.0	1.0	-	-	-	-	1.0	-	-	1.0	-	-	-	-	-	-	S
Normal	CV-3	1.0	1.0	-	1.0	-	-	1.0	-	-	-	-	1.0	-	-	1.0	-	S
<b>Factored</b>																		
Severe Environmental	CV-4	1.0	1.3	-	1.0	-	-	1.0	-	-	1.5	-	1.0	-	-	1.3	-	U
Extreme Environmental	CV-5	1.0	1.0	-	1.0	-	-	1.0	-	1.0	-	-	1.0	-	-	1.0	-	U
	CV-6	1.0	1.0	-	1.0	-	-	1.0	-	-	-	1.0	1.0	-	-	1.0	-	U
Abnormal	CV-7	1.0	1.0	-	-	1.5	-	-	1.0	-	-	-	-	1.0	-	1.25	Note*5	U
	CV-8	1.0	1.0	-	-	1.0	-	-	1.0	-	-	-	-	1.25	-	1.0	Note*5	U
	CV-9	1.0	1.0	-	-	1.25	-	-	1.0	-	-	-	-	1.0	-	1.25	Note*5	U
Abnormal/Severe Environmental	CV-10	1.0	1.0	-	-	1.25	-	-	1.0	-	1.25	-	-	1.0	-	1.0	Note*5	U
Abnormal/Extreme Environmental	CV-11	1.0	1.0	-	-	1.0	-	-	1.0	1.0	-	-	-	1.0	1.0	1.0	Note*5	U

## Notes:

\*1: The loads are described in Section 5. The allowable stresses of concrete and reinforcing steel shall be in accordance with ASME Code Section III, Division 2, Subsection CC-3400 (except for tangential shear stress carried by orthogonal reinforcement which shall be limited to 4.41 MPa (639 psi) for factored load combinations). Inclined reinforcement shall not be used to resist tangential shear.

\*2: For any load combination, if the effect of any load component (other than D) reduces the combined load, then the load component is deleted from the load combination.

\*3: Because Pa, Ta, SRV and LOCA are time-dependent loads, their effects are superimposed accordingly.

\*4: Y includes Yj, Ym and Yr.

\*5: LOCA loads, CO, CH and PS are time-dependent loads for which DLF may be used. The sequence of occurrence is shown in Figure 5.2.3-2 of Reference 2.1.2-p. The load factor for LOCA loads shall be the same as the corresponding pressure load Pa. LOCA loads shall include hydrostatic pressure (with a load factor of 1.0) due to containment flooding.

\*6: S = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3430 for Service Load Combination. U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

\*7: The peak responses of dynamic loads do not occur at the same instant. SRSS method to combine peak dynamic responses is acceptable for concrete structures.

**Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures**

[illegible]

Note \*1: GDCS Pool Water Depth is 4.48 m.  
\*2: GDCS Pool Water Depth is 0.792 mm.

Dynamic loads, i.e. seismic loads and hydrodynamic loads, are combined according to the SRSS method, as specified in Section 6.3.2 of Reference 2.1.2-g.

Opposite signs of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.

For acceptance criteria, S = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3430 for Service Load Combination. U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.



**Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)**

CV-7	Scenario	Event	LOEC	LOEC	SPD	PF12	PF13	PF14	PF15	PF16	PF17	PF18	PF19	PF20	PF21	PF22	PF23	PF24	PF25	PF26	PF27	PF28	PF29	PF30	PF31	PF32	PF33	PF34	PF35	PF36	PF37	PF38	PF39	PF40	PF41	PF42	PF43	PF44	PF45	PF46	PF47	PF48	PF49	PF50	PF51	PF52	PF53	PF54	PF55	PF56	PF57	PF58	PF59	PF60	PF61	PF62	PF63	PF64	PF65	PF66	PF67	PF68	PF69	PF70	PF71	PF72	PF73	PF74	PF75	PF76	PF77	PF78	PF79	PF80	PF81	PF82	PF83	PF84	PF85	PF86	PF87	PF88	PF89	PF90	PF91	PF92	PF93	PF94	PF95	PF96	PF97	PF98	PF99	PF100	PF101	PF102	PF103	PF104	PF105	PF106	PF107	PF108	PF109	PF110	PF111	PF112	PF113	PF114	PF115	PF116	PF117	PF118	PF119	PF120	PF121	PF122	PF123	PF124	PF125	PF126	PF127	PF128	PF129	PF130	PF131	PF132	PF133	PF134	PF135	PF136	PF137	PF138	PF139	PF140	PF141	PF142	PF143	PF144	PF145	PF146	PF147	PF148	PF149	PF150	PF151	PF152	PF153	PF154	PF155	PF156	PF157	PF158	PF159	PF160	PF161	PF162	PF163	PF164	PF165	PF166	PF167	PF168	PF169	PF170	PF171	PF172	PF173	PF174	PF175	PF176	PF177	PF178	PF179	PF180	PF181	PF182	PF183	PF184	PF185	PF186	PF187	PF188	PF189	PF190	PF191	PF192	PF193	PF194	PF195	PF196	PF197	PF198	PF199	PF200	PF201	PF202	PF203	PF204	PF205	PF206	PF207	PF208	PF209	PF210	PF211	PF212	PF213	PF214	PF215	PF216	PF217	PF218	PF219	PF220	PF221	PF222	PF223	PF224	PF225	PF
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\*2: GDCS Pool Water Depth is 0.792 mm.

Dynamic loads, i.e. seismic loads and hydro

Opposite signs of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 50

For acceptance criteria, U = Allowable Stress as in ASME Section III, Div. 2, Subsection CC-3420 for Factored Load Combination.

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used



**Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)**

Case	Description	Dead Load	Live Load	Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
				Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
				Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
				Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			
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		Dead Load		Thermal Load										Hydrodynamic Load										Wind Load				Tsunami Load			



**Table 6.3.2-1 Detail Load Combinations for Reinforced Concrete Structures (Continued)**

Case	Description	Condition	Temp (Case)	Press (Case)	Seis (Case)	Wind (Case)	Turb (Case)	Acc (Case)	Hydro (Case)	Thermal Load	Thermal Load										SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT LOFCY	SPT
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**Table 6.3.2-2 Detail Load Combinations for Steel Structures**

		Dead Load	Live Load		Pressure Load				Thermal Load																Pipe Reac.	Hydrodynamic Load										Wind Load		Tornado Load		Acceptance Criteria																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
			Normal Operation	Soil Pressure (Statics)	LOCA				LOCA (GDSC Condition1 <sup>TM</sup> )				LOCA (GDSC Condition2 <sup>TM</sup> )				LOCA & L.O.F.C.F				SPF L.O.F.C.F		LOCA				Reaction		N to S	S to N	E to W	W to E	N to S	S to N	E to W	W to E																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
					PL1	PL2	PL3	PL4	AP	PLMS	HO1H	Normal Operation	After 5 seconds	After 6 minutes	After 10 hours	After 72 hours	After 5 sec.	After 6 minutes	After 10 hours	After 72 hours	After 72 hours (both Accident)	SPF L.O.F.C.F (after 72hr.)	SRV	PS-AP		CO	CH	SRV									PS-AP	CO	CH																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
DLG3	LLO	SPC	PL1	PL2	PL3	PL4	AP	PLMS	HO1H	TLG0	TLW0	TLG1	TLW1	TLG2	TLW2	TLG3	TLW3	TLG4	TLW4	TLG5	TLW5	TLG6	TLW6	TLG7	TLW7	TLG8	TLW8	TLG9	TLW9	TLG10	TLW10	TLG11	TLW11	TLG12	TLW12	TLG13	TLW13	TLG14	TLW14	TLG15	TLW15	TLG16	TLW16	TLG17	TLW17	TLG18	TLW18	TLG19	TLW19	TLG20	TLW20	TLG21	TLW21	TLG22	TLW22	TLG23	TLW23	TLG24	TLW24	TLG25	TLW25	TLG26	TLW26	TLG27	TLW27	TLG28	TLW28	TLG29	TLW29	TLG30	TLW30	TLG31	TLW31	TLG32	TLW32	TLG33	TLW33	TLG34	TLW34	TLG35	TLW35	TLG36	TLW36	TLG37	TLW37	TLG38	TLW38	TLG39	TLW39	TLG40	TLW40	TLG41	TLW41	TLG42	TLW42	TLG43	TLW43	TLG44	TLW44	TLG45	TLW45	TLG46	TLW46	TLG47	TLW47	TLG48	TLW48	TLG49	TLW49	TLG50	TLW50	TLG51	TLW51	TLG52	TLW52	TLG53	TLW53	TLG54	TLW54	TLG55	TLW55	TLG56	TLW56	TLG57	TLW57	TLG58	TLW58	TLG59	TLW59	TLG60	TLW60	TLG61	TLW61	TLG62	TLW62	TLG63	TLW63	TLG64	TLW64	TLG65	TLW65	TLG66	TLW66	TLG67	TLW67	TLG68	TLW68	TLG69	TLW69	TLG70	TLW70	TLG71	TLW71	TLG72	TLW72	TLG73	TLW73	TLG74	TLW74	TLG75	TLW75	TLG76	TLW76	TLG77	TLW77	TLG78	TLW78	TLG79	TLW79	TLG80	TLW80	TLG81	TLW81	TLG82	TLW82	TLG83	TLW83	TLG84	TLW84	TLG85	TLW85	TLG86	TLW86	TLG87	TLW87	TLG88	TLW88	TLG89	TLW89	TLG90	TLW90	TLG91	TLW91	TLG92	TLW92	TLG93	TLW93	TLG94	TLW94	TLG95	TLW95	TLG96	TLW96	TLG97	TLW97	TLG98	TLW98	TLG99	TLW99	TLG100	TLW100	TLG101	TLW101	TLG102	TLW102	TLG103	TLW103	TLG104	TLW104	TLG105	TLW105	TLG106	TLW106	TLG107	TLW107	TLG108	TLW108	TLG109	TLW109	TLG110	TLW110	TLG111	TLW111	TLG112	TLW112	TLG113	TLW113	TLG114	TLW114	TLG115	TLW115	TLG116	TLW116	TLG117	TLW117	TLG118	TLW118	TLG119	TLW119	TLG120	TLW120	TLG121	TLW121	TLG122	TLW122	TLG123	TLW123	TLG124	TLW124	TLG125	TLW125	TLG126	TLW126	TLG127	TLW127	TLG128	TLW128	TLG129	TLW129	TLG130	TLW130	TLG131	TLW131	TLG132	TLW132	TLG133	TLW133	TLG134	TLW134	TLG135	TLW135	TLG136	TLW136	TLG137	TLW137	TLG138	TLW138	TLG139	TLW139	TLG140	TLW140	TLG141	TLW141	TLG142	TLW142	TLG143	TLW143	TLG144	TLW144	TLG145	TLW145	TLG146	TLW146	TLG147	TLW147	TLG148	TLW148	TLG149	TLW149	TLG150	TLW150	TLG151	TLW151	TLG152	TLW152	TLG153	TLW153	TLG154	TLW154	TLG155	TLW155	TLG156	TLW156	TLG157	TLW157	TLG158	TLW158	TLG159	TLW159	TLG160	TLW160	TLG161	TLW161	TLG162	TLW162	TLG163	TLW163	TLG164	TLW164	TLG165	TLW165	TLG166	TLW166	TLG167	TLW167	TLG168	TLW168	TLG169	TLW169	TLG170	TLW170	TLG171	TLW171	TLG172	TLW172	TLG173	TLW173	TLG174	TLW174	TLG175	TLW175	TLG176	TLW176	TLG177	TLW177	TLG178	TLW178	TLG179	TLW179	TLG180	TLW180	TLG181	TLW181	TLG182	TLW182	TLG183	TLW183	TLG184	TLW184	TLG185	TLW185	TLG186	TLW186	TLG187	TLW187	TLG188	TLW188	TLG189	TLW189	TLG190	TLW190	TLG191	TLW191	TLG192	TLW192	TLG193	TLW193	TLG194	TLW194	TLG195	TLW195	TLG196	TLW196	TLG197	TLW197	TLG198	TLW198	TLG199	TLW199	TLG200	TLW200	TLG201	TLW201	TLG202	TLW202	TLG203	TLW203	TLG204	TLW204	TLG205	TLW205	TLG206	TLW206	TLG207	TLW207	TLG208	TLW208	TLG209	TLW209	TLG210	TLW210	TLG211	TLW211	TLG212	TLW212	TLG213	TLW213	TLG214	TLW214	TLG215	TLW215	TLG216	TLW216	TLG217	TLW217	TLG218	TLW218	TLG219	TLW219	TLG220	TLW220	TLG221	TLW221	TLG222	TLW222	TLG223	TLW223	TLG224	TLW224	TLG225	TLW225	TLG226	TLW226	TLG227	TLW227	TLG228	TLW228	TLG229	TLW229	TLG230	TLW230	TLG231	TLW231	TLG232	TLW232	TLG233	TLW233	TLG234	TLW234	TLG235	TLW235	TLG236	TLW236	TLG237	TLW237	TLG238	TLW238	TLG239	TLW239	TLG240	TLW240	TLG241	TLW241	TLG242	TLW242	TLG243	TLW243	TLG244	TLW244	TLG245	TLW245	TLG246	TLW246	TLG247	TLW247	TLG248	TLW248	TLG249	TLW249	TLG250	TLW250	TLG251	TLW251	TLG252	TLW252	TLG253	TLW253	TLG254	TLW254	TLG255	TLW255	TLG256	TLW256	TLG257	TLW257	TLG258	TLW258	TLG259	TLW259	TLG260	TLW260	TLG261	TLW261	TLG262	TLW262	TLG263	TLW263	TLG264	TLW264	TLG265	TLW265	TLG266	TLW266	TLG267	TLW267	TLG268	TLW268	TLG269	TLW269	TLG270	TLW270	TLG271	TLW271	TLG272	TLW272	TLG273	TLW273	TLG274	TLW274	TLG275	TLW275	TLG276	TLW276	TLG277	TLW277	TLG278	TLW278	TLG279	TLW279	TLG280	TLW280	TLG281	TLW281	TLG282	TLW282	TLG283	TLW283	TLG284	TLW284	TLG285	TLW285	TLG286	TLW286	TLG287	TLW287	TLG288	TLW288	TLG289	TLW289	TLG290	TLW290	TLG291	TLW291	TLG292	TLW292	TLG293	TLW293	TLG294	TLW294	TLG295	TLW295	TLG296	TLW296	TLG297	TLW297	TLG298	TLW298	TLG299	TLW299	TLG300	TLW300	TLG301	TLW301	TLG302	TLW302	TLG303	TLW303	TLG304	TLW304	TLG305	TLW305	TLG306	TLW306	TLG307	TLW307	TLG308	TLW308	TLG309	TLW309	TLG310	TLW310	TLG311	TLW311	TLG312	TLW312	TLG313	TLW313	TLG314	TLW314	TLG315	TLW315	TLG316	TLW316	TLG317	TLW317	TLG318	TLW318	TLG319	TLW319	TLG320	TLW320	TLG321	TLW321	TLG322	TLW322	TLG323	TLW323	TLG324	TLW324	TLG325	TLW325	TLG326	TLW326	TLG327	TLW327	TLG328	TLW328	TLG329	TLW329	TLG330	TLW330	TLG331	TLW331	TLG332	TLW332	TLG333	TLW333	TLG334	TLW334	TLG335	TLW335	TLG336	TLW336	TLG337	TLW337	TLG338	TLW338	TLG339	TLW339	TLG340	TLW340	TLG341	TLW341	TLG342	TLW342	TLG343	TLW343	TLG344	TLW344	TLG345	TLW345	TLG346	TLW346	TLG347	TLW347	TLG348	TLW348	TLG349	TLW349	TLG350	TLW350	TLG351	TLW351	TLG352	TLW352	TLG353	TLW353	TLG354	TLW354	TLG355	TLW355	TLG356	TLW356	TLG357	TLW357	TLG358	TLW358	TLG359	TLW359	TLG360	TLW360	TLG361	TLW361	TLG362	TLW362	TLG363	TLW363	TLG364	TLW364	TLG365	TLW365	TLG366	TLW366	TLG367	TLW367	TLG368	TLW368	TLG369	TLW369	TLG370	TLW370	TLG371	TLW371	TLG372	TLW372	TLG373	TLW373	TLG374	TLW374	TLG375	TLW375	TLG376	TLW376	TLG377	TLW377	TLG378	TLW378	TLG379	TLW379	TLG380	TLW380	TLG381	TLW381	TLG382	TLW382	TLG383	TLW383	TLG384	TLW384	TLG385	TLW385	TLG386	TLW386	TLG387	TLW387	TLG388	TLW388	TLG389	TLW389	TLG390	TLW390	TLG391	TLW391	TLG392	TLW392	TLG393	TLW393	TLG394	TLW394	TLG395	TLW395	TLG396	TLW396	TLG397	TLW397	TLG398	TLW398	TLG399	TLW399	TLG400	TLW400	TLG401	TLW401	TLG402	TLW402	TLG403	TLW403	TLG404	TLW404	TLG405	TLW405	TLG406	TLW406	TLG407	TLW407	TLG408	TLW408	TLG409	TLW409	TLG410	TLW410	TLG411	TLW411	TLG412	TLW412	TLG413	TLW413	TLG414	TLW414	TLG415	TLW415	TLG416	TLW416	TLG417	TLW417	TLG418	TLW418	TLG419	TLW419	TLG420	TLW420	TLG421	TLW421	TLG422	TLW422	TLG423	TLW423	TLG424	TLW424	TLG425	TLW425	TLG426	TLW426	TLG427	TLW427	TLG428	TLW428	TLG429	TLW429	TLG430	TLW430	TLG431	TLW431	TLG432	TLW432	TLG433	TLW433	TLG434	TLW434	TLG435	TLW435	TLG436	TLW436	TLG437	TLW437	TLG438	TLW438	TLG439	TLW439	TLG440	TLW440	TLG441	TLW441	TLG442	TLW442	TLG443	TLW443	TLG444	TLW444	TLG445	TLW445	TLG446	TLW446	TLG447	TLW447	TLG448	TLW448	TLG449	TLW449	TLG450	TLW450	TLG451	TLW451	TLG452	TLW452	TLG453	TLW453	TLG454	TLW454	TLG455	TLW455	TLG456	TLW456	TLG457	TLW457	TLG458	TLW458	TLG459	TLW459	TLG460	TLW460	TLG461	TLW461	TLG462	TLW462	TLG463	TLW463	TLG464	TLW464	TLG465	TLW465	TLG466	TLW466	TLG467	TLW467	TLG468	TLW468	TLG469	TLW469	TLG470	TLW470	TLG471	TLW471	TLG472	TLW472	TLG473	TLW473	TLG474	TLW474	TLG475	TLW475	TLG476	TLW476	TLG477	TLW477	TLG478	TLW478	TLG479	TLW479	TLG480	TLW480	TLG481	TLW481	TLG482	TLW482	TLG483	TLW483	TLG484	TLW484	TLG485	TLW485	TLG486	TLW486	TLG487	TLW487	TLG488	TLW488	TLG489	TLW489	TLG490	TLW490	TLG491	TLW491	TLG492	TLW492	TLG493	TLW493	TLG494	TLW494	TLG495	TLW495	TLG496	TLW496	TLG497	TLW497	TLG498	TLW498	TLG499	TLW499	TLG500	TLW500	TLG501	TLW501	TLG502	TLW502	TLG503	TLW503	TLG504	TLW504	TLG505	TLW505	TLG506	TLW506	TLG507	TLW507	TLG508	TLW508	TLG509	TLW509	TLG510	TLW510	TLG511	TLW511	TLG512	TLW512	TLG513	TLW513	TLG514	TLW514	TLG515	TLW515	TLG516	TLW516	TLG517	TLW517	TLG518	TLW518	TLG519	TLW519	TLG520	TLW520	TLG521	TLW521	TLG522	TLW522	TLG523	TLW523	TLG524	TLW524	TLG525	TLW525	TLG526	TLW526	TLG527	TLW527	TLG528	TLW528	TLG529	TLW529	TLG530	TLW530	TLG531	TLW531	TLG532	TLW532	TLG533	TLW533	TLG534	TLW534	TLG535	TLW535	TLG536	TLW536	TLG537	TLW537	TLG538	TLW538	TLG539	TLW539	TLG540	TLW540	TLG541	TLW541	TLG542	TLW542	TLG543	TLW543	TLG544	TLW544	TLG545	TLW545	TLG546	TLW546	TLG547	TLW547	TLG548	TLW548	TLG549	TLW549	TLG550	TLW550	TLG551	TLW551	TLG552	TLW552	TLG553	TLW553	TLG554	TLW554	TLG555	TLW555	TLG556	TLW556	TLG557	TLW557	TLG558	TLW558	TLG559	TLW559	TLG560	TLW560	TLG561	TLW561	TLG562	TLW562	TLG563	TLW563	TLG564	TLW564	TLG565	TLW565	TLG566	TLW566	TLG567	TLW567	TLG568	TLW568	TLG569	TLW569	TLG570	TLW570	TLG571	TLW571	TLG572	TLW572	TLG573	TLW573	TLG574	TLW574	TLG575	TLW575	TLG576	TLW576	TLG577	TLW577	TLG578	TLW578	TLG579	TLW579	TLG580	TLW580	TLG581	TLW581	TLG582	TLW582	TLG583	TLW583	TLG584	TLW584	TLG585	TLW585	TLG586	TLW586	TLG587	TLW587	TLG588	TLW588	TLG589	TLW589	TLG590	TLW590	TLG591	TLW591	TLG592	TLW592	TLG593	TLW593	TLG5

Note \*1: GDCS Pool Water Depth is 4.48 m.

\*2: GDCS Pool Water Depth is 0.792 mm.

Dynamic loads, i.e. seismic loads and hydrodynamic loads are combined according to the SRSS method, as specified in Section 6.3.2 of Reference 2.1.2-g.

Opposite signs of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID

The acceptance criteria are specified in Part 1 of ANSI/AISC N690-1994-s2 (2004).

The acceptance criteria are specified in Ref. 14, ASME-BAS R-360-1997-2 (2004). For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report". Reference 2, 1-2-g.



**Table 6.3.2-2 Detail Load Combinations for Steel Structures (Continued)**

		Live Load	Dead Load	Normal Operation Soil Pressure (Status)	Pressure Load		Normal Operation	Thermal Load										LOCA & LOFCF		SPF LOFCF (after 72hr.)	Pipe Reac.	Hydrodynamic Load										Wind Load		Tornado Load		Acceptance Criteria																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
					LOCA			LOCA (GDCS Condition <sup>1</sup> )				LOCA (GDCS Condition <sup>2</sup> )				LOCA & LOFCF		Reaction				Reaction		Reaction		Reaction																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
					PL2	PL3		PL4	AP	AMB	HOB	TL20	TL20	TL21	TL21	TL22	TL22	TL23	TL23			TL24	TL24	TL25	TL25	TL26	TL26	TL27	TL27	TL28	TL28	TL29	TL29	TL30	TL30		TL31	TL31	TL32	TL32	TL33	TL33	TL34	TL34	TL35	TL35	TL36	TL36	TL37	TL37	TL38	TL38	TL39	TL39	TL40	TL40	TL41	TL41	TL42	TL42	TL43	TL43	TL44	TL44	TL45	TL45	TL46	TL46	TL47	TL47	TL48	TL48	TL49	TL49	TL50	TL50	TL51	TL51	TL52	TL52	TL53	TL53	TL54	TL54	TL55	TL55	TL56	TL56	TL57	TL57	TL58	TL58	TL59	TL59	TL60	TL60	TL61	TL61	TL62	TL62	TL63	TL63	TL64	TL64	TL65	TL65	TL66	TL66	TL67	TL67	TL68	TL68	TL69	TL69	TL70	TL70	TL71	TL71	TL72	TL72	TL73	TL73	TL74	TL74	TL75	TL75	TL76	TL76	TL77	TL77	TL78	TL78	TL79	TL79	TL80	TL80	TL81	TL81	TL82	TL82	TL83	TL83	TL84	TL84	TL85	TL85	TL86	TL86	TL87	TL87	TL88	TL88	TL89	TL89	TL90	TL90	TL91	TL91	TL92	TL92	TL93	TL93	TL94	TL94	TL95	TL95	TL96	TL96	TL97	TL97	TL98	TL98	TL99	TL99	TL100	TL100	TL101	TL101	TL102	TL102	TL103	TL103	TL104	TL104	TL105	TL105	TL106	TL106	TL107	TL107	TL108	TL108	TL109	TL109	TL110	TL110	TL111	TL111	TL112	TL112	TL113	TL113	TL114	TL114	TL115	TL115	TL116	TL116	TL117	TL117	TL118	TL118	TL119	TL119	TL120	TL120	TL121	TL121	TL122	TL122	TL123	TL123	TL124	TL124	TL125	TL125	TL126	TL126	TL127	TL127	TL128	TL128	TL129	TL129	TL130	TL130	TL131	TL131	TL132	TL132	TL133	TL133	TL134	TL134	TL135	TL135	TL136	TL136	TL137	TL137	TL138	TL138	TL139	TL139	TL140	TL140	TL141	TL141	TL142	TL142	TL143	TL143	TL144	TL144	TL145	TL145	TL146	TL146	TL147	TL147	TL148	TL148	TL149	TL149	TL150	TL150	TL151	TL151	TL152	TL152	TL153	TL153	TL154	TL154	TL155	TL155	TL156	TL156	TL157	TL157	TL158	TL158	TL159	TL159	TL160	TL160	TL161	TL161	TL162	TL162	TL163	TL163	TL164	TL164	TL165	TL165	TL166	TL166	TL167	TL167	TL168	TL168	TL169	TL169	TL170	TL170	TL171	TL171	TL172	TL172	TL173	TL173	TL174	TL174	TL175	TL175	TL176	TL176	TL177	TL177	TL178	TL178	TL179	TL179	TL180	TL180	TL181	TL181	TL182	TL182	TL183	TL183	TL184	TL184	TL185	TL185	TL186	TL186	TL187	TL187	TL188	TL188	TL189	TL189	TL190	TL190	TL191	TL191	TL192	TL192	TL193	TL193	TL194	TL194	TL195	TL195	TL196	TL196	TL197	TL197	TL198	TL198	TL199	TL199	TL200	TL200	TL201	TL201	TL202	TL202	TL203	TL203	TL204	TL204	TL205	TL205	TL206	TL206	TL207	TL207	TL208	TL208	TL209	TL209	TL210	TL210	TL211	TL211	TL212	TL212	TL213	TL213	TL214	TL214	TL215	TL215	TL216	TL216	TL217	TL217	TL218	TL218	TL219	TL219	TL220	TL220	TL221	TL221	TL222	TL222	TL223	TL223	TL224	TL224	TL225	TL225	TL226	TL226	TL227	TL227	TL228	TL228	TL229	TL229	TL230	TL230	TL231	TL231	TL232	TL232	TL233	TL233	TL234	TL234	TL235	TL235	TL236	TL236	TL237	TL237	TL238	TL238	TL239	TL239	TL240	TL240	TL241	TL241	TL242	TL242	TL243	TL243	TL244	TL244	TL245	TL245	TL246	TL246	TL247	TL247	TL248	TL248	TL249	TL249	TL250	TL250	TL251	TL251	TL252	TL252	TL253	TL253	TL254	TL254	TL255	TL255	TL256	TL256	TL257	TL257	TL258	TL258	TL259	TL259	TL260	TL260	TL261	TL261	TL262	TL262	TL263	TL263	TL264	TL264	TL265	TL265	TL266	TL266	TL267	TL267	TL268	TL268	TL269	TL269	TL270	TL270	TL271	TL271	TL272	TL272	TL273	TL273	TL274	TL274	TL275	TL275	TL276	TL276	TL277	TL277	TL278	TL278	TL279	TL279	TL280	TL280	TL281	TL281	TL282	TL282	TL283	TL283	TL284	TL284	TL285	TL285	TL286	TL286	TL287	TL287	TL288	TL288	TL289	TL289	TL290	TL290	TL291	TL291	TL292	TL292	TL293	TL293	TL294	TL294	TL295	TL295	TL296	TL296	TL297	TL297	TL298	TL298	TL299	TL299	TL300	TL300	TL301	TL301	TL302	TL302	TL303	TL303	TL304	TL304	TL305	TL305	TL306	TL306	TL307	TL307	TL308	TL308	TL309	TL309	TL310	TL310	TL311	TL311	TL312	TL312	TL313	TL313	TL314	TL314	TL315	TL315	TL316	TL316	TL317	TL317	TL318	TL318	TL319	TL319	TL320	TL320	TL321	TL321	TL322	TL322	TL323	TL323	TL324	TL324	TL325	TL325	TL326	TL326	TL327	TL327	TL328	TL328	TL329	TL329	TL330	TL330	TL331	TL331	TL332	TL332	TL333	TL333	TL334	TL334	TL335	TL335	TL336	TL336	TL337	TL337	TL338	TL338	TL339	TL339	TL340	TL340	TL341	TL341	TL342	TL342	TL343	TL343	TL344	TL344	TL345	TL345	TL346	TL346	TL347	TL347	TL348	TL348	TL349	TL349	TL350	TL350	TL351	TL351	TL352	TL352	TL353	TL353	TL354	TL354	TL355	TL355	TL356	TL356	TL357	TL357	TL358	TL358	TL359	TL359	TL360	TL360	TL361	TL361	TL362	TL362	TL363	TL363	TL364	TL364	TL365	TL365	TL366	TL366	TL367	TL367	TL368	TL368	TL369	TL369	TL370	TL370	TL371	TL371	TL372	TL372	TL373	TL373	TL374	TL374	TL375	TL375	TL376	TL376	TL377	TL377	TL378	TL378	TL379	TL379	TL380	TL380	TL381	TL381	TL382	TL382	TL383	TL383	TL384	TL384	TL385	TL385	TL386	TL386	TL387	TL387	TL388	TL388	TL389	TL389	TL390	TL390	TL391	TL391	TL392	TL392	TL393	TL393	TL394	TL394	TL395	TL395	TL396	TL396	TL397	TL397	TL398	TL398	TL399	TL399	TL400	TL400	TL401	TL401	TL402	TL402	TL403	TL403	TL404	TL404	TL405	TL405	TL406	TL406	TL407	TL407	TL408	TL408	TL409	TL409	TL410	TL410	TL411	TL411	TL412	TL412	TL413	TL413	TL414	TL414	TL415	TL415	TL416	TL416	TL417	TL417	TL418	TL418	TL419	TL419	TL420	TL420	TL421	TL421	TL422	TL422	TL423	TL423	TL424	TL424	TL425	TL425	TL426	TL426	TL427	TL427	TL428	TL428	TL429	TL429	TL430	TL430	TL431	TL431	TL432	TL432	TL433	TL433	TL434	TL434	TL435	TL435	TL436	TL436	TL437	TL437	TL438	TL438	TL439	TL439	TL440	TL440	TL441	TL441	TL442	TL442	TL443	TL443	TL444	TL444	TL445	TL445	TL446	TL446	TL447	TL447	TL448	TL448	TL449	TL449	TL450	TL450	TL451	TL451	TL452	TL452	TL453	TL453	TL454	TL454	TL455	TL455	TL456	TL456	TL457	TL457	TL458	TL458	TL459	TL459	TL460	TL460	TL461	TL461	TL462	TL462	TL463	TL463	TL464	TL464	TL465	TL465	TL466	TL466	TL467	TL467	TL468	TL468	TL469	TL469	TL470	TL470	TL471	TL471	TL472	TL472	TL473	TL473	TL474	TL474	TL475	TL475	TL476	TL476	TL477	TL477	TL478	TL478	TL479	TL479	TL480	TL480	TL481	TL481	TL482	TL482	TL483	TL483	TL484	TL484	TL485	TL485	TL486	TL486	TL487	TL487	TL488	TL488	TL489	TL489	TL490	TL490	TL491	TL491	TL492	TL492	TL493	TL493	TL494	TL494	TL495	TL495	TL496	TL496	TL497	TL497	TL498	TL498	TL499	TL499	TL500	TL500	TL501	TL501	TL502	TL502	TL503	TL503	TL504	TL504	TL505	TL505	TL506	TL506	TL507	TL507	TL508	TL508	TL509	TL509	TL510	TL510	TL511	TL511	TL512	TL512	TL513	TL513	TL514	TL514	TL515	TL515	TL516	TL516	TL517	TL517	TL518	TL518	TL519	TL519	TL520	TL520	TL521	TL521	TL522	TL522	TL523	TL523	TL524	TL524	TL525	TL525	TL526	TL526	TL527	TL527</

Note \*1: GDCS Pool Water Depth is 4.48 m.  
\*2: GDCS Pool Water Depth is 0.792 mm.

Dynamic loads, i.e. seismic loads and hydrodynamic loads are combined according to the SRSS method, as specified in Section 6.3.2 of Reference 2.1.2-q. Opposite signs of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID. The acceptance criteria are specified in Part 1 of ANSI/AISC N690-1994-s2 (2004).

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g

**Table 6.3.2-2 Detail Load Combinations for Steel Structures (Continued)**

		Dead Load		Live Load		Pressure Load				Normal Operation		Thermal Load																LOCA & LOFCF		SPE LOFCF		Pipe Reac.		Hydrodynamic Load										Wind Load				Tornado Load		Acceptance Criteria																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
				LOCA		LOCA (GDCS Condition1 <sup>(1)</sup> )																LOCA (GDCS Condition2 <sup>(2)</sup> )				Reaction										N to S		S to N		E to W		W to E																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
				LOCA		LOCA (GDCS Condition1 <sup>(1)</sup> )																LOCA (GDCS Condition2 <sup>(2)</sup> )				Reaction										N to S		S to N		E to W		W to E																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
				LOCA		LOCA (GDCS Condition1 <sup>(1)</sup> )																LOCA (GDCS Condition2 <sup>(2)</sup> )				Reaction										N to S		S to N		E to W		W to E																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
				LOCA		LOCA (GDCS Condition1 <sup>(1)</sup> )																LOCA (GDCS Condition2 <sup>(2)</sup> )				Reaction										N to S		S to N		E to W		W to E																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

Note \*1: GDCS Pool Water Depth is 4.48 m.

\*2: GDCS Pool Water Depth is 0.792 mm.

