Thornton Tomasetti
Building Solutions

ONE VANDERBILT
NEW YORK, NY

STRUCTURAL PEER REVIEW REPORT
SUPER STRUCTURE

February 23, 2017

Prepared For

Hines – New York
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New York, NY 10022

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A. STRUCTURAL PEER REVIEW STATEMENT

Structural peer reviewer name: Michael Squarzini

Structural peer reviewer address: 51 Madison Avenue, New York, NY 10010

Project address: One Vanderbilt, New York, NY

Department application number for structural work: NB 121189828

Structural Peer Reviewer Statement

I Michael Squarzini am a qualified and independent NYS licensed and registered engineer in accordance with BC Section 1617.4, and I have reviewed the structural plans, specifications, and supplemental reports for One Vanderbilt Avenue, New York, NY, NB121189828 based on the structural requirements of Title 28 of the Administrative Code and the NYC Construction Codes. The Structural Peer Review Report is attached, which includes New York City Building Code minimum requirements for peer review tasks in Section B.2 of our report. We have resolved our comments with E.O.R and we understand these comments will be incorporated into future drawing issuance, which will be reviewed by Thornton Tomasetti.

New York State Registered Design Professional

(for Structural Peer Review only)

Name (please print) Michael Squarzini

Signature ______________ **Date** 2/23/2017

PE/RA Seal (apply seal, then sign and date over seal)

STATE OF NEW YORK
MICHAEL J. SQUARZINI
Lic. No. 080640
LICENSED PROFESSIONAL ENGINEER

B. EXECUTIVE SUMMARY

1.0 INTRODUCTION

The purpose of this report is to provide a structural review of the document set issued on 15th September, 2016 for the proposed tower at One Vanderbilt Avenue in New York, NY. The current report is supplementary of the Foundation Peer Review Report issued by TT on February 12, 2016, the current report emphasizes on the superstructure. The documents used for the basis of review can be found in section C of this report, and include a geotechnical report, and a wind tunnel report, along with the typical architectural and structural design drawings. TT will review any substantial changes to the drawings made after 9/15/16 and will modify this report.

The proposed One Vanderbilt tower is a 63-story office building with a height of 1,400 feet (Top of Spire) and a footprint of about 200 feet square. The gravity-resisting system is comprised of concrete slabs over metal deck, steel beams, and sloping steel columns to accommodate the tower's sloping faces. The lateral force-resisting system involves a typical concrete core that diminishes in size on the upper floors, as well as steel truss outriggers at the mechanical floors that are one story high and help redistribute loads to minimize horizontal movement under wind and seismic loads. The four story deep foundation system is comprised of a 9.5- foot thick mat foundation below the concrete core, spread footings at the bases of perimeter columns, and concrete foundation walls around the perimeter of the building footprint.

2.0 DESIGN REVIEW FINDINGS AND COMMENTS

Based on New York City Building Code 2014 Chapter 16 (NYCBC); we have reviewed the design documents provided to us for the following items:

1. *Confirm that the design loads conform to this code.*

Thornton Tomasetti has reviewed the design loads for conformance with the NYC Building code loading requirements. The design dead, superimposed dead and live loads appear to be in conformance with the NYC Building Code.

We have reviewed wind and seismic base shear based on 2014 NYC Building and based on the building geometry from a Structural Revit model issued on September 15, 2016. Any discrepancies have been discussed and resolved with the EOR. A building of this height and massing requires a wind tunnel test to validate the wind loads on the building structure. A new wind tunnel has been performed (RWDI Wind Test Report Dated August 5, 2016), and wind loads have been estimated from this wind tunnel using the building stiffness properties. We have confirmed that wind base shear and overturning moment employed by EOR are not less than ASCE-7 requirements.

2. ***Confirm that other structural design criteria and design assumptions conform to this code and are in accordance with general accepted engineering practice.***

The structural design criteria and design assumptions appear to be in accordance with general engineering practice. We have resolved any discrepancies we have found with EOR.

3. ***Review geotechnical and other engineering investigations that are related to the foundation and structural design and confirm that the design properly incorporates the results and recommendations of the investigations.***

We have issued our foundation peer report on February 16, 2016. We have checked tower base reactions based on new wind tunnel loads and compared them with the original designed reactions. The foundation documents appear consistent with these recommendations.

4. ***Confirm that the structure has a complete load path.***

The superstructure documents appear to have a complete load path for the design loads indicated. We understand framing modification may occur to framing above the roof level; as such, TT will review major design changes and will modify this report if required.

5. ***Perform Independent calculations for a representative fraction of systems, members and details to check their adequacy. The number of representative systems, members, and details verified shall be sufficient to form a basis for the review's conclusions.***

We have performed independent calculations for sample of floor beams, columns, truss elements, shear walls and link. Any discrepancies have been discussed with the EOR and resolved accordingly.

6. ***Verify that performance-specified structural components (such as certain precast concrete elements) have been appropriately specified and coordinated with the primary building structure.***

No performance-specified structural components are included as part of the provided design drawings.

7. ***Confirm that the structural integrity provisions of the code are being followed.***

We have reviewed NYCBC integrity requirements for sample of key elements and found them in compliance with the code provisions.

8. **Review the structural and architectural plans for the building. Confirm that the structural plans are in general conformance with the architectural plans regarding *loads and other conditions that may affect the structural design.***

We have reviewed typical structural plans with the architectural drawings set issued on 9/15/16 and they are in general conformance for structural design purpose.

9. ***Confirm that major mechanical items are accommodated in the structural plans.***

The structural drawing loading schedule include MEP live load allowance comparable to industry standard. The equipment weights have not shown specifically on the design drawings.

10. ***Attest to the general completeness of the structural plans and specifications.***

The design documents peer reviewed for this report appear generally complete.

C. DOCUMENTS RECEIVED AND STRUCTURAL DRAWING LIST

TT used as a basis of this review the Architectural drawings, Structural drawings, and reports listed below. In addition, a Revit model was provided by Severud Associates in order for TT to build its own independent analysis model.

Table 1: List of Documents Received

	Document Name	By	Date
1	Geotechnical Evaluation	Langan	10/16/2016
2	Wind Tunnel Testing	RWDI	08/05/2016
3	Structural Drawings	Severud	09/15/2016
4	Architectural Drawings	KPF	09/15/2016
5	Structural Analysis Model	Severud	n/a

Table 2: Drawing List Part 1

DWG #	DRAWING TITLE	DOCUMENT ISSUANCE NO. 1	DOCUMENT ISSUANCE NO. 2	DOCUMENT ISSUANCE NO. 4	DOCUMENT ISSUANCE NO. 5	DOCUMENT ISSUANCE NO. 8	DOCUMENT ISSUANCE NO. 10
S-000	STRUCTURAL COVER SHEET AND DRAWING LIST	■	■	■	■	■	■
S-010	COLUMN COORDINATE PLAN 1	■		■	■	■	■
S-011	COLUMN COORDINATE PLAN 2					■	■
S-012	COLUMN COORDINATE PLAN 3					■	■
S-013	COLUMN COORDINATE PLAN 4					■	■
S-014	COLUMN COORDINATE PLAN 5					■	■
S-099	B2 FLOOR FRAMING PLAN	*	*	■		■	■
S-100	B1 FLOOR FRAMING PLAN	*	*	■	*	■	■
S-101	GROUND FLOOR FRAMING PLAN	*		■	*	■	■
S-102	2ND FLOOR FRAMING PLAN			■		■	■
S-103	3RD FLOOR FRAMING PLAN			■		■	■
S-104	4TH FLOOR FRAMING PLAN			■		■	■
S-105	5TH FLOOR FRAMING PLAN			■		■	■
S-106	6TH FLOOR FRAMING PLAN			■		■	■
S-107	7TH FLOOR FRAMING PLAN			■		■	■
S-108	8TH FLOOR FRAMING PLAN			■		■	■
S-109	9TH FLOOR FRAMING PLAN			■		■	■
S-110	10TH FLOOR FRAMING PLAN			■		■	■
S-111	11TH FLOOR FRAMING PLAN			■		■	■
S-112	12TH FLOOR FRAMING PLAN			■		■	■
S-113	13TH FLOOR FRAMING PLAN			■		■	■
S-114	14TH FLOOR FRAMING PLAN			■		■	■
S-115	15TH FLOOR FRAMING PLAN			■		■	■
S-116	16TH FLOOR FRAMING PLAN			■		■	■
S-117	17TH FLOOR FRAMING PLAN			■		■	■
S-118	18TH FLOOR FRAMING PLAN			■		■	■
S-119	19TH FLOOR FRAMING PLAN			■		■	■
S-120	20TH FLOOR FRAMING PLAN			■		■	■
S-121	21ST FLOOR FRAMING PLAN			■		■	■
S-122	22ND FLOOR FRAMING PLAN			■		■	■
S-123	23RD FLOOR FRAMING PLAN			■		■	■
S-124	24TH FLOOR FRAMING PLAN			■		■	■
S-125	25TH FLOOR FRAMING PLAN			■		■	■
S-126	26TH FLOOR FRAMING PLAN			■		■	■
S-127	27TH FLOOR FRAMING PLAN			■		■	■
S-128	28TH FLOOR FRAMING PLAN			■		■	■
S-129	29TH FLOOR FRAMING PLAN			■		■	■
S-130	30TH FLOOR FRAMING PLAN			■		■	■
S-131	31ST FLOOR FRAMING PLAN			■		■	■
S-132	32ND FLOOR FRAMING PLAN			■		■	■
S-133	33RD FLOOR FRAMING PLAN			■		■	■
S-134	34TH FLOOR FRAMING PLAN			■		■	■
S-135	35TH FLOOR FRAMING PLAN			■		■	■
S-136	36TH FLOOR FRAMING PLAN			■		■	■
S-137	37TH FLOOR FRAMING PLAN			■		■	■
S-138	38TH FLOOR FRAMING PLAN			■		■	■
S-139	39TH FLOOR FRAMING PLAN			■		■	■
S-140	40TH FLOOR FRAMING PLAN			■		■	■
S-141	41ST FLOOR FRAMING PLAN			■		■	■
S-142	42ND FLOOR FRAMING PLAN			■		■	■
S-143	43RD FLOOR FRAMING PLAN			■		■	■
S-144	44TH FLOOR FRAMING PLAN			■		■	■
S-145	45TH FLOOR FRAMING PLAN			■		■	■
S-146	46TH FLOOR FRAMING PLAN			■		■	■
S-147	47TH FLOOR FRAMING PLAN			■		■	■
S-148	48TH FLOOR FRAMING PLAN			■		■	■
S-149	49TH FLOOR FRAMING PLAN			■		■	■
S-150	50TH FLOOR FRAMING PLAN			■		■	■
S-151	51ST FLOOR FRAMING PLAN			■		■	■
S-152	52ND FLOOR FRAMING PLAN			■		■	■
S-153	53RD FLOOR FRAMING PLAN			■		■	■

