Frontier Building Anchorage Alaska Seismic Instrumentation

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Frontier Building, Anchorage Alaska

The Frontier Building (FB) is a 14 story (169 ft high) cast in place moment resistant reinforced concrete frame structure with rigid floor diaphragms built on circular columns.

The building has no basement. The building was constructed in 1981utilizing the 1979 edition of Uniform Building Code (UBC, 1979).

The floor system is lift-slab concrete constructions pre-stressed in the longitudinal direction. The floor plan dimension is 195 ft x 107 ft.

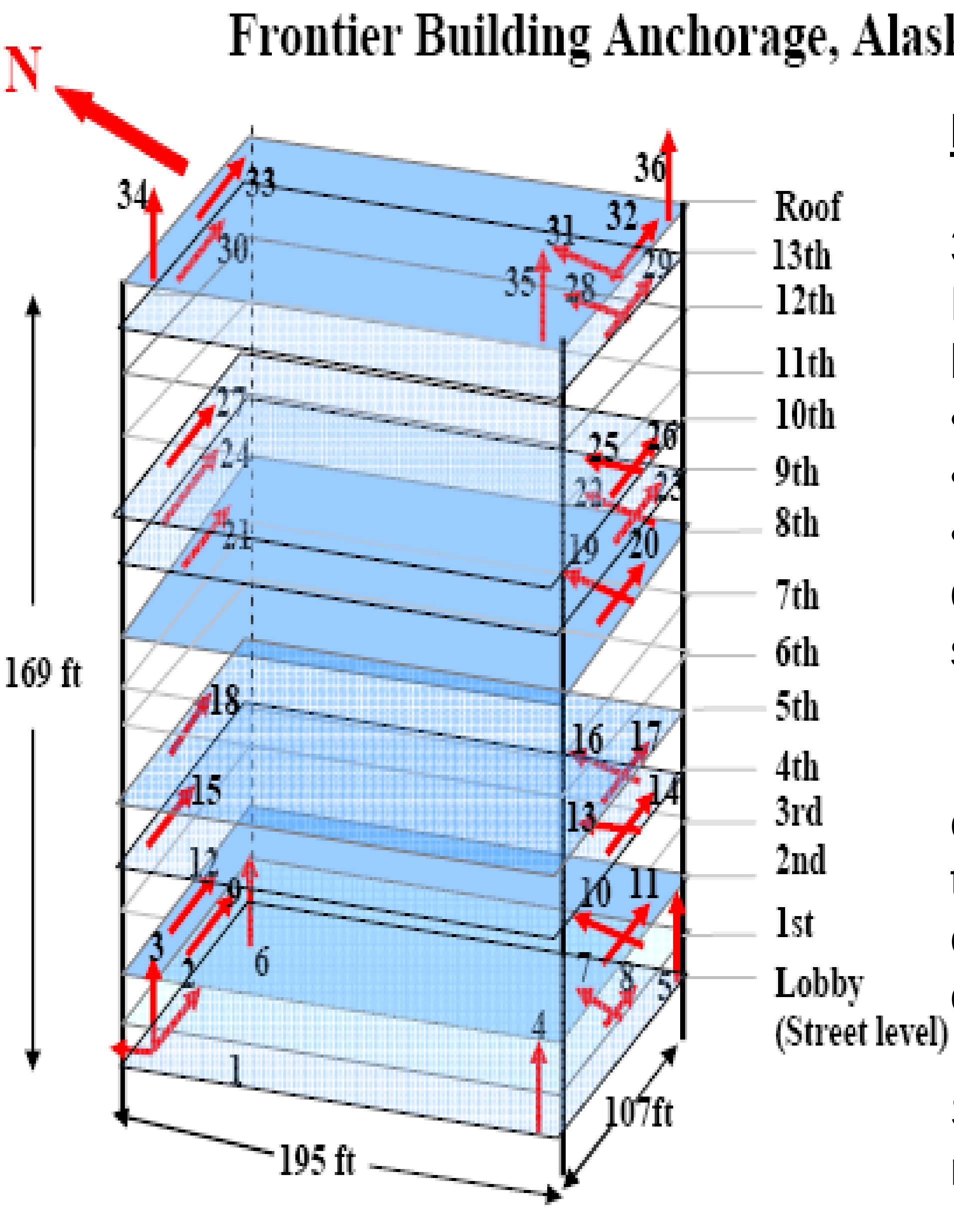
With the exception of 13th floor which has floor to ceiling height of 14 ft 6 inches, all other floors are 11ft 6 inches high.

The FB foundation plan (204 ft 8inches x 116 ft 8 inches) of spread footings in the transverse direction with no real tie in the longitudinal direction and consists of 9 ft wide and 6 ft thick grade beams.

The building has no shear walls.