Dynamic loads, i.e. seismic loads and hydrodynamic loads are combined according to the SRSS method, as specified in Section 6.3.2 of Reference 2.1.2-q

Opposite signs of stresses due to the hydrodynamic load or combination of hydrodynamic and seismic load to the other loads is considered. In that case, 500 is added to the original LOAD ID.

The acceptance criteria are specified in Part 1 of ANSI/AISC N690-1994-s2 (2004).

For unit load cases which are shaded in the table, the results of stress analysis are based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g.





**Table 6.3.3-1 Combined Forces and Moments, 1.05D + 1.3L + 1.3To + 1.3W: Winter**  
**– Load ID = 4021 (Selected Load Combination FB-4)**

Location	Element ID		N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	OTHR	-2.761	-2.158	-0.833	-0.155	-1.183	0.019	-0.066	-0.940
		TEMP	-1.399	0.244	-0.150	1.389	1.248	0.082	-0.323	-0.124
	60219	OTHR	-2.521	-1.990	-0.577	0.103	-0.753	0.145	0.027	-0.858
		TEMP	2.141	-3.473	1.526	-16.532	-22.653	-0.638	-0.009	-2.744
	70201	OTHR	-0.927	-0.381	0.019	-1.345	-0.894	-0.609	0.588	-0.045
		TEMP	2.590	3.915	-1.049	-5.504	-5.911	0.402	-0.198	0.757
	70204	OTHR	-1.294	-1.779	-0.213	0.449	-1.951	-0.415	-0.086	1.941
		TEMP	1.973	1.474	-0.981	-5.183	-6.088	0.322	0.084	0.078
	110718	OTHR	-0.743	-1.075	-0.846	-0.079	0.018	0.047	0.072	0.103
		TEMP	-2.857	-4.097	-1.806	-2.527	-2.904	0.015	0.243	-0.324
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.206	-1.135	-0.107	0.033	0.189	0.008	0.000	0.075
		TEMP	7.429	2.426	0.697	-1.402	-1.563	0.008	-0.029	-0.075
	62019	OTHR	-0.339	-0.714	-0.078	0.018	0.119	-0.030	0.012	0.059
		TEMP	10.022	0.294	-2.625	-1.562	-1.942	-0.063	0.045	-0.137
	72001	OTHR	-0.073	-0.261	-0.058	-0.268	-0.039	0.054	0.145	0.026
		TEMP	5.610	-1.657	3.481	-0.530	-1.166	0.047	-0.963	0.332
	72004	OTHR	-0.278	-0.666	-0.073	0.390	0.266	0.053	0.061	-0.165
		TEMP	8.962	1.077	3.662	-1.724	-2.091	0.110	-0.068	0.213
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.255	-0.308	-0.066	-0.122	-0.585	0.002	-0.002	0.067
		TEMP	5.619	0.223	0.312	-1.261	-0.544	-0.026	-0.006	-0.099
	64019	OTHR	0.004	-0.413	-0.085	-0.069	-0.408	0.056	0.067	0.054
		TEMP	6.640	1.810	1.921	-1.323	-0.590	0.031	-0.009	-0.068
	74001	OTHR	-0.023	-0.056	0.119	0.057	-0.051	-0.042	-0.031	-0.029
		TEMP	3.770	-0.975	-4.229	-0.993	-0.606	0.162	-0.381	0.129
	74004	OTHR	-0.027	-0.227	0.086	-0.084	-0.383	-0.062	0.018	-0.061
		TEMP	5.254	0.289	-4.060	-1.230	-0.396	-0.031	0.029	0.115
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	OTHR	-2.105	-1.488	-0.683	0.638	1.075	0.111	0.184	-0.012
		TEMP	-2.782	-4.484	-0.289	-13.307	-12.914	-1.206	-0.062	-1.487
	70801	OTHR	-1.408	-0.699	-0.089	-3.527	-0.259	-0.424	2.179	-0.351
		TEMP	0.397	4.656	-0.384	-5.261	-5.277	0.027	0.021	-0.027
	70804	OTHR	-1.217	-1.098	-0.094	2.790	1.829	-0.341	0.324	0.256
		TEMP	-0.972	0.944	0.201	-5.140	-5.323	0.365	-0.042	0.181
	110748	OTHR	-0.545	-0.665	-0.428	-0.053	-0.042	-0.069	0.102	-0.059
		TEMP	-0.574	-3.683	-1.399	-1.735	-2.298	-0.112	0.476	-0.198
5 Basemat	90306	OTHR	-4.302	-3.074	0.797	0.965	-0.801	0.431	-0.612	1.576
		TEMP	-0.551	-0.079	0.609	2.135	1.086	0.301	-0.278	0.264
	90310	OTHR	-2.505	-2.555	0.255	-0.649	-0.533	-0.048	0.390	0.184
		TEMP	0.239	0.313	0.518	1.691	1.777	0.959	0.054	-0.064
	90410	OTHR	-3.285	-5.455	0.721	-2.050	-0.017	1.722	1.710	-0.342
		TEMP	-0.173	-0.844	0.141	0.811	2.381	-0.132	-0.103	-0.121
5 Basemat @ Spent Fuel Pool	90486	OTHR	-3.440	-5.735	-0.328	3.065	1.550	-0.126	-0.139	-0.216
		TEMP	-4.244	-2.720	0.470	-24.557	-25.455	2.673	-0.139	0.534
	90490	OTHR	-3.543	-4.705	0.200	-1.336	0.798	0.351	1.536	-0.326
		TEMP	-3.300	3.303	0.448	-29.781	-29.188	0.728	2.617	2.051
	90526	OTHR	-4.260	-6.628	-0.408	0.655	-5.562	-0.299	-0.211	-1.879
		TEMP	3.535	0.045	-0.194	-25.792	-9.116	0.463	-1.405	2.015
6 Slab EL4.65m	93306	OTHR	0.042	-0.229	-0.085	0.100	0.164	0.016	0.034	-0.158
		TEMP	-1.235	-0.073	-1.154	-0.070	0.029	-0.024	0.086	-0.038
	93310	OTHR	-0.038	-0.035	0.140	0.092	0.042	0.011	-0.050	0.004
		TEMP	-2.819	-2.798	-3.576	-0.996	-1.005	-0.291	0.362	0.365
	93410	OTHR	-0.051	-0.174	0.009	0.220	0.058	-0.047	-0.099	-0.017
		TEMP	-0.718	-3.379	-0.128	-0.172	-0.035	0.000	-0.089	-0.038

OTHR: Loads other than thermal loads

TEMP: Thermal loads

Note: Load combination includes the results of NASTRAN based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g, as shown in Table 6.3.2-1.



**Table 6.3.3-2 Combined Forces and Moments, LOCA After 72 hours (1.5Pa): Winter**  
**-- Load ID = 6441 (Selected Load Combination FB-8)**

Location	Element ID		N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	OTHR	-2.180	-2.014	-0.749	-0.156	-1.172	0.013	-0.079	-0.817
		TEMP	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
		HYDR	0.343	0.293	0.291	0.021	0.118	0.009	0.011	0.040
	60219	OTHR	-1.837	-1.810	-0.486	-0.058	-0.765	0.068	0.027	-0.605
		TEMP	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
		HYDR	0.317	0.588	0.207	0.084	0.203	0.013	0.007	0.035
	70201	OTHR	-0.655	-0.304	0.026	-0.934	-0.689	-0.446	0.399	-0.021
		TEMP	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
		HYDR	0.010	0.175	0.191	0.016	0.053	0.003	0.023	0.017
	70204	OTHR	-0.909	-1.543	-0.127	0.303	-1.514	-0.294	-0.067	1.423
		TEMP	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
		HYDR	0.094	0.569	0.366	0.044	0.100	0.012	0.002	0.023
	110718	OTHR	-0.527	-1.090	-0.694	-0.070	0.033	0.037	0.062	0.118
		TEMP	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
		HYDR	0.159	0.275	0.063	0.016	0.037	0.002	0.004	0.018
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.164	-1.130	-0.068	0.029	0.147	0.007	0.002	0.055
		TEMP	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
		HYDR	0.101	0.076	0.187	0.003	0.012	0.001	0.004	0.003
	62019	OTHR	-0.256	-0.686	-0.078	0.008	0.087	-0.026	0.008	0.040
		TEMP	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
		HYDR	0.061	0.126	0.193	0.003	0.011	0.001	0.001	0.002
	72001	OTHR	-0.044	-0.180	-0.014	-0.199	-0.029	0.034	0.117	0.018
		TEMP	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
		HYDR	0.023	0.198	0.270	0.007	0.005	0.001	0.002	0.004
	72004	OTHR	-0.202	-0.583	-0.015	0.302	0.200	0.036	0.044	-0.113
		TEMP	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
		HYDR	0.052	0.190	0.321	0.004	0.006	0.001	0.001	0.001
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.002	-0.326	-0.056	-0.121	-0.599	0.001	-0.002	0.083
		TEMP	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
		HYDR	0.344	0.002	0.133	0.005	0.015	0.002	0.001	0.002
	64019	OTHR	-0.160	-0.426	-0.134	-0.067	-0.419	0.052	0.067	0.067
		TEMP	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
		HYDR	0.254	0.011	0.101	0.005	0.011	0.004	0.002	0.002
	74001	OTHR	-0.036	-0.042	0.158	0.044	-0.056	-0.036	-0.028	-0.028
		TEMP	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
		HYDR	0.020	0.018	0.092	0.009	0.004	0.004	0.005	0.003
	74004	OTHR	-0.101	-0.239	0.179	-0.084	-0.399	-0.055	0.014	-0.080
		TEMP	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
		HYDR	0.118	0.009	0.173	0.003	0.004	0.004	0.001	0.001
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	OTHR	-1.496	-1.383	-0.597	0.277	0.634	0.027	0.139	-0.023
		TEMP	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
		HYDR	0.057	0.403	0.247	0.083	0.054	0.022	0.009	0.015
	70801	OTHR	-0.949	-0.535	-0.048	-2.507	-0.190	-0.332	1.569	-0.269
		TEMP	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
		HYDR	0.028	0.219	0.302	0.036	0.010	0.009	0.012	0.005
	70804	OTHR	-0.813	-0.985	-0.033	2.046	1.302	-0.251	0.231	0.205
		TEMP	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
		HYDR	0.051	0.378	0.366	0.033	0.015	0.017	0.003	0.010
	110748	OTHR	-0.379	-0.726	-0.447	-0.079	-0.049	-0.053	0.092	-0.050
		TEMP	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
		HYDR	0.060	0.095	0.068	0.010	0.010	0.015	0.002	0.006

OTHR: Loads other than thermal and hydrodynamic loads

TEMP: Thermal loads

HYDR: Hydrodynamic loads

Note: Load combination includes the results of NASTRAN based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g, as shown in Table 6.3.2-1.



**Table 6.3.3-2 Combined Forces and Moments, LOCA After 72 hours (1.5Pa): Winter**  
**– Load ID = 6441 (Selected Load Combination FB-8) (Continued)**

Location	Element ID		N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
5 Basemat	90306	OTHR	-3.550	-2.447	0.674	0.918	-0.661	0.322	-0.541	1.431
		TEMP	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
		HYDR	0.379	0.165	0.412	0.357	0.091	0.349	0.331	0.408
	90310	OTHR	-1.958	-1.982	0.184	-0.545	-0.444	-0.171	0.342	0.119
		TEMP	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
		HYDR	0.052	0.139	0.022	0.062	0.063	0.144	0.111	0.142
	90410	OTHR	-2.640	-4.305	0.681	-1.813	0.002	1.619	1.592	-0.270
		TEMP	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
		HYDR	0.071	0.650	0.200	0.146	0.116	0.471	0.230	0.146
5 Basemat @ Spent Fuel Pool	90486	OTHR	-2.599	-4.369	-0.202	3.046	1.621	0.005	-0.099	-0.152
		TEMP	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
		HYDR	0.158	0.207	0.127	1.680	1.236	0.208	0.129	0.088
	90490	OTHR	-2.642	-3.509	0.202	-0.803	0.812	0.385	1.391	-0.177
		TEMP	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
		HYDR	0.057	0.699	0.167	0.334	0.711	0.173	0.524	0.090
	90526	OTHR	-3.180	-4.999	-0.266	0.879	-3.885	-0.140	-0.187	-1.585
		TEMP	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
		HYDR	0.271	0.062	0.398	0.923	0.352	0.426	0.198	0.477
6 Slab EL4.65m	93306	OTHR	0.053	-0.186	-0.139	0.087	0.128	0.012	0.034	-0.142
		TEMP	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
		HYDR	0.184	0.036	0.234	0.034	0.041	0.003	0.008	0.008
	93310	OTHR	-0.037	-0.027	0.108	0.079	0.035	0.013	-0.045	0.002
		TEMP	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
		HYDR	0.035	0.026	0.060	0.032	0.030	0.004	0.034	0.031
	93410	OTHR	-0.015	-0.083	-0.075	0.165	0.045	-0.049	-0.073	-0.015
		TEMP	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032
		HYDR	0.017	0.128	0.106	0.023	0.007	0.012	0.016	0.001

OTHR: Loads other than thermal and hydrodynamic loads

TEMP: Thermal loads

HYDR: Hydrodynamic loads

Note: Load combination includes the results of NASTRAN based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g, as shown in Table 6.3.2-1.



**Table 6.3.3-3 Combined Forces and Moments, LOCA After 72 hours + SSE: Winter**  
**- Load ID = 7441 (Selected Load Combination FB-9)**

Location	Element ID		N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	OTHR	-2.179	-2.004	-0.745	-0.154	-1.159	0.012	-0.076	-0.809
		TEMP	-0.932	0.104	-0.283	1.040	0.845	0.081	-0.279	-0.151
		SEIS	3.391	1.389	1.662	0.152	1.097	0.062	0.309	0.411
		HYDR	0.241	0.207	0.204	0.015	0.085	0.007	0.008	0.029
	60219	OTHR	-1.837	-1.809	-0.485	-0.058	-0.765	0.071	0.027	-0.605
		TEMP	1.775	-2.822	0.999	-12.784	-17.538	-0.622	0.026	-2.138
		SEIS	4.507	1.922	1.484	2.874	5.191	1.147	0.405	2.304
		HYDR	0.224	0.415	0.145	0.059	0.141	0.008	0.005	0.024
	70201	OTHR	-0.655	-0.307	0.030	-0.935	-0.688	-0.446	0.399	-0.021
		TEMP	2.001	2.952	-0.673	-4.155	-4.561	0.310	-0.183	0.610
		SEIS	0.602	0.811	2.674	1.445	0.852	0.681	0.452	0.270
		HYDR	0.007	0.122	0.136	0.011	0.038	0.002	0.016	0.012
	70204	OTHR	-0.914	-1.541	-0.123	0.304	-1.512	-0.294	-0.067	1.423
		TEMP	1.559	1.017	-0.470	-3.984	-4.709	0.285	0.069	0.073
		SEIS	2.332	2.155	4.012	0.621	2.107	0.487	0.097	1.544
		HYDR	0.067	0.403	0.260	0.031	0.071	0.008	0.001	0.016
	110718	OTHR	-0.526	-1.088	-0.689	-0.070	0.031	0.038	0.062	0.117
		TEMP	-2.155	-3.145	-1.392	-1.934	-2.203	0.009	0.190	-0.234
		SEIS	2.496	1.141	2.693	0.133	0.241	0.123	0.108	0.258
		HYDR	0.114	0.194	0.045	0.011	0.026	0.002	0.003	0.013
2 Exterior Wall @ EL4.65 ~6.60m	62011	OTHR	-0.162	-1.120	-0.066	0.029	0.151	0.007	0.002	0.056
		TEMP	5.880	1.937	0.541	-1.090	-1.228	0.001	-0.030	-0.062
		SEIS	1.284	0.962	2.571	0.199	0.891	0.038	0.042	0.348
		HYDR	0.072	0.054	0.130	0.002	0.008	0.000	0.003	0.002
	62019	OTHR	-0.256	-0.685	-0.078	0.008	0.089	-0.026	0.009	0.040
		TEMP	7.722	0.133	-2.024	-1.201	-1.492	-0.050	0.033	-0.106
		SEIS	0.805	1.650	2.732	0.399	0.738	0.166	0.075	0.202
		HYDR	0.043	0.088	0.135	0.002	0.008	0.001	0.000	0.001
	72001	OTHR	-0.044	-0.197	-0.006	-0.199	-0.029	0.034	0.117	0.018
		TEMP	4.333	-1.692	2.655	-0.388	-0.891	0.038	-0.739	0.255
		SEIS	1.556	3.040	4.567	0.663	0.200	0.165	0.301	0.085
		HYDR	0.016	0.138	0.191	0.005	0.004	0.001	0.001	0.003
	72004	OTHR	-0.198	-0.588	-0.002	0.302	0.200	0.036	0.044	-0.113
		TEMP	7.043	0.683	2.803	-1.318	-1.608	0.083	-0.056	0.166
		SEIS	1.884	2.616	5.021	0.622	0.871	0.106	0.117	0.460
		HYDR	0.037	0.133	0.227	0.002	0.004	0.001	0.001	0.001
3 Exterior Wall @ EL22.50 ~24.60m	64011	OTHR	0.050	-0.326	-0.059	-0.123	-0.604	0.001	-0.002	0.084
		TEMP	4.710	0.187	0.313	-0.963	-0.391	-0.017	-0.003	-0.083
		SEIS	3.265	0.377	1.666	0.160	0.719	0.055	0.028	0.221
		HYDR	0.242	0.001	0.092	0.004	0.011	0.001	0.001	0.001
	64019	OTHR	-0.131	-0.425	-0.116	-0.068	-0.422	0.052	0.067	0.068
		TEMP	5.505	1.413	1.655	-1.023	-0.448	0.026	-0.009	-0.051
		SEIS	2.843	0.448	1.400	0.100	0.545	0.212	0.103	0.088
		HYDR	0.178	0.008	0.070	0.004	0.008	0.002	0.002	0.002
	74001	OTHR	-0.032	-0.046	0.146	0.046	-0.055	-0.037	-0.029	-0.028
		TEMP	2.905	-0.810	-3.488	-0.742	-0.459	0.125	-0.302	0.092
		SEIS	0.221	0.275	1.173	0.154	0.094	0.225	0.073	0.052
		HYDR	0.014	0.013	0.064	0.006	0.003	0.003	0.003	0.002
	74004	OTHR	-0.080	-0.240	0.154	-0.085	-0.400	-0.056	0.014	-0.080
		TEMP	4.031	0.191	-3.611	-0.936	-0.298	-0.021	0.021	0.087
		SEIS	1.773	0.355	2.028	0.120	0.449	0.151	0.071	0.211
		HYDR	0.083	0.006	0.121	0.002	0.003	0.003	0.001	0.001

OTHR: Loads other than thermal, seismic and hydrodynamic loads

TEMP: Thermal loads, SEIS: Seismic loads, HYDR: Hydrodynamic loads

Note: Load combination includes the results of NASTRAN based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g, as shown in Table 6.3.2-1.



**Table 6.3.3-3 Combined Forces and Moments, LOCA After 72 hours + SSE: Winter**  
**– Load ID = 7441 (Selected Load Combination FB-9) (Continued)**

Location	Element ID		N <sub>x</sub> (MN/m)	N <sub>y</sub> (MN/m)	N <sub>xy</sub> (MN/m)	M <sub>x</sub> (MNm/m)	M <sub>y</sub> (MNm/m)	M <sub>xy</sub> (MNm/m)	Q <sub>x</sub> (MN/m)	Q <sub>y</sub> (MN/m)
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	OTHR	-1.497	-1.381	-0.597	0.277	0.635	0.029	0.139	-0.023
		TEMP	-2.067	-3.594	-0.353	-10.280	-9.932	-1.102	-0.058	-1.158
		SEIS	2.815	1.358	1.990	6.707	2.047	1.474	0.416	1.095
		HYDR	0.039	0.284	0.174	0.058	0.037	0.016	0.006	0.011
	70801	OTHR	-0.950	-0.542	-0.041	-2.508	-0.190	-0.332	1.569	-0.269
		TEMP	0.377	3.314	-0.183	-3.883	-4.019	0.017	-0.013	-0.017
		SEIS	2.446	1.484	3.257	4.046	0.609	0.812	2.099	0.610
		HYDR	0.019	0.153	0.214	0.025	0.007	0.006	0.009	0.003
	70804	OTHR	-0.819	-0.982	-0.023	2.046	1.302	-0.251	0.231	0.205
		TEMP	-0.589	0.585	0.363	-3.927	-4.089	0.317	-0.051	0.144
		SEIS	2.332	1.601	3.755	3.232	1.357	0.538	0.366	0.553
		HYDR	0.036	0.267	0.261	0.023	0.011	0.012	0.002	0.007
	110748	OTHR	-0.379	-0.723	-0.443	-0.078	-0.049	-0.053	0.092	-0.050
		TEMP	-0.434	-2.821	-1.077	-1.340	-1.771	-0.097	0.369	-0.150
		SEIS	1.618	1.105	2.135	0.421	0.143	0.255	0.101	0.099
		HYDR	0.043	0.066	0.049	0.007	0.007	0.011	0.001	0.004
5 Basemat	90306	OTHR	-3.541	-2.445	0.674	0.917	-0.652	0.323	-0.542	1.429
		TEMP	-0.842	-0.093	0.302	1.812	0.786	0.047	-0.013	0.259
		SEIS	2.617	0.678	2.942	1.298	0.418	2.974	2.642	1.674
		HYDR	0.266	0.117	0.292	0.253	0.065	0.246	0.234	0.289
	90310	OTHR	-1.958	-1.979	0.185	-0.542	-0.441	-0.170	0.342	0.115
		TEMP	0.134	0.271	0.321	1.221	1.339	0.612	0.152	-0.060
		SEIS	0.583	1.065	0.300	0.726	0.502	0.939	1.193	2.000
		HYDR	0.036	0.099	0.016	0.044	0.045	0.102	0.078	0.100
	90410	OTHR	-2.630	-4.301	0.674	-1.786	0.003	1.615	1.584	-0.270
		TEMP	-0.192	-0.439	0.257	0.435	1.801	0.052	-0.016	-0.216
		SEIS	0.369	4.923	2.060	1.989	0.824	2.609	1.088	1.731
		HYDR	0.050	0.457	0.140	0.106	0.081	0.332	0.163	0.102
5 Basemat @ Spent Fuel Pool	90486	OTHR	-2.594	-4.374	-0.208	3.019	1.614	-0.002	-0.108	-0.148
		TEMP	-3.327	-2.050	0.616	-18.282	-19.282	2.304	-0.005	0.385
		SEIS	0.450	1.155	1.352	6.105	4.467	2.495	1.324	0.507
		HYDR	0.113	0.145	0.089	1.198	0.875	0.148	0.090	0.061
	90490	OTHR	-2.642	-3.508	0.201	-0.804	0.810	0.377	1.391	-0.182
		TEMP	-2.565	2.723	0.532	-22.985	-22.408	0.850	2.142	1.611
		SEIS	0.329	6.047	1.760	9.878	4.395	1.601	1.904	1.863
		HYDR	0.040	0.495	0.117	0.237	0.504	0.121	0.370	0.063
	90526	OTHR	-3.184	-4.999	-0.266	0.868	-3.882	-0.145	-0.188	-1.583
		TEMP	2.586	0.040	0.156	-19.469	-6.941	0.735	-0.998	1.464
		SEIS	3.195	0.408	3.822	3.345	5.356	4.786	1.856	1.932
		HYDR	0.192	0.044	0.282	0.655	0.248	0.301	0.141	0.339
6 Slab EL4.65m	93306	OTHR	0.051	-0.186	-0.110	0.086	0.127	0.012	0.034	-0.141
		TEMP	-0.789	-0.028	-1.656	-0.051	0.035	-0.014	0.080	-0.030
		SEIS	1.696	0.171	1.135	0.408	0.395	0.029	0.104	0.175
		HYDR	0.129	0.026	0.171	0.024	0.029	0.002	0.005	0.006
	93310	OTHR	-0.034	-0.026	0.124	0.077	0.035	0.014	-0.043	0.002
		TEMP	-2.219	-2.170	-3.223	-0.752	-0.783	-0.242	0.267	0.288
		SEIS	0.577	0.275	0.548	0.580	0.327	0.108	0.431	0.423
		HYDR	0.024	0.018	0.044	0.023	0.022	0.003	0.024	0.022
	93410	OTHR	-0.010	-0.085	-0.080	0.163	0.045	-0.050	-0.072	-0.015
		TEMP	-0.686	-2.429	-0.064	-0.055	-0.015	0.020	-0.106	-0.032
		SEIS	0.606	0.801	1.358	0.813	0.172	0.209	0.392	0.027
		HYDR	0.013	0.091	0.076	0.017	0.005	0.008	0.011	0.001

OTHR: Loads other than thermal, seismic and hydrodynamic loads

TEMP: Thermal loads, SEIS: Seismic loads, HYDR: Hydrodynamic loads

Note: Load combination includes the results of NASTRAN based on the RB/FB global FE model which is used in Appendix E of "ESBWR Reactor Building Structural Design Report", Reference 2.1.2-g, as shown in Table 6.3.2-1.



Table 6.4.1.1-1 Material Constants for Stress Calculations

Material	Property	Value	
Concrete	Compressive strength, $f_c'$	Basemat	27.6 MPa
		Others	34.5 MPa
	Young's modulus	Basemat	$2.49 \times 10^4$ MPa
		Others	$2.78 \times 10^4$ MPa
	Poisson's ratio	0.17	
Reinforcement	Yield stress, $f_y$	413.6 MPa	
	Young's modulus	$2.00 \times 10^5$ MPa	

Table 6.4.1.1-2 Allowable Stress of Concrete for Membrane Plus Bending

Load Condition	Allowable Compressive Stress (MPa)		
Primary	Basemat	20.7	$(0.75 f_c')$
	Others	25.9	
Primary plus secondary	Basemat	23.5	$(0.85 f_c')$
	Others	29.3	

Table 6.4.1.1-3 Allowable Stress of Reinforcement for Membrane Plus Bending

	Allowable Stress (MPa)	
Tension	372.2	$(0.90 f_y)$
Compression	372.2	$(0.90 f_y)$

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 74

REV. 1

of 155

**Table 6.4.1.1-4 Allowable Stress of Concrete for Membrane Compressive Forces**

Load Category	Load Condition	Allowable Compressive Stress (MPa)		
Factored	Primary	Basemat	16.6	(0.60 $f_c'$ )
		Others	20.7	
	Primary plus secondary	Basemat	20.7	(0.75 $f_c'$ )
		Others	25.9	
Service	Primary	Basemat	8.3	(0.30 $f_c'$ )
		Others	10.4	
	Primary plus secondary	Basemat	12.4	(0.45 $f_c'$ )
		Others	15.5	

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 75

REV. 1

of 155

**Table 7.3.1.1.1-1 Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation**

Location	Element ID	Thickn ess (m)	Primary Reinforcement					Shear Tie		
			Position	Direction 1 <sup>1</sup>		Direction 2 <sup>1</sup>				
				Arrangement* <sup>2</sup>	Ratio (%)	Arrangement* <sup>2</sup>	Ratio (%)	Arrangement	Ratio (%)	
1 Exterior Wall and Pool Wall Bottom	60011	2.0	Inside	3-#11@200	0.755	1-#11@100 +3-#11@200	1.258	#6@200x200	0.710	
			Outside	1-#11@100 +3-#11@200	1.258	2-#11@100 +2-#11@200	1.510			
	60219	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710	
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258			
	70201 70204	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710	
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516			
	110718	1.5	Inside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342	#6@400x200	0.355	
			Outside	2-#11@200	0.671	3-#11@200 (+1-#11@200)	1.342			
	2 Exterior Wall @ EL4.65 to 6.60m	62011 62019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
				Outside	3-#11@200	1.510	3-#11@200	1.510		
72001		1.0	Inside	3-#11@200	1.510	3-#11@200	1.510	#5@400x200	0.250	
			Outside	3-#11@200	1.510	3-#11@200	1.510			
72004		1.0	Inside	3-#11@200	1.510	2-#11@200 (+1-#11@200)	1.510	#5@400x200	0.250	
			Outside	3-#11@200	1.510	3-#11@200	1.510			
3 Exterior Wall @ EL22.50 to 24.60m		64011	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125
				Outside	2-#11@200 (+1-#11@200)	1.510	2-#11@200 (+1-#11@200)	1.510		
	64019	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125	
			Outside	2-#11@200	1.006	2-#11@200	1.006			
	74001 74004	1.0	Inside	2-#11@200	1.006	2-#11@200	1.006	#5@400x400	0.125	
			Outside	3-#11@200	1.510	3-#11@200	1.510			

Note: Updated arrangements of reinforcements and shear ties from standard design are shown in red.

\*1: Exterior Wall, Pool Wall  
Basemat, SlabDirection 1: Horizontal  
Direction 1: N-SDirection 2: Vertical  
Direction 2: E-W

\*2: Rebar in parentheses indicates additional bars locally required.





**Table 7.3.1.1.1-1 Sectional Thicknesses and Rebar Ratios of FB Used in the Evaluation (Continued)**

Location	Element ID	Thickness (m)	Primary Reinforcement					Shear Tie	
			Position	Direction 1 <sup>1</sup>		Direction 2 <sup>1</sup>		Arrangement	Ratio (%)
				Arrangement <sup>2</sup>	Ratio (%)	Arrangement <sup>2</sup>	Ratio (%)		
4 Spent Fuel Pool Wall @ EL-5.10 to -3.30m	60819	3.6	Inside	6-#11@200	0.839	6-#11@200	0.839	#6@200x200	0.710
			Outside	1-#11@100 +7-#11@200	1.258	1-#11@100 +7-#11@200	1.258		
	70801 70804	2.0	Inside	3-#11@100 +1-#11@200	1.761	3-#11@100 +1-#11@200	1.761	#6@200x200	0.710
			Outside	3-#11@100 +1-#11@200	1.761	5-#11@100	2.516		
	110748	1.5	Inside	2-#11@200	0.671	3-#11@200	1.006	#6@400x400	0.177
			Outside	2-#11@200	0.671	3-#11@200	1.006		
5 Basemat	90306 90310 90410	4.0	Top	4-#11@200	0.503	4-#11@200	0.503	#11@400x400	0.629
			Bottom	5-#11@200	0.629	5-#11@200	0.629		
5 Basemat @ Spent Fuel Pool	90486	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@600x400	0.419
			Bottom	5-#11@200	0.457	5-#11@200	0.457		
	90490 90526	5.5	Top	4-#11@200 (+2-#11@200)	0.549	4-#11@200 (+2-#11@200)	0.549	#11@400x400	0.629
			Bottom	5-#11@200	0.457	5-#11@200	0.457		
6 Slab EL4.65m	93306 93310 93410	1.3	Top	2-#11@200	0.774	2-#11@200	0.774	#5@200x200	0.500
			Bottom	2-#11@200	0.774	2-#11@200	0.774		

Note: Updated arrangements of reinforcements and shear ties from standard design are shown in red.

\*1: Exterior Wall, Pool Wall Direction 1: Horizontal Direction 2: Vertical  
Basemat, Slab Direction 1: N-S Direction 2: E-W

\*2: Rebar in parentheses indicates additional bars locally required.

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 77

REV. 1

of 155

**Table 7.3.1.1.1-2 Rebar and Concrete Stresses of FB, 1.05D+1.3L+1.3To+1.3W: Winter**  
**– Load ID = 4021 (Selected Load Combination FB-4)**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)					Allowabl e
		Calculated	Allowable	Calculated					
				Direction 1*		Direction 2*			
				In/Top	Out/Bottom	In/Top	Out/Bottom		
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-3.4	-29.3	-4.5	-19.2	-4.5	-3.3	372.2	
	60219	-7.6	-29.3	-9.6	30.1	-32.4	53.7	372.2	
	70201	-9.9	-29.3	-12.0	90.3	-10.1	85.1	372.2	
	70204	-9.2	-29.3	-4.6	31.0	-30.5	67.6	372.2	
	110718	-11.3	-29.3	-16.3	84.8	-26.3	48.4	372.2	
2 Exterior Wall @ EL4.65 ~-6.60m	62011	-6.4	-29.3	33.6	85.5	-12.0	27.9	372.2	
	62019	-10.5	-29.3	53.3	116.8	-27.0	79.9	372.2	
	72001	-9.5	-29.3	22.5	108.4	-20.1	80.0	372.2	
	72004	-11.5	-29.3	56.9	73.6	-23.0	74.1	372.2	
3 Exterior Wall @ EL22.50 ~-24.60m	64011	-8.4	-29.3	25.5	101.5	-18.6	66.4	372.2	
	64019	-8.4	-29.3	40.6	151.3	-9.4	116.7	372.2	
	74001	-4.6	-29.3	23.5	93.7	3.2	80.2	372.2	
	74004	-7.5	-29.3	13.7	108.0	1.8	116.4	372.2	
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-5.1	-29.3	-18.1	17.6	-21.1	15.2	372.2	
	70801	-11.7	-29.3	-32.2	102.4	1.9	58.6	372.2	
	70804	-2.9	-29.3	-12.2	4.0	-5.7	12.8	372.2	
	110748	-8.8	-29.3	0.6	57.9	-32.1	33.7	372.2	
5 Basemat	90306	-2.1	-23.5	-2.5	-13.7	-5.0	-3.8	372.2	
	90310	-0.8	-23.5	-2.6	-4.6	-2.1	-4.9	372.2	
	90410	-2.3	-23.5	-7.7	-1.3	-5.7	-15.4	372.2	
5 Basemat @ Spent Fuel Pool	90486	-4.0	-23.5	-12.9	8.2	-16.1	8.6	372.2	
	90490	-4.2	-23.5	-13.2	23.1	-4.7	11.6	372.2	
	90526	-3.1	-23.5	-3.2	12.7	-14.0	4.4	372.2	
6 Slab EL4.65m	93306	-1.8	-29.3	18.1	4.0	41.8	5.0	372.2	
	93310	-7.5	-29.3	-12.4	53.2	-14.1	56.6	372.2	
	93410	-2.6	-29.3	-0.4	-1.8	-16.8	-17.3	372.2	

Note: Negative value means compression.