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Table 3: Drawing List Part 2

DWG #	DRAWING TITLE	DOCUMENT ISSUANCE NO. 1	DOCUMENT ISSUANCE NO. 2	DOCUMENT ISSUANCE NO. 4	DOCUMENT ISSUANCE NO. 5	DOCUMENT ISSUANCE NO. 8	DOCUMENT ISSUANCE NO. 10
S-154	54TH FLOOR FRAMING PLAN			■		■	■
S-155	55TH FLOOR FRAMING PLAN			■		■	■
S-156	56TH FLOOR FRAMING PLAN			■		■	■
S-157	57TH FLOOR FRAMING PLAN			■		■	■
S-158	58TH FLOOR FRAMING PLAN			■		■	■
S-159	59TH FLOOR FRAMING PLAN			■		■	■
S-160	COOLING TOWER ACCESS			■		■	■
S-161	MECHANICAL ACCESS - BMU 1			■		■	■
S-162	MECHANICAL ACCESS - BMU 2			■		■	■
S-163	MECHANICAL ACCESS - BMU 3			■		■	■
S-171	CEILING FRAMING PLAN 1					■	■
S-172	CEILING FRAMING PLAN 2					■	■
S-173	CEILING FRAMING PLAN 3						■
S-181	CONCRETE CURB PLANS 1						■
S-182	CONCRETE CURB PLANS 2						■
S-183	CONCRETE CURB PLANS 3						■
S-184	CONCRETE CURB PLANS 4						■
S-185	CONCRETE CURB PLANS 5						■
S-186	CONCRETE CURB PLANS 6						■
S-187	CONCRETE CURB PLANS 7						■
S-188	CONCRETE CURB PLANS 8						■
S-189	CONCRETE CURB PLANS 9						■
S-201	LOWER LEVEL SUPERSTRUCTURE SECTIONS AND DETAILS 1					■	■
S-202	LOWER LEVEL SUPERSTRUCTURE DETAILS 2					■	■
S-203	LOWER LEVEL SUPERSTRUCTURE DETAILS 3						■
S-221	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 1			■		■	■
S-222	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 2					■	■
S-223	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 3 - CON ED VAULT FRAMING					■	■
S-224	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 4					■	■
S-225	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 5					■	■
S-226	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 6						■
S-227	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 7						■
S-228	TOWER SUPERSTRUCTURE SECTIONS AND DETAILS 8						■
S-241	CORE SECTIONS AND DETAILS 1			■		■	■
S-242	CORE SECTIONS AND DETAILS 2					■	■
S-243	CORE SECTIONS AND DETAILS 3					■	■
S-244	CORE SECTIONS AND DETAILS 4						■
S-261	CONCRETE STAIR DETAILS 1					■	■
S-301	SHEAR WALL ELEVATIONS 1			■		■	■
S-302	SHEAR WALL ELEVATIONS 2			■		■	■
S-303	SHEAR WALL ELEVATIONS 3			■		■	■
S-304	SHEAR WALL ELEVATIONS 4			■		■	■
S-305	SHEAR WALL ELEVATIONS 5			■		■	■
S-306	SHEAR WALL ELEVATIONS 6			■		■	■
S-307	SHEAR WALL ELEVATIONS 7			■		■	■
S-308	SHEAR WALL ELEVATIONS 8			■		■	■
S-309	SHEAR WALL ELEVATIONS 9			■		■	■
S-310	SHEAR WALL ELEVATIONS 10			■		■	■
S-311	SHEAR WALL ELEVATIONS 11			■		■	■
S-312	SHEAR WALL ELEVATIONS 12			■		■	■
S-313	SHEAR WALL ELEVATIONS 13			■		■	■
S-314	SHEAR WALL ELEVATIONS 14			■		■	■
S-315	SHEAR WALL ELEVATIONS 15			■		■	■
S-316	SHEAR WALL ELEVATIONS 16			■		■	■
S-317	SHEAR WALL ELEVATIONS 17			■		■	■
S-318	SHEAR WALL ELEVATIONS 18			■		■	■
S-401	STAIR ELEVATIONS 1			■		■	■
S-402	STAIR ELEVATIONS 2			■		■	■
S-403	STAIR ELEVATIONS 3					■	■
S-404	STAIR ELEVATIONS 4					■	■
S-405	STAIR ELEVATIONS 5					■	■

Table 4: Drawing List Part 3

DWG #	DRAWING TITLE	DOCUMENT ISSUANCE NO. 1	DOCUMENT ISSUANCE NO. 2	DOCUMENT ISSUANCE NO. 4	DOCUMENT ISSUANCE NO. 5	DOCUMENT ISSUANCE NO. 8	DOCUMENT ISSUANCE NO. 10
S-406	STAIR ELEVATIONS 6					■	■
S-407	STAIR ELEVATIONS 7					■	■
S-408	STAIR ELEVATIONS 8					■	■
S-409	STAIR ELEVATIONS 9					■	■
S-410	STAIR ELEVATIONS 10					■	■
S-421	STAIR WALL ELEVATIONS 1					■	■
S-422	STAIR WALL ELEVATIONS 2					■	■
S-423	STAIR WALL ELEVATIONS 3					■	■
S-424	STAIR WALL ELEVATIONS 4					■	■
S-451	STEEL FRAME ELEVATIONS 1					■	■
S-452	STEEL FRAME ELEVATIONS 2					■	■
S-453	STEEL FRAME ELEVATIONS 3					■	■
S-454	STEEL FRAME ELEVATIONS 4					■	■
S-455	STEEL FRAME ELEVATIONS 5					■	■
S-456	STEEL FRAME ELEVATIONS 6					■	■
S-457	STEEL FRAME ELEVATIONS 7					■	■
S-458	STEEL FRAME ELEVATIONS 8					■	■
S-459	STEEL FRAME ELEVATIONS 9					■	■
S-460	STEEL FRAME ELEVATIONS 10					■	■
S-461	STEEL FRAME ELEVATIONS 11					■	■
S-462	STEEL FRAME ELEVATIONS 12					■	■
S-463	STEEL FRAME ELEVATIONS 13					■	■
S-464	STEEL FRAME ELEVATIONS 14					■	■
S-465	STEEL FRAME ELEVATIONS 15					■	■
S-466	STEEL FRAME ELEVATIONS 16					■	■
S-467	STEEL FRAME ELEVATIONS 17					■	■
S-468	STEEL FRAME ELEVATIONS 18					■	■
S-469	STEEL FRAME ELEVATIONS 19					■	■
S-470	STEEL FRAME ELEVATIONS 20					■	■
S-471	STEEL FRAME ELEVATIONS 21					■	■
S-472	STEEL FRAME ELEVATIONS 22					■	■
S-473	STEEL FRAME ELEVATIONS 23					■	■
S-474	STEEL FRAME ELEVATIONS 24					■	■
S-475	STEEL FRAME ELEVATIONS 25					■	■
S-501	TRUSS ELEVATIONS 1			■		■	■
S-502	TRUSS ELEVATIONS 2			■		■	■
S-503	TRUSS ELEVATIONS 3			■		■	■
S-504	TRUSS ELEVATIONS 4			■		■	■
S-505	TRUSS ELEVATIONS 5			■		■	■
S-506	TRUSS ELEVATIONS 6			■		■	■
S-507	TRUSS ELEVATIONS 7			■		■	■
S-508	TRUSS ELEVATIONS 8			■		■	■
S-509	TRUSS ELEVATIONS 9			■		■	■
S-510	TRUSS ELEVATIONS 10					■	■
S-521	PLATE GIRDER ELEVATIONS 1					■	■
S-522	PLATE GIRDER ELEVATIONS 2					■	■
S-601	COLUMN SCHEDULE 1	■		■		■	■
S-602	COLUMN SCHEDULE 2					■	■
S-603	COLUMN SCHEDULE 3					■	■
S-651	COLUMN DETAILS 1	■		■		■	■
S-701	GENERAL NOTES	■		■	■	■	■
S-702	LOADING SCHEDULE	■		■		■	■
S-703	TYPICAL FLOOR CONSTRUCTION DETAILS	■		■		■	■
S-711	TYPICAL STEEL SECTIONS AND DETAILS 1					■	■
S-712	TYPICAL STEEL SECTIONS AND DETAILS 2					■	■
S-713	TYPICAL STEEL SECTIONS AND DETAILS 3					■	■