PowerPoint Research and Presentation Prepared by Dr. Utpal Dutta,UAA

Structural Array: Frontier Building



Instrumentation

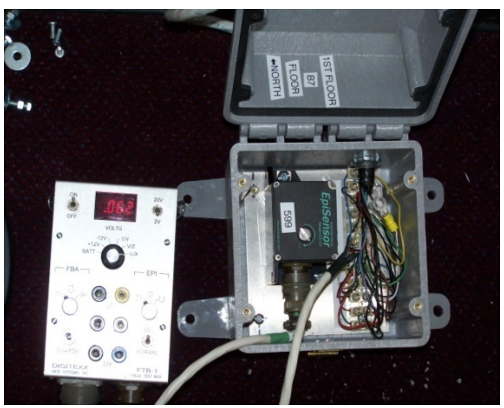
36 Accelerometers (4g Episensors , Kinemterics. Inc) in 10 levels of the building.

- 20 sensors are in E-W direction
- 10 sensors are in N-S direction
- 6 sensors are in Vertical direction (3 sensors are in roof, 3 sensors are in lobby level)

Three K2 (Kinemetrics) 12 channel recorder are used to connect the sensors and are placed in the communication room at the 10th floor of the Building .

System is operating under triggered mode with threshold trigger value set at 1 gal at the base of the building.

Instrumentation Installation



Sensor mounted in a box

Recorder Room

- Kinemetrics EpiSensor Force Balance Accelerometers
  - FBA ES-T (Triaxial)
  - FBA ES-U2 (Uniaxial)
- Altus K2 Strong Motion Accelerograph Digital Recorders
  - Equipped with GPS for $\pm$0.5ms timing accuracy for synchronized recordings

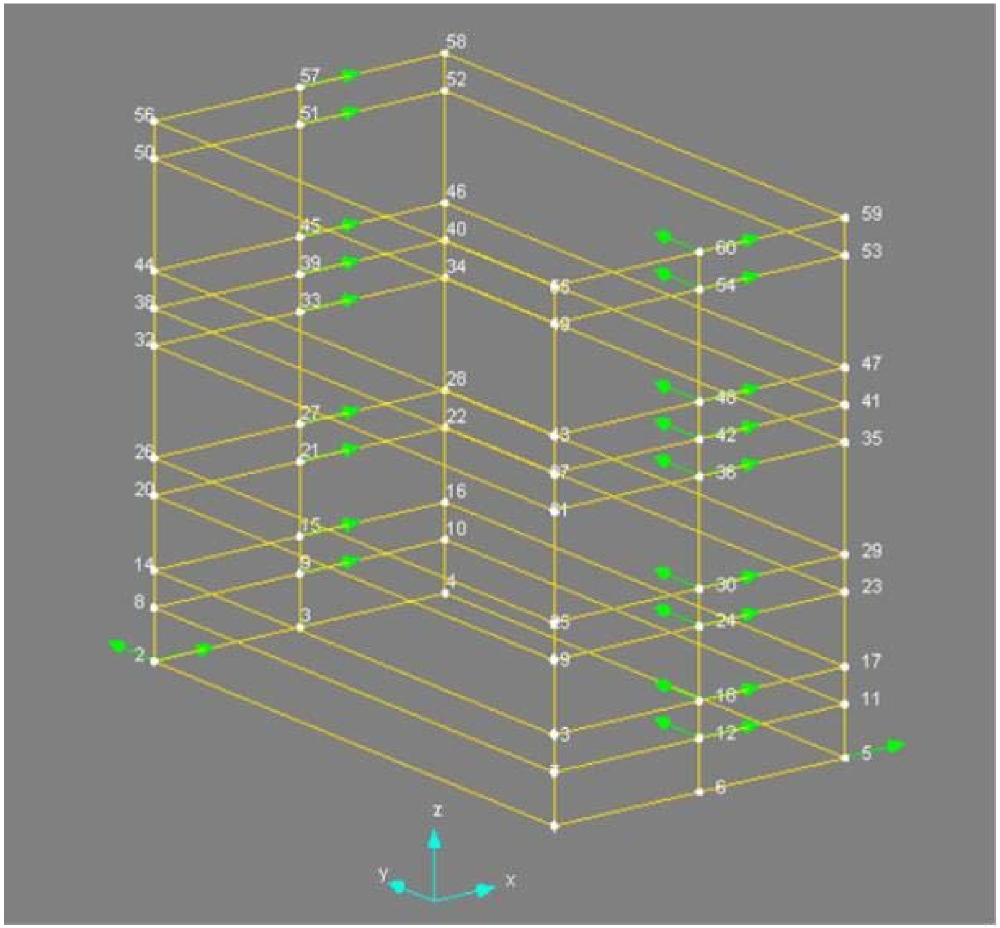
Tasks Identified

- We have identified following tasks:
- To identify fundamental and higher modes of building response.
- Study the Soil-Structure Interaction : Particularly the effect of seasonally frozen ground on the building response
- System Identification and development of 3D-finite element model of the building