Note \*: Exterior Wall, Pool Wall  
Basemat, SlabDirection 1: Horizontal,  
Direction 1: N-S,Direction 2: Vertical  
Direction 2: E-W



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 78

REV. 1

of 155

**Table 7.3.1.1.1-3 Rebar and Concrete Stresses of FB, LOCA After 72 hours (1.5Pa):  
Winter – Load ID = 6441 (Selected Load Combination FB-8)**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
		Calculated	Allowable	Calculated				Allowable
				Direction 1*		Direction 2*		
				In/Top	Out/Bottom	In/Top	Out/Bottom	
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	-2.8	-29.1	-3.8	-15.3	-8.5	-1.8	370.5
	60219	-6.3	-28.5	-7.2	27.8	-26.9	45.0	366.4
	70201	-7.5	-28.3	-7.7	70.1	-7.9	67.5	364.6
	70204	-7.4	-28.3	-2.6	26.3	-27.2	56.0	364.6
	110718	-8.8	-27.5	-12.7	70.7	-23.7	36.0	359.1
2 Exterior Wall @ EL4.65 ~6.60m	62011	-3.8	-28.3	24.2	64.7	-10.3	22.1	365.0
	62019	-8.6	-28.3	35.5	95.8	-19.8	75.5	365.0
	72001	-8.1	-28.3	24.8	92.9	-19.0	64.9	365.0
	72004	-7.2	-28.3	73.9	56.4	-25.2	59.7	365.0
3 Exterior Wall @ EL22.50 ~24.60m	64011	-8.5	-28.3	29.4	94.3	-17.7	68.8	365.0
	64019	-6.7	-28.3	32.3	96.9	-8.3	75.4	365.0
	74001	-4.0	-28.3	24.1	76.0	6.3	66.2	365.0
	74004	-6.2	-28.3	13.6	102.0	3.8	101.0	365.0
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	-4.3	-28.5	-13.6	17.1	-18.4	13.1	366.4
	70801	-8.6	-28.3	-23.4	81.7	2.2	47.0	364.6
	70804	-2.1	-28.3	-7.7	7.4	-7.1	13.4	364.6
	110748	-7.2	-27.5	2.1	53.8	-25.9	28.5	359.1
5 Basemat	90306	-2.1	-23.2	-2.3	-14.2	-3.9	-3.2	370.3
	90310	-0.7	-23.2	-2.1	-3.9	-1.4	-4.3	370.3
	90410	-2.0	-23.2	-7.3	-0.9	-5.0	-13.1	370.3
5 Basemat @ Spent Fuel Pool	90486	-3.6	-22.9	-10.9	11.3	-13.0	9.3	367.2
	90490	-3.3	-22.9	-10.1	18.9	-4.9	12.3	367.2
	90526	-2.4	-22.9	-3.0	12.7	-10.6	3.5	367.2
6 Slab EL4.65m	93306	-2.4	-28.5	51.7	29.2	72.1	34.7	366.1
	93310	-6.1	-28.5	-5.3	56.5	-7.2	60.8	366.1
	93410	-2.0	-28.5	0.4	-3.5	-12.3	-12.8	366.1

Note: Negative value means compression.

Note \*: Exterior Wall, Pool Wall  
Basemat, Slab

Direction 1: Horizontal,  
Direction 1: N-S,

Direction 2: Vertical  
Direction 2: E-W



**Table 7.3.1.1.1-4 Rebar and Concrete Stresses of FB, LOCA After 72 hours + SSE:  
Winter – Load ID = 7441 (Selected Load Combination FB-9)**

Location	Element ID	Concrete Stress (MPa)		Primary Reinforcement Stress (MPa)				
		Calculated	Allowable	Calculated				Allowable
				Direction 1*		Direction 2*		
				In/Top	Out/Bottom	In/Top	Out/Bottom	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	-4.6	-29.3	57.3	-25.0	28.0	5.1	372.2
	60219	-10.4	-28.5	35.8	66.5	-39.1	78.8	366.4
	70201	-7.1	-28.3	8.2	127.5	7.5	104.2	364.6
	70204	-11.7	-28.3	72.2	84.6	-40.0	85.8	364.6
	110718	-12.1	-28.1	-10.9	115.7	-18.4	83.9	363.3
2 Exterior Wall @ EL4.65 ~6.60m	62011	-17.3	-29.3	106.8	202.7	257.3	206.1	372.2
	62019	-20.4	-29.3	179.6	233.7	167.4	199.6	372.2
	72001	-16.2	-29.3	176.8	327.0	99.7	204.5	372.2
	72004	-15.8	-29.3	282.2	333.3	251.7	240.1	372.2
3 Exterior Wall @ EL22.50 ~24.60m	64011	-22.1	-29.3	130.4	267.0	42.6	235.8	372.2
	64019	-7.1	-29.3	233.0	291.1	30.6	255.5	372.2
	74001	-8.7	-29.3	77.0	98.6	65.0	82.4	372.2
	74004	-9.6	-29.3	148.1	217.0	5.0	220.4	372.2
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	-8.3	-28.5	-32.5	46.4	-20.9	22.2	366.4
	70801	-14.1	-28.3	67.7	146.0	30.0	86.9	364.6
	70804	-8.6	-28.3	126.3	71.5	85.5	45.1	364.6
	110748	-9.8	-28.1	33.0	92.8	-26.6	62.1	363.3
5 Basemat	90306	-5.6	-23.5	59.9	-23.2	55.2	1.0	372.2
	90310	-1.7	-23.5	-2.5	-6.5	1.1	-7.1	372.2
	90410	-4.0	-23.5	16.1	-5.7	44.9	-22.7	372.2
5 Basemat @ Spent Fuel Pool	90486	-6.0	-22.9	-11.7	35.4	-15.6	17.4	367.2
	90490	-7.0	-22.9	15.8	89.6	99.7	60.3	367.2
	90526	-5.0	-22.9	111.5	19.0	48.6	34.4	367.2
6 Slab EL4.65m	93306	-4.3	-29.3	82.9	90.7	133.5	38.8	372.2
	93310	-8.7	-29.3	36.4	96.6	12.7	92.0	372.2
	93410	-6.9	-29.3	83.9	90.3	20.1	-14.7	372.2

Note: Negative value means compression.

Note \*: Exterior Wall, Pool Wall  
Basemat, Slab

Direction 1: Horizontal,  
Direction 1: N-S,

Direction 2: Vertical  
Direction 2: E-W



Table 7.3.1.1-5 Maximum Stress Ratios for Flexure and Membrane Forces

Location	Element ID	Concrete		Primary Reinforcement							
		$\sigma/\sigma_a$	Load ID	Direction 1*				Direction 2*			
				In/Top		Out/Bottom		In/Top		Out/Bottom	
				$\sigma/\sigma_a$	Load ID	$\sigma/\sigma_a$	Load ID	$\sigma/\sigma_a$	Load ID	$\sigma/\sigma_a$	Load ID
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	0.246	7461	0.159	7621	0.250	8011	0.112	9013	0.164	7461
	60219	0.481	8511	0.227	7601	0.256	9011	0.168	7701	0.306	8511
	70201	0.448	6981	0.123	7751	0.467	8512	0.111	7751	0.374	8514
	70204	0.551	8511	0.212	7601	0.349	9011	0.217	7701	0.356	8514
	110718	0.719	7492	0.481	7701	0.512	8511	0.111	7751	0.377	7492
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.692	8514	0.383	9013	0.632	7492	0.729	9012	0.801	7492
	62019	0.738	8514	0.531	9014	0.638	7471	0.556	7991	0.540	7482
	72001	0.576	8511	0.766	7653	0.863	8511	0.761	7653	0.710	7491
	72004	1.033	8512	0.839	7221	0.948	8512	0.979	7632	0.946	8071
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.778	8511	0.508	7961	0.726	7521	0.451	8071	0.644	8511
	64019	0.505	7501	0.630	8513	0.798	8513	0.277	8071	0.686	7441
	74001	0.306	8511	0.217	8511	0.276	8511	0.188	7581	0.231	8511
	74004	0.460	8511	0.421	8514	0.584	7471	0.327	8061	0.593	7471
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	0.343	8511	0.277	7711	0.239	7601	0.086	7611	0.120	7491
	70801	0.700	7491	0.300	7601	0.534	7492	0.220	7601	0.336	7492
	70804	0.472	8513	0.434	7861	0.377	7311	0.290	7861	0.253	8513
	110748	0.547	8511	0.517	8001	0.387	8511	0.273	8001	0.278	8511
5 Basemat	90306	0.247	8512	0.181	7121	0.063	8514	0.176	7121	0.017	7911
	90310	0.150	7211	0.042	2011	0.039	7211	0.040	2011	0.044	7961
	90410	0.282	7491	0.061	8021	0.057	7461	0.128	8021	0.199	7711
5 Basemat @ Spent Fuel Pool	90486	0.347	8514	0.158	7251	0.212	7492	0.059	7251	0.165	8514
	90490	0.356	8511	0.230	7601	0.304	7492	0.273	7621	0.212	7992
	90526	0.239	7491	0.300	7921	0.088	7991	0.141	7601	0.145	8512
6 Slab EL4.65m	93306	0.165	7211	0.517	7201	0.245	7301	0.368	8514	0.174	8001
	93310	0.303	8514	0.267	7431	0.268	8514	0.243	7411	0.257	8514
	93410	0.289	7561	0.596	7491	0.395	7701	0.275	7501	0.259	7701

Note \*: Exterior Wall, Pool Wall Direction1 : Horizontal, Direction2 : Vertical  
Basemat, Slab Direction1 : N-S, Direction2 : E-W

$\sigma$  and  $\sigma_a$  are calculated and allowable stress.

Exceedance is highlighted. As shown in Figure 7.3.1.1-1, the exceedance is resolved by considering the moment capacity of wall according to the specifications of ACI 349-01.



HITACHI

WG3-U97-ERD-S-0001 SH NO. 81

REV. 1

of 155

Table 7.3.1.1.2-1 Membrane Compressive Forces of FB

Location	Element ID	Load ID	Section Forces (MN/m)			Thickness h (m)	Calculated Concrete Stress (MPa)				Allowable Stress $\sigma_a$ (MPa)	$\sigma_c/\sigma_a$
			$N_x$	$N_y$	$N_{xy}$		$\sigma_x$	$\sigma_y$	$\tau_{xy}$	$\sigma_c$		
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	7251	-5.591	-3.421	-2.432	2.0	-2.796	-1.711	-1.216	-3.585	-20.7	0.173
	60219	7251	-6.359	-3.814	-1.988	3.6	-1.766	-1.059	-0.552	-2.068	-20.7	0.100
	70201	7201	-1.257	-1.136	2.712	2.0	-0.629	-0.568	1.356	-1.955	-20.7	0.094
	70204	7251	-3.249	-3.768	-4.153	2.0	-1.624	-1.884	-2.077	-3.835	-20.7	0.185
	110718	8511	-7.621	-7.362	-6.148	1.5	-5.081	-4.908	-4.098	-9.094	-25.9	0.351
2 Exterior Wall @ EL4.65 ~6.60m	62011	7491	-3.314	-1.939	3.178	1.0	-3.314	-1.939	3.178	-5.878	-25.9	0.227
	62019	7411	-2.386	-2.691	3.254	1.0	-2.386	-2.691	3.254	-5.796	-25.9	0.224
	72001	7501	-1.599	-3.269	4.578	1.0	-1.599	-3.269	4.578	-7.087	-20.7	0.342
	72004	7501	-2.074	-3.215	5.045	1.0	-2.074	-3.215	5.045	-7.722	-20.7	0.373
3 Exterior Wall @ EL22.50 ~24.60m	64011	7601	-3.251	0.052	1.609	1.0	-3.251	0.052	1.609	-3.905	-20.7	0.189
	64019	7101	-2.993	-0.873	-1.518	1.0	-2.993	-0.873	-1.518	-3.785	-20.7	0.183
	74001	8511	-0.253	-1.193	-2.891	1.0	-0.253	-1.193	-2.891	-3.652	-25.9	0.141
	74004	8511	-1.788	-0.595	-3.522	1.0	-1.788	-0.595	-3.522	-4.763	-25.9	0.184
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	-5.441	-5.636	-3.045	3.6	-1.511	-1.565	-0.846	-2.385	-25.9	0.092
	70801	7251	-3.397	-2.046	-3.314	2.0	-1.698	-1.023	-1.657	-3.052	-20.7	0.147
	70804	7251	-3.152	-2.628	-3.794	2.0	-1.576	-1.314	-1.897	-3.347	-20.7	0.162
	110748	8511	-3.019	-6.596	-4.345	1.5	-2.013	-4.397	-2.897	-6.337	-25.9	0.245
5 Basemat	90306	7251	-6.193	-3.143	3.646	4.0	-1.548	-0.786	0.912	-2.155	-16.6	0.130
	90310	2001	-1.976	-2.034	0.198	4.0	-0.494	-0.509	0.050	-0.551	-8.3	0.067
	90410	7251	-3.005	-9.273	2.743	4.0	-0.751	-2.318	0.686	-2.576	-16.6	0.156
5 Basemat @ Spent Fuel Pool	90486	2001	-2.656	-4.465	-0.269	5.5	-0.483	-0.812	-0.049	-0.819	-8.3	0.099
	90490	7251	-2.977	-9.601	1.971	5.5	-0.541	-1.746	0.358	-1.844	-16.6	0.111
	90526	2001	-3.307	-5.026	-0.442	5.5	-0.601	-0.914	-0.080	-0.933	-8.3	0.113
6 Slab EL4.65m	93306	8514	-2.833	-0.427	-2.614	1.3	-2.180	-0.329	-2.011	-3.468	-25.9	0.134
	93310	2021	-2.208	-2.184	-2.411	1.3	-1.698	-1.680	-1.854	-3.544	-15.5	0.228
	93410	7492	-0.828	-3.805	-1.983	1.3	-0.637	-2.927	-1.525	-3.689	-25.9	0.143

Note: Positive value means tension.

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 82

REV. 1

of 155

**Table 7.3.1.1.3-1 Transverse Shear of FB**

Location	Element ID	Load ID	d (m)	p <sub>v</sub> (%)	Shear Force (MN/m)				V <sub>u</sub> /φV <sub>n</sub>
					V <sub>u</sub>	V <sub>c</sub>	V <sub>s</sub>	φV <sub>n</sub>	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	8511	1.70	0.710	1.55	4.02	5.00	7.67	0.202
	60219	8511	3.05	0.710	4.67	3.77	8.96	10.82	0.432
	70201	7481	1.65	0.710	1.19	1.72	4.84	5.58	0.213
	70204	7481	1.59	0.710	3.14	2.16	4.67	5.81	0.540
	110718	7492	1.12	0.355	0.82	1.14	1.64	2.36	0.346
2 Exterior Wall @ EL4.65 ~-6.60m	62011	7571	0.78	0.125	0.49	0.84	0.40	1.06	0.463
	62019	7601	0.72	0.125	0.18	0.13	0.37	0.43	0.407
	72001	7581	0.73	0.250	0.47	0.00	0.76	0.64	0.728
	72004	7612	0.72	0.250	0.46	0.00	0.74	0.63	0.732
3 Exterior Wall @ EL22.50 ~-24.60m	64011	7492	0.72	0.125	0.31	0.71	0.37	0.92	0.336
	64019	8511	0.80	0.125	0.22	0.00	0.41	0.35	0.635
	74001	7492	0.73	0.125	0.15	0.18	0.38	0.47	0.321
	74004	8513	0.72	0.125	0.30	0.40	0.37	0.66	0.462
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	3.05	0.710	2.44	4.35	8.97	11.32	0.216
	70801	8514	1.71	0.710	4.03	2.03	5.02	5.99	0.672
	70804	7571	1.62	0.710	1.11	0.69	4.75	4.62	0.240
	110748	8511	1.22	0.177	1.06	1.32	0.89	1.88	0.563
5 Basemat	90306	8514	3.53	0.629	4.82	6.96	9.18	13.73	0.351
	90310	7511	3.52	0.629	2.82	5.95	9.15	12.84	0.220
	90410	7471	3.53	0.629	3.47	6.91	9.19	13.68	0.254
5 Basemat @ Spent Fuel Pool	90486	7492	5.04	0.419	1.86	4.63	8.74	11.36	0.164
	90490	8514	5.04	0.629	5.65	5.53	13.11	15.85	0.356
	90526	7221	5.03	0.629	4.48	9.27	13.07	18.99	0.236
6 Slab EL4.65m	93306	7482	1.10	0.500	0.41	0.79	2.27	2.60	0.158
	93310	7571	1.10	0.500	0.93	2.47	2.27	4.03	0.231
	93410	7501	1.10	0.500	0.46	0.99	2.27	2.77	0.168

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 83

REV. 1

of 155

**Table 7.3.1.1.3-2 Transverse Shear of FB for DCD Load Combinations**

Location	Element ID	Load ID	d (m)	p <sub>v</sub> (%)	Shear Force (MN/m)				V <sub>u</sub> /φV <sub>n</sub>
					V <sub>u</sub>	V <sub>c</sub>	V <sub>s</sub>	φV <sub>n</sub>	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	FB-9	1.70	0.710	1.53	3.97	4.99	7.62	0.200
	60219	FB-9	3.05	0.710	4.04	4.08	8.96	11.08	0.364
	70201	FB-9	1.65	0.710	0.98	1.78	4.85	5.64	0.174
	70204	FB-9	1.59	0.710	3.01	2.56	4.67	6.15	0.490
	110718	FB-9	1.12	0.355	0.50	1.13	1.64	2.36	0.211
2 Exterior Wall @ EL4.65 ~-6.60m	62011	FB-9	0.72	0.125	0.38	0.75	0.37	0.95	0.400
	62019	FB-9	0.78	0.125	0.17	0.24	0.40	0.55	0.314
	72001	FB-9	0.73	0.250	0.47	0.00	0.76	0.64	0.727
	72004	FB-9	0.72	0.250	0.36	0.00	0.74	0.63	0.567
3 Exterior Wall @ EL22.50 ~-24.60m	64011	FB-9	0.72	0.125	0.31	0.71	0.37	0.92	0.334
	64019	FB-9	0.80	0.125	0.22	0.00	0.41	0.35	0.617
	74001	FB-9	0.73	0.125	0.16	0.30	0.38	0.58	0.269
	74004	FB-9	0.72	0.125	0.30	0.41	0.37	0.66	0.457
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	FB-9	3.05	0.710	2.05	6.00	8.97	12.72	0.161
	70801	FB-9	1.71	0.710	3.77	2.16	5.02	6.10	0.617
	70804	FB-9	1.62	0.710	1.02	1.36	4.75	5.19	0.197
	110748	FB-9	1.21	0.177	0.64	1.15	0.88	1.73	0.368
5 Basemat	90306	FB-9	3.53	0.629	4.66	6.92	9.18	13.68	0.341
	90310	FB-9	3.49	0.629	2.66	5.67	9.08	12.54	0.212
	90410	FB-9	3.53	0.629	3.47	6.91	9.19	13.68	0.254
5 Basemat @ Spent Fuel Pool	90486	FB-9	5.04	0.419	1.58	6.56	8.74	13.00	0.122
	90490	FB-9	5.04	0.629	5.35	5.77	13.11	16.05	0.333
	90526	FB-9	5.02	0.629	4.42	9.24	13.07	18.97	0.233
6 Slab EL4.65m	93306	FB-9	1.10	0.500	0.41	0.78	2.27	2.60	0.158
	93310	FB-9	1.10	0.500	0.97	2.85	2.27	4.35	0.223
	93410	FB-9	1.10	0.500	0.57	2.20	2.27	3.80	0.151



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 84

REV. 1

of 155

**Table 7.3.1.2-1 Maximum Stress Ratio of FB Reinforced Concrete Column**

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$	
610101	1400 x 1400	F2		FD		Design Forces $F_u$						
Location [Direction]	Reinforcing			Ratio (%)		Load No.	Thermal Load	Other Loads	Total			
FULL [NS SIDE]	Main Bars	12	-	#11	(0.62)	P	7461	0.00	-20.14	-20.14	-41.36	0.49
		12	-	#11	(0.62)	M	7491	0.00	3.88	3.88	9.46	0.41
	Other Bars	32	-	#11	(1.64)							
	Tie Bars	5	-	#6 @200	(0.51)	V	7701	0.00	-0.89	-0.89	-4.48	0.20
FULL [EW SIDE]	Main Bars	16	-	#11	(0.82)	P	7461	0.00	-20.14	-20.14	-45.03	0.45
		16	-	#11	(0.82)	M	7211	0.00	-3.58	-3.58	-9.91	0.36
	Other Bars	24	-	#11	(1.23)							
	Tie Bars	5	-	#6 @200	(0.51)	V	7211	0.00	-1.34	-1.34	-7.31	0.18

ID No.	Sizes (mm)	Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
610107	1400 x 1400	F2	FD		Design Forces $F_u$					
Location [Direction]	Reinforcing				Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	7 - #11	(0.36)	P	7261	0.00	-8.73	-8.73	-36.78	0.24
		7 - #11	(0.36)	M	8514	0.00	-4.34	-4.34	-7.56	0.57
	Other Bars	14 - #11	(0.72)							
	Tie Bars	4 - #5 @200	(0.29)	V	8514	0.00	1.61	1.61	5.41	0.30
FULL [EW SIDE]	Main Bars	7 - #11	(0.36)	P	7261	0.00	-8.73	-8.73	-36.78	0.24
		7 - #11	(0.36)	M	7811	0.00	-1.63	-1.63	-5.97	0.27
	Other Bars	14 - #11	(0.72)							
	Tie Bars	4 - #5 @200	(0.29)	V	7711	0.00	0.58	0.58	3.12	0.19

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$	
611302	1500 x 1500	F1		FC		Design Forces			$F_u$			
Location [Direction]	Reinforcing					Load No.	Thermal Load	Other Loads	Total			
FULL [NS SIDE]	Main Bars	17	-	#11	(0.76)	P	7971	0.00	9.44	9.44	16.32	0.58
		17	-	#11	(0.76)	M	7971	0.00	2.05	2.05	8.69	0.24
	Other Bars	30	-	#11	(1.34)							
	Tie Bars	8	-	#5 @200	(0.53)	V	7961	0.00	-1.02	-1.02	-3.78	0.27
FULL [EW SIDE]	Main Bars	15	-	#11	(0.67)	P	9013	0.00	9.59	9.59	20.38	0.47
		15	-	#11	(0.67)	M	7371	0.00	0.74	0.74	11.09	0.07
	Other Bars	34	-	#11	(1.52)							
	Tie Bars	2	-	#5 @200	(0.13)	V	9013	0.00	-0.23	-0.23	-2.57	0.09

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 85

REV. 1

of 155

**Table 7.3.1.2-1 Maximum Stress Ratio of FB Reinforced Concrete Column (Continued)**

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
611312	1500 x 1500	F1		FC		Design Forces $F_u$					
Location [Direction]	Reinforcing					Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	17 - #11		(0.76)	P	8514	0.00	5.63	5.63	17.45	0.32
		17 - #11		(0.76)	M	8511	0.00	3.04	3.04	11.21	0.27
	Other Bars	30 - #11		(1.34)							
	Tie Bars	8 - #5 @200		(0.53)	V	6965	0.00	-0.98	-0.98	-4.77	0.21
FULL [EW SIDE]	Main Bars	15 - #11		(0.67)	P	8514	0.00	5.63	5.63	20.84	0.27
		15 - #11		(0.67)	M	7261	0.00	0.35	0.35	10.51	0.03
	Other Bars	34 - #11		(1.52)							
	Tie Bars	2 - #5 @200		(0.13)	V	8513	0.00	0.25	0.25	2.99	0.08

ID No.	Sizes (mm)	Column-Row			Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
612002	1500 x 1500	F3	FF	Design Forces $F_u$							
Location [Direction]	Reinforcing			Load No.		Thermal Load	Other Loads	Total			
FULL [NS SIDE]	Main Bars	9 - #11	(0.40)	P	7211	0.00	6.14	6.14	10.73	0.57	
		9 - #11	(0.40)	M	8511	0.00	-2.41	-2.41	-9.51	0.25	
	Other Bars	14 - #11	(0.63)								
	Tie Bars	4 - #5 @200	(0.27)	V	7211	0.00	-0.41	-0.41	-2.11	0.19	
FULL [EW SIDE]	Main Bars	7 - #11	(0.31)	P	7571	0.00	6.14	6.14	8.85	0.69	
		7 - #11	(0.31)	M	7571	0.00	0.41	0.41	1.17	0.35	
	Other Bars	18 - #11	(0.81)								
	Tie Bars	2 - #5 @200	(0.13)	V	7571	0.00	0.24	0.24	2.15	0.11	

ID No.	Sizes (mm)	Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
612012	1500 x 1500	F3	FF		Design Forces $F_u$					
Location [Direction]	Reinforcing				Load No.	Thermal Load	Other Loads	Total		
FULL [NS SIDE]	Main Bars	9 - #11	(0.40)	P	4023	0.00	-5.83	-5.83	-43.10	0.14
		9 - #11	(0.40)	M	4022	0.00	-1.57	-1.57	-9.07	0.17
	Other Bars	14 - #11	(0.63)							
	Tie Bars	4 - #5 @200	(0.27)	V	4022	0.00	-0.67	-0.67	-5.40	0.12
FULL [EW SIDE]	Main Bars	7 - #11	(0.31)	P	4023	0.00	-5.83	-5.83	-41.27	0.14
		7 - #11	(0.31)	M	8514	0.00	1.56	1.56	8.07	0.19
	Other Bars	18 - #11	(0.81)							
	Tie Bars	2 - #5 @200	(0.13)	V	8514	0.00	0.80	0.80	5.41	0.15

**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 86

REV. 1

of 155

**Table 7.3.1.2-2 Maximum Stress Ratio of FB Reinforced Concrete Girder**

ID No.	Sizes (mm)			Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
620001	800	x	1500	F1-F2	FE		Design Forces $F_n$					
Location	Reinforcing				Ratio (%)		Load No.	Thermal Load	Other Loads	Total		
END 1 [F1 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	3011	0.00	-4.78	-4.78	-30.05	0.16	
		Bot.	15 - #11	(1.26)	M	7511	0.00	3.55	3.55	7.39	0.48	
	Stirrup			6 - #5 @200	(0.75)	V	7471	0.00	1.33	1.33	3.14	0.42
	Main Bars	Top	10 - #11	(0.84)	P	3011	0.00	-4.78	-4.78	-30.05	0.16	
Bot.		15 - #11	(1.26)	M	7231	0.00	-2.80	-2.80	-6.82	0.41		
CENTER	Stirrup			6 - #5 @200	(0.75)	V	7461	0.00	1.73	1.73	3.96	0.44
	Main Bars	Top	10 - #11	(0.84)	P	4014	0.00	-2.58	-2.58	-30.05	0.09	
		Bot.	15 - #11	(1.26)	M	7101	0.00	1.13	1.13	8.50	0.13	
	END 2 [F2 SIDE]	Stirrup			6 - #5 @200	(0.75)	V	7221	0.00	-0.58	-0.58	-3.16

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
622001	800	x 1500	F1-F2	FE		Design Forces $F_u$					
Location	Reinforcing			Ratio (%)		Load No.	Thermal Load	Other Loads	Total		
END 1 [F1 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-4.68	-4.68	-27.75	0.17
		Bot.	10 - #11	(0.84)	M	8514	0.00	1.54	1.54	6.67	0.23
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7561	0.00	-0.41	-0.41	-2.68	0.15
CENTER	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-4.30	-4.30	-27.75	0.16
		Bot.	10 - #11	(0.84)	M	8514	0.00	0.93	0.93	6.65	0.14
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7461	0.00	0.33	0.33	3.60	0.09
END 2 [F2 SIDE]	Main Bars	Top	10 - #11	(0.84)	P	8514	0.00	-3.34	-3.34	-27.75	0.12
		Bot.	10 - #11	(0.84)	M	7431	0.00	-2.38	-2.38	-7.36	0.32
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7431	0.00	0.98	0.98	2.66	0.37

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\Phi F_n$	Ratio $F_u/\Phi F_n$
620209	800	x 1500	F2	FC-FD		Design Forces $F_u$					
Location	Reinforcing			Ratio (%)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FD SIDE]	Main Bars	Top	10 - #11	(0.84)	P	4012	0.00	-2.49	-2.49	-27.75	0.09
		Bot.	10 - #11	(0.84)	M	7461	0.00	-2.17	-2.17	-7.20	0.30
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7471	0.00	-0.77	-0.77	-2.44	0.32
CENTER	Main Bars	Top	10 - #11	(0.84)	P	4012	0.00	-2.49	-2.49	-27.75	0.09
		Bot.	10 - #11	(0.84)	M	7461	0.00	0.67	0.67	7.02	0.09
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7471	0.00	-0.78	-0.78	-2.52	0.31
END 2 [FC SIDE]	Main Bars	Top	10 - #11	(0.84)	P	4014	0.00	-1.96	-1.96	-27.75	0.07
		Bot.	10 - #11	(0.84)	M	7491	0.00	-1.03	-1.03	-7.54	0.14
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7492	0.00	0.30	0.30	2.66	0.11

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WG3-U97-ERD-S-0001 SH NO. 87

REV. 1

of 155

**Table 7.3.1.2-2 Maximum Stress Ratio of FB Reinforced Concrete Girder (Continued)**

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
622209	800	x 1500	F2	FC-FD		Design Forces $F_u$					
Location	Reinforcing			Ratio (%)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FD SIDE]	Main Bars	Top	10 - #11	(0.84)	P	7461	0.00	0.40	0.40	10.67	0.04
		Bot.	10 - #11	(0.84)	M	7261	0.00	-1.02	-1.02	-7.79	0.13
				(0.00)							
	Stirrup			4 - #5 @200	(0.50)	V	7261	0.00	-0.53	-0.53	-2.50
CENTER	Main Bars	Top	10 - #11	(0.84)	P	7461	0.00	0.39	0.39	13.60	0.03
		Bot.	10 - #11	(0.84)	M	7492	0.00	0.55	0.55	7.56	0.07
				(0.00)							
	Stirrup			4 - #5 @200	(0.50)	V	7461	0.00	-0.56	-0.56	-2.58
END 2 [FC SIDE]	Main Bars	Top	10 - #11	(0.84)	P	7461	0.00	0.28	0.28	14.15	0.02
		Bot.	10 - #11	(0.84)	M	7492	0.00	-0.48	-0.48	-7.75	0.06
				(0.00)							
	Stirrup			4 - #5 @200	(0.50)	V	7441	0.00	0.27	0.27	2.53

ID No.	Sizes (mm)		Column-Row		Checked Items	Section Forces (MN, MN-m)				Allowable Strength $\phi F_n$	Ratio $F_u/\phi F_n$
622201	800	x 1500	F2	FE-FF		Design Forces $F_u$					
Location	Reinforcing			Ratio (%)		Load No.	Thermal Load	Other Loads	Total		
END 1 [FF SIDE]	Main Bars	Top	10 - #11	(0.84)	P	7481	0.00	0.20	0.20	11.26	0.02
		Bot.	10 - #11	(0.84)	M	8513	0.00	-1.03	-1.03	-7.75	0.13
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7482	0.00	-0.37	-0.37	-2.62	0.14
CENTER	Main Bars	Top	10 - #11	(0.84)	P	7481	0.00	0.21	0.21	13.47	0.02
		Bot.	10 - #11	(0.84)	M	7521	0.00	0.62	0.62	7.63	0.08
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	8513	0.00	-0.42	-0.42	-2.97	0.14
END 2 [FE SIDE]	Main Bars	Top	10 - #11	(0.84)	P	7481	0.00	0.26	0.26	8.82	0.03
		Bot.	10 - #11	(0.84)	M	7571	0.00	-1.58	-1.58	-7.78	0.20
				(0.00)							
	Stirrup		4 - #5 @200	(0.50)	V	7261	0.00	0.92	0.92	2.54	0.36

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WG3-U97-ERD-S-0001 SH NO. 88

REV. 1

of 155

**Table 7.3.2-1 Maximum Stress Ratio of FB Steel Girder**

Member Name : FB Roof FB											
Section ID :		100	Section Type :		H	CBAR ID :		630301			
Flange PL :		1000 x 75	Web PL :		1550 x 60			i - edge			
Maximum Ratio		Load ID	Design Load (MN, MN-m)			Stress (MPa)			Allowable Stress (MPa)		
			P	M	V	$f_{ac}, f_{at}$	$f_{bc}, f_{bt}$	$f_v$	$F_{ac}, F_{at}$	$F_{bc}, F_{bt}$	$F_v$
$f_{ac}/F_{ac}+f_{bc}/F_{bc}$		0.100	8128	-5.05	0.00	-20.8	0.0		327.6	318.2	
$f_{at}/F_{at}+f_{bt}/F_{bt}$		0.018	5503	1.41	0.00	5.8	0.0		330.9	330.9	
$f_v/F_v$		0.159	8103		3.14			30.8			193.1

Member Name : FB Roof FB											
Section ID :		100	Section Type :		H	CBAR ID :		630305			
Flange PL :		1000 x 75	Web PL :		1550 x 60			j - edge			
Maximum Ratio		Load ID	Design Load (MN, MN-m)			Stress (MPa)			Allowable Stress (MPa)		
			P	M	V	$f_{ac}, f_{at}$	$f_{bc}, f_{bt}$	$f_v$	$F_{ac}, F_{at}$	$F_{bc}, F_{bt}$	$F_v$
$f_{ac}/F_{ac}+f_{bc}/F_{bc}$		0.436	5001	-2.10	16.34	-8.6	118.0		307.2	299.5	
$f_{at}/F_{at}+f_{bt}/F_{bt}$		0.164	7520	0.06	7.48	0.2	54.0		330.9	330.9	
$f_v/F_v$		0.072	8103		-1.42			-14.0			193.1

Member Name : FB Roof FC											
Section ID :		100	Section Type :		H	CBAR ID :		630206			
Flange PL :		1000 x 75	Web PL :		1550 x 60			i - edge			
Maximum Ratio		Load ID	Design Load (MN, MN-m)			Stress (MPa)			Allowable Stress (MPa)		
			P	M	V	$f_{ac}, f_{at}$	$f_{bc}, f_{bt}$	$f_v$	$F_{ac}, F_{at}$	$F_{bc}, F_{bt}$	$F_v$
$f_{ac}/F_{ac}+f_{bc}/F_{bc}$		0.500	5001	-1.71	19.34	-7.0	139.6		307.2	299.5	
$f_{at}/F_{at}+f_{bt}/F_{bt}$		0.194	7520	0.05	8.85	0.2	63.9		330.9	330.9	
$f_v/F_v$		0.059	5002		1.17			11.4			193.1