D. PROJECT DESCRIPTION AND SCOPE OF WORK

Thornton Tomasetti (TT) was retained by Hines to conduct a structural peer review for the One Vanderbilt Avenue project located in New York, NY. Hines is the developer of the project, SL Green Realty Corporation is the owner, KPF architect of the record and Severud is structural engineer of record (EOR) of the project.

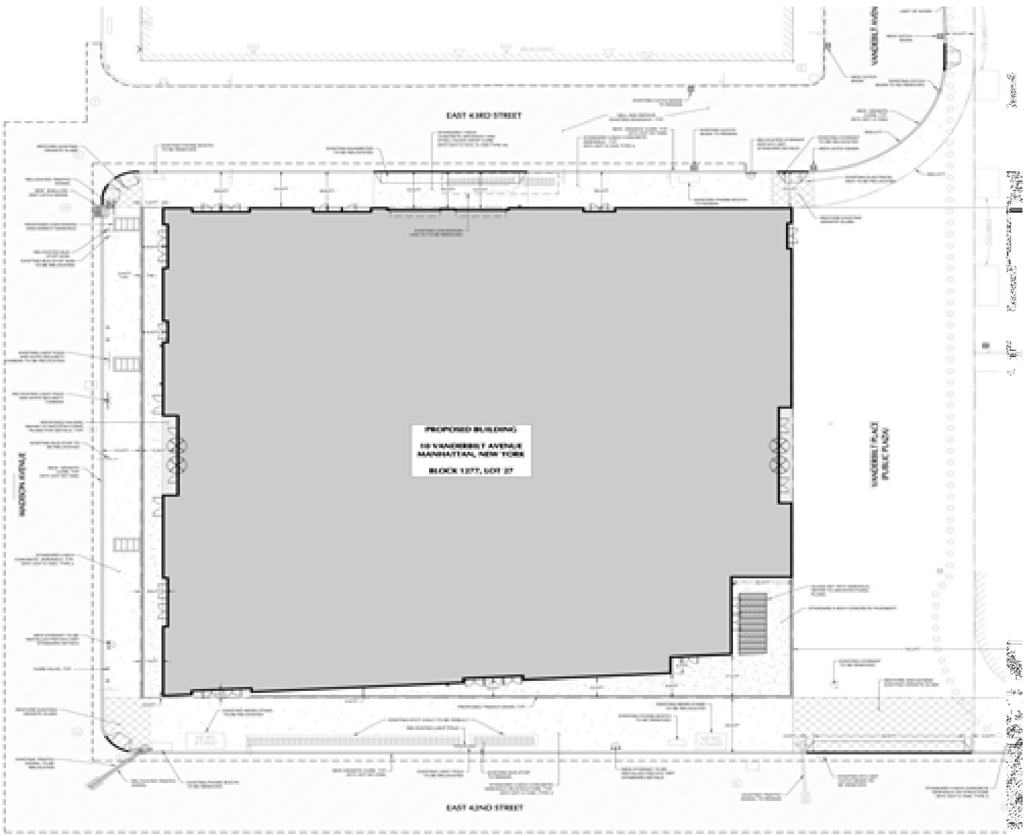

Figure 1. Site Map

This peer review is based on drawings set issued in September of 2016. The building is a 63-story high-rise office tower with a height of approximately 1,400 feet above grade, with 4 below-grade levels. Levels 1, 2, and 3 contain lobby and amenity spaces. Mechanical areas are located on Levels 4, 5, 12, 32, 45, 55, 56 and 60. The remainder of the floors are primarily office space.

The lot size is approximately 216 feet wide x 201 feet deep, with a tower that tapers to approximately 120 feet wide by 120 feet deep at the top occupiable floor.

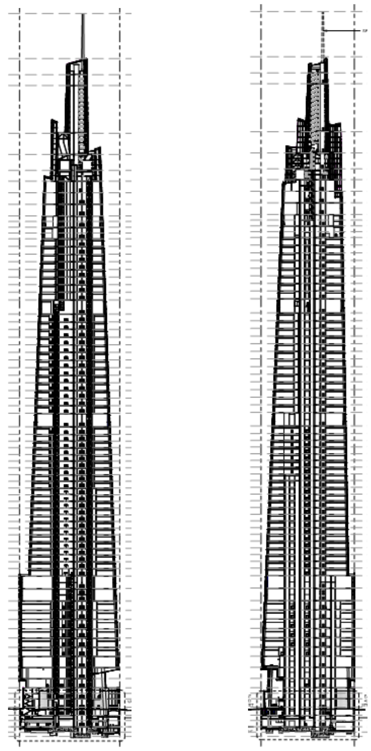

Figure 2. Building Sections

TT's role is to perform a peer review of the floor framing and lateral system, which includes the overall building behavior. TT's review is based on the Architectural and Structural drawings dated September 15, 2016 prepared by Kohn Pederson Fox Associates (KPF) and Severud Associates Consulting Engineers respectively. TT also studied the structural design for compliance to the recommendations in the Geotechnical report by Langan dated October 16, 2016 and the Wind-Induced Structural Responses report by RWDI dated August 05, 2016.

TT's scope of work as required by NYC DoB Building Code 2014 (Section 1617.5.1) is as follows:

1. Confirm that the design loads conform to this code
2. Confirm that other structural design criteria and design assumptions conform to this code and are in accordance with general accepted engineering practice.
3. Review geotechnical and other engineering investigations that are related to the foundation and structural design and confirm that the design properly incorporates the results and recommendations of the investigations.
4. Review the structural frame and the load supporting parts of floors, roofs, walls and foundations. Cladding, cladding framing, stairs, equipment supports, ceiling supports, non-loadbearing partitions, railings and guards, and other secondary structural items shall be

excluded.

5. Confirm that the structure has a complete load path
6. Perform Independent calculations for a representative fraction of systems, members, and details to check their adequacy. The number of representative systems, members, and details verified shall be sufficient to form a basis for the review's conclusions.
7. Verify that performance-specified structural components (such as certain precast concrete elements) have been appropriately specified and coordinated with the primary building structure.
8. Verify that the design engineer of record complied with the structural integrity provisions of the code.
9. Review the structural and architectural plans for the building. Confirm that the structural plans are in general conformance with the architectural plans regarding loads and other conditions that may affect the structural design.
10. Confirm that major mechanical items are accommodated in the structural plans.
11. Attest to the general completeness of the structural plans and specifications.

E. DRAWING REVIEW, FINDINGS AND SEVERUD RESPONSES

TT reviewed structural drawings, dated 16th October, 2016, to verify that structural plans are in general conformance with the architectural plans, that major mechanical items are accommodated in the structural plans. A general review of the structural frame and the load supporting parts of the floors, roofs, walls and foundation was performed.

Observations and recommendations as a results of TT review and analysis of the Severud structural drawings were sent to EOR and resolved accordingly.

F. STRUCTURAL SYSTEM DESCRIPTION

The lateral load resisting system is composed of a reinforced concrete shear wall core with steel truss outriggers. The outriggers are one story deep at the 32nd, 45th and 55th floors, and span between the concrete core roughly at the center of the floor plans and the perimeter steel columns. The upper and lower chords are comprised of built-up box beam members, while the diagonals are standard hot-rolled wide-flange shapes.