Identification of Modal Frequencies

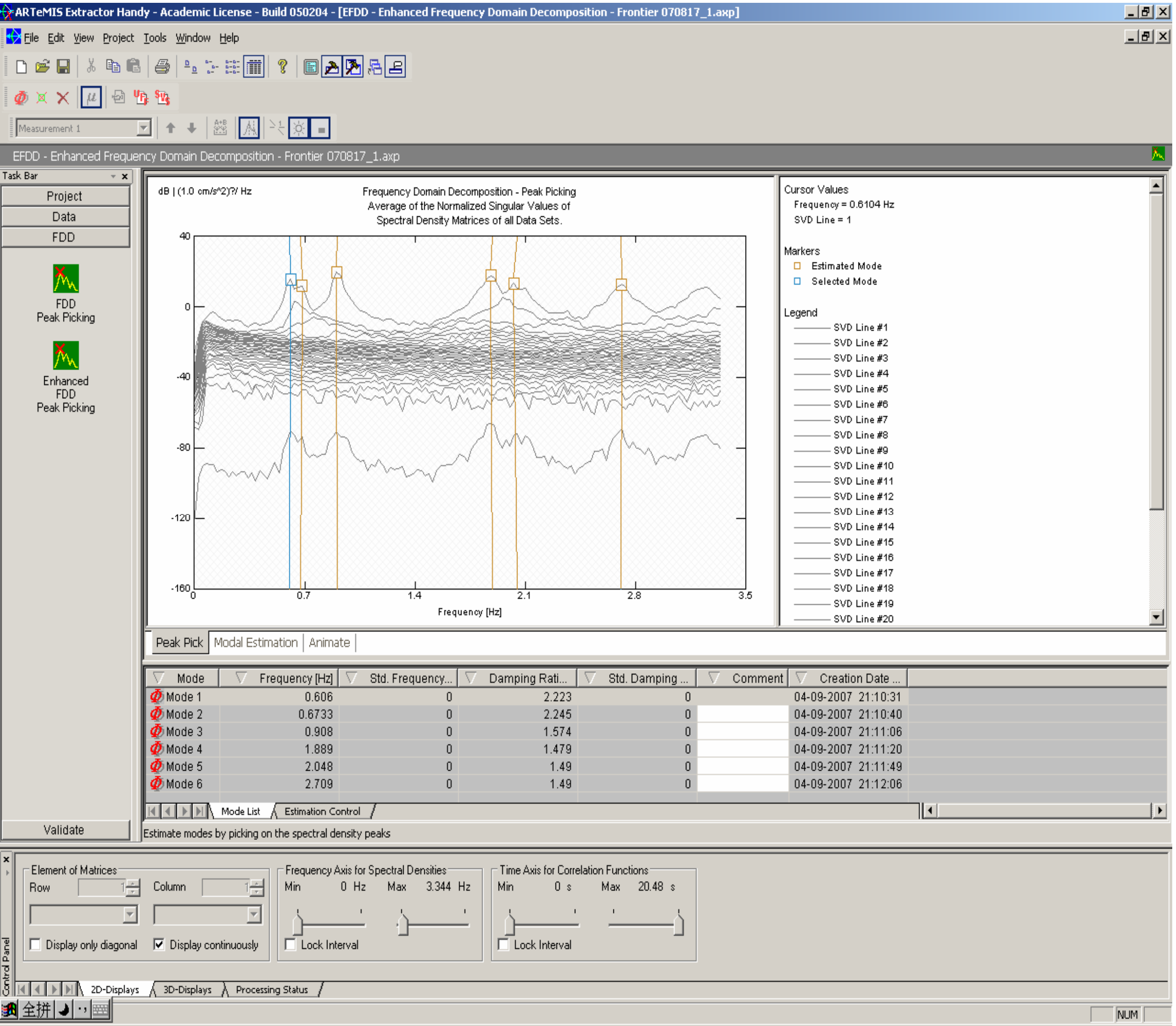
- We used recorded data (two earthquake events and four random vibration measurements) from the building array to identify the various building modes
- We used the ARTeMIS software for the modal identification of the building.
- In the Frequency domain such identification is based on the singular value decomposition of the spectral density matrix.

ARTeMIS Geometric Model



- 10 Floors Instrumented
  - 1 Triaxial FBA
  - 28 Uniaxial FBA
- 30 Channels
  - 20 E-W (Weak Axis) Sensitivity
  - 10 N-S (Strong Axis) Sensitivity
- Y-Axis Represents N-S
- X-Axis Represents E-W
- Z-Axis Represents Elevation
- First Floor Southwest Corner at Local Coordinate (0, 0, 0)

Identification of Modal Peaks in Frequency Domain



- Operational Modal Analysis (OMA) or Output-Only Modal Identification
- Used to identify the Mode Shape of the structure

Tabulated Data Summary

The results of our findings on modal frequencies are given below along with the estimated frozen ground thickness values computed on the basis of on the temperature data from the Anchorage International Airport.