Member Name : FB Roof FE											
Section ID :		100	Section Type :		H	CBAR ID :		630006			
Flange PL :		1000 x 75	Web PL :		1550 x 60			i - edge			
Maximum Ratio		Load ID	Design Load (MN, MN-m)			Stress (MPa)			Allowable Stress (MPa)		
			P	M	V	$f_{ac}, f_{at}$	$f_{bc}, f_{bt}$	$f_v$	$F_{ac}, F_{at}$	$F_{bc}, F_{bt}$	$F_v$
$f_{ac}/F_{ac}+f_{bc}/F_{bc}$		0.368	5001	-1.97	13.63	-8.1	98.4		307.2	299.5	
$f_{at}/F_{at}+f_{bt}/F_{bt}$		0.137	7520	0.03	6.26	0.1	45.2		330.9	330.9	
$f_v/F_v$		0.050	8126		0.98			9.6			193.1

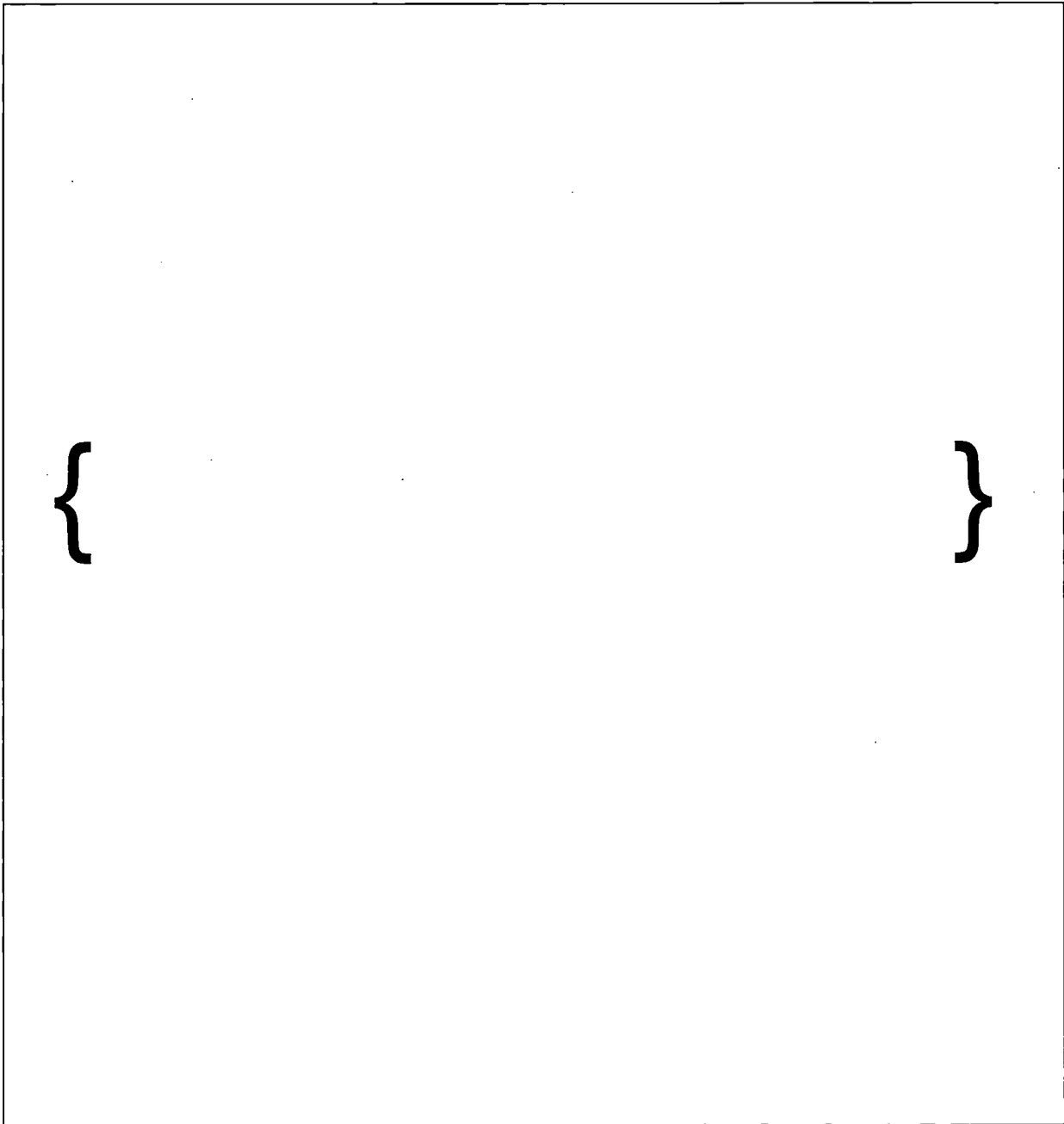


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WG3-U97-ERD-S-0001 SH NO. 89

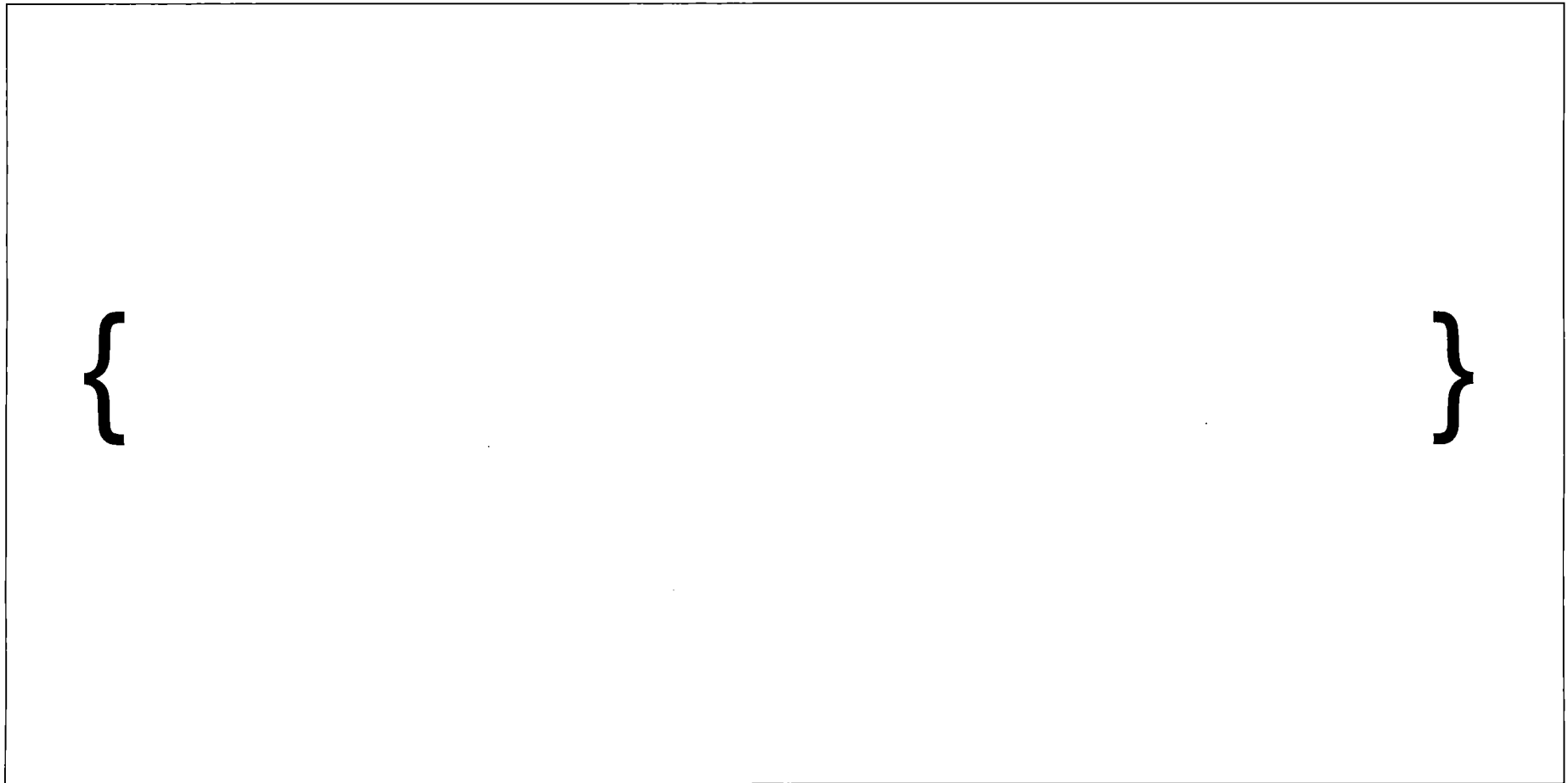
REV. 1

of 155



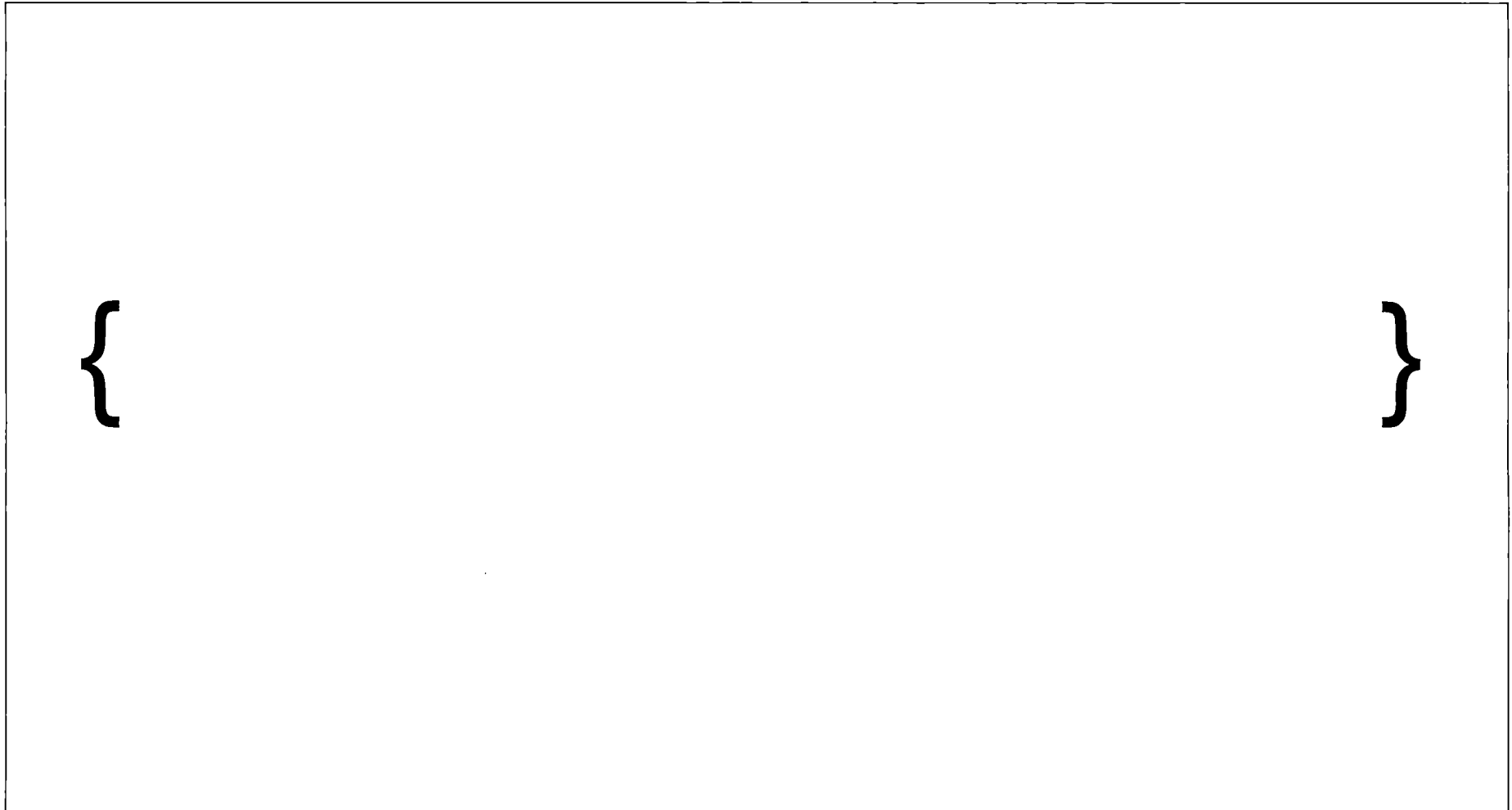
**Figure 1-1 RB/FB Global FE Analysis Model**

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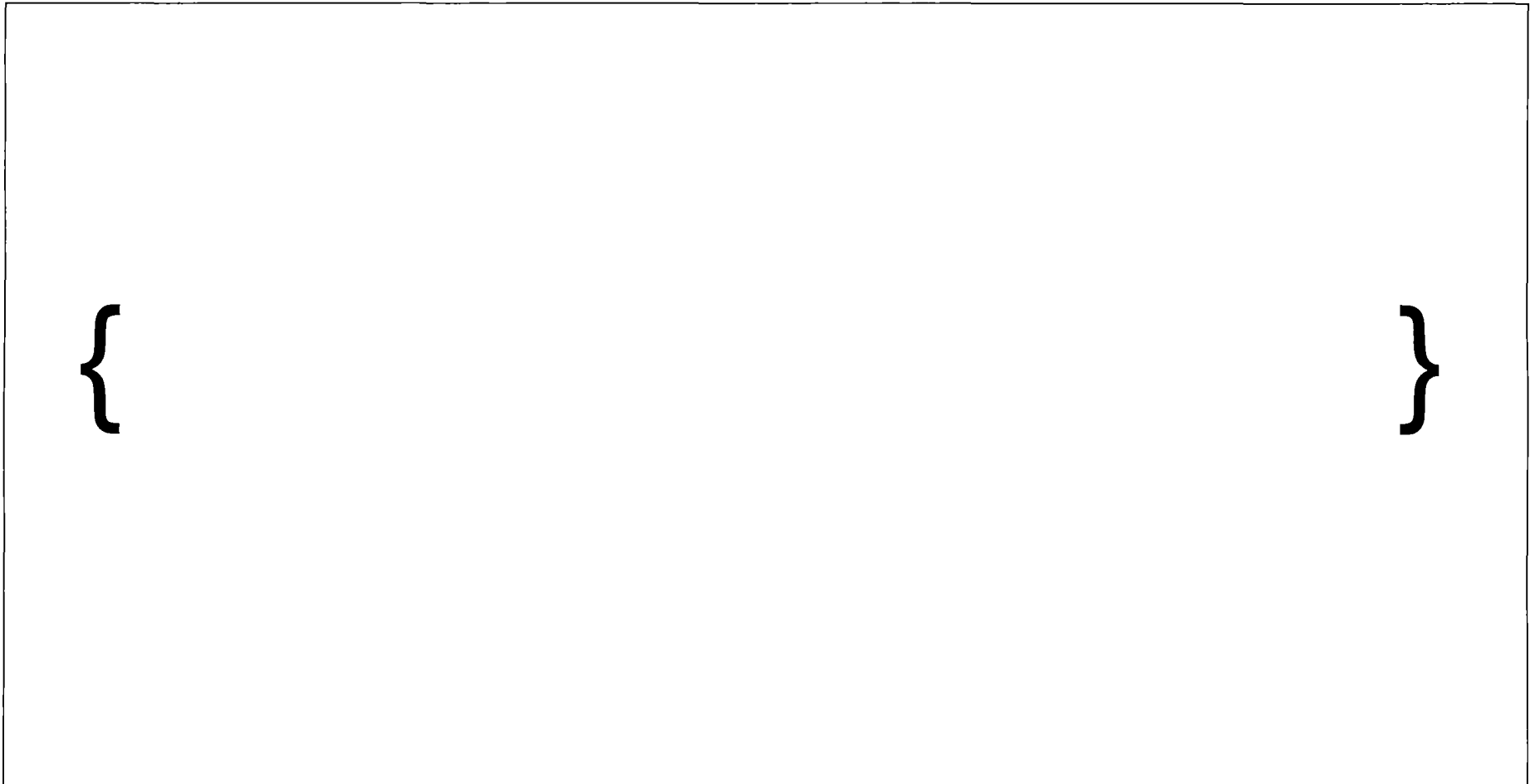
**Figure 3.1-1 RB and FB Concrete Outline Plan at EL -11500**

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**Figure 3.1-2 RB and FB Concrete Outline Plan at EL 4650**  
{{{Security-Related Information - Withheld Under 10 CFR-2.390}}}





**Figure 3.1-3 RB and FB Concrete Outline Plan at EL 17500**

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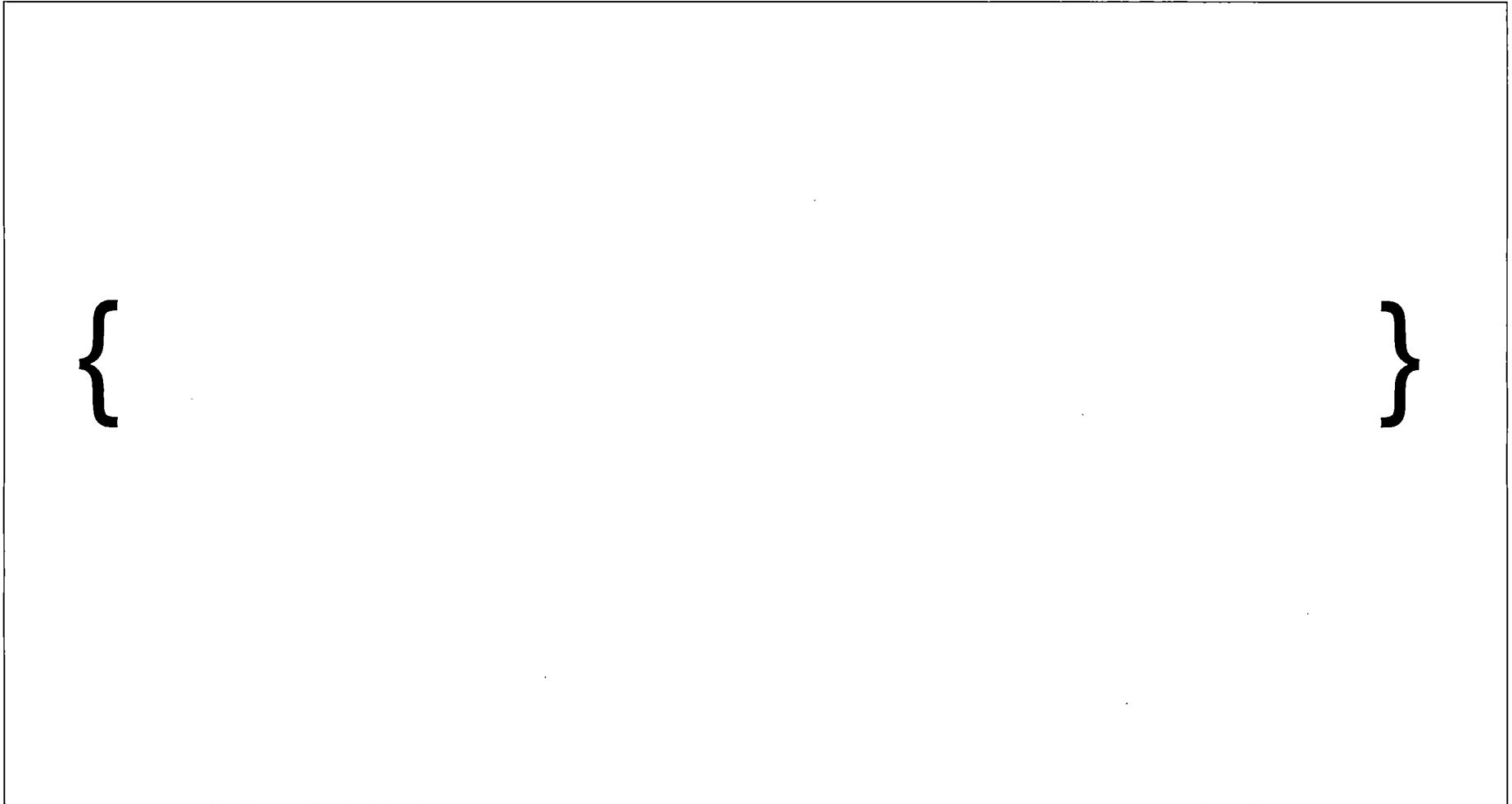


Figure 3.1-4 RB and FB Concrete Outline Plan at EL 27000

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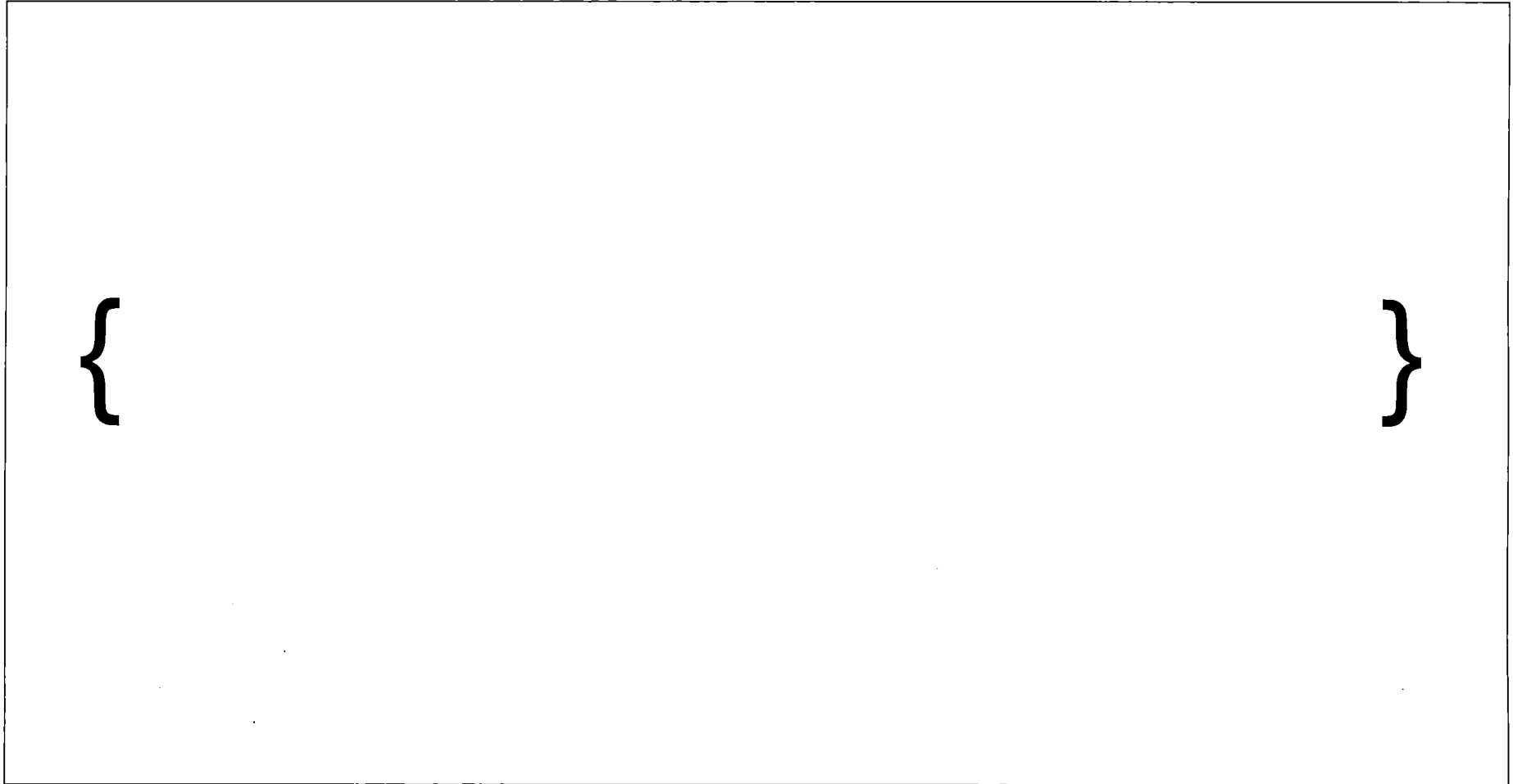
**Figure 3.1-5 RB Concrete Outline Plan at EL 34000**

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**Figure 3.1-6 RB and FB Concrete Outline N-S Section**

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**Figure 3.1-7 RB and FB Concrete Outline E-W Section**

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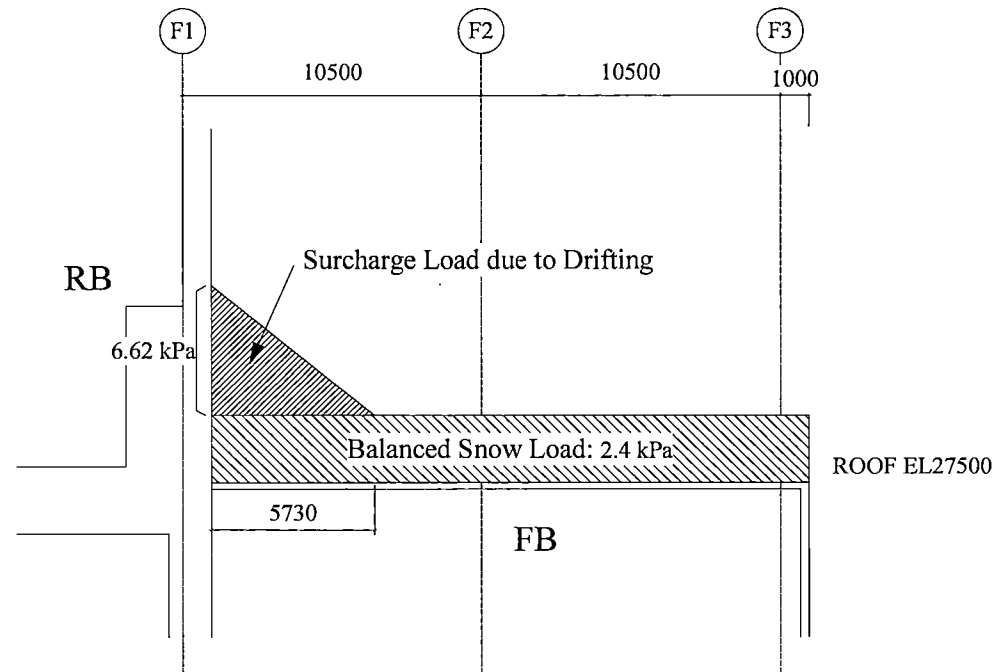


Figure 5.1.2-1 Snow Load Considered Drift Load



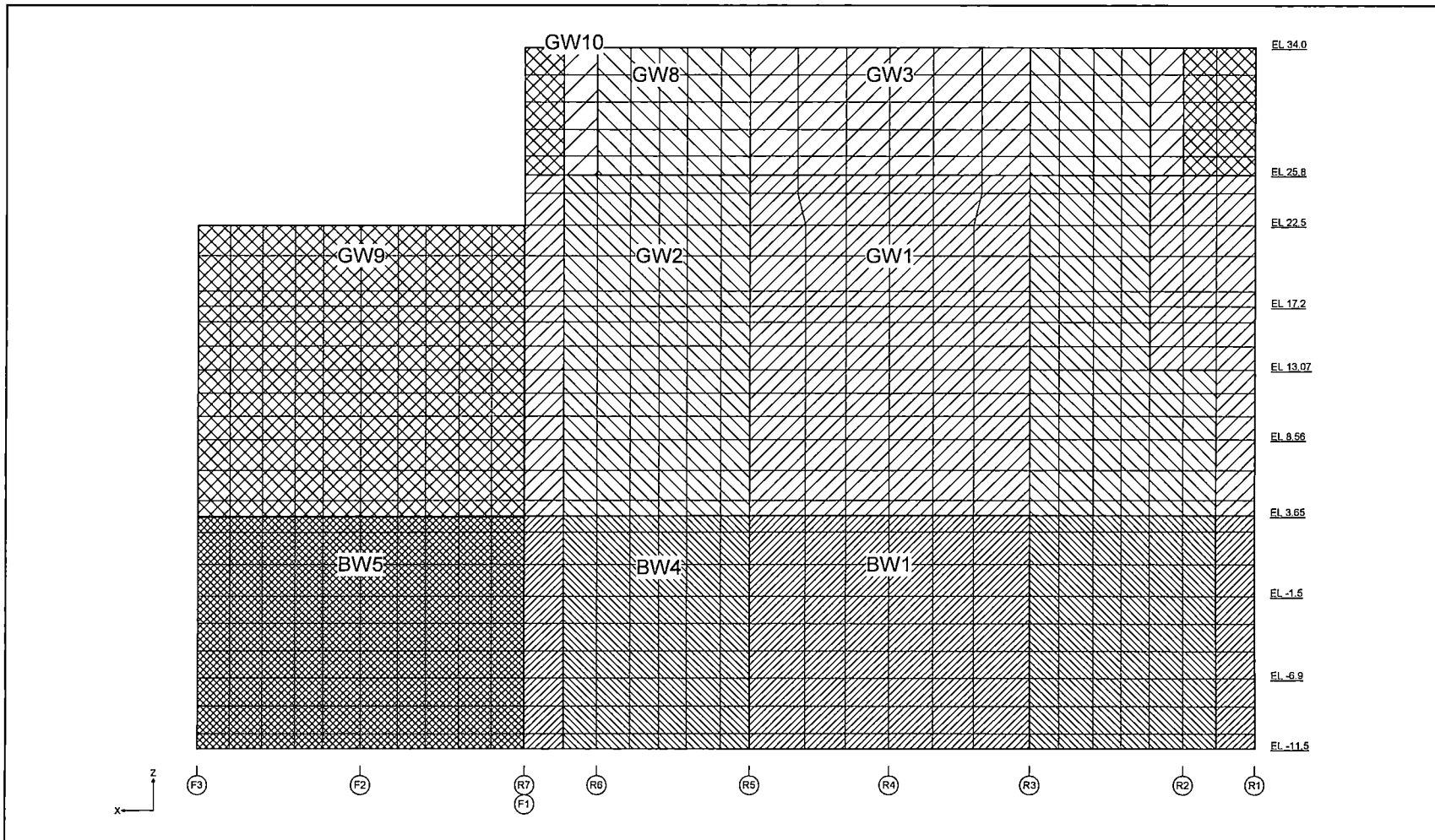
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WG3-U97-ERD-S-0001

SH NO. 98

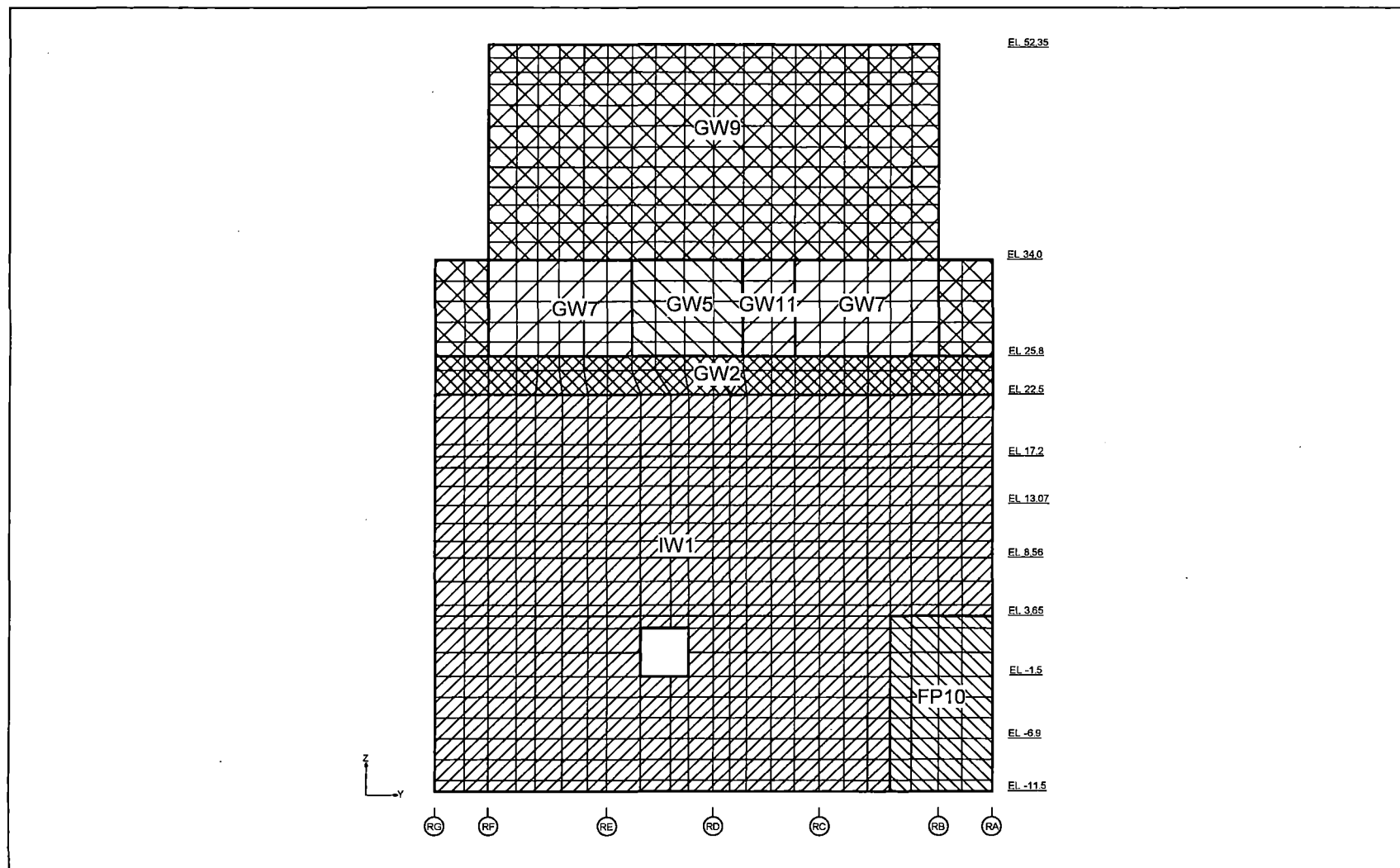
REV. 1

of 155









**Figure 5.2.2-3 Application of Thermal Load on the External Wall (R7/F1)**

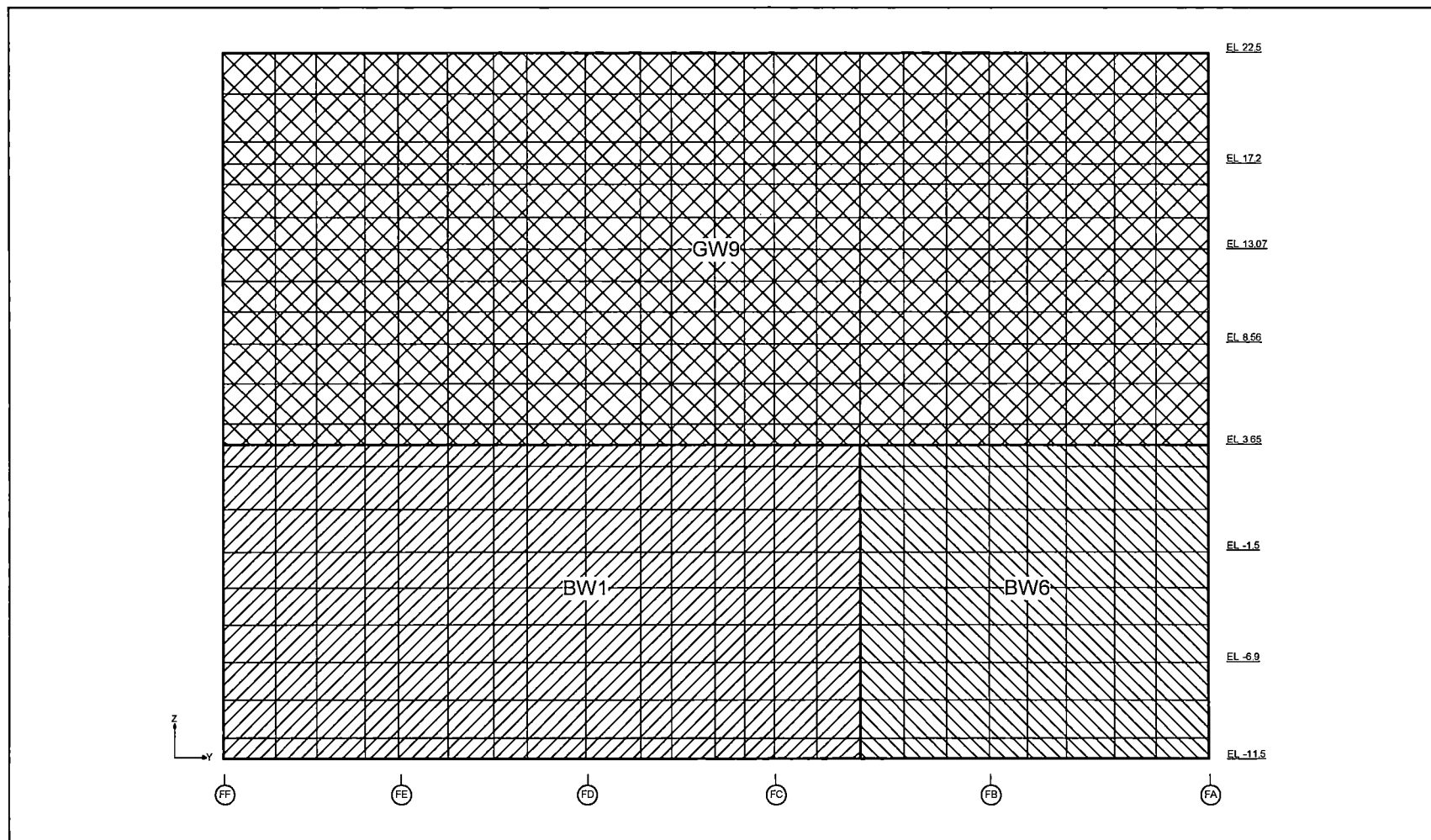


Figure 5.2.2-4 Application of Thermal Load on the External Wall (F3)