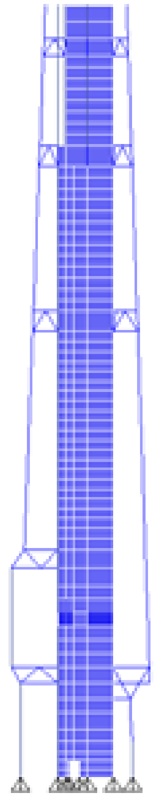

Figure 3. ETABS Image of Lateral System

In addition to the trusses described above acting as outriggers, there is a series of transfer trusses on floors 5, 6, 12, and 13 that allow gravity loads to transfer where the building increases or decreases in width. These trusses are primarily gravity system elements, but they do contribute to the lateral system behavior as well.

The typical office floor construction is a 3” metal deck with an additional 2 1/2" of concrete, while mechanical floors and floors directly above the mechanical floors include a 4 ½” thick normal weight concrete topping over 3” metal deck. Steel framing supports the deck and spans between the concrete core and perimeter steel wide-flange columns.

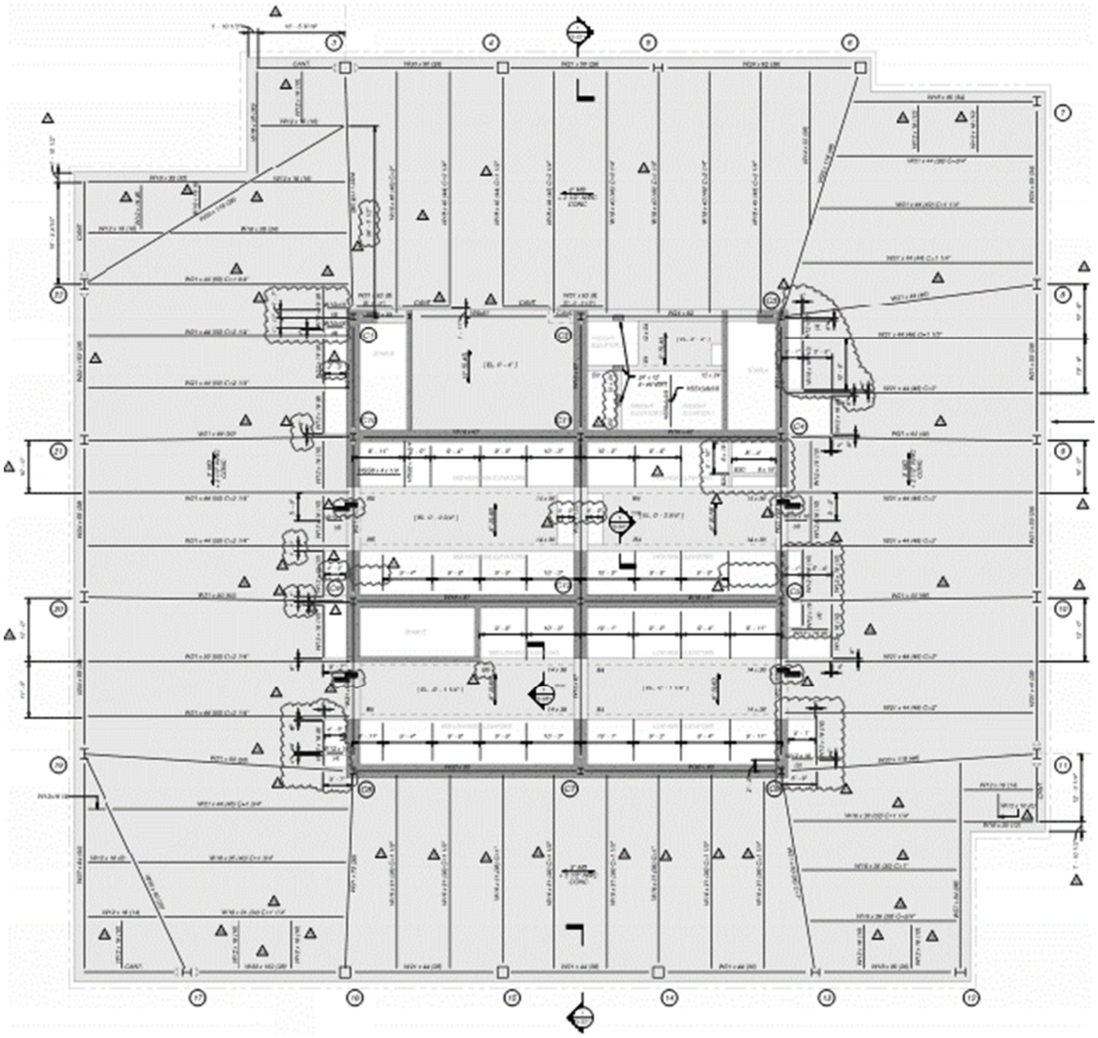

Figure 4. Typical Framing Plan

The foundation system consists of spread footings bearing on rock with an allowable bearing capacity of 60tsf. A 9'-6" thick mat is set beneath the core, and individual spread footings support most of the perimeter columns. Foundation walls typically consist of 24" double-reinforced concrete walls.

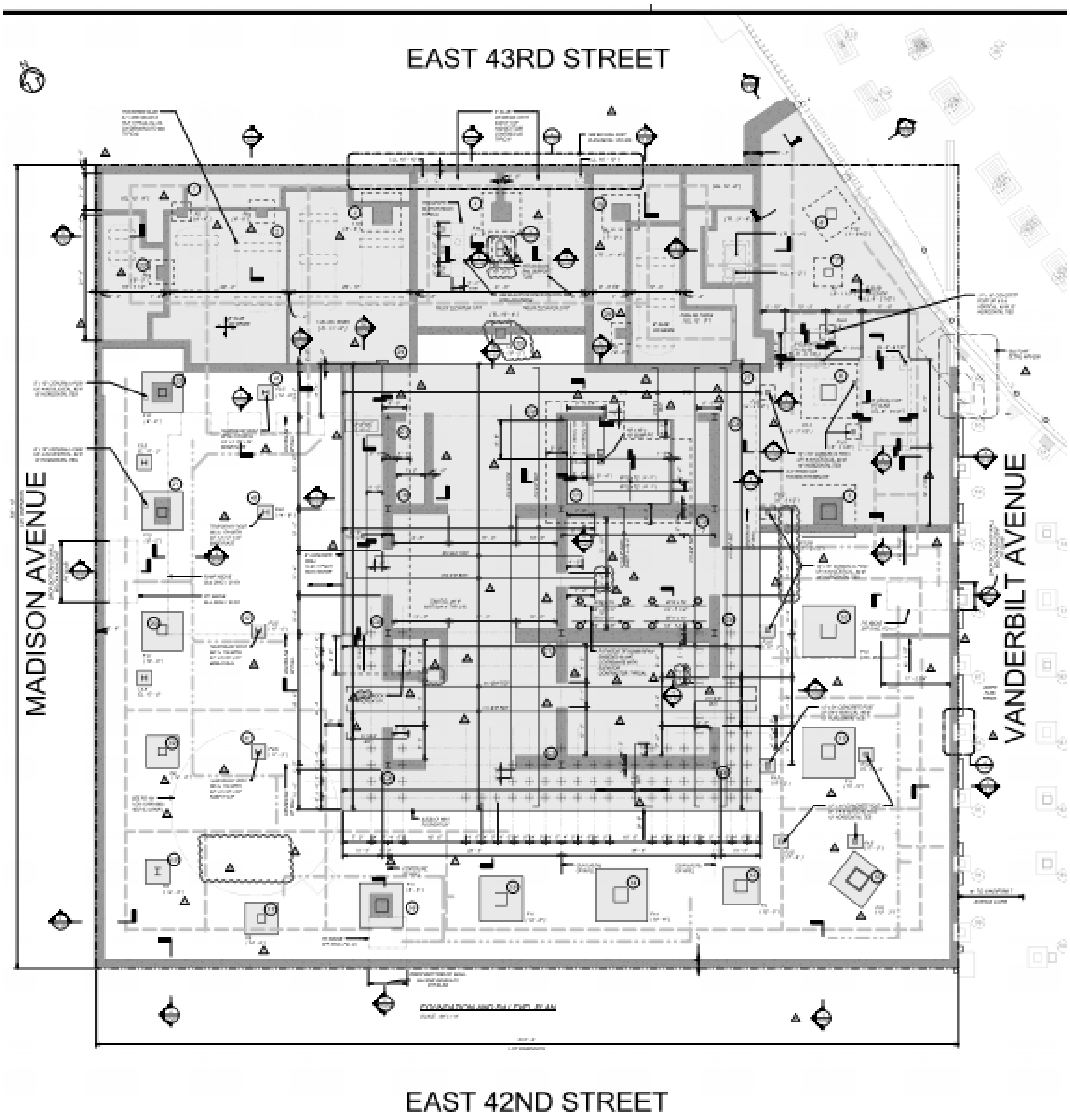

Figure 5. Typical Foundation Section

G. BUILDING CODE AND LOAD REVIEW

1.0 BUILDING CODES

Based on the General Notes on S-701, and Loading Schedule on S-702, the structural design was conducted according to the following building codes:

- 2014 Edition of the New York City Building Code
- ASCE-7 (2010), Minimum Design Loads for Buildings and other Structures
- ASCE-7 (2005), Minimum Design Loads for Buildings and other Structures
- AISC 360 (2005), Specification for Structural Steel Buildings.
- ACI-318 (2011), Building code requirements for Reinforced Concrete
- AWS D1.1 (2004), Structural Welding Code
- ASTM Standards
- AISC Design Guide 11

The building codes listed on the Peer Review Set drawings are consistent and appropriate for this project.