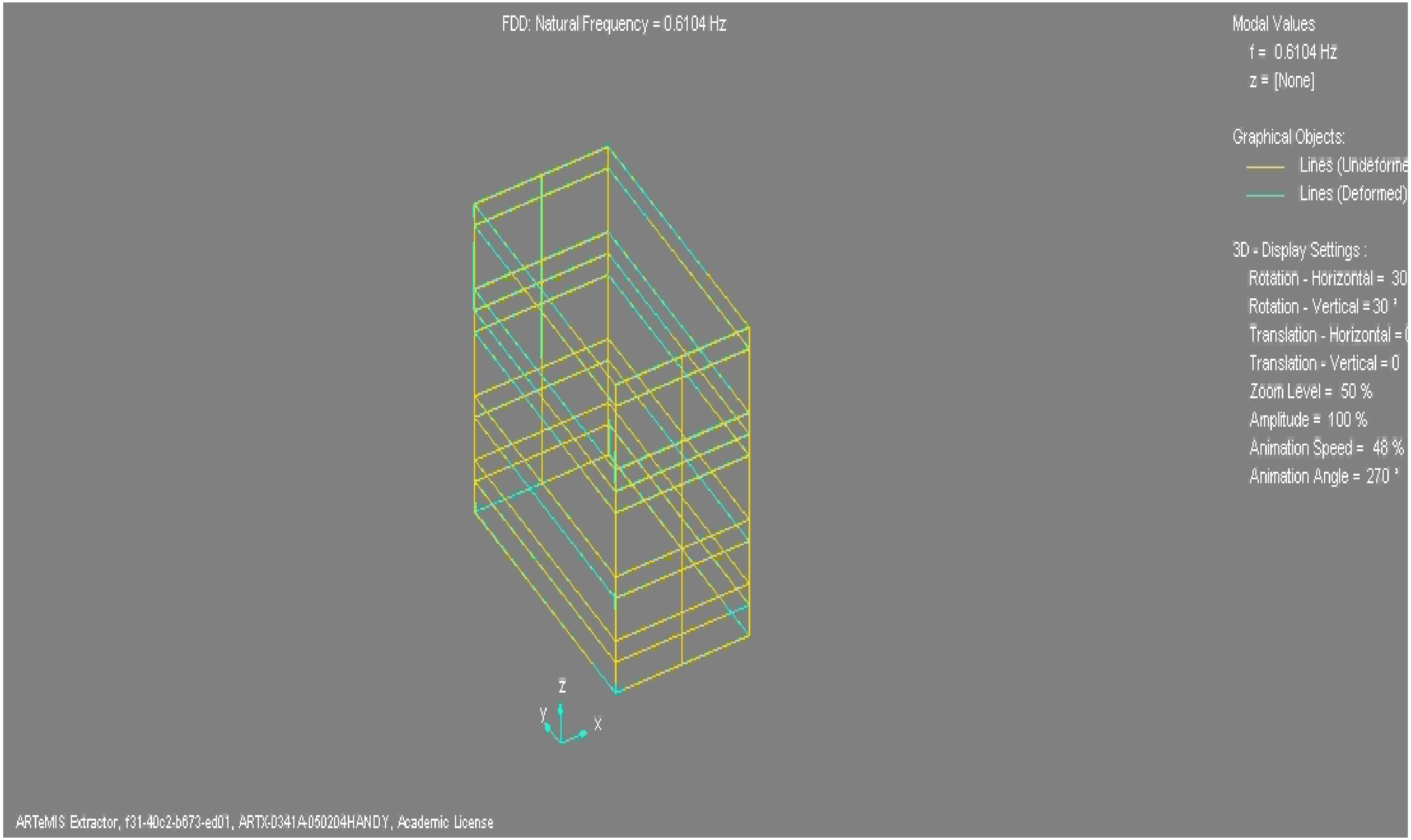
Event Date	Frozen Ground Thickness (m)	EFDD Frequency (Hz)					
		1st Mode			2nd Mode		
		E-W[b]	N-S	Torsion	E-W[b]	N-S	Torsion
03/01/2007	1.84	0.5945	0.6773	0.9183	1.861	2.059	2.736
04/05/2007	1.89	0.5936	0.6665	0.9012	1.845	2.025	2.698
04/25/2007[a]	1.34	0.5994	--	--	1.836	--	--
05/22/2007[a]	0.73	0.5888	0.6718	--	1.833	--	--
06/01/2007	0.50	0.6020	0.6766	0.9067	1.870	2.019	2.709
08/17/2007	0.00	0.6104	0.6836	0.933	1.889	2.026	2.71