HITACHI

WG3-U97-ERD-S-0001

SH NO. 102

REV. 1

of 155

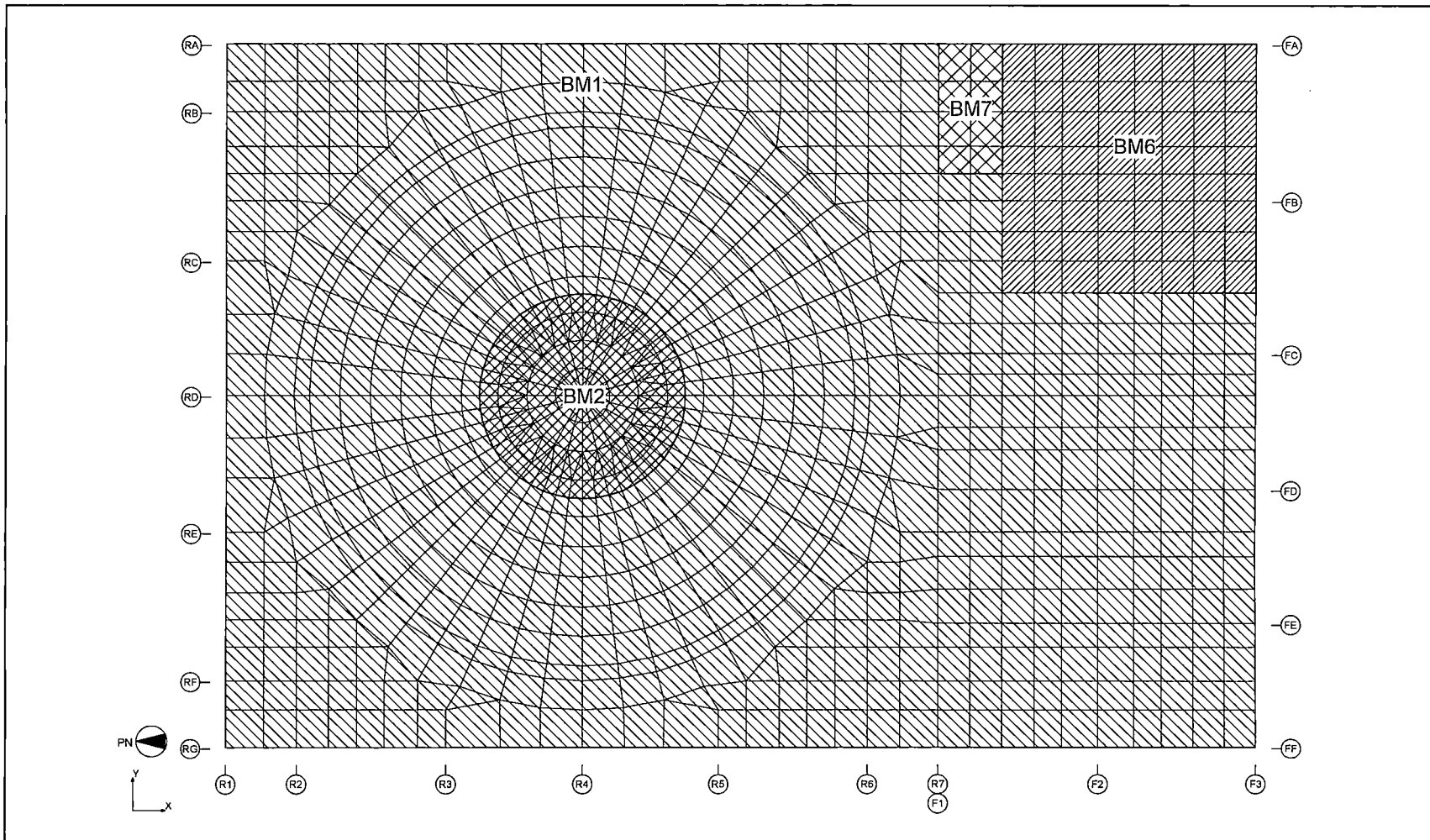


Figure 5.2.2-5 Application of Thermal Load on the Basemat



HITACHI

WG3-U97-ERD-S-0001

SH NO. 103

REV. 1

of 155

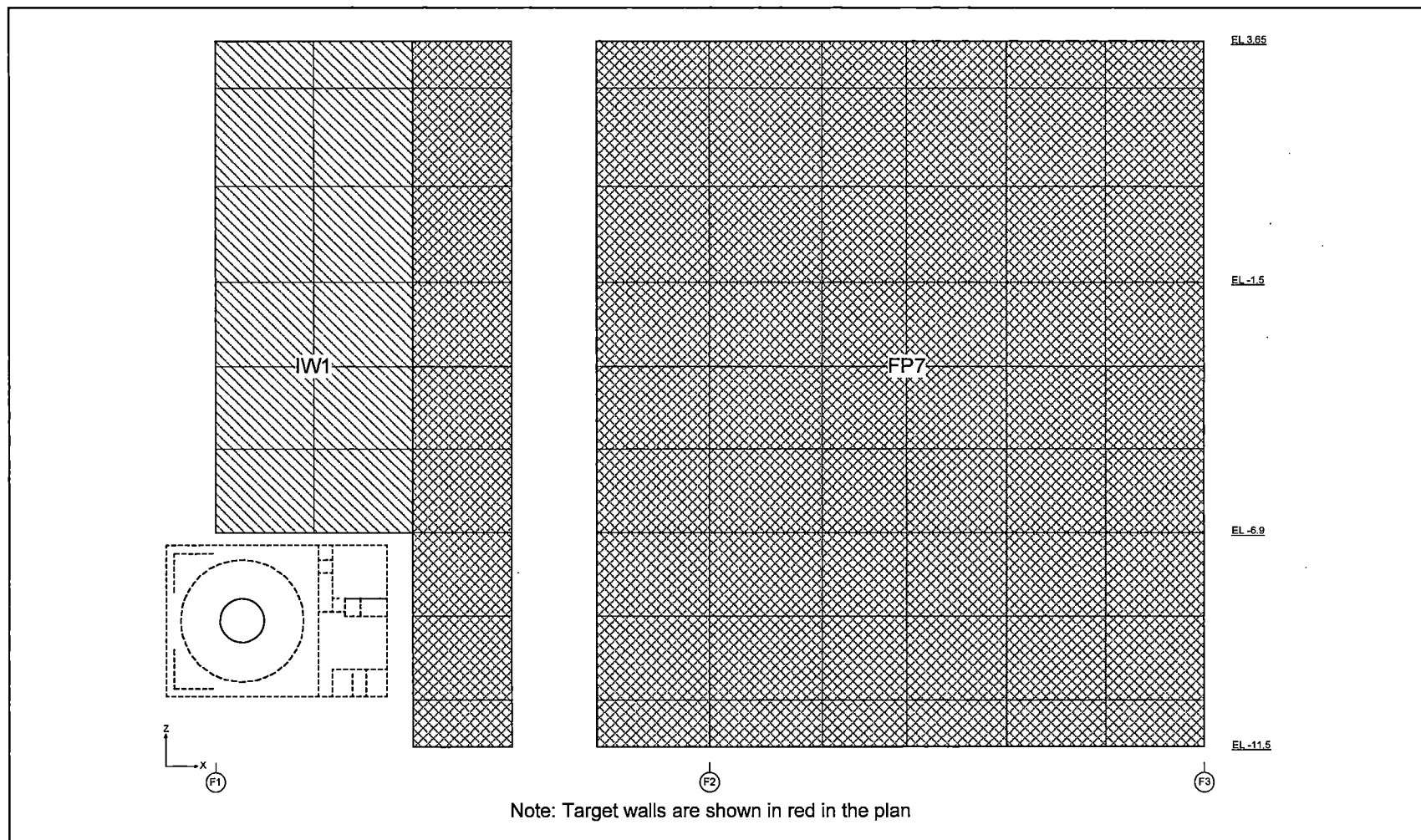


Figure 5.2.2-6 Application of Thermal Load on the Spent Fuel Pool Wall-1

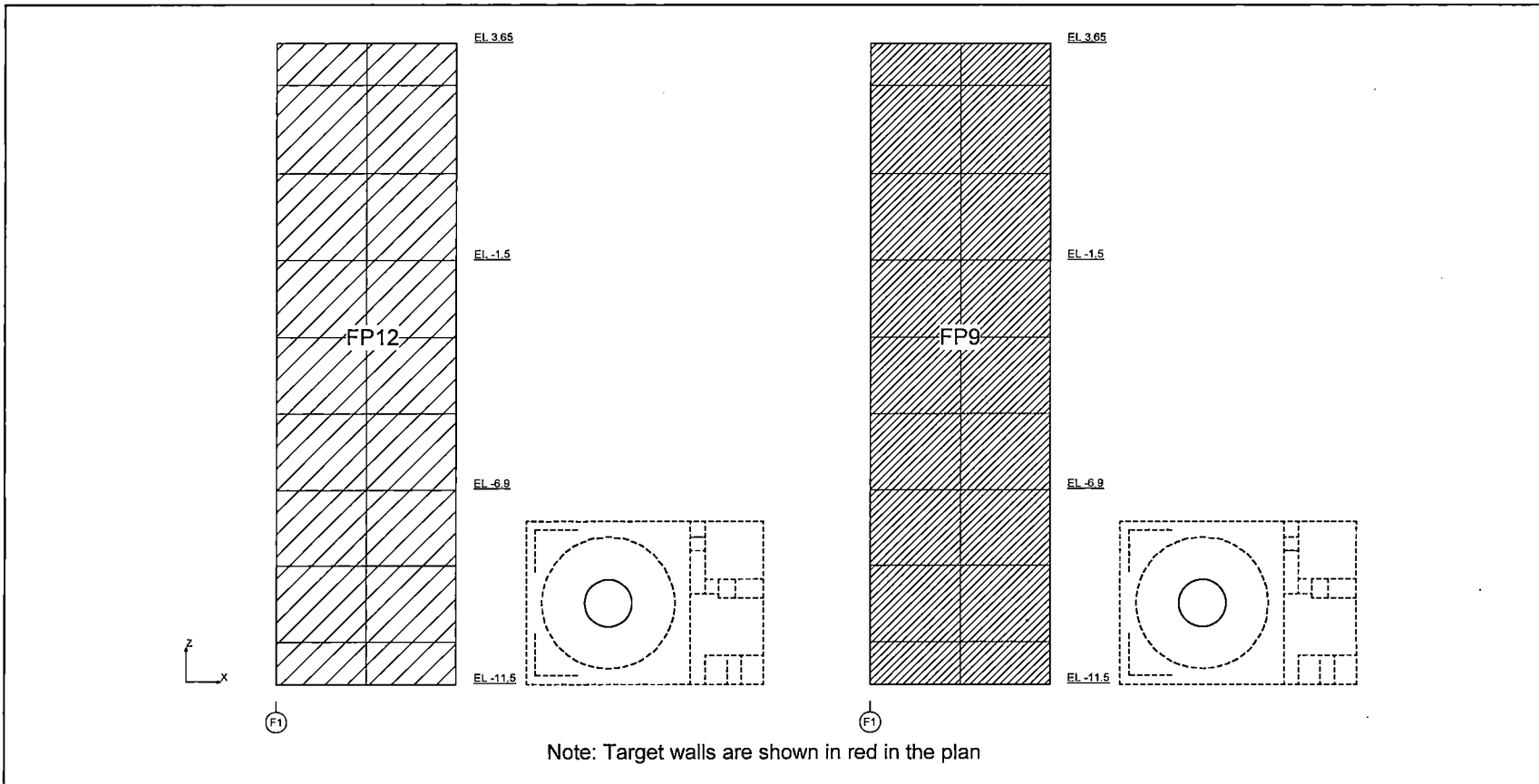
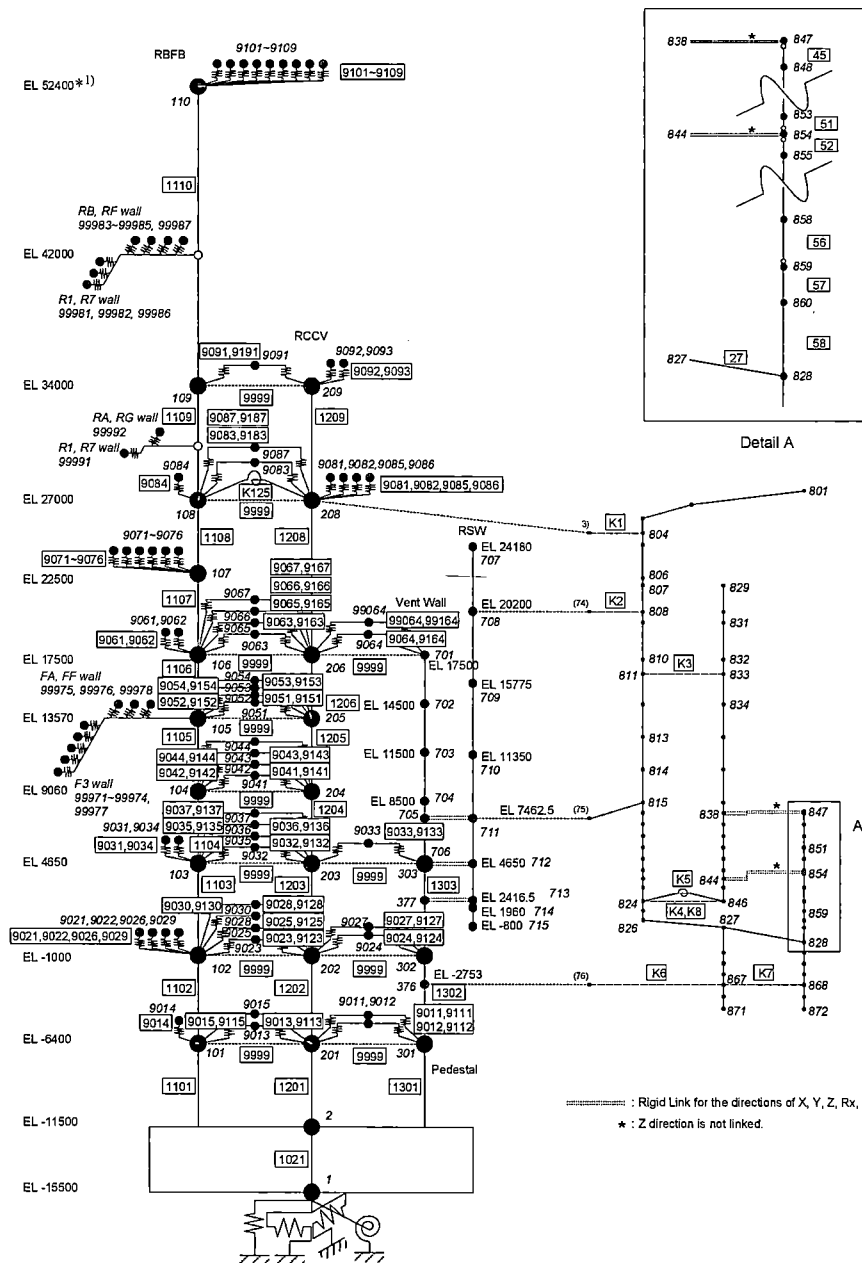


Figure 5.2.2-7 Application of Thermal Load on the Spent Fuel Pool Wall-2

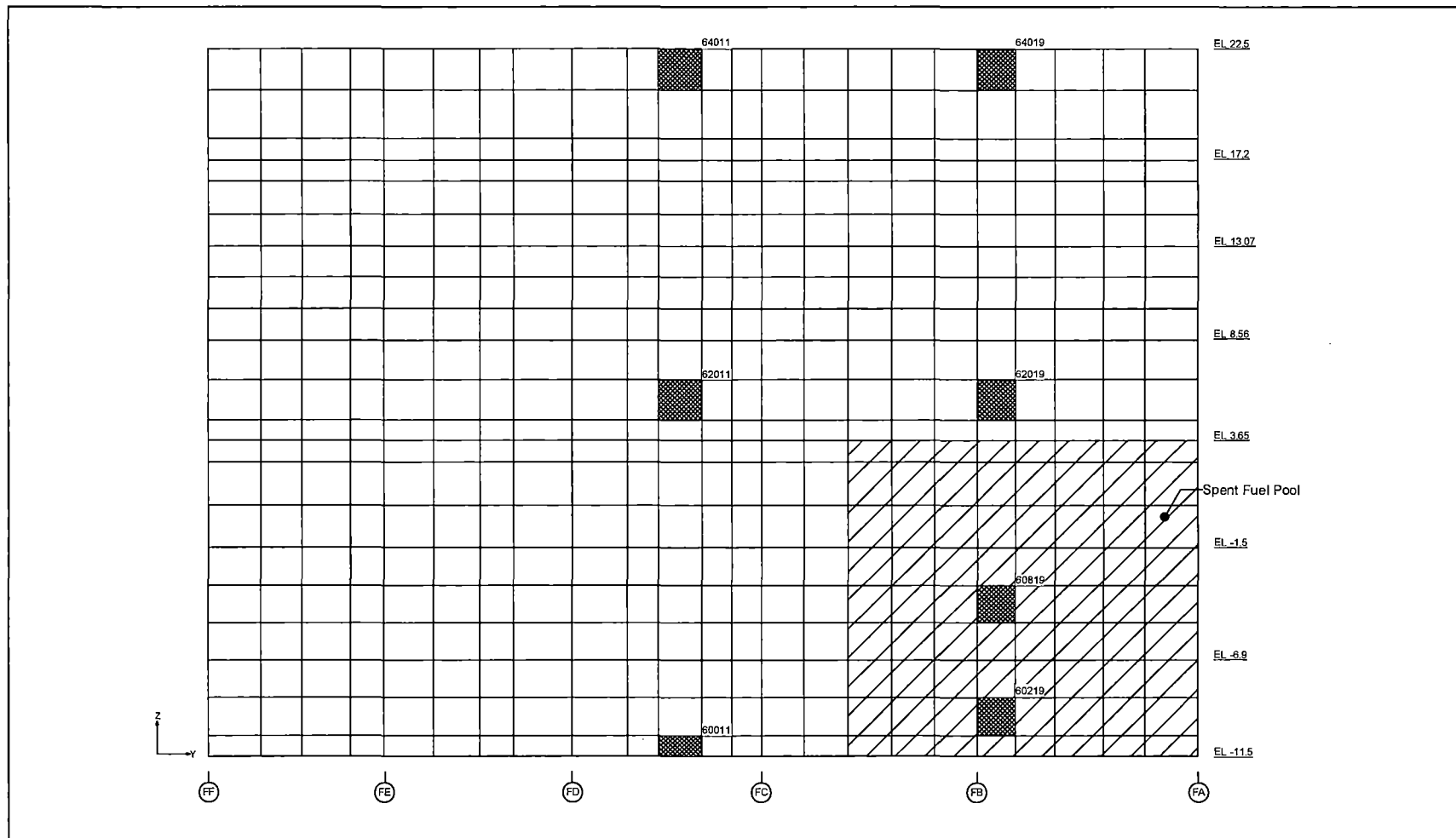


**Figure 5.2.2-8 Application of Thermal Load on the Spent Fuel Pool Wall-3**



Note: \*1) The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.  
Slab oscillator node 99064 is only for the model considering 0% (CR00) and 50% (CR50) of infill concrete stiffness of the vent wall and diaphragm floor.  
Additional oscillators for cracked model are shown in red.

Figure 5.3.3-1 Dynamic Analysis Model



**Figure 6.2.4-1 Elements Selected for Tabulation (External Wall F3)**





HITACHI

WG3-U97-ERD-S-0001 SH NO. 108  
REV. 1 of 155

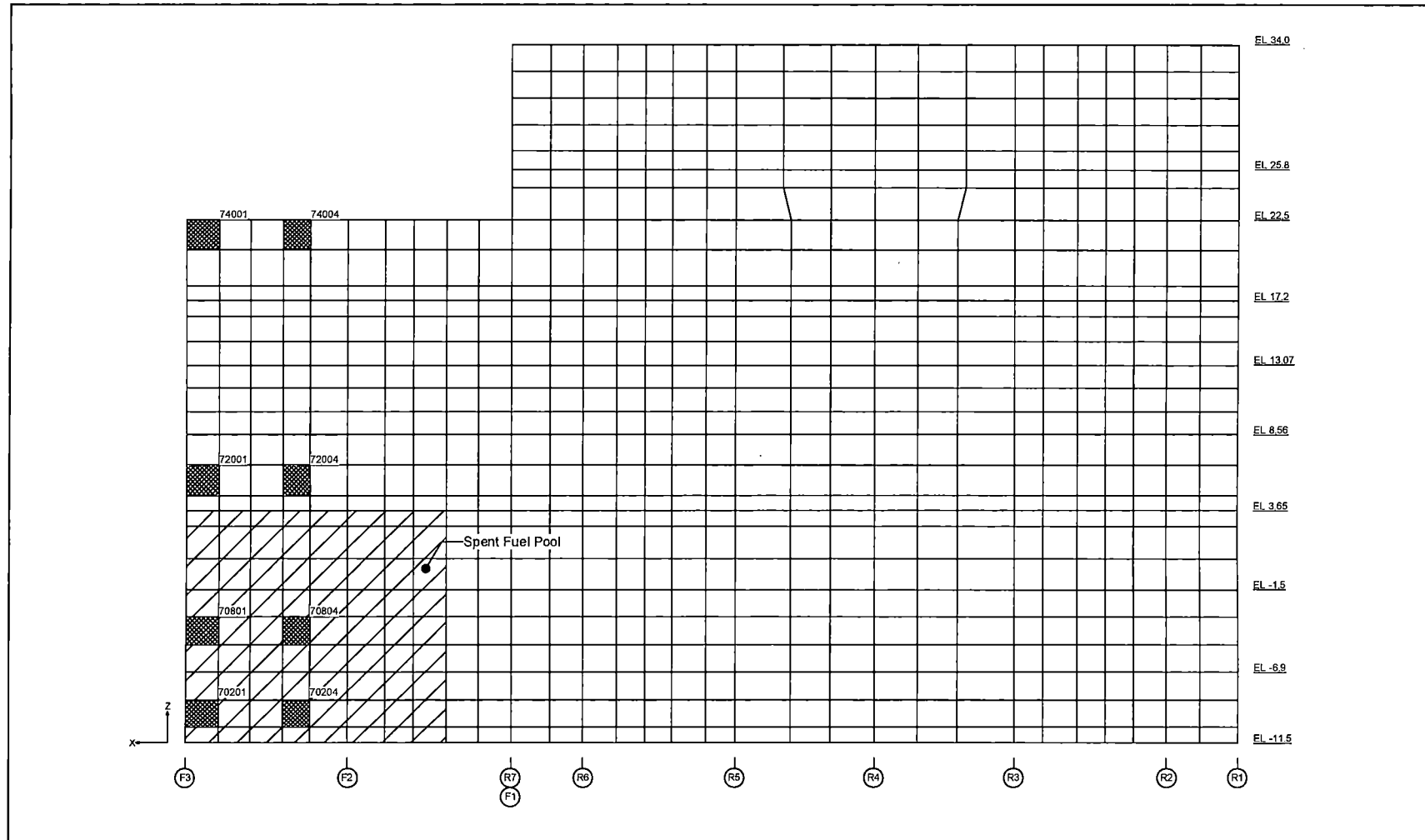
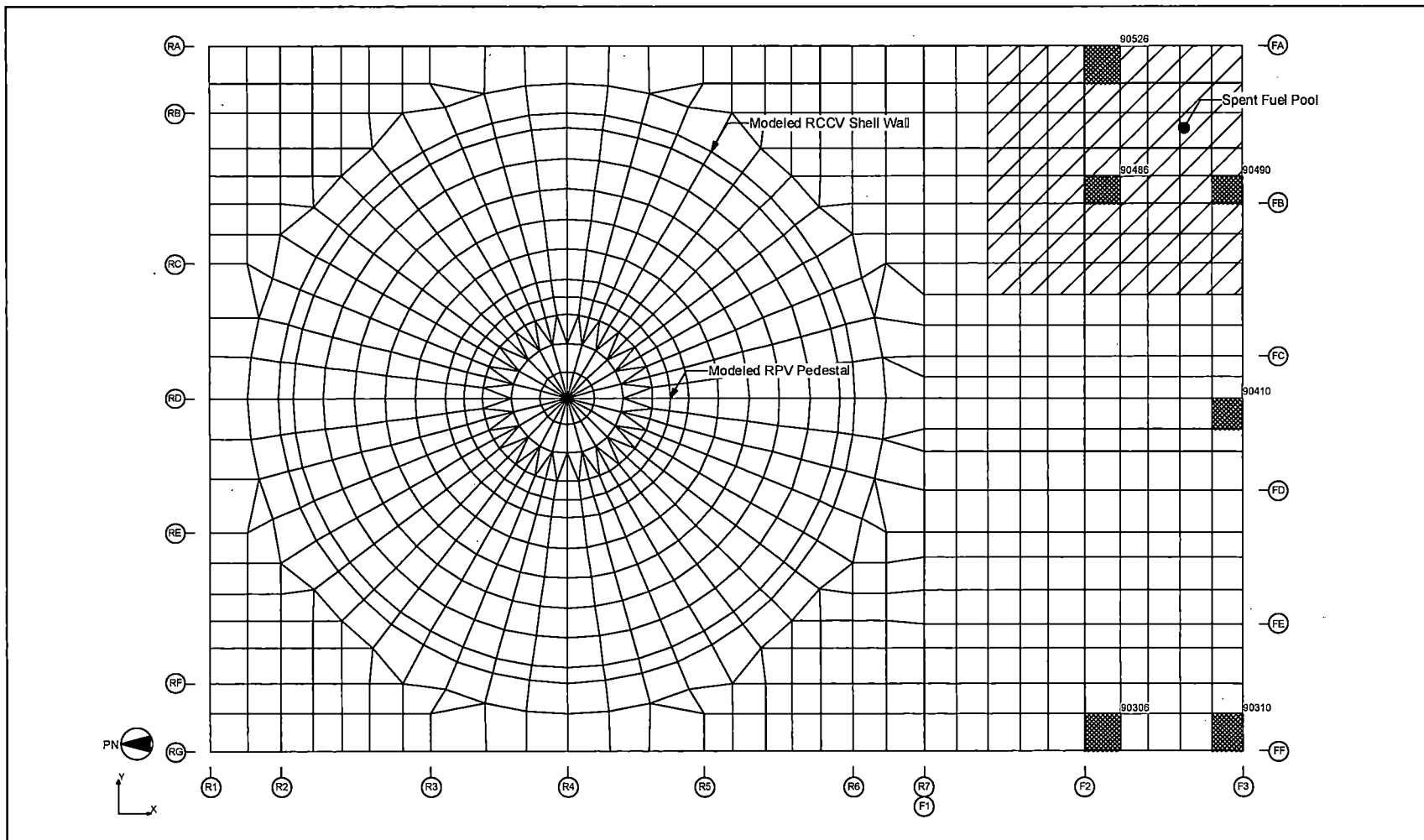


Figure 6.2.4-2 Elements Selected for Tabulation (External Wall RA FA)



**Figure 6.2.4-3 Elements Selected for Tabulation (Basemat)**



HITACHI

WG3-U97-ERD-S-0001 SH NO. 110

REV. 1

of 155

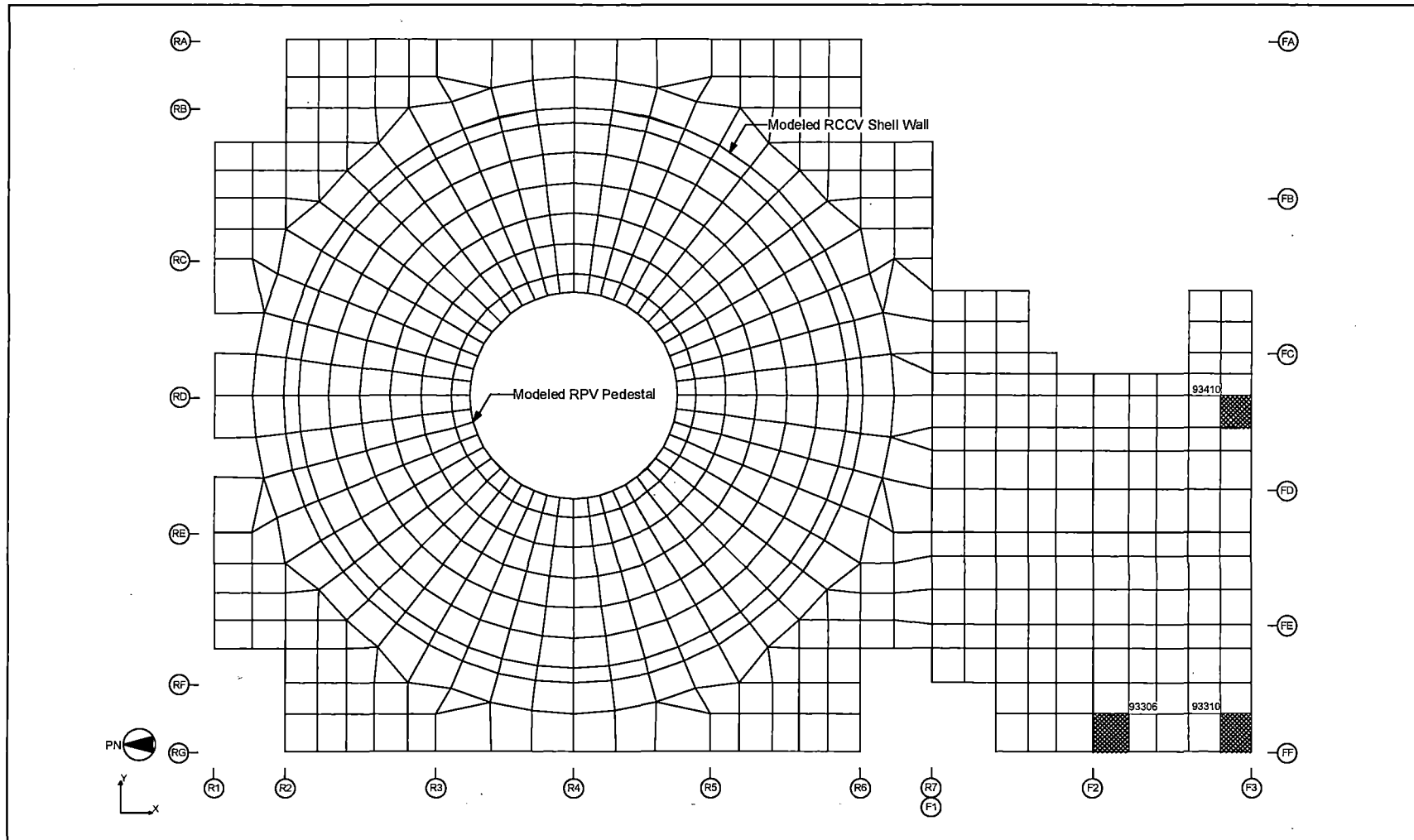


Figure 6.2.4-4 Elements Selected for Tabulation (Slab at EL 4,650)



