



Sharif University of Technology  
Department of Mechanical Engineering

# درس تحلیل و طراحی سازه های فراساحلی

## بارگذاری موج در

# SAP2000

تهیه: مجید قادری

مدرس: تابش پور

دانشگاه صنعتی شریف

# Content

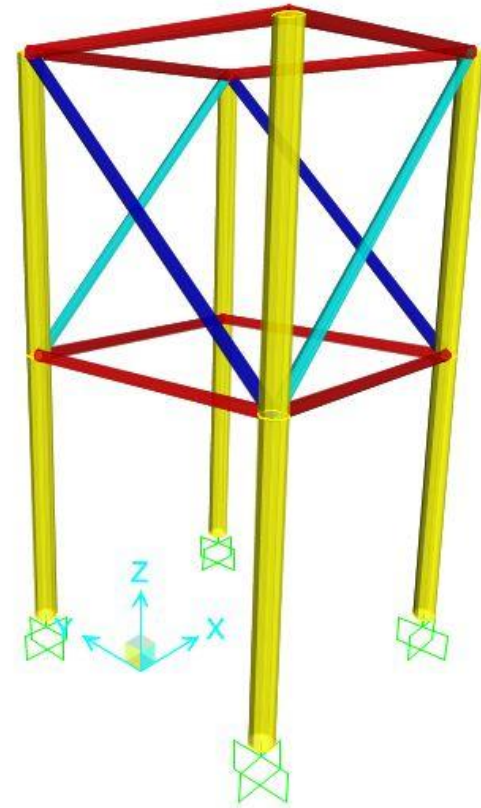
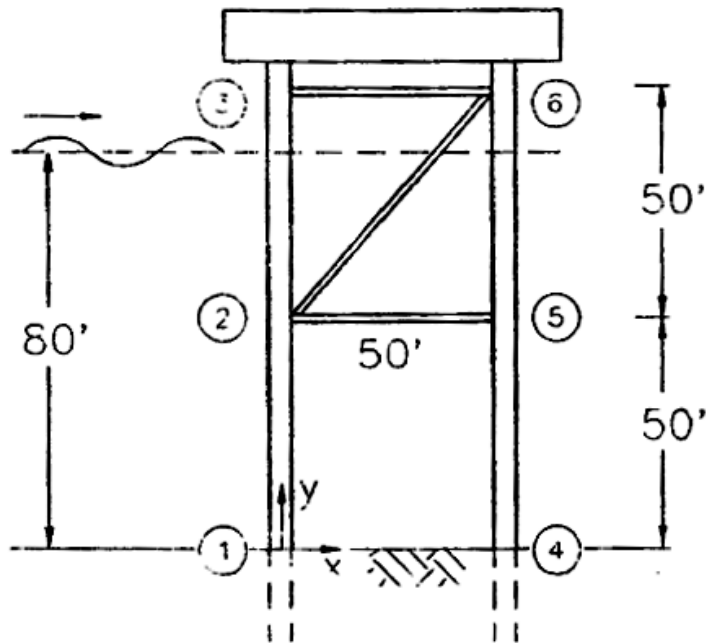
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- Model Properties
- Define Wave Load Pattern
- Modification of Wave Load
- Assign wave characteristics
- View wave characteristics
- Apply wave load

# Model Properties

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- $(D,t)$  (brace & beam) =  $(2 \text{ ft}, 0.05 \text{ ft})$
- $(D,t)$  (leg) =  $(4 \text{ ft}, 0.1 \text{ ft})$