[a] Actual Recorded Earthquake Events

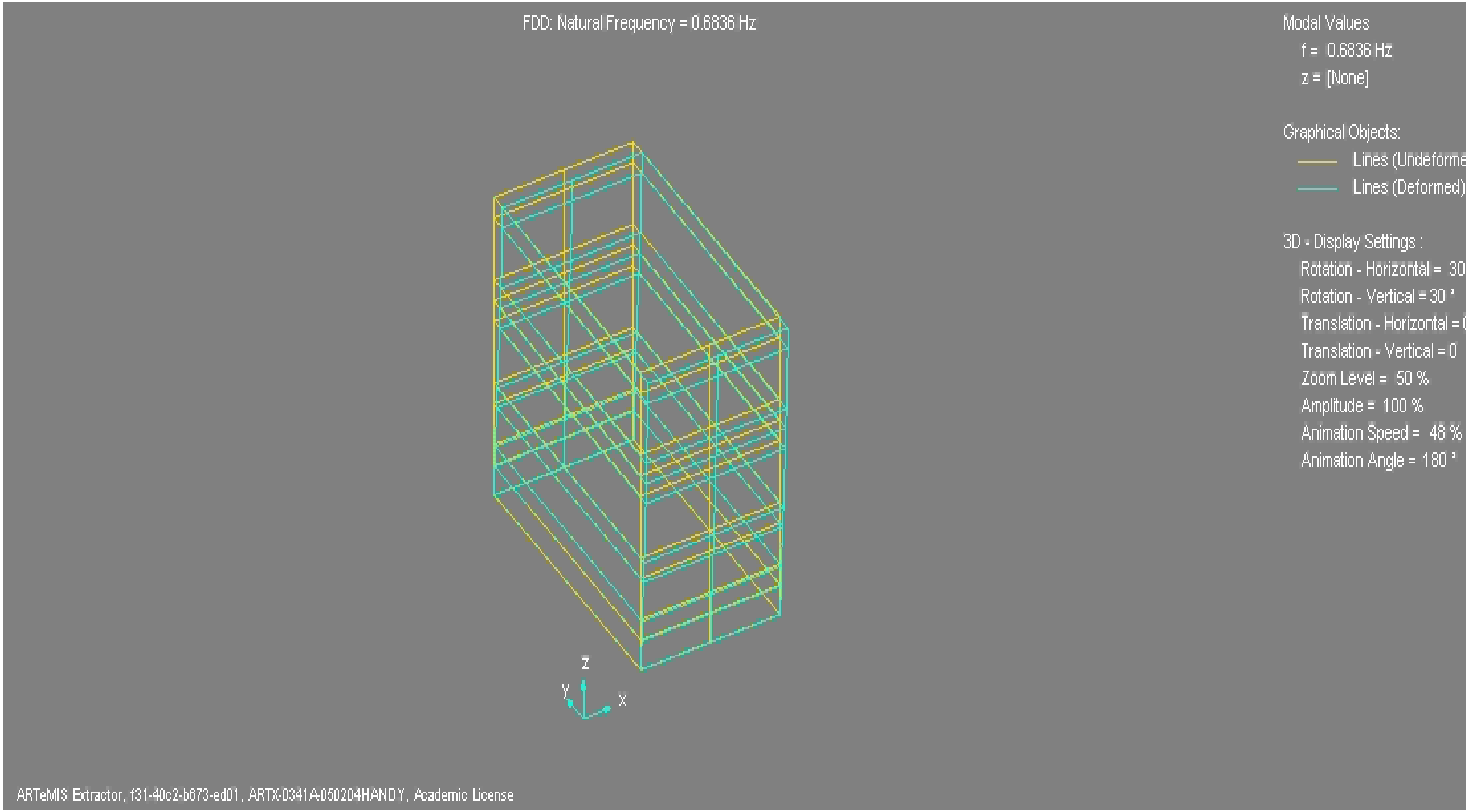
[b] E-W Direction Represents the Weak Axis of the Building

- The correlation between frozen ground thickness and 1st and 2nd mode frequencies are tabulated above
- Minimal variance in the frequencies can be noted with respect to varying degrees of frozen ground thickness