HITACHI

WG3-U97-ERD-S-0001 SH NO. 111

REV. 1

of 155

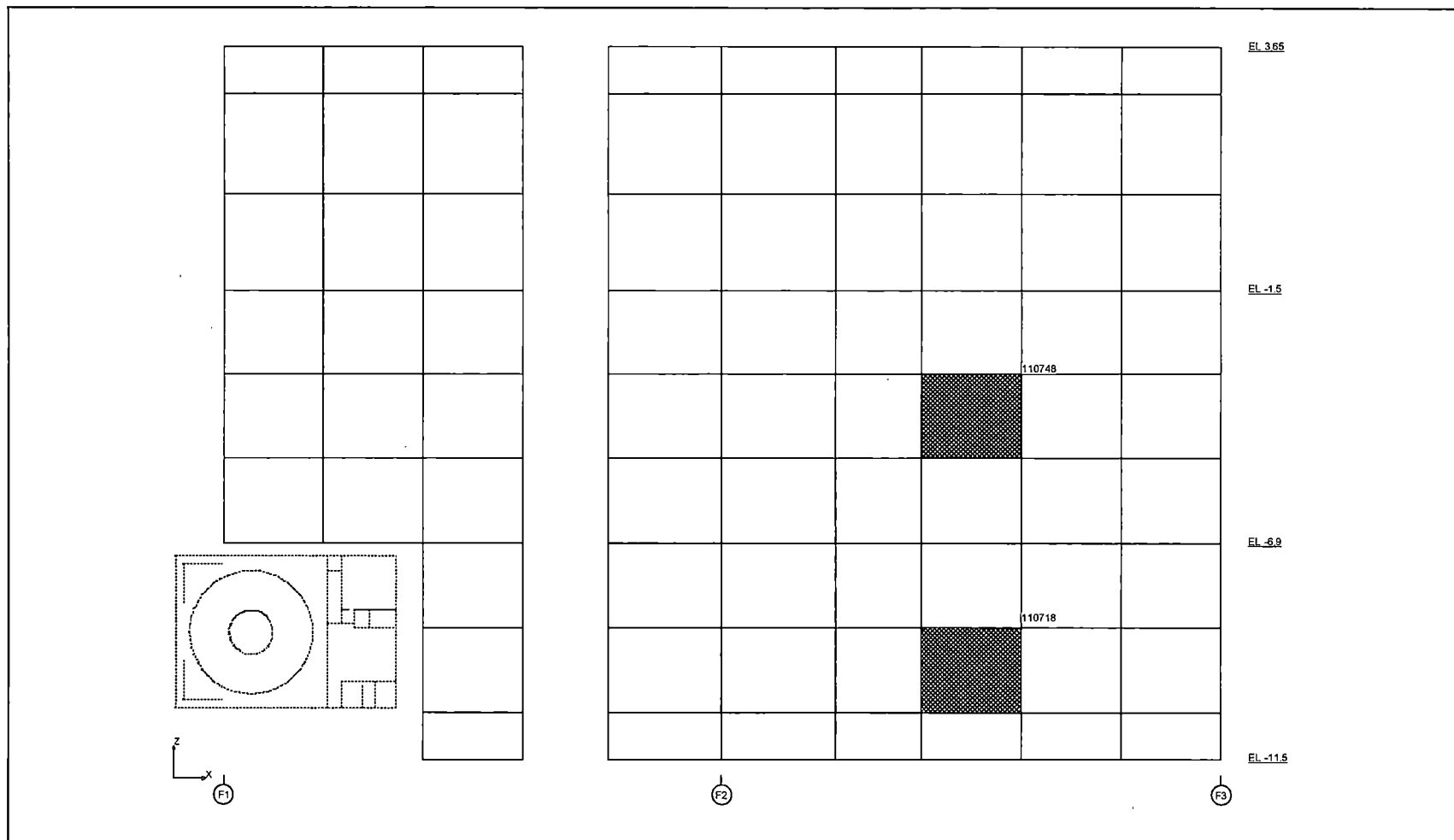
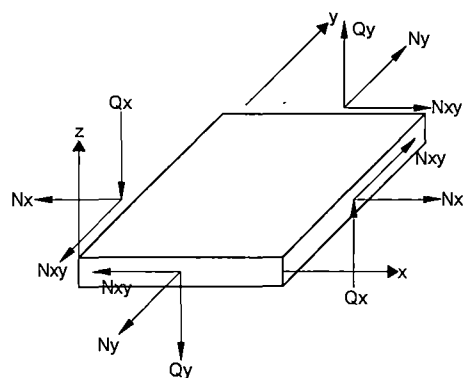
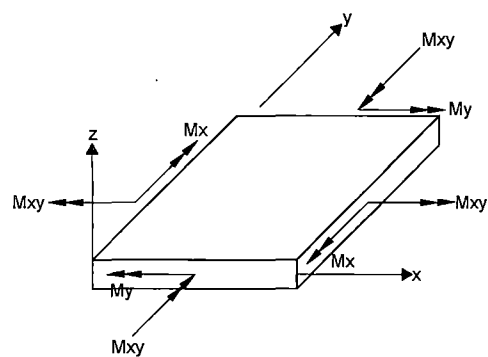


Figure 6.2.4-5 Elements Selected for Tabulation (Spent Fuel Pool Wall)



Membrane and Shear Forces



Moments

Definition of Element Coordinate System

Structure	x	y	z
RCCV Wall RPV Pedestal External Wall	horizontal	vertical	outward
Wall in N-S Direction	horizontal	vertical	toward West
Wall in E-W Direction	horizontal	vertical	toward South
Foundation Mat Floor Slab Top Slab	toward South	toward West	downward
Suppression Pool Slab	radial	circumferential	downward

Figure 6.2.4-6 Force and Moment in Shell Element

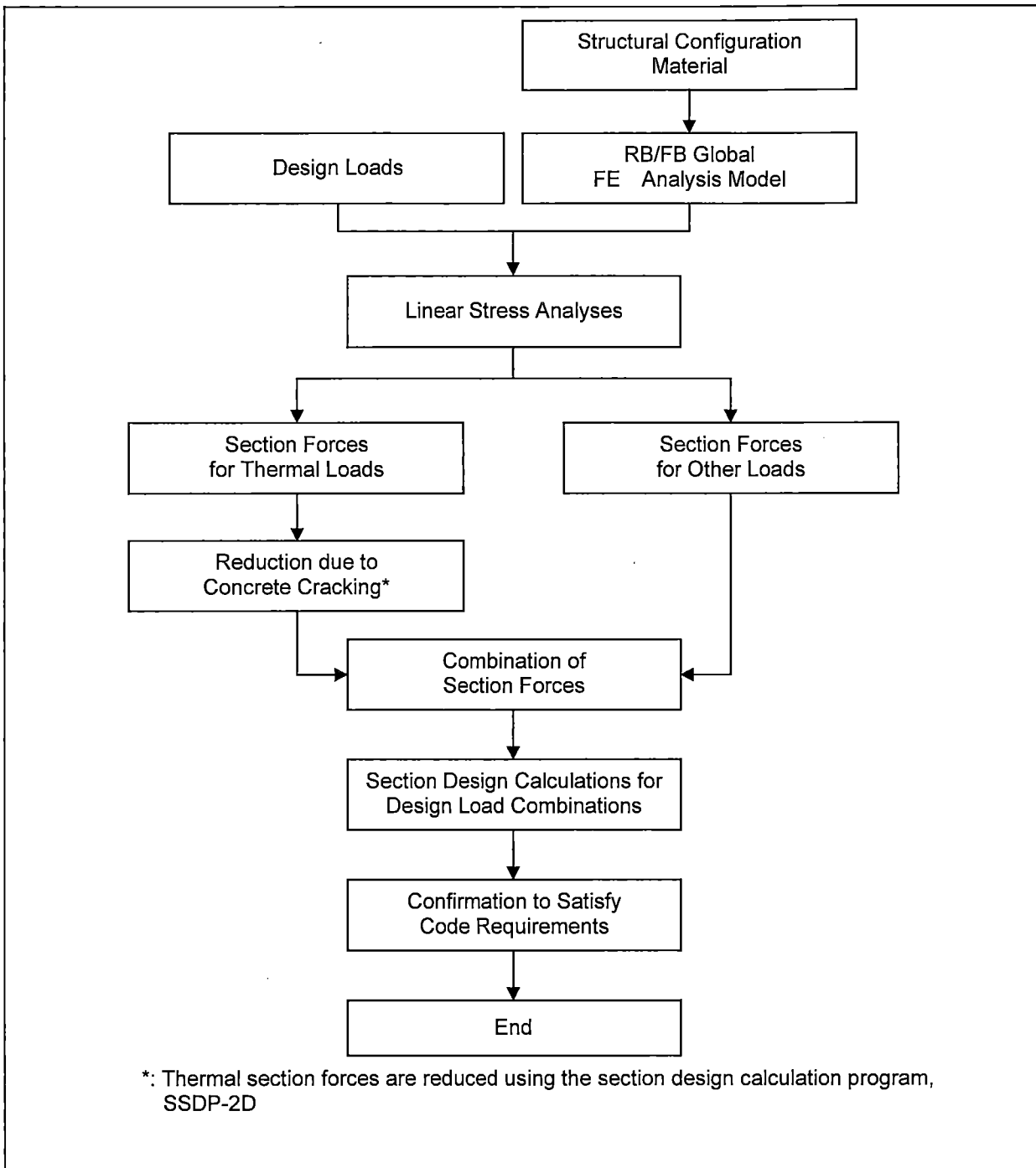


Figure 6.4.1-1 Design Flow Chart of Reinforced Concrete Structures

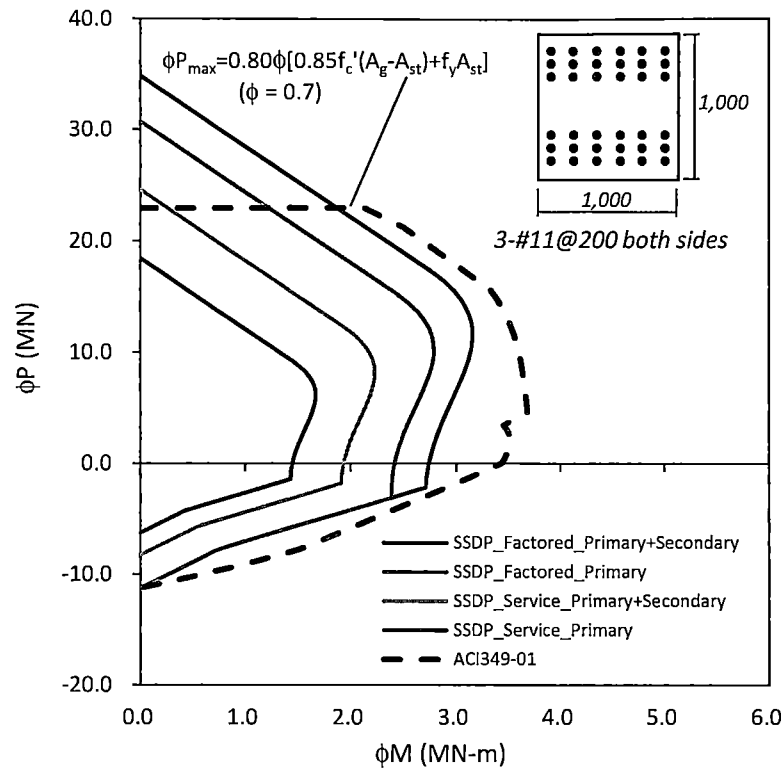


Figure 6.4.1-2 Comparison of Bending Moment-Axial Force (P-M) Interactions

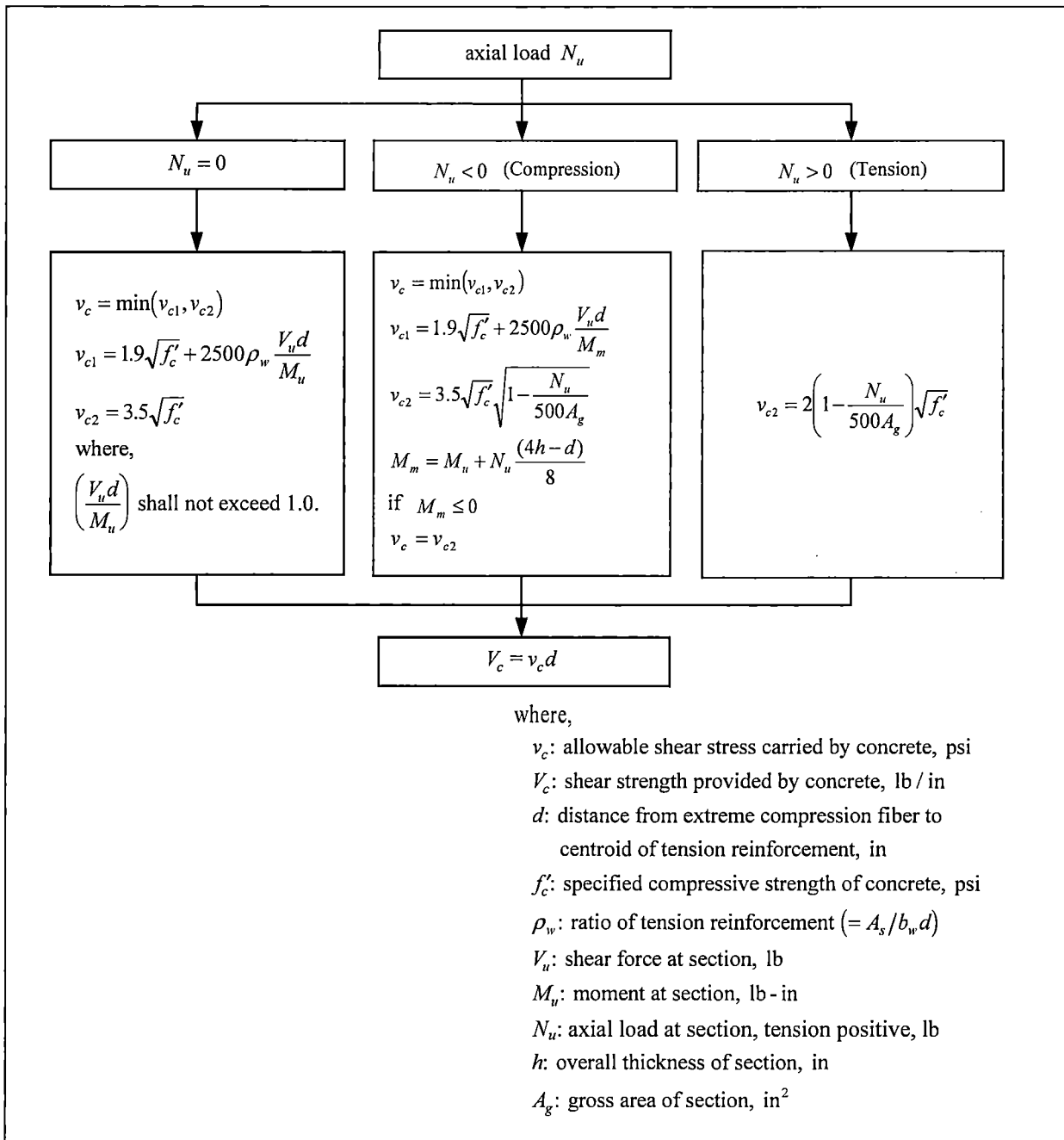


Figure 6.4.1.1-1 Calculation of Shear Strength Provided by Concrete





HITACHI

WG3-U97-ERD-S-0001 SH NO. 116

REV. 1

of 155

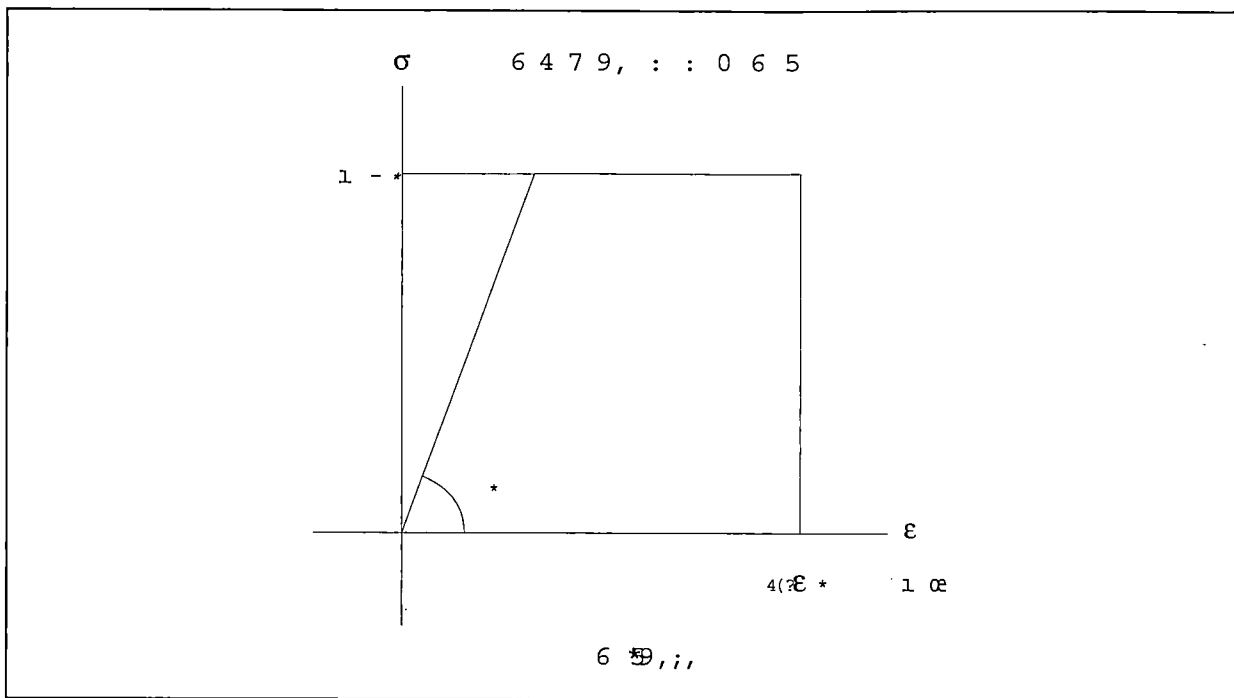


Figure 6.4.1.2-1 Stress-Strain Relationship Assumed for Strength Check



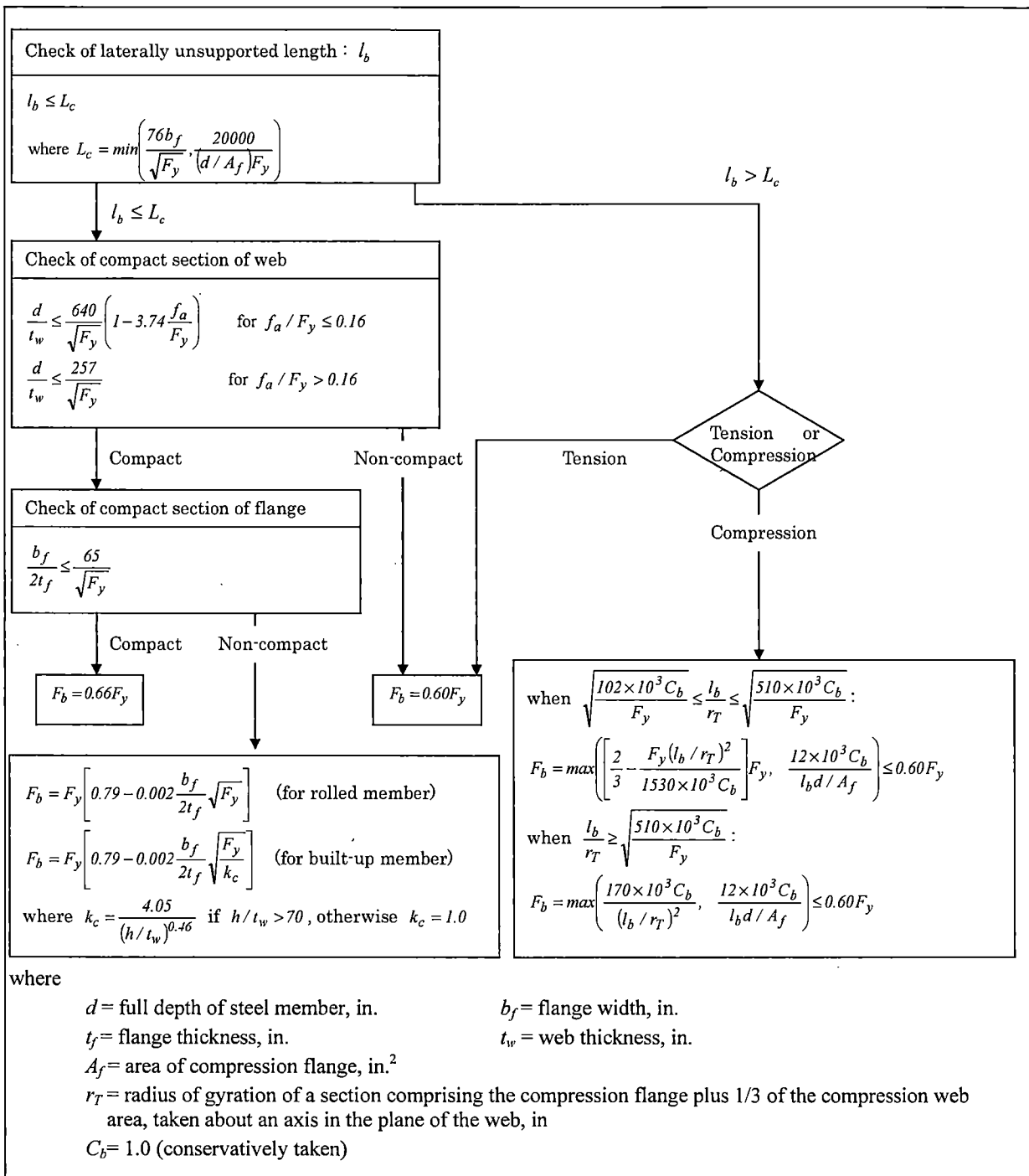
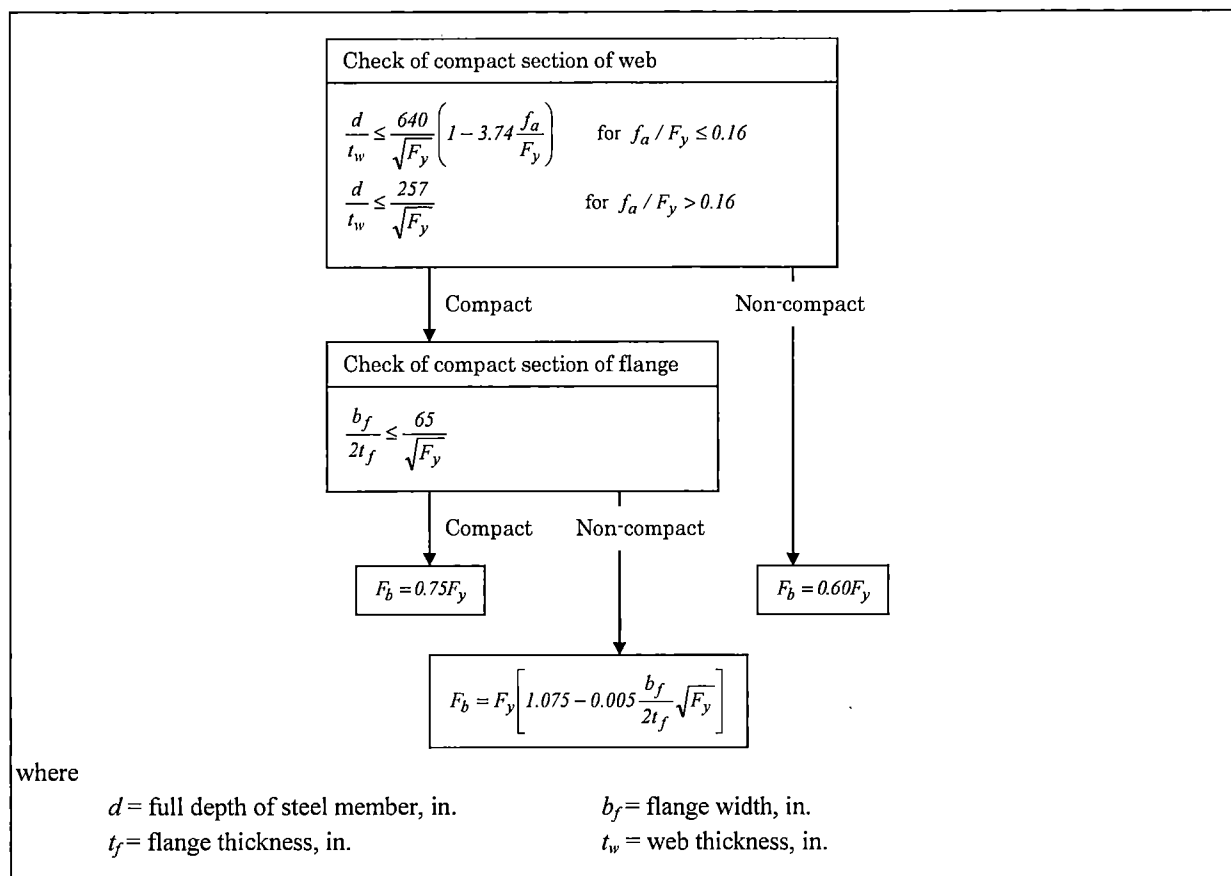


Figure 6.4.2-1 Allowable Stress of W-shaped Members (Strong Axis Bending)

**Figure 6.4.2-2 Allowable Stress of W-shaped Members (Weak Axis Bending)**

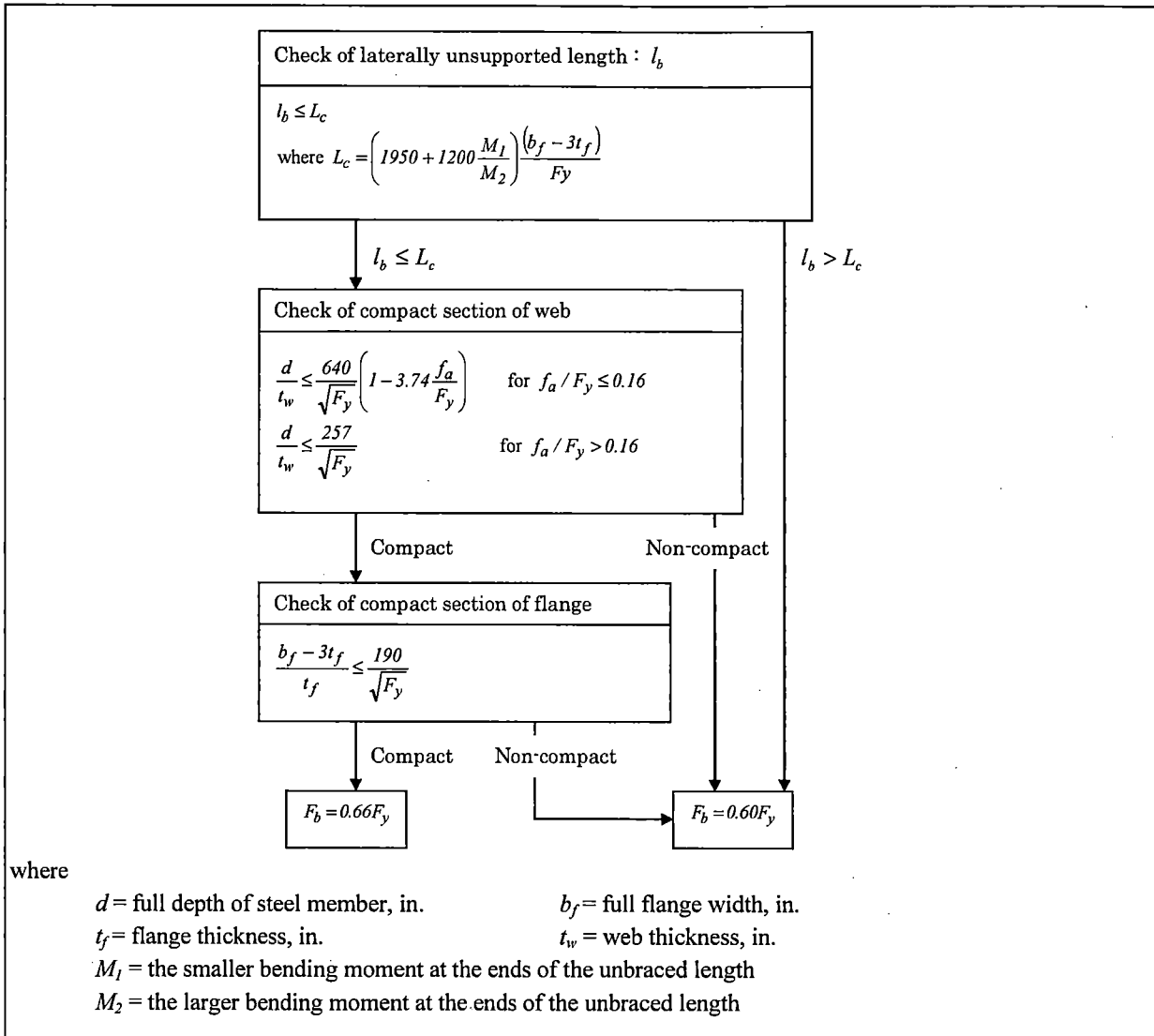


Figure 6.4.2-3 Allowable Bending Stress of Box Members



{

}

**Figure 7.1-2 List of FB Wall and Slab Reinforcement**

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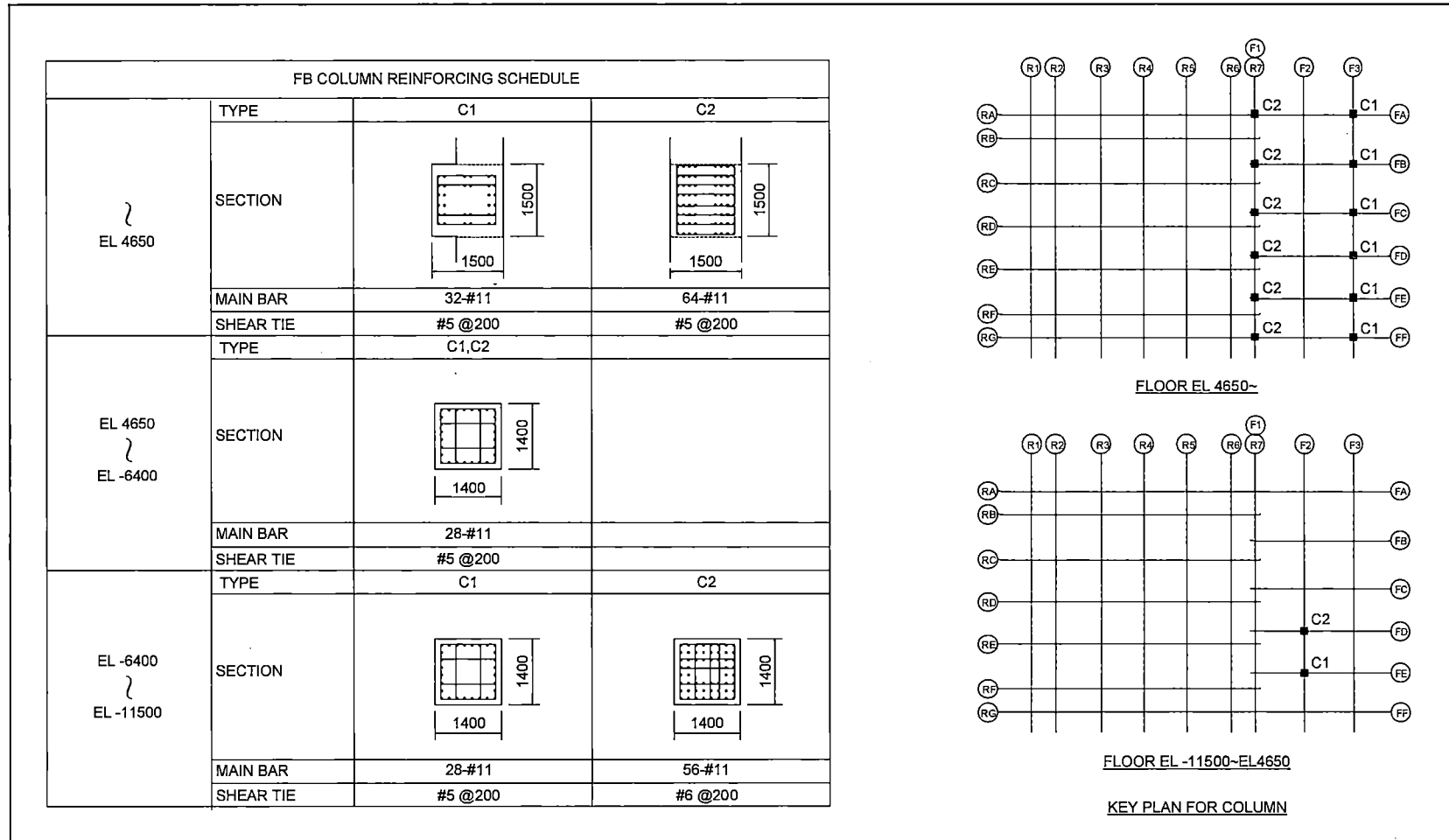