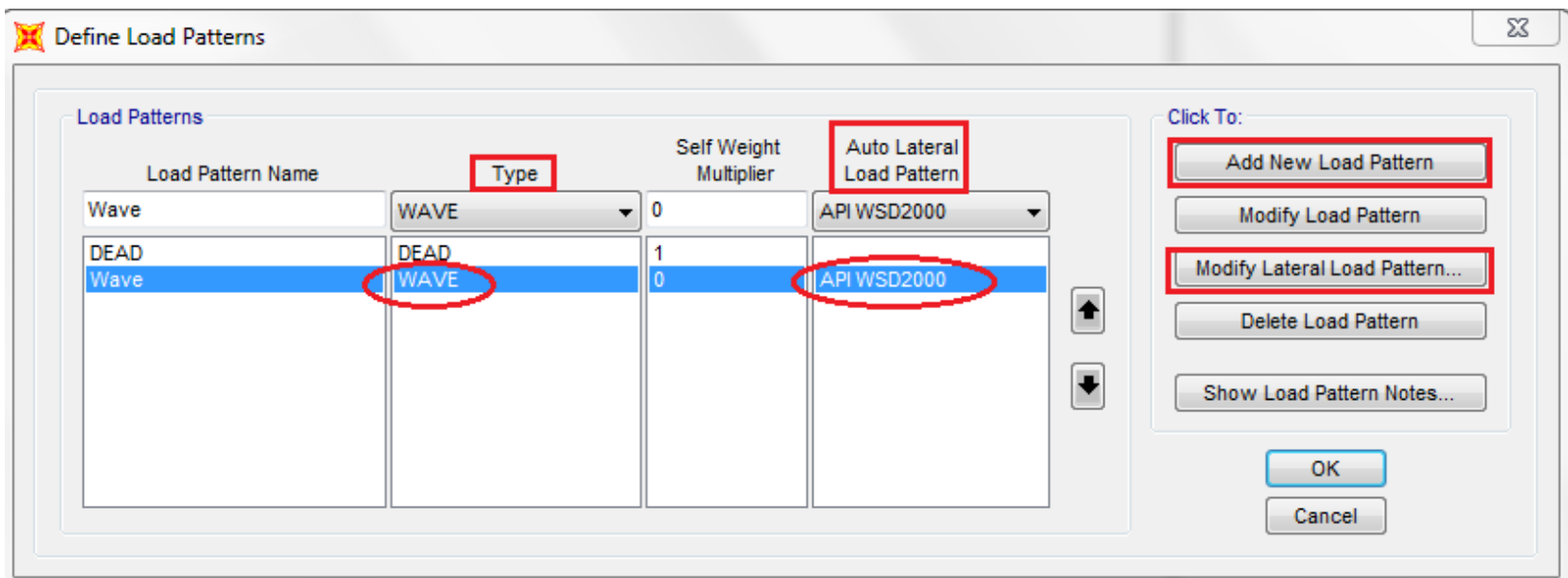


Wave Loading via SAP2000

# Define Wave Load Pattern

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- Define -> Load Pattern
- Load Type : WAVE -> Auto Lateral Load Pattern -> Add New Load Pattern
- Modify Lateral Load Pattern -> Wave Load Pattern



# Define Wave Load Pattern

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**Wave Load Pattern**

**Wave Load Pattern Parameters**

Wave Characteristics	WCHR2	Add	Modify/Show	Delete
Current Profile	None	Add	Modify/Show	Delete
Marine Growth	None	Add	Modify/Show	Delete
Drag and Inertia Coefficients	WDIC1	Add	Modify/Show	Delete
Wind Load	None	Add	Modify/Show	Delete

Include Buoyant Loads

**Wave Load Pattern Discretization**

Maximum Discretization Segment Size: 5

**Wave Crest Position**

Global X Coord of Pt on Initial Crest Position: 0

Global Y Coord of Pt on Initial Crest Position: 0

Number of Wave Crest Positions Considered: 1

**Wave Direction**

Wave Approach Angle in Degrees: 0

**Vertical Reference Elevation for Wave**

Global Z Coordinate of Vertical Datum: 80

**Other Vertical Elevations Relative To Datum**

Mudline from Datum: -80

High Tide from Datum: 0

**Sea Water Properties**

Water Weight Density: 64

Show Wave Table    Show Wave Plot

OK    Cancel

# Define Wave Load Pattern

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## □ Wave Characteristics

Wave Characteristics

Edit

Wave Characteristic Name: WCHR2

**Wave Factors**

Wave Kinematics Factor: 1.

Storm Water Depth: 80.

**Wave Data**

Wave Height: 20.

Wave Period: 7.93

**Wave Type**

From Selected Wave Theory

User Defined

**Wave Theory**

Airy Wave Theory (Linear)

Stokes Wave Theory Order:

Cnoidal Wave Theory Order:

OK Cancel

# Define Wave Load Pattern

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## □ Wave kinematic factor -> API 5.3.1.2.4

### 5.3.1.2.4 Wave Kinematics Factor

The two-dimensional regular wave kinematics from stream function or Stokes V wave theory do not account for wave directional spreading or irregularity in wave profile shape. These “real world” wave characteristics can be approximately modeled in deterministic wave analyses by multiplying the horizontal velocities and accelerations from the two-dimensional regular wave solution by a wave kinematics factor. Wave kinematics measurements support a factor in the range 0.85 to 0.95 for tropical storms and 0.95 to 1.00 for extratropical storms. Particular values within these ranges that shall be used for calculating guideline wave forces are specified for the Gulf of Mexico and for other U.S. waters in API 2MET. Section B.5.3.1.2.4 provides additional guidance for calculating the wave kinematics factor for particular sea states whose directional spreading characteristics are known from measurements or hindcasts.