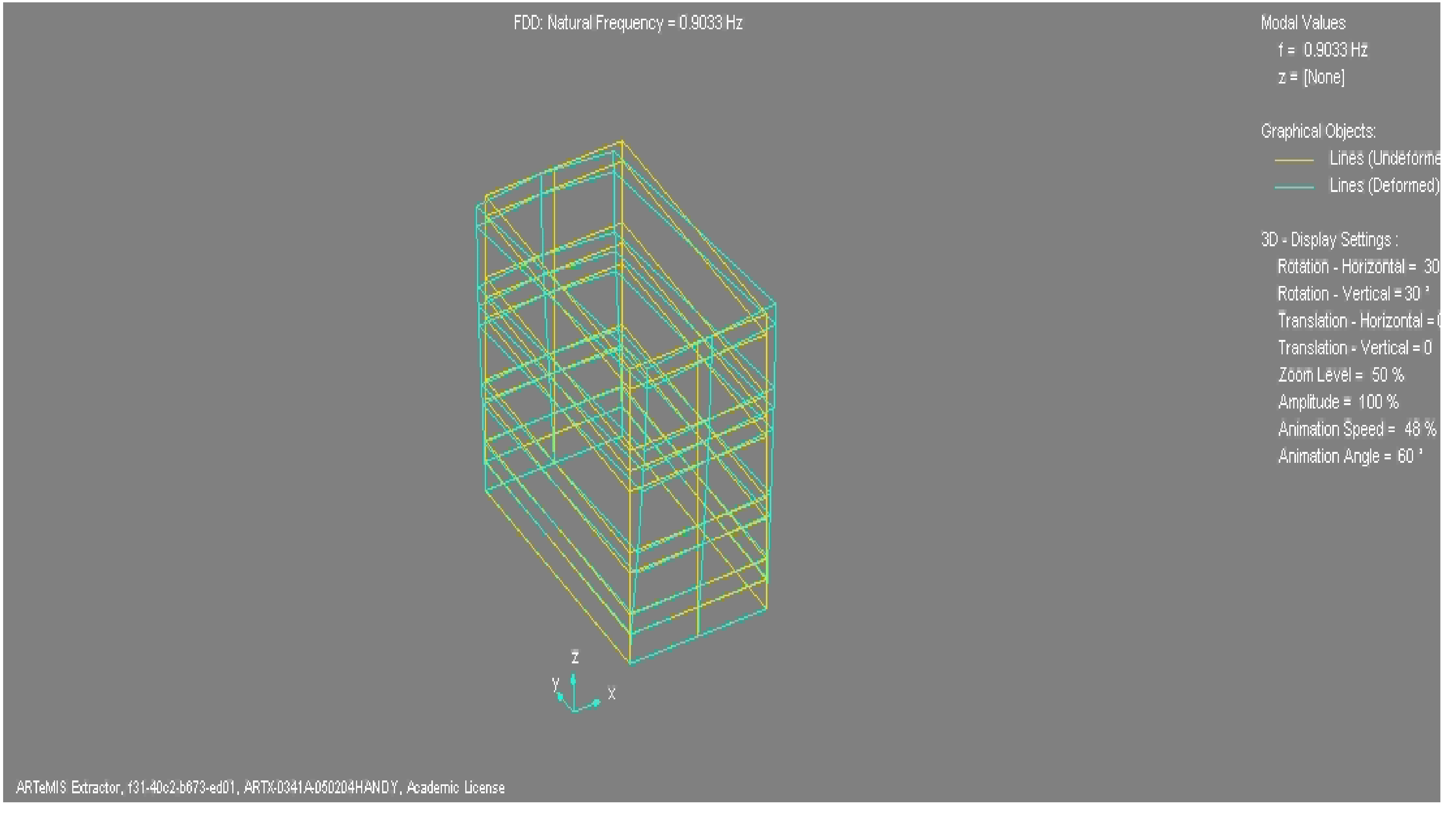
Fundamental mode in E-W direction: f= 0.6104 Hz



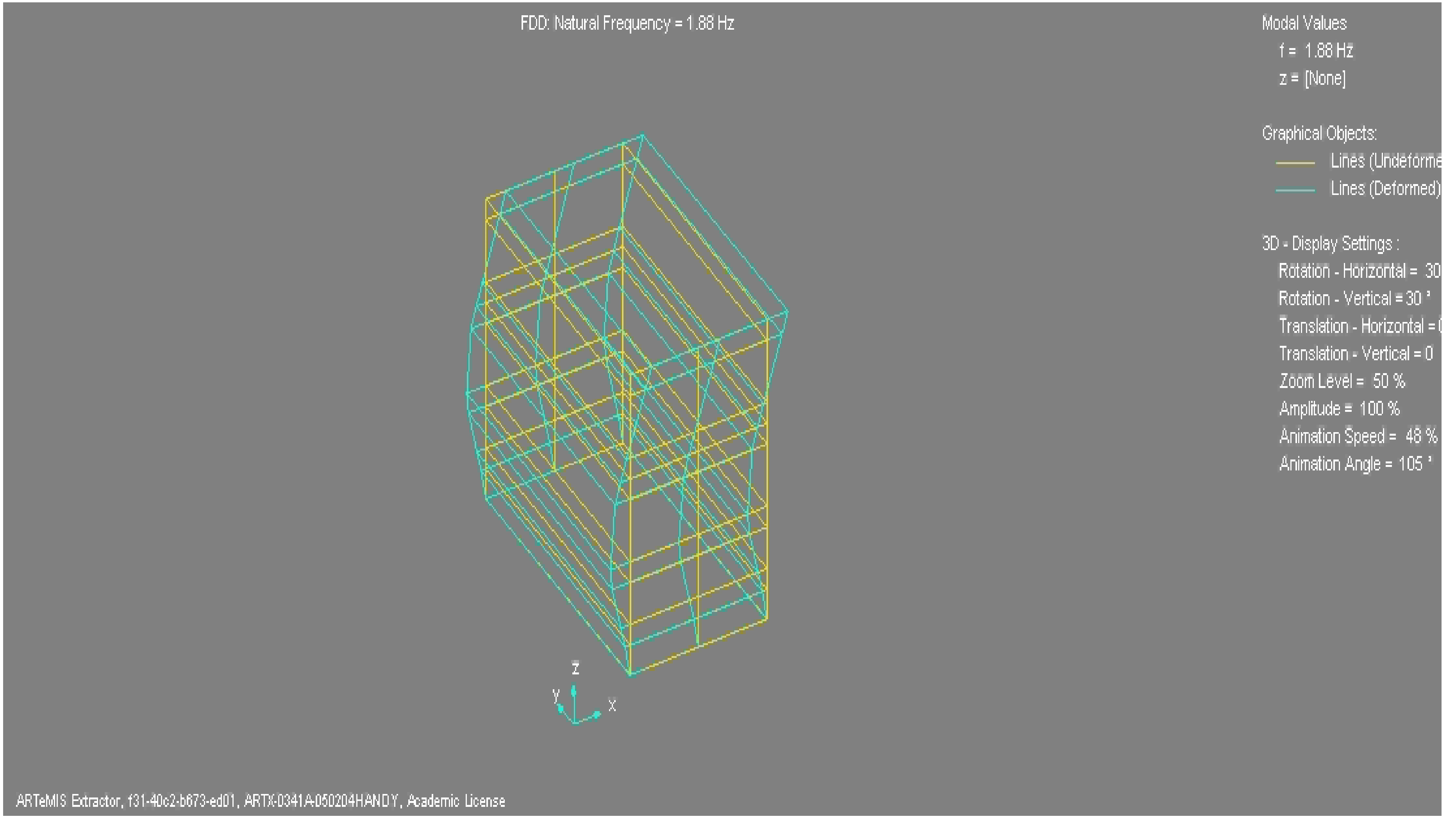
Fundamental mode in N-S direction: f= 0.6836 Hz