2.0 MATERIAL PROPERTIES

The material properties noted in the General Notes on S-701 for the major structural elements are noted below.

Structural Steel:	ASTM A992 or ASTM A572, Grade 50
HSS Steel:	ASTM A500, Grade B
Footings and Foundation Mat:	10,000 psi
Piers and Buttresses:	10,000 psi
Foundation Walls	10,000 psi
Slabs On Grade	6,000 psi
Shear Walls – Foundation to 13th Floor	14,000 psi
Shear Walls – 13th Floor - 26th Floor	12,000 psi
Shear Walls – 26th Floor - 39th Floor	10,000 psi
Shear Walls – 39th Floor - 51st Floor	8,000 psi
Shear Walls – Above 51st Floor	6,000 psi
Raised Slabs	4,000 psi
Concrete on Metal Deck	4,000 psi
Bar Reinforcing	ASTM A 615, Grade 60

3.0 STRUCTURAL LOADING

3.1 GRAVITY LOADS

The gravity loading consists of the member self-weight, the superimposed dead load (floor finish, partitions, ceiling & hung mechanical), and live load. The Gravity Design Loads are shown in the Loading Schedule on S-702 of the structural drawings. The following tables summarize the types of dead loads and live loads used, as well as TT comments.

Table 5: Dead Loads per S-702

SLAB CONSTRUCTION	LOAD (PSF)	COMMENTS
6" NWC SLAB	75	
CONCRETE RISERS*	130	
TYPE 1	55	2 1/2" NWC on 3" DECK (TYP.)
TYPE 2	80	4 1/2" NWC on 3" DECK (TYP.)
TYPE 3	115	4 1/2" NWC on 3" DECK +3" FILL (TYP.)
TYPE 4	80	4 1/2" NWC on 3" DECK (TYP.)
18" NWC SLAB	225	
24" NWC SLAB	300	

Table 6: Live Loads per S-702

AREA	LIVE LOAD (PSF)	TT COMMENTS
Core	100	Treat as Lobby Space
Core – Stairs	100	Per Code
Typical – Mechanical	150	75 Req'd for Equipment Rooms
Elevator Machine Room	75+*	
Core- Freight Elevator Vestibule	100	Treat as a Lobby Space
Core – MEP	100	75 Req'd for Equipment Rooms
Core - Passenger Elevator Lobby	100	Treat as a Lobby Space
Core - Toilet Rooms	100	Same as Floor Load
Terrace	100	Roof for Promenade Purposes
Typical - Office	50	Office Load Explicitly Addressed in Code
Core - Elevator Machine Room	75+*	Treat as an equipment rooms
Core - Back of House	100	Conservative estimation, Engineering Judgement
Temporary Construction Loading - Staging Area	250	Equivalent to "Heavy Storage Warehouses" - Reasonable

Temporary Construction Loading - Truck Areas	600	Typical Construction Surcharge Load
Typical – Amenity	100	Reasonably assumption
Typical - Dock Master	100	Not addressed in Code, reasonable assumption
Typical - Messenger Center	100	Not addressed in Code, reasonable assumption
Typical - Office Lobby	100	Office Lobby Load Explicitly Addressed in Code
Typical – Retail	100	Retail Load Explicitly Addressed in Code
Typical - Subway Entrance	100	Treat as a Lobby Space
Typical - Transit Hall	100	
Core – Circulation	100	Treat as a Lobby Space
Typical - Toilet Rooms	50	Assumed same as floor load
Roof - Glass	40	20 psf required for Roofs, 40 psf for catwalk
Roof - Slab	100	20 psf required for Roofs
BMU-1	50	Plus BMU unit loads
BMU-2	50	Plus BMU unit loads
BMU-3	50	Plus BMU unit loads
Top Of Building	40	
Typical - Trading Floor	100	
B1 (Cellar) East	100	
B1 (Cellar) Northwest	100	
B1 (Cellar) West	100	
Shuttle Platform	100	

*+ Sheave Beam Reactions

TT found the Gravity loads to be acceptable and in conformance with the NYC Building Code 2014 and general practice.

3.2 WIND LOADS

The wind loads for the structural design are based on the following parameters per ASCE 7-05 and the New York City Building Code:

Design Wind Speed, V	98mph
Occupancy Category	III
Wind Exposure	B
Importance Factor	1.15

The existing wind tunnel report provides Effective Static Floor-by-Floor Wind loads for Fx, Fy and Mz. In turn, these loads were used in TT's analysis with the load factors given in 24 load combinations. We have also compared RWDI and ASCE-7 base wind loads per following table. Severud has confirmed that the applied wind loads in their analysis model is greater than those of RWDI or 80% of ASCE-7 loads.

Table 7 Wind Load Comparison

	RWDI 08/05/16 with IF	TT/NYCBC 2014 ASCE 7-05	Severud/NYCBC 2014/RWDI
Wind (mph)	98	98	98
Exposure	-	B	B
Occupancy Category	-	III	III
Importance Factor	1.15	1.15	1.15
Height (ft)	1273.5	1288	1288
Fx (kips) EW dir.	7,372	9,611	8,510
Fy (kips) NS dir.	7,912	9,830	9,331
My (k-ft)	5,347,500	5,747,278	5,347,500
Mx (k-ft)	5,704,000	5,728,749	5,704,000
Mz (k-ft)	124,200		124,200
80% of TT ASCE 7-05 ***Fx***		*7689*	
80% of TT ASCE 7-05 ***Fy***		*7864*	
80% of TT ASCE 7-05 ***My***		*4597822*	
80% of TT ASCE 7-05 ***Mx***		*4582999*	

3.3 SEISMIC LOADS

The General Notes indicate that the seismic loads comply with Chapter 16 of the NYC Building Code using the following seismic parameters:

Table 8: Seismic Parameters

Parameter	**Value**	**Reference**
Occupancy Category	III	Table 1604.5
Importance Factor, I_e	1.25	Table 11.5.1
S_s	0.281 g	1613.5.1
S_1	0.073 g	1613.5.1
Site Class	B	Per Geotech
F_a	1.0	Table 1613.5.3(1)
F_v	1.0	Table 1613.5.3(2)
S_{ms}	0.281 g	Section 1613.5.3
S_{m1}	0.073 g	Section 1612.5.3
S_{ds}	0.187 g	Section 1612.5.4
S_{d1}	0.049 g	Section 1612.5.4
Design Category	B	Table 1616..5.6
Seismic Force Resisting System	Ordinary Reinforced Concrete Shear Walls	
Response Mod., R	4.0	Table 12.2-1, ASCE 7-10
Deflection Amp., C_d	4.0	Table 12.2-1, ASCE 7-10
Approx. Fundamental Period, T_a	2.00 s	Eq. 12.8-7 ASCE 7-10
Fund. Period, T	3.40 s	Not Listed
Seismic Weight, W	Not Provided	
Base Shear, V	**3,911 kips**	Per design drawings

TT found that these parameters are consistent with the NYC Building Code and ASCE 7-10. TT has performed an independent analysis of the seismic loads, and found the Seismic Weight to be approximately 389,929k. Based on the building weight our calculated seismic base shear is 4018 kips. Since the wind loads generally control the lateral members design, the minor discrepancy between our seismic base shear and that of EOR is acceptable.

3.4 WIND AND SEISMIC LOAD COMPARISON

The table and figures below show TT calculated building shear and moment for wind in the X direction (East/West), wind in the Y direction (North/South), and for seismic design. All wind loads include 1.15 importance factor.