Figure 7.1-3 FB Reinforced Concrete Column Reinforcing Schedule





HITACHI

WG3-U97-ERD-S-0001

SH NO.124

REV. 1

of 155

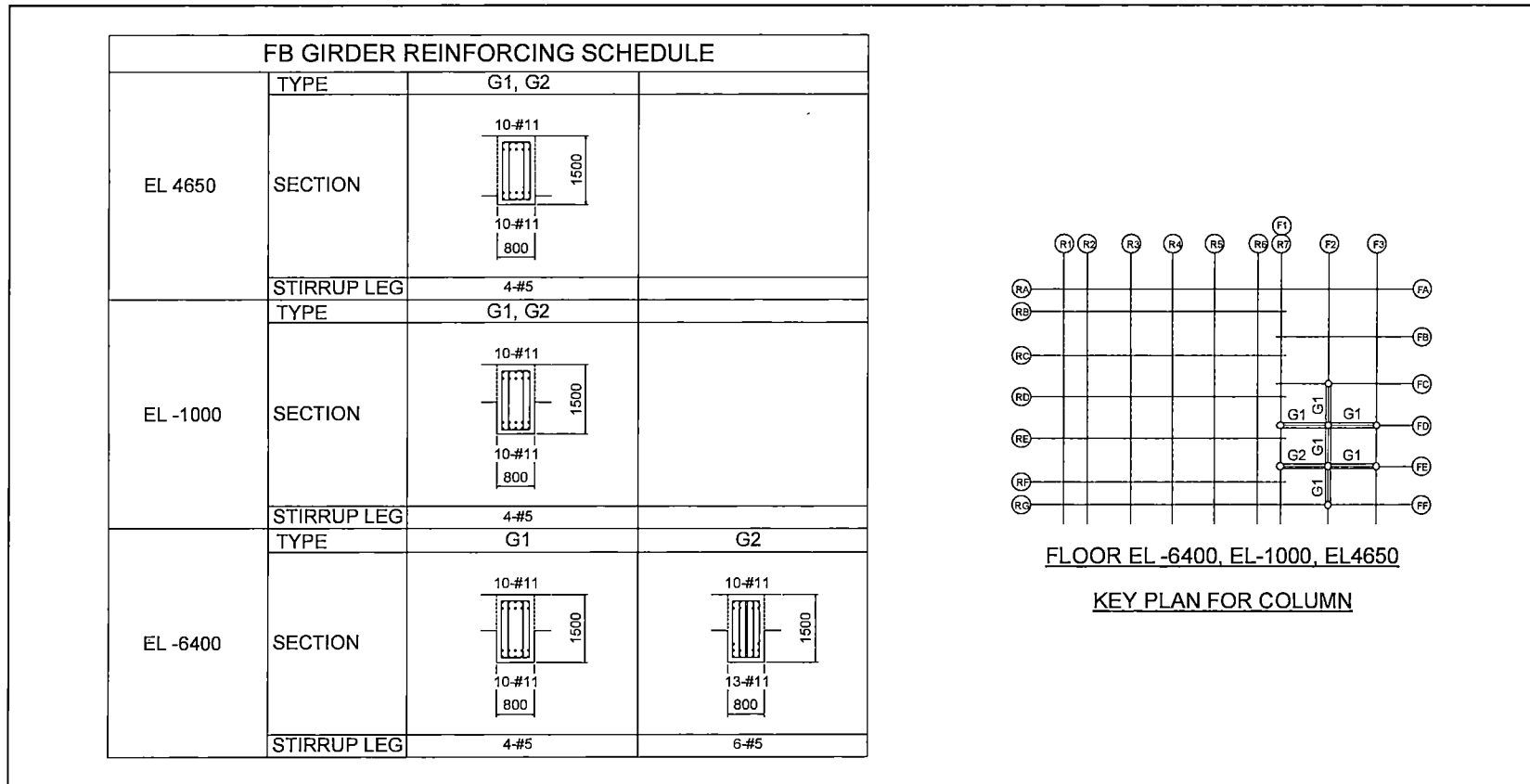
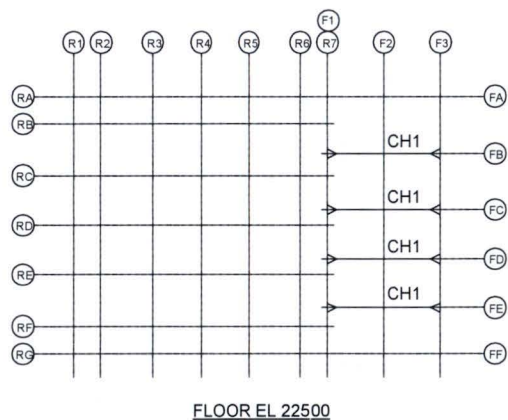
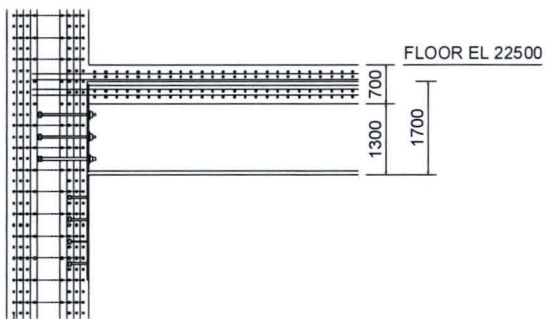


Figure 7.1-4 FB Reinforced Concrete Girder Reinforcing Schedule



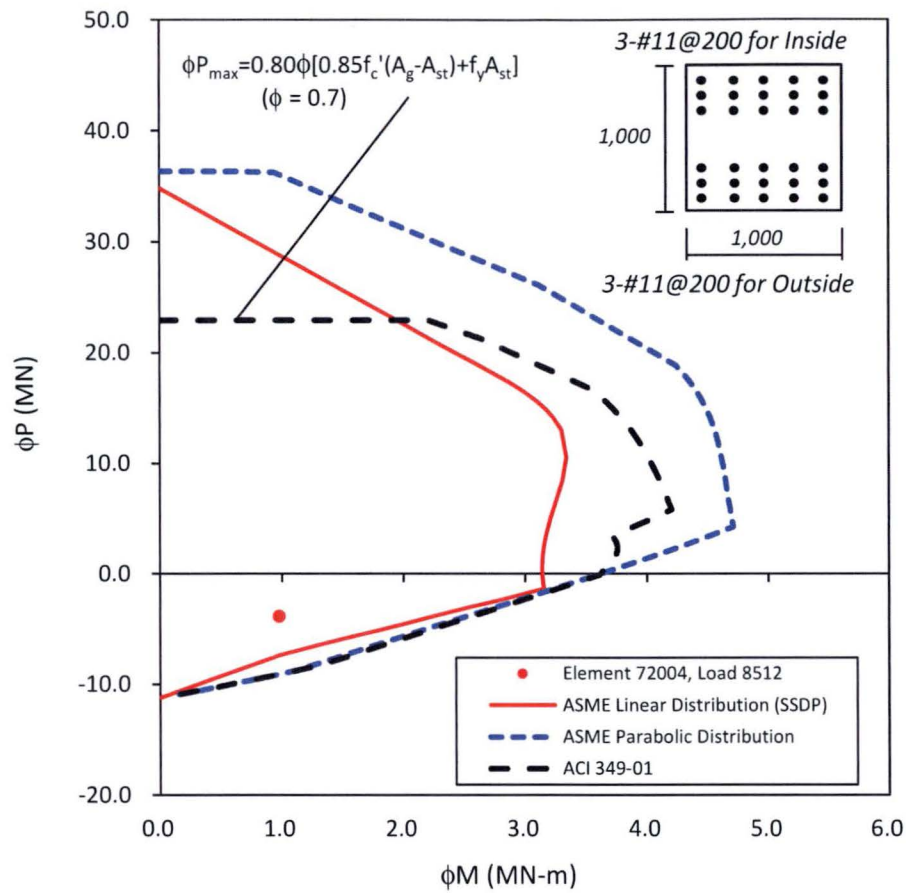
FB ROOF STRUCTURAL STEEL MEMBER SCHEDULE

ID NO.	WELDED PL NUMBER	
	FLG. PL	WEB PL
CH1	1000x75	1550x60



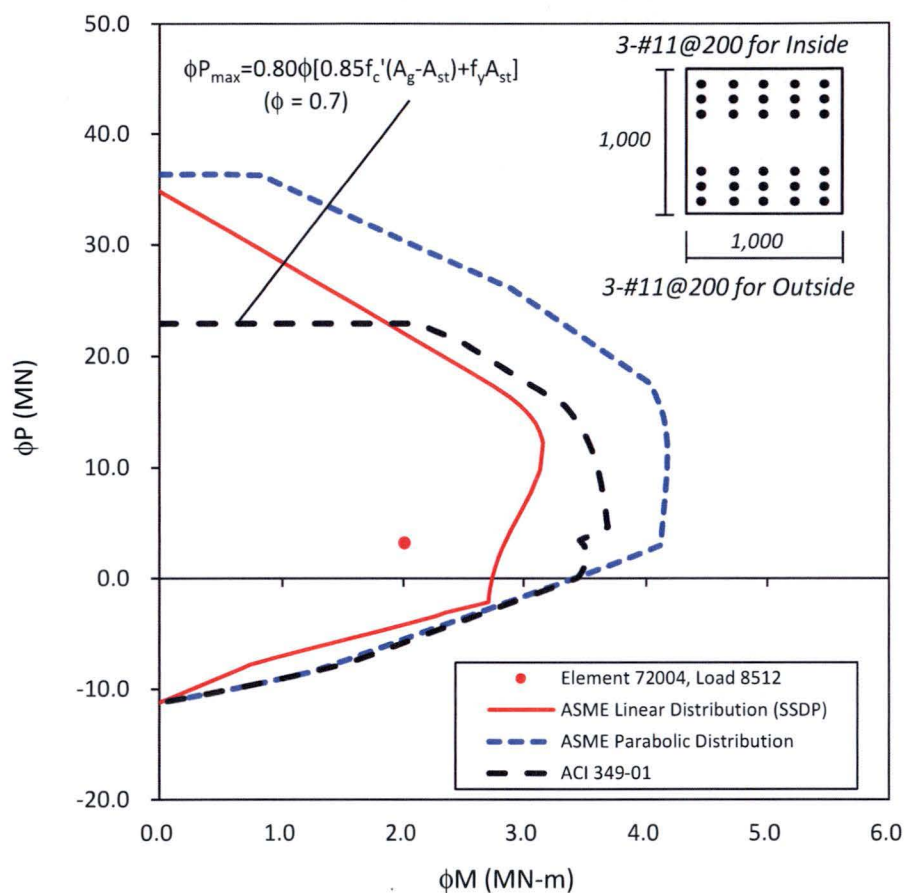
KEY PLAN FOR STRUCTURAL STEEL

Figure 7.1-5 FB Steel Girder Member



(a) Horizontal Direction

Figure 7.3.1.1-1 P-M Demand and Capacities for Element 72004 with New Arrangement of Reinforcement



(b) Vertical Direction

Figure 7.3.1.1-1 P-M Demand and Capacities for Element 72004 with New Arrangement of Reinforcement (Continued)



HITACHI

WG3-U97-ERD-S-0001

SH NO.128

REV..1

of 155

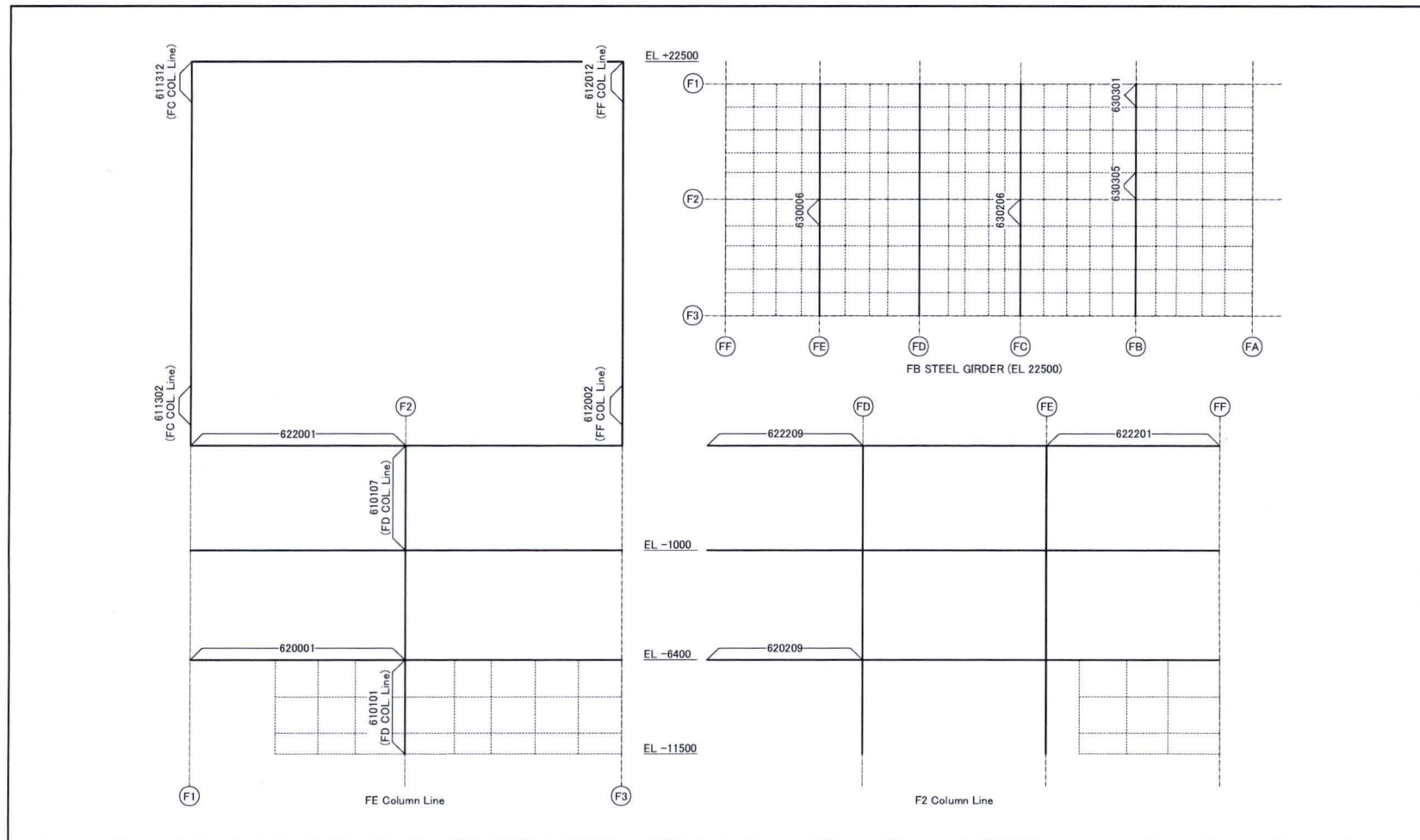


Figure 7.3.1.2-1 Elements Selected for Tabulation - FB Frame -



**HITACHI**

WG3-U97-ERD-S-0001	SH NO.129
REV. 1	of 155

## **APPENDIX A**

### **COMPARISON WITH DCD DATA**



### List of Tables

Table A.1-1 Design Seismic Shear Loads for Horizontal.....	131
Table A.1-2 Design Seismic Moment Loads for Horizontal .....	132
Table A.1-3 Design Seismic Torsion Loads for Horizontal .....	133
Table A.1-4 Vertical Acceleration.....	134
Table A.1-5 Soil Pressure Due to an Earthquake .....	137
Table A.1-6 Seismic Hydrodynamic Loads for Spent Fuel Pool.....	138
Table A.2-1 Maximum Stress Ratios for Flexure and Membrane Forces: FB .....	139
Table A.2-2 Maximum Stress Ratios for Membrane Compressive Forces: FB .....	141
Table A.2-3 Calculation Results for Maximum Transverse Shear: FB .....	143

### List of Figures

None



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 131

REV. 1

of 155

**Table A.1-1 Design Seismic Shear Loads for Horizontal**

Elev. (m)	Elem No.	Node No.	NS-direction			EW-direction		
			NA3 (MN)	DCD (MN)	Ratio (NA3/DCD)	NA3 (MN)	DCD (MN)	Ratio (NA3/DCD)
52.40*	1110	110 109	192.2	151.9	1.27	140.0	158.2	0.89
34.00	1109	109 108	173.2	191.7	0.90	113.9	153.0	0.74
27.00	1108	108 107	396.0	425.4	0.93	259.4	400.7	0.65
22.50	1107	107 106	436.4	483.7	0.90	291.8	464.0	0.63
17.50	1106	106 105	438.4	532.9	0.82	343.5	555.4	0.62
13.57	1105	105 104	450.7	569.2	0.79	363.7	599.9	0.61
9.06	1104	104 103	454.6	610.1	0.75	383.4	654.3	0.59
4.65	1103	103 102	454.7	839.8	0.54	360.1	872.2	0.41
-1.00	1102	102 101	240.0	871.4	0.28	226.6	938.5	0.24
-6.40 -11.50	1101	101 2	237.7	933.6	0.25	200.4	1029.7	0.19

\*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.



**Table A.1-2 Design Seismic Moment Loads for Horizontal**

Elev. (m)	Elem No.	Node No.	NS-direction			EW-direction		
			NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)
52.40*	1110	110	2724	1642	1.66	2143	1808	1.19
			5838	4303	1.36	4488	4465	1.01
34.00	1109	109	8196	5585	1.47	5821	5497	1.06
			8719	6477	1.35	6389	6317	1.01
27.00	1108	108	9400	7685	1.22	7162	7106	1.01
			9599	8964	1.07	7958	8596	0.93
22.50	1107	107	11216	9905	1.13	8328	9193	0.91
			11424	11464	1.00	9227	11297	0.82
17.50	1106	106	12105	12386	0.98	9408	11935	0.79
			12349	13778	0.90	10195	13867	0.74
13.57	1105	105	12839	14298	0.90	10255	14377	0.71
			13651	16593	0.82	11216	16740	0.67
9.06	1104	104	13904	16966	0.82	11338	17191	0.66
			15231	19378	0.79	12506	19672	0.64
4.65	1103	103	9392	19064	0.49	6302	20192	0.31
			10952	23163	0.47	7759	24272	0.32
-1.00	1102	102	6545	23673	0.28	4819	24948	0.19
			7303	27655	0.26	5358	29263	0.18
-6.40 -11.50	1101	2	4748	28126	0.17	3351	30038	0.11
			5053	32235	0.16	3356	35275	0.10

\*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

**Table A.1-3 Design Seismic Torsion Loads for Horizontal**

Elev. (m)	Elem No.	Node No.	Calculated Torsion			Accidental Torsion			Design Torsion		
			NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)	NA3 (MN-m)	DCD (MN-m)	Ratio (NA3/DCD)
52.40*	1110	110	1284	1379	0.93	471	388	1.22	1755	1766	0.99
34.00	1109	109	1938	2405	0.81	424	470	0.90	2362	2874	0.82
27.00	1108	108	2799	3329	0.84	1386	1489	0.93	4185	4822	0.87
22.50	1107	107	4678	6093	0.77	1527	1693	0.90	6205	7786	0.80
17.50	1106	106	4023	5068	0.79	1535	1944	0.79	5557	7012	0.79
13.57	1105	105	4211	5245	0.80	1578	2100	0.75	5788	7344	0.79
9.06	1104	104	4694	5985	0.78	1591	2290	0.69	6285	8275	0.76
4.65	1103	103	5248	11425	0.46	1591	3053	0.52	6839	14478	0.47
-1.00	1102	102	2718	11523	0.24	840	3285	0.26	3558	14808	0.24
-6.40 -11.50	1101	101 2	2079	11690	0.18	832	3604	0.23	2910	15294	0.19

\*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.

**Table A.1-4 Vertical Acceleration****(a) RB/FB**

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
52.40*	110	RBFB	1.56	1.25	1.25
34.00	109	RBFB	1.20	0.83	1.45
27.00	108	RBFB	1.02	0.73	1.40
22.50	107	RBFB	0.92	0.73	1.26
17.50	106	RBFB	0.80	0.73	1.10
13.57	105	RBFB	0.72	0.74	0.97
9.06	104	RBFB	0.62	0.73	0.85
4.65	103	RBFB	0.56	0.78	0.72
-1.00	102	RBFB	0.57	0.76	0.75
-6.40	101	RBFB	0.53	0.68	0.78
-11.50	2	RBFB	0.51	0.63	0.81
-15.50	1	RBFB	0.52	0.51	1.02

\*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.



Table A.1-4 Vertical Acceleration (Continued)

## (b) Slab Oscillator

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
52.4*	9101	Oscillator	0.33	1.20	0.28
	9102	Oscillator	1.33	1.82	0.73
	9103	Oscillator	6.27	3.14	2.00
	9104	Oscillator	2.62	2.26	1.16
	9105	Oscillator	2.42	2.32	1.04
	9106	Oscillator	3.74	2.99	1.25
	9107	Oscillator	3.22	2.80	1.15
	9108	Oscillator	2.50	2.61	0.96
	9109	Oscillator	1.53	---	---
34.00	9091	Oscillator	1.61	1.29	1.25
	9092	Oscillator	1.61	1.06	1.52
	9093	Oscillator	1.12	---	---
27.00	9081	Oscillator	1.64	1.16	1.41
	9082	Oscillator	1.52	0.99	1.54
	9083	Oscillator	1.30	1.09	1.19
	9084	Oscillator	1.67	1.31	1.27
	9085	Oscillator	1.46	0.97	1.51
	9086	Oscillator	1.12	---	---
	9087	Oscillator	1.03	---	---
22.50	9071	Oscillator	1.15	1.60	0.72
	9072	Oscillator	1.79	1.31	1.37
	9073	Oscillator	4.47	2.03	2.20
	9074	Oscillator	1.67	1.31	1.27
	9075	Oscillator	1.51	1.16	1.30
	9076	Oscillator	1.65	---	---
17.50	9061	Oscillator	3.65	1.79	2.04
	9062	Oscillator	2.62	1.49	1.76
	9063	Oscillator	1.17	0.82	1.43
	9064	Oscillator	2.56	1.84	1.39
	9065	Oscillator	1.28	1.42	0.90
	99064	Oscillator	0.99	1.07	0.93
	9066	Oscillator	1.09	---	---
	9067	Oscillator	0.91	---	---

\*The difference between the modeled elevation 52.4 m and the actual elevation 52.7 m at the RB roof is negligibly small.





Table A.1-4 Vertical Acceleration (Continued)

## (b) Slab Oscillator

Elev. (m)	Node No.	Stick Model	NA3 (g)	DCD (g)	Ratio (NA3/DCD)
13.57	9051	Oscillator	1.11	0.81	1.37
	9052	Oscillator	1.25	1.46	0.86
	9053	Oscillator	0.99	---	---
	9054	Oscillator	0.83	---	---
9.06	9041	Oscillator	1.02	0.88	1.16
	9042	Oscillator	1.26	1.42	0.89
	9043	Oscillator	0.93	---	---
	9044	Oscillator	0.80	---	---
4.65	9031	Oscillator	1.62	1.17	1.38
	9032	Oscillator	0.89	0.97	0.92
	9033	Oscillator	1.12	1.02	1.10
	9034	Oscillator	1.81	1.51	1.20
	9035	Oscillator	1.09	1.38	0.79
	9036	Oscillator	0.94	---	---
	9037	Oscillator	0.82	---	---
-1.00	9021	Oscillator	0.97	1.12	0.87
	9022	Oscillator	2.07	1.45	1.43
	9023	Oscillator	0.98	1.01	0.97
	9024	Oscillator	1.12	0.89	1.26
	9025	Oscillator	1.21	1.34	0.90
	9026	Oscillator	1.63	1.57	1.04
	9027	Oscillator	0.93	0.88	1.06
	9028	Oscillator	0.96	---	---
	9029	Oscillator	1.30	---	---
	9030	Oscillator	0.87	---	---
-6.40	9011	Oscillator	0.84	0.92	0.91
	9012	Oscillator	1.17	0.92	1.27
	9013	Oscillator	1.52	1.35	1.13
	9014	Oscillator	1.19	---	---
	9015	Oscillator	1.03	---	---

**Table A.1-5 Soil Pressure Due to an Earthquake**

<b>Elevation (m)</b>	<b>R1 and F3 Wall</b>			<b>RA and RG Wall</b>			<b>Note</b>
	<b>NA3 (MPa)</b>	<b>DCD (MPa)</b>	<b>Ratio (NA3/DCD)</b>	<b>NA3 (MPa)</b>	<b>DCD (MPa)</b>	<b>Ratio (NA3/DCD)</b>	
4.65							Grade
	0.56	0.30	1.87	0.45	0.33	1.36	
-1							
	0.28	0.29	0.97	0.29	0.29	1.00	
-6.4							
	0.24	0.25	0.96	0.22	0.23	0.96	
-11.5							
	0.94	0.29	3.24	0.76	0.26	2.92	
-15.5							



Table A.1-6 Seismic Hydrodynamic Loads for Spent Fuel Pool

## (a) NS Motion

Wall				Floor			
Depth d/H	Pressure			Distance x/(L/2)	Pressure		
	NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)		NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)
0.0	12.3	12.3	1.00	0.0	0.0	0.0	---
0.2	23.6	22.6	1.04	0.2	7.4	7.1	1.04
0.4	37.8	36.1	1.05	0.4	15.2	14.5	1.05
0.6	44.6	42.6	1.05	0.6	23.7	22.7	1.05
0.8	45.2	43.2	1.05	0.8	33.6	32.1	1.05
1.0	45.2	43.2	1.05	1.0	45.2	43.2	1.05

## (b) EW Motion

Wall				Floor			
Depth d/H	Pressure			Distance x/(L/2)	Pressure		
	NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)		NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)
0.0	11.8	11.8	1.00	0.0	0.0	0.0	---
0.2	24.2	23.2	1.04	0.2	8.5	8.2	1.04
0.4	40.0	38.2	1.05	0.4	17.5	16.7	1.05
0.6	49.4	47.2	1.05	0.6	27.4	26.2	1.05
0.8	52.2	49.8	1.05	0.8	38.7	37.0	1.05
1.0	52.2	49.8	1.05	1.0	52.2	49.8	1.05

## (c) Vertical Motion

Depth d/H	Wall			Floor		
	Pressure			NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)
	NA3 (kN/m <sup>2</sup> )	DCD (kN/m <sup>2</sup> )	Ratio (NA3/DCD)			
0.0	0.0	0.0	---	98.5  for all floor area	98.5  for all floor area	1.00
0.2	19.7	19.7	1.00			
0.4	39.4	39.4	1.00			
0.6	59.1	59.1	1.00			
0.8	78.8	78.8	1.00			
1.0	98.5	98.5	1.00			

Note: 1) "d" is depth from the top of water. "H" is water height of the pool.  
 2) "x" is distance from the center of the pool. "L" is width of the pool.



Table A.2-1 Maximum Stress Ratios for Flexure and Membrane Forces: FB

Location	Element ID	Concrete				
		NA3		DCD		Ratio (NA3/DCD)
		$\sigma/\sigma_s$	Load ID	$\sigma/\sigma_s$	Load ID	
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	0.246	7461	0.392	7301	0.63
	60219	0.481	8511	0.467	7482	1.03
	70201	0.448	6981	0.433	6981	1.03
	70204	0.551	8511	0.654	7482	0.84
	110718	0.719	7492	0.808	7492	0.89
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.692	8514	0.579	7561	1.20
	62019	0.738	8514	0.449	7482	1.64
	72001	0.576	8511	0.520	7482	1.11
	72004	1.033	8512	0.550	7482	1.88
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.778	8511	0.918	7561	0.85
	64019	0.505	7501	0.541	7501	0.93
	74001	0.306	8511	0.281	7581	1.09
	74004	0.460	8511	0.493	7201	0.93
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	0.343	8511	0.313	7482	1.10
	70801	0.700	7491	0.800	7492	0.88
	70804	0.472	8513	0.603	7561	0.78
	110748	0.547	8511	0.579	7492	0.94
5 Basemat	90306	0.247	8512	0.451	7241	0.55
	90310	0.150	7211	0.213	7211	0.71
	90410	0.282	7491	0.508	7601	0.55
5 Basemat @ Spent Fuel Pool	90486	0.347	8514	0.715	7201	0.49
	90490	0.356	8511	0.436	7481	0.82
	90526	0.239	7491	0.414	7201	0.58
6 Slab EL4.65m	93306	0.165	7211	0.212	7481	0.78
	93310	0.303	8514	0.314	7421	0.97
	93410	0.289	7561	0.226	7561	1.28

Note : Exceedance is highlighted. As shown in Figure 7.3.1.1-1, this exceedance is resolved in Section 7.3.1.1.1 by comparing the axial-flexural demand to the axial-flexural capacity with conservatism removed. Refer to Section 7.3.1.1.1.





HITACHI

WG3-U97-ERD-S-0001 SH NO. 140  
REV. 1 of 155

Table A.2-1 Maximum Stress Ratios for Flexure and Membrane Forces: FB (Continued)

Location	Element ID	Primary Reinforcement																			
		Direction 1'										Direction 2'									
		In/Top					Out/Bottom					In/Top					Out/Bottom				
		NA3		DCD		Ratio (NA3 /DCD)	NA3		DCD		Ratio (NA3 /DCD)	NA3		DCD		Ratio (NA3 /DCD)	NA3		DCD		Ratio (NA3 /DCD)
		σ/σ <sub>a</sub>	Load ID	σ/σ <sub>a</sub>	Load ID		σ/σ <sub>a</sub>	Load ID	σ/σ <sub>a</sub>	Load ID		σ/σ <sub>a</sub>	Load ID	σ/σ <sub>a</sub>	Load ID		σ/σ <sub>a</sub>	Load ID	σ/σ <sub>a</sub>	Load ID	
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	0.159	7621	0.763	7601	0.21	0.250	8011	0.960	8011	0.26	0.112	9013	0.910	7982	0.12	0.164	7461	0.896	7992	0.18
	60219	0.227	7601	0.824	7601	0.27	0.256	9011	0.821	7982	0.31	0.168	7701	0.833	7601	0.20	0.306	8511	0.827	7982	0.37
	70201	0.123	7751	0.254	7701	0.49	0.467	8512	0.666	7491	0.70	0.111	7751	0.394	7701	0.28	0.374	8514	0.816	7482	0.46
	70204	0.212	7601	0.581	7831	0.37	0.349	9011	0.561	7981	0.62	0.217	7701	0.986	7601	0.22	0.356	8514	0.779	7981	0.46
	110718	0.481	7701	0.692	8001	0.70	0.512	8511	0.515	8001	0.99	0.111	7751	0.278	7711	0.40	0.377	7492	0.596	8001	0.63
2 Exterior Wall @ EL4.65 ~6.60m	62011	0.383	9013	0.593	8081	0.65	0.632	7492	0.742	7492	0.85	0.729	9012	0.879	8021	0.83	0.801	7492	0.952	7492	0.84
	62019	0.531	9014	0.551	7991	0.96	0.638	7471	0.678	7482	0.94	0.556	7991	0.666	8071	0.84	0.540	7482	0.570	7601	0.95
	72001	0.766	7653	0.808	7481	0.95	0.863	8511	0.754	7121	1.14	0.761	7653	0.883	7931	0.86	0.710	7491	0.715	7491	0.99
	72004	0.839	7221	0.833	7491	1.01	0.948	8512	0.851	7482	1.11	0.979	7632	0.774	7811	1.27	0.946	8071	0.989	8071	0.96
3 Exterior Wall @ EL22.50 ~24.60m	64011	0.508	7961	0.579	7931	0.88	0.726	7521	0.823	7521	0.88	0.451	8071	0.639	8071	0.71	0.644	8511	0.744	7521	0.87
	64019	0.630	8513	0.650	7581	0.97	0.798	8513	0.833	7421	0.96	0.277	8071	0.389	8071	0.71	0.686	7441	0.795	7421	0.86
	74001	0.217	8511	0.298	7331	0.73	0.276	8511	0.278	7482	0.99	0.188	7581	0.210	7331	0.90	0.231	8511	0.241	7482	0.96
	74004	0.421	8514	0.405	8061	1.04	0.584	7471	0.587	7421	0.99	0.327	8061	0.386	8071	0.85	0.593	7471	0.613	7441	0.97
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	0.277	7711	0.773	7711	0.36	0.239	7601	0.783	7601	0.30	0.086	7611	0.860	7612	0.10	0.120	7491	0.958	7601	0.12
	70801	0.300	7601	0.569	7601	0.53	0.534	7492	0.925	7492	0.58	0.220	7601	0.561	7601	0.39	0.336	7492	0.754	7492	0.45
	70804	0.434	7861	0.785	7841	0.55	0.377	7311	0.718	7711	0.53	0.290	7861	0.879	7991	0.33	0.253	8513	0.889	7711	0.28
	110748	0.517	8001	0.490	8001	1.06	0.387	8511	0.399	7981	0.97	0.273	8001	0.376	8001	0.73	0.278	8511	0.260	8001	1.07
5 Basemat	90306	0.181	7121	0.732	8071	0.25	0.063	8514	0.436	7601	0.14	0.176	7121	0.685	7601	0.26	0.017	7911	0.153	7941	0.11
	90310	0.042	2011	0.045	7431	0.92	0.039	7211	0.084	7931	0.46	0.040	2011	0.072	7601	0.55	0.044	7961	0.106	7931	0.42
	90410	0.061	8021	0.746	8021	0.08	0.057	7461	0.169	7411	0.33	0.128	8021	0.681	8021	0.19	0.199	7711	0.414	7911	0.48
5 Basemat @ Spent Fuel Pool	90486	0.158	7251	0.559	7201	0.28	0.212	7492	0.611	7601	0.35	0.059	7251	0.398	7991	0.15	0.165	8514	0.482	7601	0.34
	90490	0.230	7601	0.640	7601	0.36	0.304	7492	0.349	8001	0.87	0.273	7621	0.867	7921	0.31	0.212	7992	0.548	7601	0.39
	90526	0.300	7921	0.907	7982	0.33	0.088	7991	0.433	7601	0.20	0.141	7601	0.548	7921	0.26	0.145	8512	0.291	7492	0.50
6 Slab EL4.65m	93306	0.517	7201	0.641	7201	0.81	0.245	7301	0.425	7941	0.58	0.368	8514	0.351	7301	1.05	0.174	8001	0.242	7991	0.72
	93310	0.267	7431	0.339	7411	0.79	0.268	8514	0.363	7601	0.74	0.243	7411	0.328	7411	0.74	0.257	8514	0.327	7421	0.78
	93410	0.596	7491	0.436	7491	1.37	0.395	7701	0.248	7701	1.59	0.275	7501	0.267	7701	1.03	0.259	7701	0.257	7701	1.01

Note \*: Exterior Wall, Pool Wall Direction1 : Horizontal, Direction2 : Vertical  
Basemat, Slab Direction1 : N-S, Direction2 : E-W  
 $\sigma$  and  $\sigma_a$  are calculated and allowable stress.