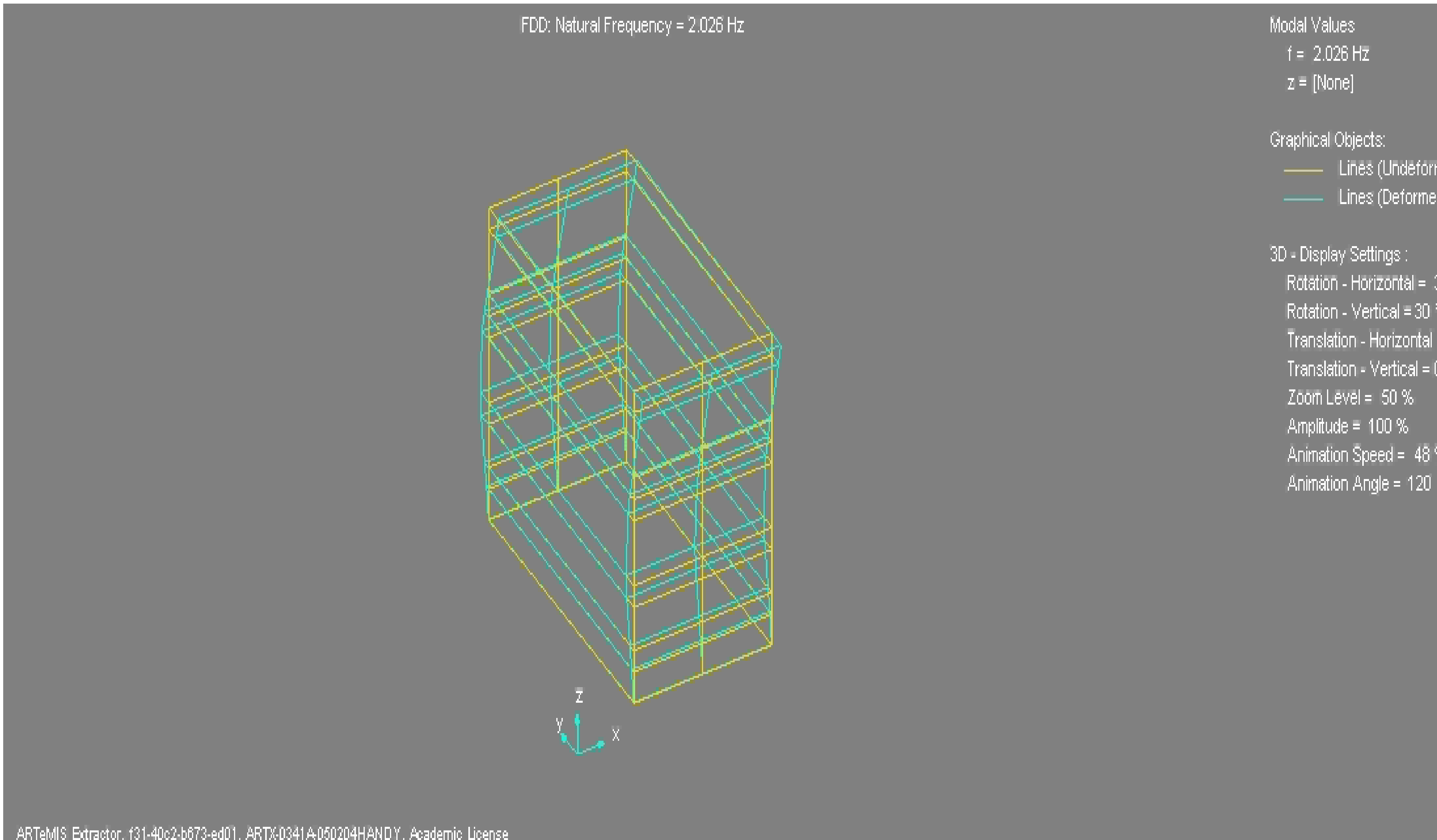
First Torsion motion: f= 0.933 Hz



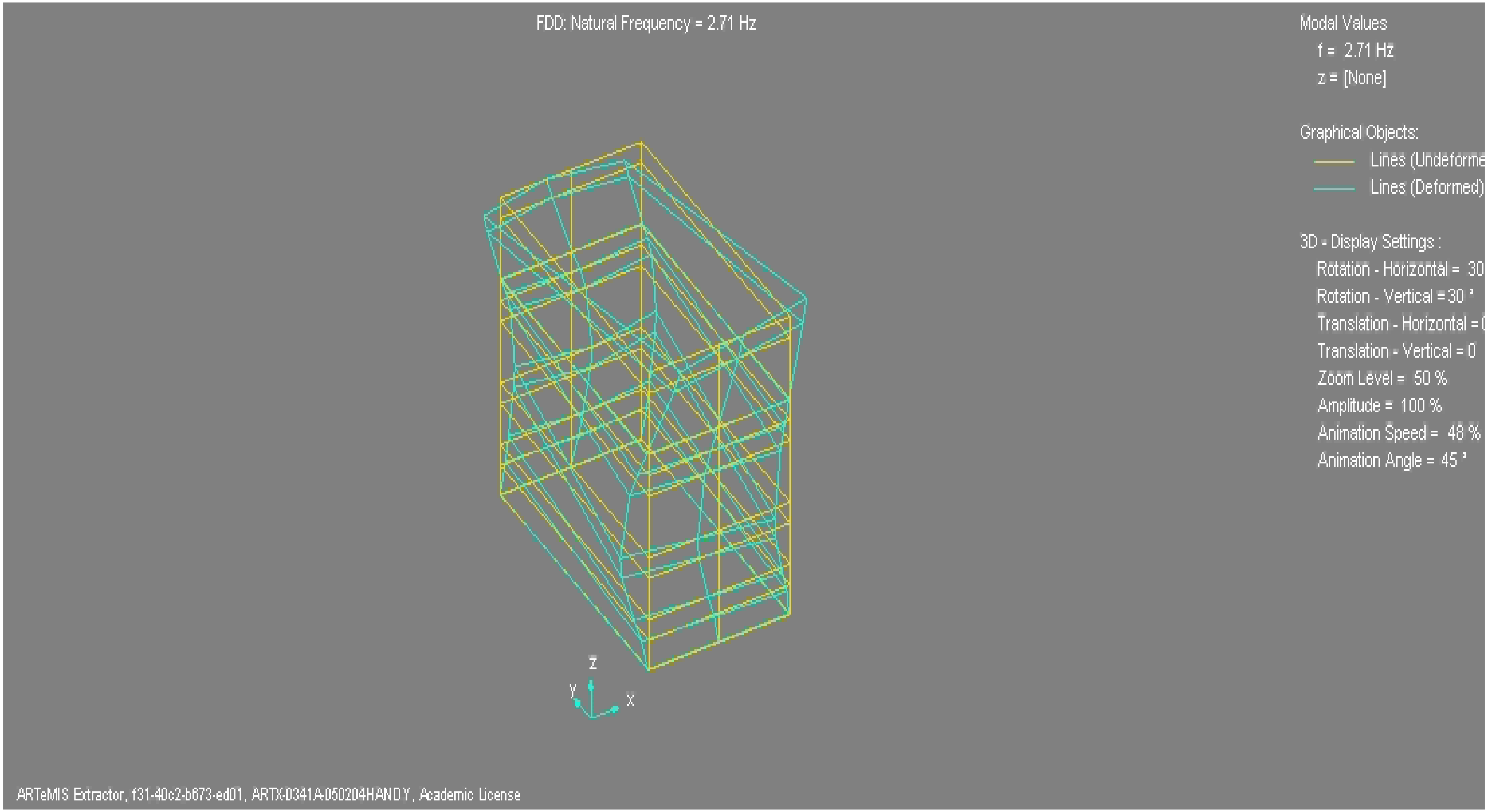
2^{nd} Mode E-W direction: f=1.88 Hz



2^{nd} Mode E-W direction: f=2.026 Hz



2^{nd} torsion mode: f=2.71 Hz



Conclusion

We did not notice so far any significant variation in the modal frequencies with change in thickness of the frozen layer at the Frontier Building, in contrast to near about 5-8% change as observed at Atwood Building, Anchorage ,Alaska

Our speculation is such behavior may be related to the difference in design [presence of open basement (Parking Garage) in Atwood building in contrast to absence of basement at Frontier building] of two buildings significantly reduces the influence of the frozen layer on the structural vibration. We are currently working to test this hypothesis by developing appropriate models of two buildings. This could be of interest in structural design practice in Alaska