Table 9: Applied lateral load comparison

Seismic vs Wind Shear Base Shear and Moment Comparison						
	Wind Load (RWDI*Iw) Iw=1.15				EQ Loads	
	Vx [k]	Vy [k]	My [k-ft]	Mx [k-f]	Vi [k]	Mi [k-f]
BASE	**7371**	**7515**	**5342314**	**5401169**	**4018**	**3167841**

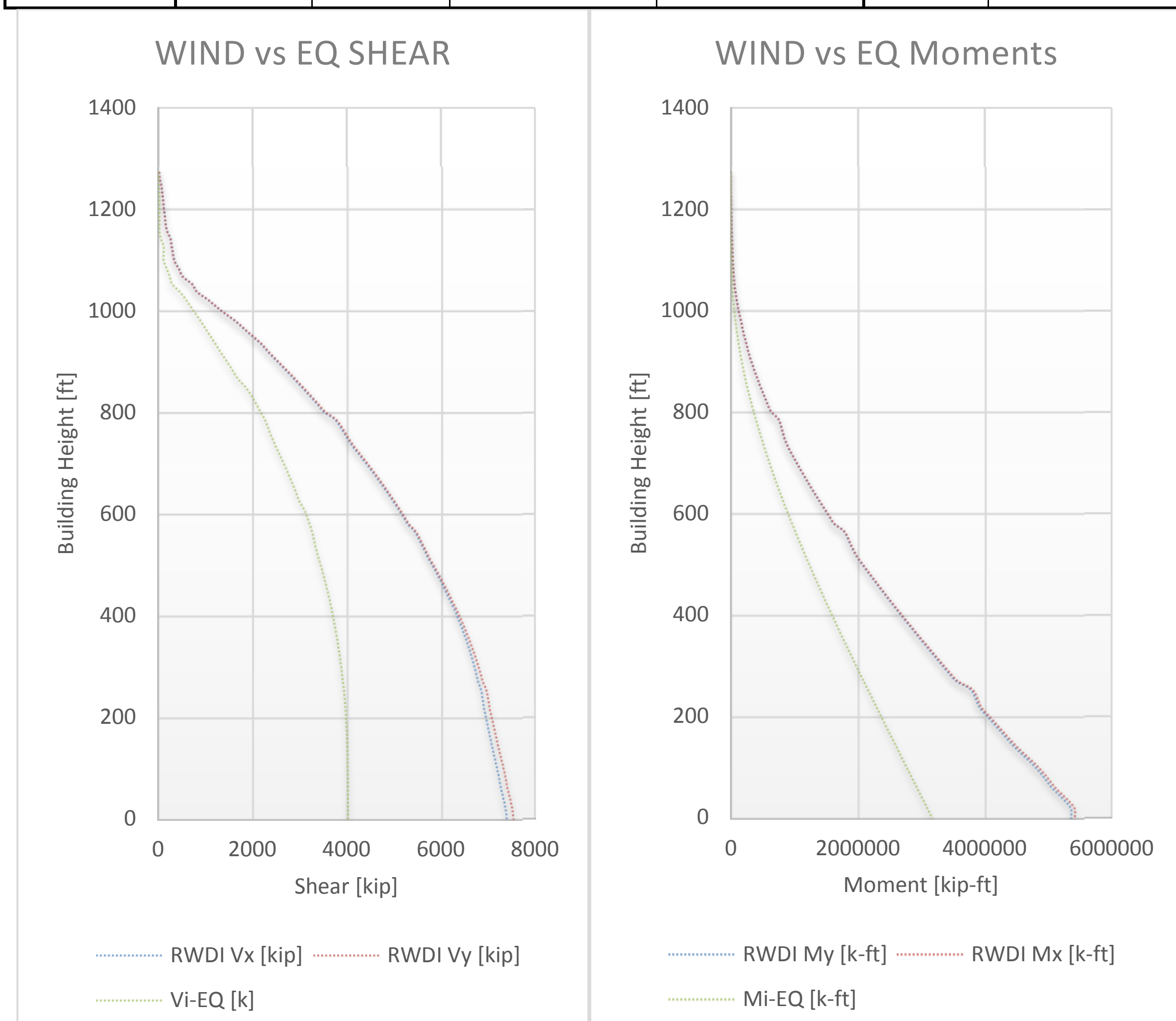

Figure 6: Wind vs EQ Shear

3.5 LOAD COMBINATIONS

The following load combinations in accordance with the NYCBC 2014 have been used to verify members' strength and service design. In addition, RWDI wind load cases have been included in the following load combinations.

Ultimate (Strength) Design
1.4D
1.2D+1.6L+0.5(Lr or S or R)
1.2D+1.6(Lr or S or R)+(f_1L or 0.8W)
1.2D+1.6W+f_1L+0.5(Lr or S or R)
1.2D+1.0E+f_1L+f_2S
0.9D+1.6W
0.9D+1.0E

The load factor on L in combinations 3,4 and 5 is permitted to equal 0.5 for all occupancies in which Live load is less than or equal to 100 psf.

Allowable Stress (Service) Design
D
D+L
D+L+(Lr or S or R)
D+0.75L+0.75(Lr or S or R)
D+(W or 0.7E)
D+0.75L+0.75(W or 0.7E)+0.75(Lr or S or R)
0.6D+W
0.6D+0.7E

H. STRUCTURAL MODELING

2.0 CORE MODELING

TT has built its independent model using ETABS software. The One Vanderbilt core is a rectangular grid of concrete shear walls that is two bays wide in the East/West direction and three bays wide in the North/South direction. While the openings for doors tend to weaken the system, the link beams above the doors and the steel frame within the concrete will tend to strengthen it. We have modeled walls and deep link beams with shell elements to accurately to determine the overall building stiffness under wind and earthquake loading, and the correct load distribution to the different walls and foundation.
Severud has not provided their analysis model for our review however, they have confirmed that general analysis parameters such as model shapes, deflection, base reaction is in good agreement with our analysis results.

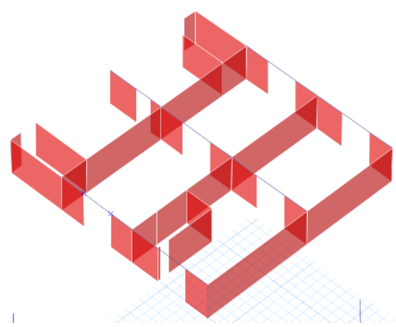

Figure 7: Structural analysis modeling methods, shell elements for shear walls.

3.0 LOAD PATH REVIEW

The concrete core is main lateral resisting elements in tandem with outriggers truss. The core walls are continuous from level 61 to foundation level with setbacks at level 59, 33 and 24 as shown in Figure 8. The core walls provide a clear load path for lateral loads.
For gravity loads, typical floor steel beams transfer the loads to the perimeter sloped steel columns and central concrete core. The steel columns are transferred at levels 12-13 and 5-6 to provide setbacks required per building architectural design. Transfer girders and trusses at these levels provide clear load path for the gravity loads.

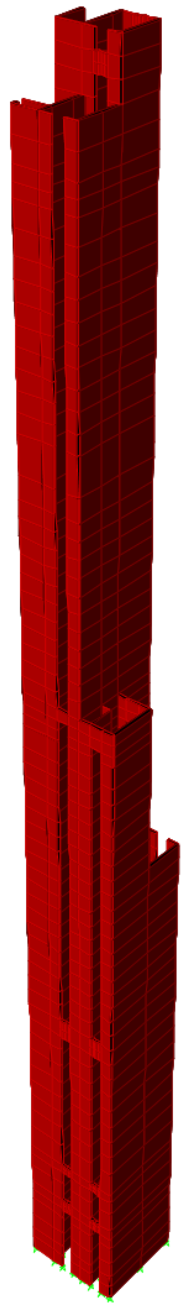

Figure 8 Shear walls

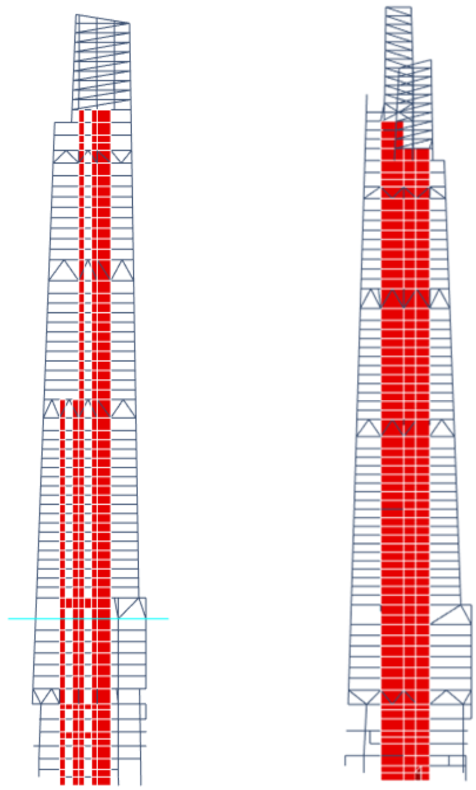

Figure 9: Load Path Elevation Views

I. DYNAMIC BEHAVIOR AND SERVICEABILITY CHECK

4.0 DYNAMIC BEHAVIOR

The building periods for the first three modes as shown in the wind tunnel test report are given in the table below. Based on TT's independent analysis model, the non-iterative P-delta eigenvalue analysis was performed. The periods for the first three modes are also shown in the table below.