Table A.2-2 Maximum Stress Ratios for Membrane Compressive Forces: FB

Location	Element ID	Thickness h (m)	NA3					DCD					Ratio (NA3/DCD)			
			Load ID	Calculated Concrete Stress (MPa)				Load ID	Calculated Concrete Stress (MPa)							
				$\sigma_x$ (MPa)	$\sigma_y$ (MPa)	$\tau_{xy}$ (MPa)	$\sigma_c$ (MPa)		$\sigma_x$ (MPa)	$\sigma_y$ (MPa)	$\tau_{xy}$ (MPa)	$\sigma_c$ (MPa)	$\sigma_x$	$\sigma_y$	$\tau_{xy}$	$\sigma_c$
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	2.0	7251	-2.796	-1.711	-1.216	-3.585	7201	-3.406	-3.527	-3.384	-6.851	0.82	0.49	0.36	0.52
	60219	3.6	7251	-1.766	-1.059	-0.552	-2.068	7201	-1.705	-3.165	-1.440	-4.049	1.04	0.33	0.38	0.51
	70201	2.0	7201	-0.629	-0.568	1.356	-1.955	7501	0.660	-1.724	-1.471	-2.425	-0.95	0.33	-0.92	0.81
	70204	2.0	7251	-1.624	-1.884	-2.077	-3.835	7201	-1.699	-4.839	-2.656	-6.354	0.96	0.39	0.78	0.60
	110718	1.5	8511	-5.081	-4.908	-4.098	-9.094	7482	-5.590	-7.281	-4.164	-10.684	0.91	0.67	0.98	0.85
2 Exterior Wall @ EL4.65 ~6.60m	62011	1.0	7491	-3.314	-1.939	3.178	-5.878	7301	-1.454	-2.815	-4.170	-6.360	2.28	0.69	-0.76	0.92
	62019	1.0	7411	-2.386	-2.691	3.254	-5.796	7201	-1.365	-2.941	-3.465	-5.706	1.75	0.91	-0.94	1.02
	72001	1.0	7501	-1.599	-3.269	4.578	-7.087	7441	1.224	-4.484	5.783	-8.079	-1.31	0.73	0.79	0.88
	72004	1.0	7501	-2.074	-3.215	5.045	-7.722	7501	-1.229	-3.807	4.709	-7.401	1.69	0.84	1.07	1.04
3 Exterior Wall @ EL22.50 ~24.60m	64011	1.0	7601	-3.251	0.052	1.609	-3.905	7601	-3.859	0.142	1.995	-4.683	0.84	0.36	0.81	0.83
	64019	1.0	7101	-2.993	-0.873	-1.518	-3.785	7101	-3.098	-0.965	-1.693	-4.032	0.97	0.91	0.90	0.94
	74001	1.0	8511	-0.253	-1.193	-2.891	-3.652	7482	-0.270	-1.159	-2.781	-3.531	0.94	1.03	1.04	1.03
	74004	1.0	8511	-1.788	-0.595	-3.522	-4.763	7101	-1.979	-0.674	1.992	-3.422	0.90	0.88	-1.77	1.39
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	3.6	8511	-1.511	-1.565	-0.846	-2.385	7201	-1.338	-3.405	-1.538	-4.225	1.13	0.46	0.55	0.56
	70801	2.0	7251	-1.698	-1.023	-1.657	-3.052	7201	1.294	-1.749	2.286	-2.974	-1.31	0.58	-0.72	1.03
	70804	2.0	7251	-1.576	-1.314	-1.897	-3.347	7201	1.538	-3.401	2.629	-4.539	-1.02	0.39	-0.72	0.74
	110748	1.5	8511	-2.013	-4.397	-2.897	-6.337	7482	-2.156	-5.184	-2.909	-6.949	0.93	0.85	1.00	0.91
5 Basemat	90306	4.0	7251	-1.548	-0.786	0.912	-2.155	7201	-2.779	-1.199	1.583	-3.758	0.56	0.66	0.58	0.57
	90310	4.0	2001	-0.494	-0.509	0.050	-0.551	2001	-0.494	-0.508	0.049	-0.551	1.00	1.00	1.00	1.00
	90410	4.0	7251	-0.751	-2.318	0.686	-2.576	7201	-0.891	-3.394	1.419	-4.035	0.84	0.68	0.48	0.64
5 Basemat @ Spent Fuel Pool	90486	5.5	2001	-0.483	-0.812	-0.049	-0.819	7561	-0.904	-1.396	-0.465	-1.676	0.53	0.58	0.11	0.49
	90490	5.5	7251	-0.541	-1.746	0.358	-1.844	7201	-0.686	-2.376	0.812	-2.702	0.79	0.73	0.44	0.68
	90526	5.5	2001	-0.601	-0.914	-0.080	-0.933	7201	-1.620	-1.099	-1.131	-2.520	0.37	0.83	0.07	0.37
6 Slab EL4.65m	93306	1.3	8514	-2.180	-0.329	-2.011	-3.468	7211	-3.190	-0.464	-1.635	-3.956	0.68	0.71	1.23	0.88
	93310	1.3	2021	-1.698	-1.680	-1.854	-3.544	2021	-1.698	-1.680	-1.854	-3.544	1.00	1.00	1.00	1.00
	93410	1.3	7492	-0.637	-2.927	-1.525	-3.689	7492	-0.481	-3.287	-1.231	-3.750	1.32	0.89	1.24	0.98

Notes: Compressive forces are negative.





Table A.2-2 Maximum Stress Ratios for Membrane Compressive Forces: FB (Continued)

Location	Element ID	Thickness h (m)	NA3			DCD			Ratio (NA3/DCD)
			Load ID	Allowable Stress $\sigma_a$ (MPa)	$\sigma_c/\sigma_a$	Load ID	Allowable Stress $\sigma_a$ (MPa)	$\sigma_c/\sigma_a$	
1 Exterior Wall and Pool Wall @ EL-11.50 ~-10.50m	60011	2.0	7251	-20.7	0.173	7201	-20.7	0.331	0.523
	60219	3.6	7251	-20.7	0.100	7201	-20.7	0.196	0.511
	70201	2.0	7201	-20.7	0.094	7501	-20.7	0.117	0.806
	70204	2.0	7251	-20.7	0.185	7201	-20.7	0.307	0.604
	110718	1.5	8511	-25.9	0.351	7482	-25.9	0.413	0.851
2 Exterior Wall @ EL4.65 ~-6.60m	62011	1.0	7491	-25.9	0.227	7301	-20.7	0.307	0.739
	62019	1.0	7411	-25.9	0.224	7201	-20.7	0.276	0.813
	72001	1.0	7501	-20.7	0.342	7441	-25.9	0.312	1.097
	72004	1.0	7501	-20.7	0.373	7501	-20.7	0.358	1.043
3 Exterior Wall @ EL22.50 ~-24.60m	64011	1.0	7601	-20.7	0.189	7601	-20.7	0.226	0.834
	64019	1.0	7101	-20.7	0.183	7101	-20.7	0.195	0.939
	74001	1.0	8511	-25.9	0.141	7482	-25.9	0.136	1.035
	74004	1.0	8511	-25.9	0.184	7101	-20.7	0.165	1.113
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	3.6	8511	-25.9	0.092	7201	-25.9	0.163	0.564
	70801	2.0	7251	-20.7	0.147	7201	-20.7	0.144	1.026
	70804	2.0	7251	-20.7	0.162	7201	-20.7	0.219	0.737
	110748	1.5	8511	-25.9	0.245	7482	-25.9	0.269	0.912
5 Basemat	90306	4.0	7251	-16.6	0.130	7201	-16.6	0.227	0.573
	90310	4.0	2001	-8.3	0.067	2001	-8.3	0.067	1.000
	90410	4.0	7251	-16.6	0.156	7201	-16.6	0.244	0.638
5 Basemat @ Spent Fuel Pool	90486	5.5	2001	-8.3	0.099	7561	-16.6	0.101	0.977
	90490	5.5	7251	-16.6	0.111	7201	-16.6	0.163	0.682
	90526	5.5	2001	-8.3	0.113	7201	-16.6	0.152	0.741
6 Slab EL4.65m	93306	1.3	8514	-25.9	0.134	7211	-25.9	0.153	0.877
	93310	1.3	2021	-15.5	0.228	2021	-15.5	0.228	1.000
	93410	1.3	7492	-25.9	0.143	7492	-25.9	0.145	0.984

Notes: Compressive forces are negative.



**HITACHI**

WG3-U97-ERD-S-0001 SH NO. 143

REV. 1

of 155

**Table A.2-3 Calculation Results for Maximum Transverse Shear: FB**

Location	Element ID	NA3			DCD			NA3					DCD					Ratio (NA3/DCD)				
		Load ID	d (m)	p <sub>v</sub> (%)	Load ID	d (m)	p <sub>v</sub> (%)	Shear Force (MN/m)				V <sub>u</sub> /φV <sub>n</sub>	Shear Force (MN/m)				V <sub>u</sub> /φV <sub>n</sub>	Shear Force (MN/m)				V <sub>u</sub> /φV <sub>n</sub>
								V <sub>u</sub>	V <sub>c</sub>	V <sub>s</sub>	φV <sub>n</sub>		V <sub>u</sub>	V <sub>c</sub>	V <sub>s</sub>	φV <sub>n</sub>		V <sub>u</sub>	V <sub>c</sub>	V <sub>s</sub>	φV <sub>n</sub>	
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	8511	1.70	0.710	7982	1.74	0.177	1.55	4.02	5.00	7.67	0.202	0.38	0.00	1.28	1.08	0.346	4.14	1.00	3.92	7.07	0.58
	60219	8511	3.05	0.710	7982	3.36	0.177	4.67	3.77	8.96	10.82	0.432	0.26	0.31	2.46	2.35	0.112	17.70	12.08	3.65	4.60	3.85
	70201	7481	1.65	0.710	7982	1.69	0.177	1.19	1.72	4.84	5.58	0.213	0.15	0.18	1.24	1.20	0.125	7.91	9.72	3.92	4.65	1.70
	70204	7481	1.59	0.710	4021	1.69	0.710	3.14	2.16	4.67	5.81	0.540	1.98	2.06	4.97	5.98	0.331	1.59	1.05	0.94	0.97	1.63
	110718	7492	1.12	0.355	7482	1.10	0.355	0.82	1.14	1.64	2.36	0.346	1.02	1.41	1.61	2.56	0.397	0.80	0.81	1.02	0.92	0.87
2 Exterior Wall @ EL4.65 ~6.60m	62011	7571	0.78	0.125	7982	0.78	0.125	0.49	0.84	0.40	1.06	0.463	0.27	0.23	0.40	0.54	0.499	1.81	3.61	1.00	1.96	0.93
	62019	7601	0.72	0.125	7982	0.72	0.125	0.18	0.13	0.37	0.43	0.407	0.11	0.13	0.37	0.42	0.256	1.62	1.06	1.00	1.02	1.59
	72001	7581	0.73	0.250	7982	0.72	0.250	0.47	0.00	0.76	0.64	0.728	0.45	0.10	0.75	0.72	0.620	1.05	0.00	1.02	0.89	1.17
	72004	7612	0.72	0.250	7982	0.72	0.125	0.46	0.00	0.74	0.63	0.732	0.23	0.00	0.37	0.32	0.734	1.99	1.00	2.00	2.00	1.00
3 Exterior Wall @ EL22.50 ~24.60m	64011	7492	0.72	0.125	7482	0.72	0.125	0.31	0.71	0.37	0.92	0.336	0.29	0.72	0.37	0.92	0.310	1.08	0.99	1.00	0.99	1.08
	64019	8511	0.80	0.125	7482	0.80	0.125	0.22	0.00	0.41	0.35	0.635	0.24	0.00	0.41	0.35	0.680	0.93	1.00	1.00	1.00	0.93
	74001	7492	0.73	0.125	4021	0.72	0.125	0.15	0.18	0.38	0.47	0.321	0.10	0.12	0.37	0.42	0.249	1.45	1.44	1.02	1.13	1.29
	74004	8513	0.72	0.125	4021	0.72	0.125	0.30	0.40	0.37	0.66	0.462	0.06	0.08	0.37	0.38	0.168	4.75	5.34	1.00	1.73	2.75
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	8511	3.05	0.710	7982	3.33	0.177	2.44	4.35	8.97	11.32	0.216	0.37	0.43	2.44	2.44	0.151	6.63	10.04	3.67	4.63	1.43
	70801	8514	1.71	0.710	7482	1.69	0.710	4.03	2.03	5.02	5.99	0.672	3.99	1.84	4.97	5.79	0.690	1.01	1.10	1.01	1.04	0.97
	70804	7571	1.62	0.710	7982	1.59	0.177	1.11	0.69	4.75	4.62	0.240	0.11	0.13	1.17	1.10	0.098	10.25	5.37	4.07	4.20	2.44
	110748	8511	1.22	0.177	7482	1.22	0.177	1.06	1.32	0.89	1.88	0.563	1.09	1.38	0.89	1.93	0.563	0.97	0.96	1.00	0.97	1.00
5 Basemat	90306	8514	3.53	0.629	7982	3.49	0.629	4.82	6.96	9.18	13.73	0.351	6.11	1.70	9.07	9.15	0.667	0.79	4.10	1.01	1.50	0.53
	90310	7511	3.52	0.629	7482	3.48	0.629	2.82	5.95	9.15	12.84	0.220	3.70	5.75	9.06	12.59	0.294	0.76	1.04	1.01	1.02	0.75
	90410	7471	3.53	0.629	7982	3.50	0.629	3.47	6.91	9.19	13.68	0.254	3.90	1.76	9.09	9.23	0.423	0.89	3.92	1.01	1.48	0.60
5 Basemat @ Spent Fuel Pool	90486	7492	5.04	0.419	7982	3.92	0.419	1.86	4.63	8.74	11.36	0.164	2.91	3.66	6.79	8.89	0.327	0.64	1.26	1.29	1.28	0.50
	90490	8514	5.04	0.629	7482	5.05	0.629	5.65	5.53	13.11	15.85	0.356	11.99	6.04	13.13	16.29	0.736	0.47	0.92	1.00	0.97	0.48
	90526	7221	5.03	0.629	7982	3.94	0.629	4.48	9.27	13.07	18.99	0.236	6.45	3.16	10.25	11.40	0.566	0.69	2.93	1.28	1.67	0.42
6 Slab EL4.65m	93306	7482	1.10	0.500	6483	1.10	0.500	0.41	0.79	2.27	2.60	0.158	0.22	0.26	2.27	2.15	0.101	1.89	3.08	1.00	1.21	1.56
	93310	7571	1.10	0.500	7482	1.10	0.500	0.93	2.47	2.27	4.03	0.231	1.08	2.95	2.27	4.44	0.244	0.86	0.84	1.00	0.91	0.94
	93410	7501	1.10	0.500	7482	1.10	0.500	0.46	0.99	2.27	2.77	0.168	0.46	2.15	2.27	3.75	0.121	1.02	0.46	1.00	0.74	1.38



**HITACHI**

WG3-U97-ERD-S-0001 SH NO.144

REV. 1

of 155

## **APPENDIX B**

### **IN-PLANE SHEAR CHECK FOR FB ACCORDING TO ACI 349-01**



Table of Contents

B.1	SCOPE .....	146
B.2	IN-PLANE SHEAR CHECK .....	146
B.3	CONCLUSIONS.....	146

List of Tables

Table B-1	Maximum Stress Ratios for In-Plane Shear Check .....	148
Table B-2	In-Plane Shear Check for Entire Wall .....	149

List of Figures

Figure B-1	Selected Elements for In-plane Shear Check on Entire Wall.....	151
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## B.1 SCOPE

This appendix describes In-plane Shear Check for FB according to ACI 349-01.

## B.2 IN-PLANE SHEAR CHECK

According to ACI 349-01 Section 21.6.5.2, the maximum shear strength of a horizontal wall segment per unit length is calculated as follows:

$$Vn = (2\sqrt{f'_c} + \rho_n f_y)h \quad (\text{lb/in})$$

Where,  $h$  is wall thickness.

Shear strength calculated above shall not be taken greater than the following equation specified in ACI 349-01, Section 21.6.5.6.

$$Vn_{\max} = 8\sqrt{f'_c}h \quad (\text{lb/in})$$

Although  $10\sqrt{f'_c}h$  is used for the strength of individual wall piers according to Sections 21.6.5.6 and 21.6.5.7 of ACI 349-01, the capacity  $8\sqrt{f'_c}h$  for combined strength of wall piers on a wall line according to Section 21.6.5.6 of ACI 349-01 is conservatively used.

The reduction of thermal stresses due to the decreased stiffness of a cracked concrete section is considered by a method which is the same as out-of-plane flexure as described in Section 6.4.1.1.1.

## B.3 CONCLUSIONS

The results of in-plane shear check for the selected elements are shown in Table B-1. For some exterior walls and Spent Fuel Pool walls, the element shear demands  $N_{xy}$  are larger than the allowable shear strength evaluated above.

RB/FB is a box-type structure and as shown in Figure 5.3.3-1, the exterior walls are represented as part of the combined stiffness of the RB and FB walls. Since the seismic loads based on the results of SSI analyses of the lumped mass stick model are applied over the entire length of walls as in-plane shear force as shown in Figure 6.2.3.9-6 and Table 6.2.3.9-4 of Reference 2.1.2-p, in-plane shear check for the exterior walls are developed for the entire walls (irrespective of difference in wall thickness along its length) as highlighted in Figure B-1.



**HITACHI**

WG3-U97-ERD-S-0001 SH NO.147

REV. 1 of 155

The results of in-plane shear check on the entire walls are shown in Table B-2 and in-plane shear stresses are confirmed to be lower than the allowable stress.





Table B-1 Maximum Stress Ratios for In-Plane Shear Check

Location	Element ID	Load Case	$N_{xy}$ (MN/m)	Thickness $h$ (m)	Primary Reinforcement Ratio	Allowable Shear Strength $\phi V_n = \phi 8 f_c^{0.5} h$ (MN/m)	$N_{xy}/\phi V_n$
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	8514	2.887	2.0	2.013 %	6.630	0.435
	60219	7461	2.172	3.6	2.097 %	11.934	0.182
	70201	8514	3.303	2.0	3.522 %	6.630	0.498
	70204	8514	4.731	2.0	3.522 %	6.630	0.714
	110718	8511	6.148	1.5	1.342 %	4.973	1.236
2 Exterior Wall @ EL 4.65 ~6.60m	62011	7481	3.182	1.0	2.516 %	3.315	0.960
	62019	7482	3.327	1.0	2.516 %	3.315	1.004
	72001	8511	6.381	1.0	3.020 %	3.315	1.925
	72004	8512	5.803	1.0	3.020 %	3.315	1.750
3 Exterior Wall @ EL22.50 ~24.60m	64011	7491	1.758	1.0	2.516 %	3.315	0.530
	64019	8513	1.641	1.0	2.012 %	3.315	0.495
	74001	8511	2.891	1.0	2.516 %	3.315	0.872
	74004	8511	3.522	1.0	2.516 %	3.315	1.062
4 Spent Fuel Pool Wall @ EL-5.10 ~-3.30m	60819	8511	3.045	3.6	2.097 %	11.934	0.255
	70801	7492	3.571	2.0	3.522 %	6.630	0.539
	70804	7441	3.956	2.0	3.522 %	6.630	0.597
	110748	8511	4.345	1.5	1.342 %	4.973	0.874

Note: Exceedance is highlighted.



HITACHI

WG3-U97-ERD-S-0001 SH NO.149

REV. 1

of 155

Table B-2 In-Plane Shear Check for Entire Wall

Critical Load Case	Location	Element	Element Length	Element Thickness	Shear Area of Element	Shear Area of Wall	Element Shear Force in Unit Length	Element Shear Force	Total Shear Force	Average Shear Stress	Allowable Shear Stress	$\tau / \tau_a$
			Li (m)	Ti (m)	Ai (m <sup>2</sup> )	As (m <sup>2</sup> )	Qi (MN/m)	Q (MN)	Qt (MN)	$\tau$ (MN/m <sup>2</sup> )	$\tau_a$ (MN/m <sup>2</sup> )	
7481	Exterior Wall @EL 4.65 ~6.60m	62001	2.50	1.50	3.75		2.994	7.485				
		62002	2.00	1.50	3.00		2.276	4.552				
		62003	2.30	1.50	3.45		2.207	5.076				
		62004	1.60	1.50	2.40		2.212	3.539				
		62005	2.30	1.50	3.45		2.293	5.274				
		62006	2.20	1.50	3.30		2.294	5.047				
		62007	1.60	1.50	2.40		2.328	3.725				
		62008	2.80	1.50	4.20		2.411	6.753				
		62009	2.60	1.50	3.90		2.698	7.012				
		62010	1.50	1.50	2.25		2.923	4.385				
		62011	2.10	1.50	3.15		3.182	6.682				
		62012	1.40	1.50	2.10		3.313	4.638				
		62013	1.40	1.50	2.10		3.230	4.522				
		62014	2.05	1.50	3.08		3.596	7.372				
		62015	2.05	1.50	3.08		3.602	7.384				
		62016	2.10	1.50	3.15		3.129	6.571				
		62017	2.00	1.50	3.00		2.828	5.656				
		62018	2.05	1.50	3.08		2.777	5.693				
		62019	1.80	1.50	2.70		2.936	5.285				
		62020	1.85	1.50	2.78		2.992	5.535				
		62021	2.30	1.50	3.45		3.113	7.160				
		62022	2.00	1.50	3.00		3.255	6.510				
		62023	2.50	1.50	3.75	70.50	3.420	8.550	134.406	1.906	3.315	0.575
7201	Exterior Wall @EL 4.65 ~6.60m	32001	2.50	1.50	3.75		3.964	9.910				
		32002	2.16	1.50	3.24		2.184	4.724				
		32003	2.14	1.50	3.21		2.700	5.770				
		32004	1.85	1.50	2.78		3.386	6.264				
		32005	1.80	1.50	2.70		3.485	6.273				
		32006	2.20	1.50	3.30		3.471	7.636				
		32007	1.85	1.50	2.78		3.687	6.821				
		32008	3.60	1.50	5.40		3.433	12.359				
		32009	2.60	1.50	3.90		3.276	8.518				
		32010	2.80	1.50	4.20		3.084	8.635				
		32011	2.80	1.50	4.20		2.959	8.285				
		32012	2.60	1.50	3.90		2.812	7.311				
		32013	3.60	1.50	5.40		2.616	9.418				
		32014	1.85	1.50	2.78		2.365	4.375				
		32015	2.20	1.50	3.30		2.773	6.101				
		32016	1.80	1.50	2.70		2.833	5.099				
		32017	1.85	1.50	2.78		2.997	5.544				
		32018	2.14	1.50	3.21		3.583	7.657				
		32019	2.16	1.50	3.24		4.107	8.883				
		32020	2.50	1.50	3.75		3.032	7.580				
		72001	2.10	1.00	2.10		6.039	12.682				
		72002	2.10	1.00	2.10		6.102	12.814				
		72003	2.10	1.00	2.10		5.844	12.272				
		72004	1.80	1.00	1.80		5.534	9.961				
		72005	2.40	1.00	2.40		5.493	13.183				
		72006	2.40	1.00	2.40		5.374	12.898				
		72007	1.80	1.00	1.80		5.339	9.610				
		72008	2.10	1.00	2.10		5.290	11.109				
		72009	2.10	1.00	2.10		5.119	10.750				
		72010	2.10	1.00	2.10	91.50	5.166	10.849	263.292	2.878	3.315	0.868

**HITACHI**

WG3-U97-ERD-S-0001 SH NO.150

REV. 1

of 155

**Table B-2 In-Plane Shear Check for Entire Wall (Continued)**

Critical Load Case	Location	Element	Element Length	Element Thickness	Shear Area of Element	Shear Area of Wall	Element Shear Force in Unit Length	Element Shear Force	Total Shear Force	Average Shear Stress	Allowable Shear Stress	$\tau / \tau_a$
			Li (m)	Ti (m)	Ai (m <sup>2</sup> )	As (m <sup>2</sup> )	Qi (MN/m)	Q (MN)	Qt (MN)	$\tau$ (MN/m <sup>2</sup> )	$\tau_a$ (MN/m <sup>2</sup> )	
8514	Exterior Wall @EL 20.50 ~22.50m	34001	2.50	1.50	3.75		3.108	7.770				
		34002	2.16	1.50	3.24		3.544	7.666				
		34003	2.14	1.50	3.21		3.802	8.125				
		34004	1.85	1.50	2.78		3.939	7.287				
		34005	1.80	1.50	2.70		4.040	7.272				
		34006	2.20	1.50	3.30		4.089	8.996				
		34007	1.85	1.50	2.78		4.084	7.555				
		34008	3.60	1.50	5.40		4.063	14.627				
		34009	2.60	1.50	3.90		3.809	9.903				
		34010	2.80	1.50	4.20		3.535	9.898				
		34011	2.80	1.50	4.20		3.271	9.159				
		34012	2.60	1.50	3.90		3.034	7.888				
		34013	3.60	1.50	5.40		2.764	9.950				
		34014	1.85	1.50	2.78		2.667	4.934				
		34015	2.20	1.50	3.30		2.546	5.601				
		34016	1.80	1.50	2.70		2.430	4.374				
		34017	1.85	1.50	2.78		2.342	4.333				
		34018	2.14	1.50	3.21		2.299	4.913				
		34019	2.16	1.50	3.24		2.281	4.934				
		34020	2.50	1.50	3.75		2.337	5.843				
		74001	2.10	1.00	2.10		1.626	3.415				
		74002	2.10	1.00	2.10		2.029	4.261				
		74003	2.10	1.00	2.10		2.315	4.862				
		74004	1.80	1.00	1.80		2.550	4.590				
		74005	2.40	1.00	2.40		2.752	6.605				
		74006	2.40	1.00	2.40		3.147	7.553				
		74007	1.80	1.00	1.80		3.145	5.661				
		74008	2.10	1.00	2.10		3.335	7.004				
		74009	2.10	1.00	2.10		4.069	8.545				
		74010	2.10	1.00	2.10	91.50	5.867	12.321	215.843	2.359	3.315	0.712
8514	Spent Fuel Pool Wall @ EL-10.50 ~8.70m	110715	2.40	1.50	3.60		0.166	0.398				
		110716	2.40	1.50	3.60		1.461	3.506				
		110717	1.80	1.50	2.70		3.388	6.098				
		110718	2.10	1.50	3.15		2.688	5.645				
		110719	2.10	1.50	3.15		2.033	4.269				
		110720	2.10	1.50	3.15	19.35	1.588	3.335	23.252	1.202	3.315	0.362

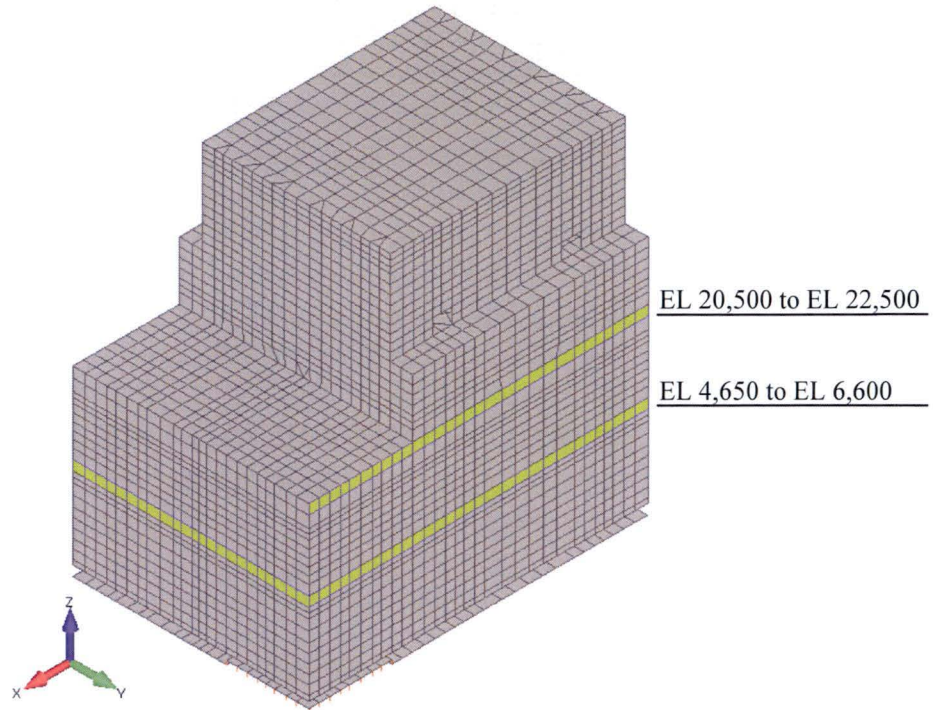


HITACHI

WG3-U97-ERD-S-0001 SH NO.151

REV. 1

of 155



(a) Exterior Wall



(b) Spent Fuel Pool Wall

Figure B-1 Selected Elements for In-plane Shear Check on Entire Wall



**HITACHI**

WG3-U97-ERD-S-0001 SH NO.152

REV. 1

of 155

## **APPENDIX C**

### **COMPRESSION LIMIT CHECK FOR FB ACCORDING TO ACI 349-01**





**Table of Contents**

C.1	SCOPE .....	154
C.2	MEMBRANE COMPRESSIVE FORCE CHECK .....	154
C.3	CONCLUSION.....	154

**List of Tables**

Table C-1	Membrane Compressive Stress Check According to ACI 349-01 .....	155
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**List of Figures**

None

**C.1 SCOPE**

This appendix describes Membrane Compressive Force Check for FB according to ACI 349-01.

**C.2 MEMBRANE COMPRESSIVE FORCE CHECK**

According to ACI 349-01 Section 10.3.5.2, design axial load strength of compression members shall not be taken greater than the following:

$$\phi P_n(\max) = 0.80\phi \left[ 0.85f'_c (A_g - A_{st}) + f_y A_{st} \right]$$

Where,  $A_g$  and  $A_{st}$  are gross area and total cross-sectional area of reinforcement of section.

**C.3 CONCLUSION**

The results of compression force check are shown in Table C-1. It is confirmed that the calculated compression force are less than the allowable compression force evaluated based on the above strength.



Table C-1 Membrane Compressive Stress Check According to ACI 349-01

Location	Element ID	Load ID	Section Forces (MN/m)			Thickness h (m)	Calculated Concrete Stress (MPa)				Allowable Stress $\sigma_a$ (MPa)	$\sigma_c/\sigma_a$
			$N_x$	$N_y$	$N_{xy}$		$\sigma_x$	$\sigma_y$	$\tau_{xy}$	$\sigma_c$		
1 Exterior Wall and Pool Wall @ EL-11.50 ~10.50m	60011	8511	-7.014	-2.936	-2.745	2.0	-3.507	-1.468	-1.372	-4.197	-20.8	0.202
	60219	7481	-6.893	-4.879	-1.991	3.6	-1.915	-1.355	-0.553	-2.255	-20.9	0.108
	70201	7201	-1.257	-1.136	2.712	2.0	-0.629	-0.568	1.356	-1.955	-24.0	0.081
	70204	8514	-3.260	-2.863	-4.731	2.0	-1.630	-1.432	-2.366	-3.899	-24.0	0.162
	110718	8511	-7.621	-7.362	-6.148	1.5	-5.081	-4.908	-4.098	-9.094	-19.3	0.471
2 Exterior Wall @ EL4.65 ~6.60m	62011	7491	-3.314	-1.939	3.178	1.0	-3.314	-1.939	3.178	-5.878	-21.8	0.269
	62019	7411	-2.386	-2.691	3.254	1.0	-2.386	-2.691	3.254	-5.796	-21.8	0.265
	72001	7471	2.043	-4.952	6.044	1.0	2.043	-4.952	6.044	-8.438	-22.9	0.368
	72004	7571	-2.933	-2.886	5.044	1.0	-2.933	-2.886	5.044	-7.954	-22.9	0.347
3 Exterior Wall @ EL22.50 ~24.60m	64011	7491	-3.706	-0.703	1.758	1.0	-3.706	-0.703	1.758	-4.516	-21.8	0.207
	64019	7491	-3.544	-0.976	-1.548	1.0	-3.544	-0.976	-1.548	-4.271	-20.8	0.206
	74001	8511	-0.253	-1.193	-2.891	1.0	-0.253	-1.193	-2.891	-3.652	-21.8	0.167
	74004	8511	-1.788	-0.595	-3.522	1.0	-1.788	-0.595	-3.522	-4.763	-21.8	0.218
4 Spent Fuel Pool Wall @ EL-5.10 ~3.30m	60819	8511	-5.441	-5.636	-3.045	3.6	-1.511	-1.565	-0.846	-2.385	-20.9	0.114
	70801	7481	-3.440	-2.402	-3.412	2.0	-1.720	-1.201	-1.706	-3.186	-24.0	0.133
	70804	8514	-4.648	-1.903	-3.849	2.0	-2.324	-0.951	-1.924	-3.681	-24.0	0.153
	110748	8511	-3.019	-6.596	-4.345	1.5	-2.013	-4.397	-2.897	-6.337	-19.3	0.328
5 Basemat	90306	7481	-7.988	-2.992	3.858	4.0	-1.997	-0.748	0.965	-2.522	-15.6	0.162
	90310	7491	-3.356	-3.772	0.488	4.0	-0.839	-0.943	0.122	-1.024	-15.6	0.066
	90410	8511	-3.199	-10.517	3.097	4.0	-0.800	-2.629	0.774	-2.913	-15.6	0.187
5 Basemat @ Spent Fuel Pool	90486	7471	-5.741	-7.153	1.489	5.5	-1.044	-1.300	0.271	-1.472	-15.3	0.096
	90490	7491	-4.851	-11.890	2.350	5.5	-0.882	-2.162	0.427	-2.291	-15.3	0.149
	90526	7571	-7.134	-5.515	-4.154	5.5	-1.297	-1.003	-0.755	-1.919	-15.3	0.125
6 Slab EL4.65m	93306	8514	-2.833	-0.427	-2.614	1.3	-2.180	-0.329	-2.011	-3.468	-19.8	0.176
	93310	8514	-2.937	-2.507	-3.390	1.3	-2.259	-1.928	-2.608	-4.707	-19.8	0.238
	93410	7492	-0.828	-3.805	-1.983	1.3	-0.637	-2.927	-1.525	-3.689	-19.8	0.187