Table 10: Building Period Comparison

	RWDI Analysis		TT Analysis – not cracked	
Mode	Direction	Period	Direction	Period
1	UY	6.281 s	UY	6.68 s
2	UX	5.951 s	UX	5.95 s
3	RZ	2.104 s	RZ	2.74 s

5.0 SERVICEABILITY CHECK

5.1 WIND OVERALL DEFLECTION

As a matter of standard practice, the wind deflection limit is typically set to H/400 for a storm with a 10 year return period, where H is the elevation of the floor at which the deflection is measured. Per TT's independent FE model, TT found a maximum overall wind deflection of 22.5" at the 63rd floor in the North/South direction. The maximum allowable deflection at this height is 33.4", so the structural design, to the degree that TT was able to match the intended structural properties, does seem to meet industry standard criteria at this stage of the design. The building acceleration have checked by wind tunnel test for appropriate acceleration and recommended using tune mass dampers.

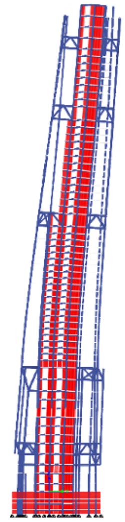

Figure 10: TT Wind Deflection Shape

5.2 WIND INTER-STORY DRIFT

Based on industry standard, wind inter-story drift less than h/400 is acceptable, where h is the story height for the floor at which the relative displacements are determined. TT found a maximum inter-story drift of 0.45" on a floor with a height of 16.5 ft. On such a floor the allowable story drift is 0.5", so the criteria are met. However, the curtain wall system and other equipment shall be designed for such a drift limit.

5.3 SEISMIC INTER-STORY DRIFT

TT reviewed the inter-story drift due to seismic ($\delta = (Cd/Ie)*\delta e$) for a limit of 0.02h as per the Building Code. TT calculated the seismic inter-story drift and it was found that the maximum value was 1.4" at a story of height 16.5 ft. The allowable drift is 3.96" by the criteria above, so the criteria is met. However, the curtain wall system and other equipment shall be designed for such a drift limit.

J. MEMBER DESIGN CHECK

3.0 FLOOR FRAMING CHECK

TT has checked floor framing for typical composite floors 15 and 38 and has that concluded that floor framing has been design to NYC Building Code and AISC 360. Floor framing checks where done using RAM Structural Systems models. In general, the floor framing are adequate for strength and are relatively constant for serviceability parameters.

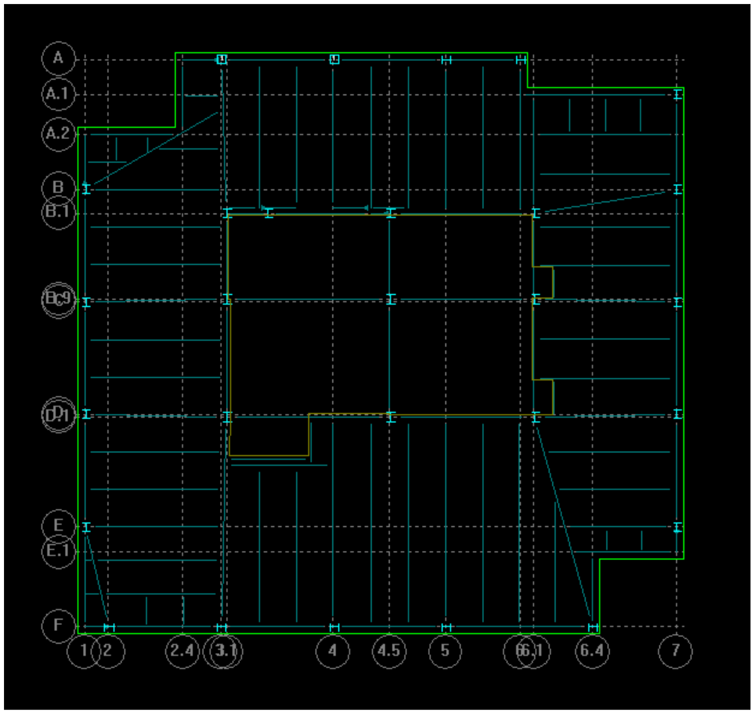

Figure 11: 38th Floor RAM Model

4.0 VIBRATION CHECK

TT's check of the typical floor framing (Level 38) concluded that the floor framing vibration accelerations are within the acceptable levels described in AISC Design Guide 11 (2016).

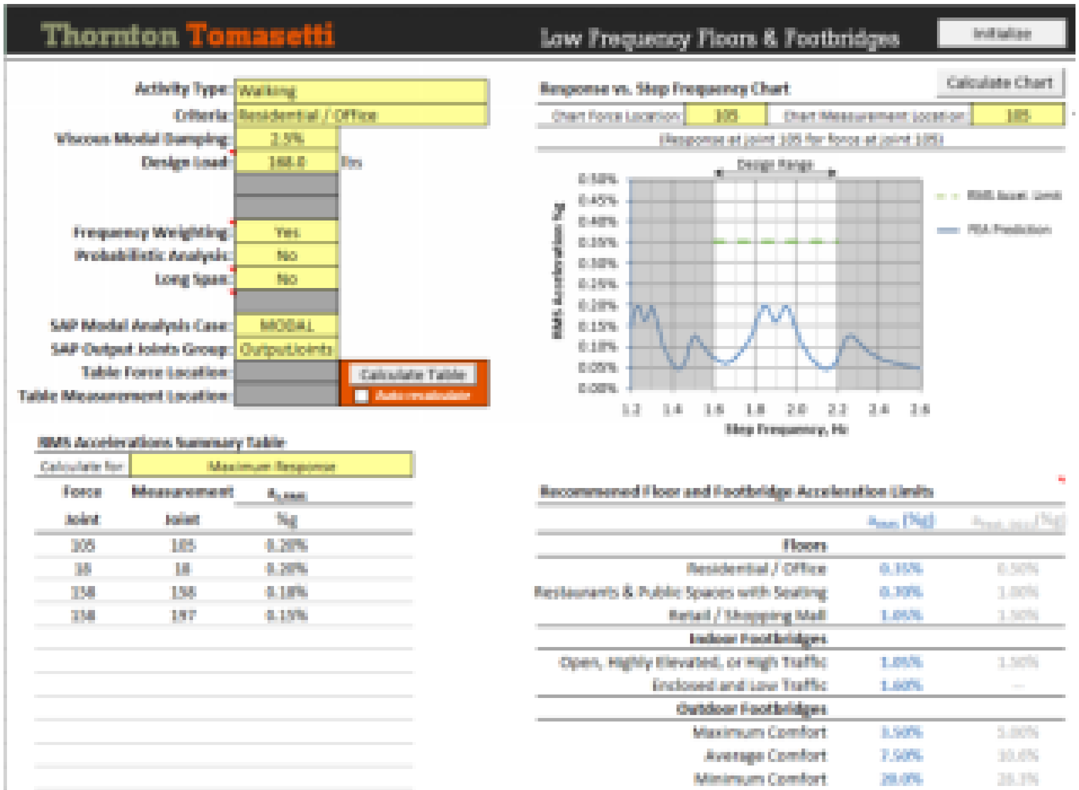

Figure 12: Vibration Analysis

5.0 COLUMN CHECK

TT performed column checks on a sample of columns and verified that they have sufficient capacity for loads and load combinations as required by NYC Building Code 2014. TT calculated column reactions at the foundation match those calculated by Severud, see foundation peer review report issued by TT on February 12th, 2016.

6.0 SHEAR WALL AND LINK BEAM CHECK

We have checked a limited number of shear walls based on our independent analysis model and confirmed their design. We have resolved our discrepancies on link beam design with EOR and modification will be applied to the drawings.

7.0 OUTRIGGER AND TRANSFER TRUSS CHECK

TT checked a sample of Outrigger and Transfer trusses have sufficient capacities for loading as per NYC Building code load combinations. Additionally truss forces shown on SA S-500 series drawings match or exceed forces calculated by TT.

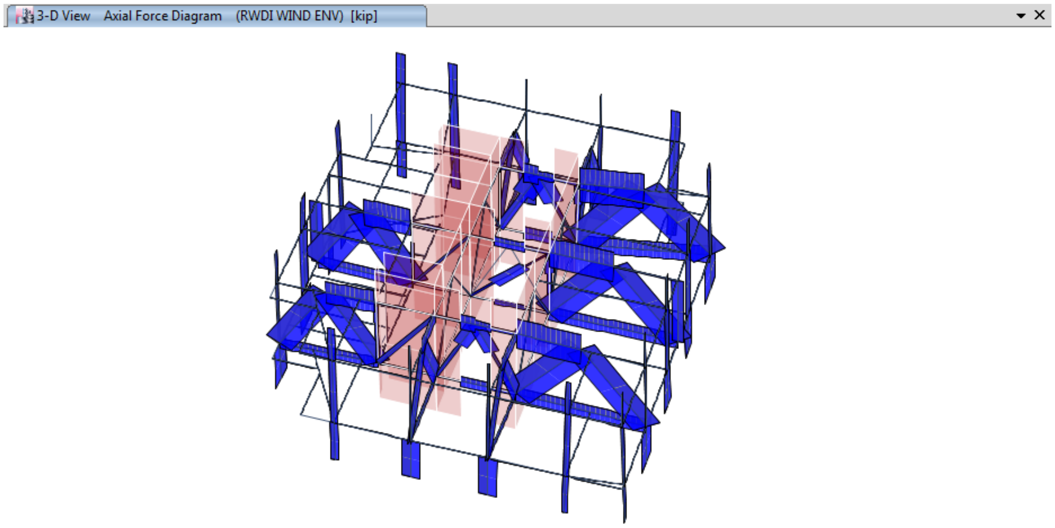

Figure 13: 45th Floor Outrigger Wind Loads

A sample of transfer trusses at the 12th and 6th floors have been checked by TT . Transfer trusses have been checked for Seismic with Overstrength factor (Ω=3), in addition to gravity and wind loads, as required by NYC building Codes and ASCE 7 for vertical structural irregularities.

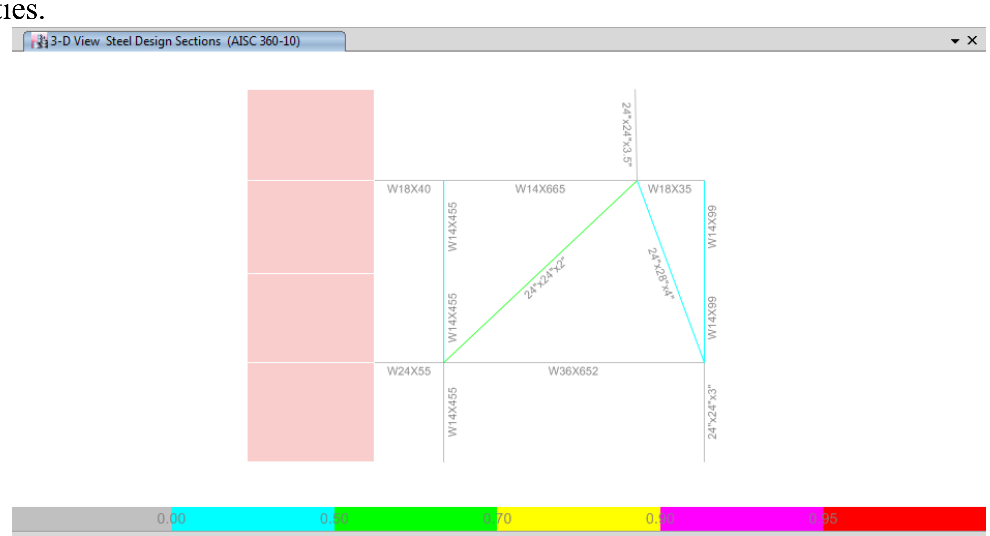

Figure 14: Truss 12TR06 Member sample Checks

6.0 STRUCTURAL INTEGRITY – KEY ELEMENT ANALYSIS

Section BC1616 of the NYC Building Code requires integrity checks to be performed on " key elements of the building, which falls under the code requirements due to the building aspect ratio higher than 7 and also its height greater than 600ft.

Key elements of the structural system, including its connections, are elements which when lost result in more that local collapse or whose tributary area exceeds 3000 square feet on a single level. Additionally elements that brace a key element, which result in failure of the key element are also considered as key elements.

Our review for representative key elements indicates that they meet the integrity requirements for Key Elements via the "specific load resistance method", where key elements shall be designed using specific local loads, as 1616.7 NYC Building Code.

1. *"Each compression element shall be designed for a concentrated load equal to 2 percent of its axial load but not less than 15 kips, applied at midspan in any direction, perpendicular to its longitudinal axis. This load shall be applied in combination with the full dead load and 50 percent of the live load in the compression element."*

   TT verified a sample, two (2) columns, (2) outrigger diagonals, (2) shear walls of axial member for the integrity requirements. The sample used for the study are Column 22 at Lvl13; Column 5 at Lvl 33, diagonals from trusses 5TR06 and 45TR02, and shear wall A at the 7th floor and shear wall D at the 1st floor.

2. *"Each bending element shall be designed for the combination of the principal acting moments plus an additional moment, equal to 10 percent of the principal acting moment applied in the perpendicular plane."*

   Walls A and G at the 7th and 1st floor respectably where checked and confirmed to be designed for 10% of the principal acting moment applied in the perpendicular plane.

3. *"Connections of each tension element shall be designed to develop the smaller of the ultimate tension capacity of the member or three times the force in the member."*

   It is understood through communication with the connection engineer that the connection provision 3 above is being followed for key element connection design. An example of such location are hanger connections for columns 12 and 13 below the 13th floor. These hangers where connection for their full tension capacity,

4. *"All structural elements shall be designed for a reversal of load. The reversed load shall be equal to 10 percent of the design load used in sizing the member."*

   Our sample check of beams, columns and walls are adequate for this requirement.

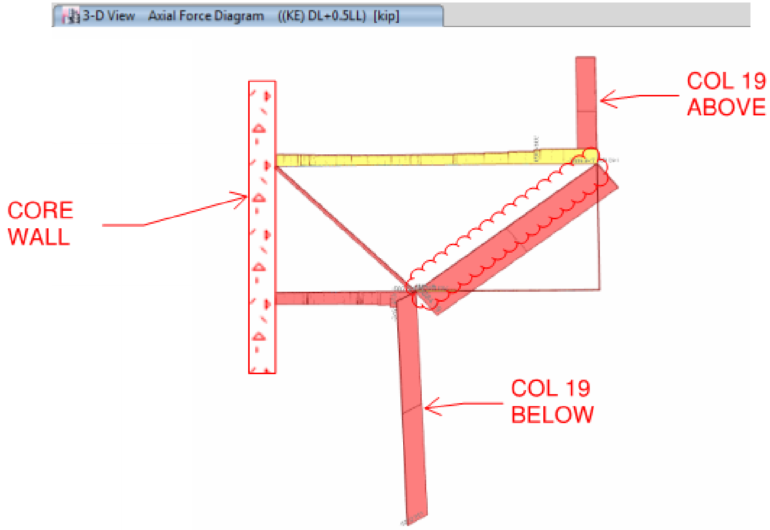

Figure 15: 5TR06 Diagonal integrity sample check

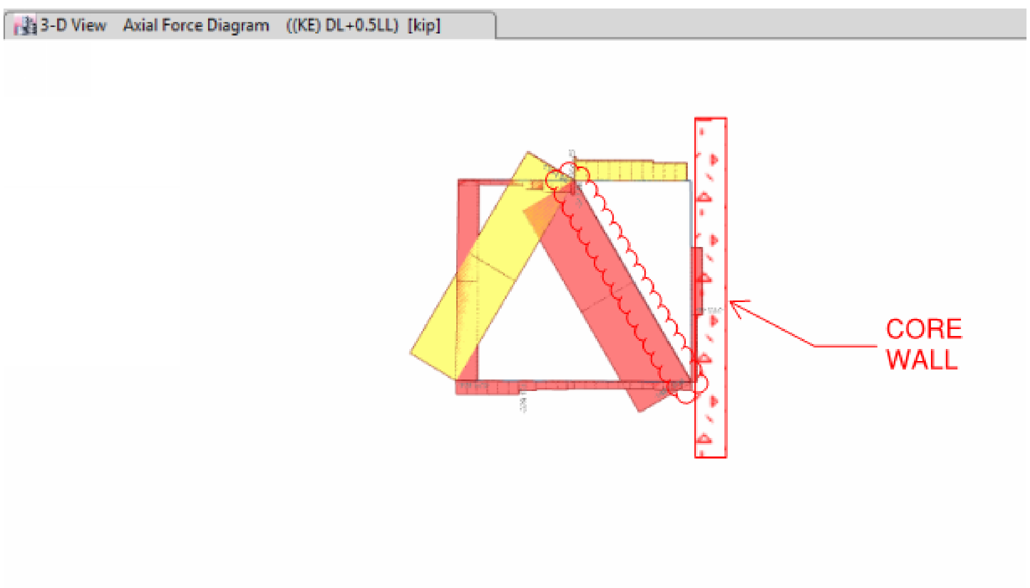

Figure 16: 45TR02 Diagonal integrity sample check

7.0 FOUNDATION AND GEOTECH REPORT

For foundation review topics and Geotechnical report, refer to the foundation peer review report issued by TT on February 12, 2016. We have checked the reactions of core wall at foundation level based on new wind tunnel loads, model (shorter building), and found out they are generally less than loads that sued to design the foundation as reported in our previous report.