# Define Wave Load Pattern

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## □ Drag & Inertia Coefficient -> API 5.3.1.2.8:

### 5.3.1.2.8 Drag and Inertia Coefficients

Drag and inertia coefficients are discussed in detail in B.5.3.1.2.8. For typical design situations, global platform wave forces can be calculated using the following values for unshielded circular cylinders:

Smooth:  $C_d = 0.65$ ,  $C_m = 1.6$

Rough:  $C_d = 1.05$ ,  $C_m = 1.2$

Drag and Inertia Coefficients

Edit

Drag and Inertia Coefficient Name: WDIC1

Data is Specified at This Number of Elevations

Number of Elevations: 1

Drag and Inertia Coefficient Data

	Vert from Datum	Drag Coeff	Inertia Coeff
1	0.	1.	2.

Order

OK

Cancel



# Define Wave Load Pattern

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- Drag & Inertia Coefficient , Wave kinematic factor in 300-9:

۲-۲-۱-۳-۲ سینماتیک دو بعدی امواج

اندازه‌گیریهای انجام شده در مورد سینماتیک امواج، بیانگر آن است که ضریب سینماتیکی موج برای طوفانهای شدید، بین ۰/۹۵-۰/۸۵ و برای طوفانهای بسیار شدید، بین ۱-۰/۹۵ می‌باشد.

۲-۲-۱-۳-۲ ضرایب دراگ و اینرسی

در بخش اول آیین‌نامه، در مورد ضرایب دراگ و اینرسی بحث شده است. برای شرایط طراحی نمونه، می‌توان برای استوانه‌های بدون پوشش، نیروهای کلی موج بر سکو را با استفاده از مقادیر زیر محاسبه کرد:

$$C_d = 0/65 , C_m = 1/6$$

صاف

$$C_d = 1/05 , C_m = 1/2$$

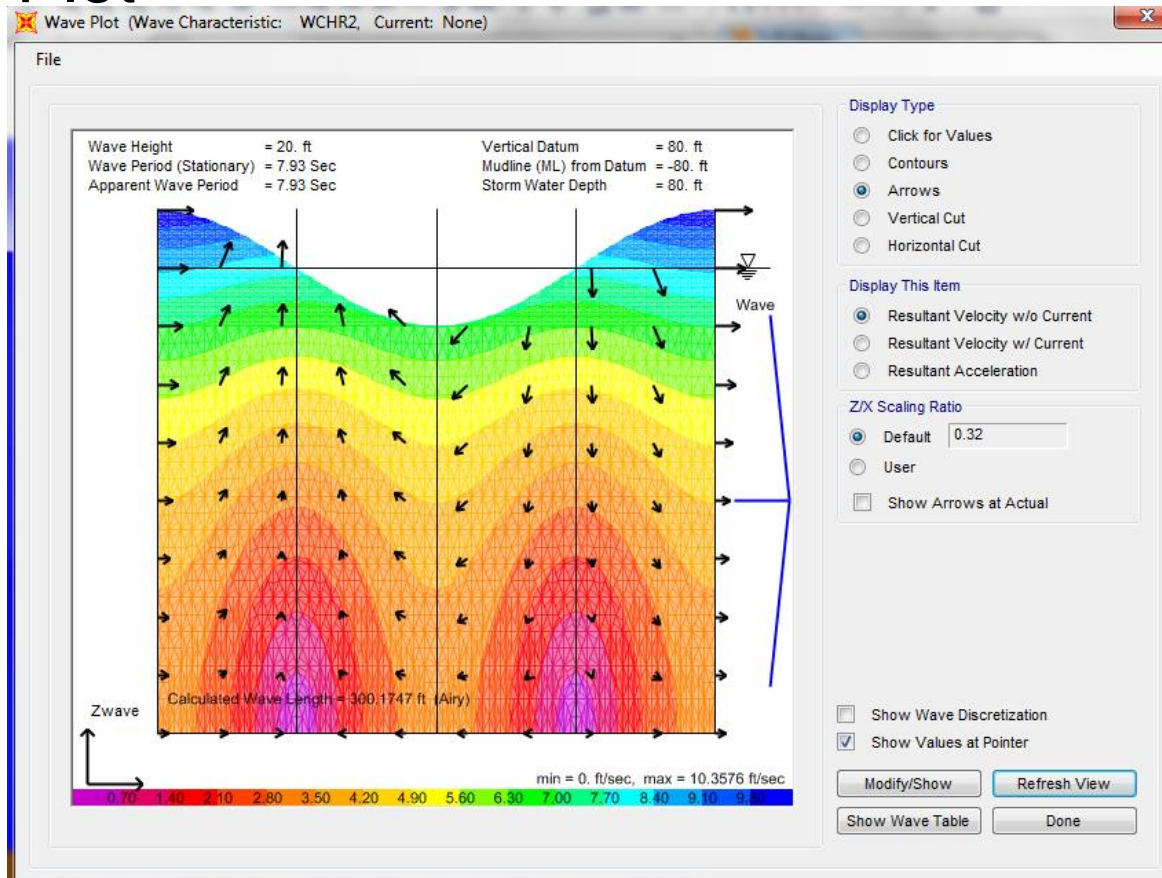
زبر



# Define Wave Load Pattern

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## Wave Plot

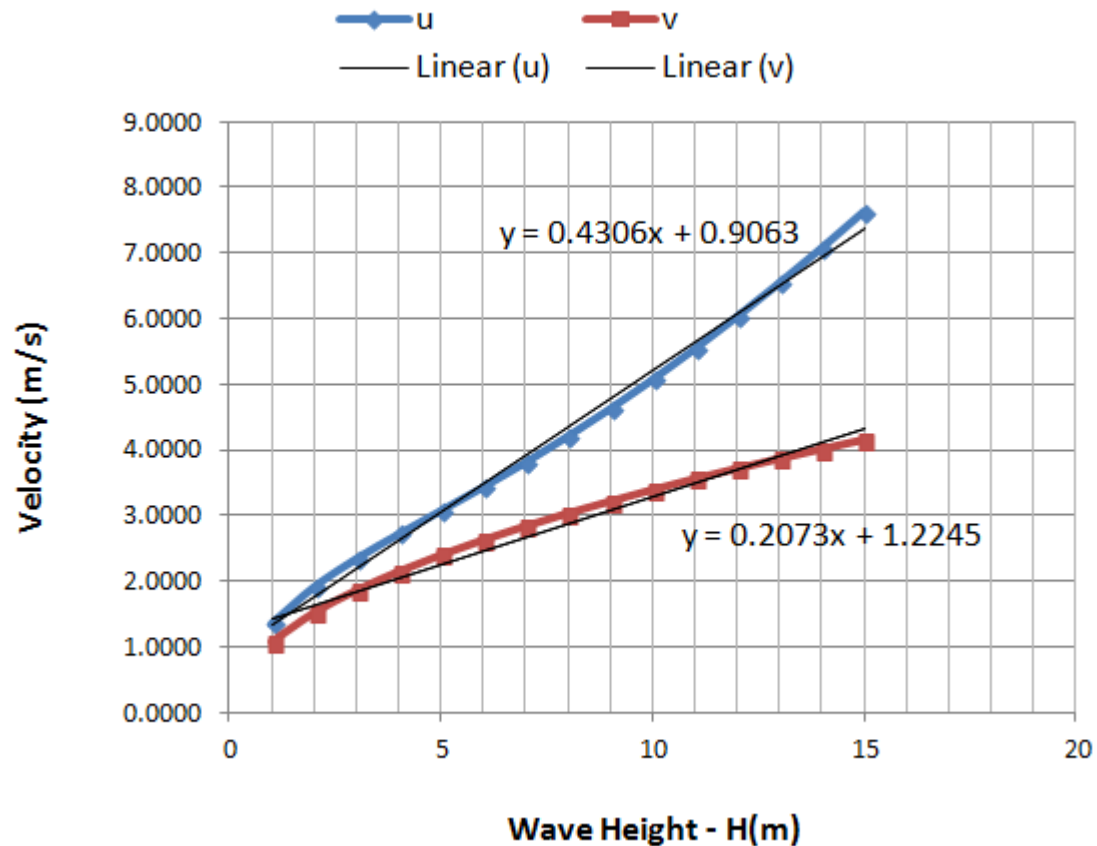


Wave Loading via SAP2000

# Define Wave Load Pattern

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## □ Wave velocity

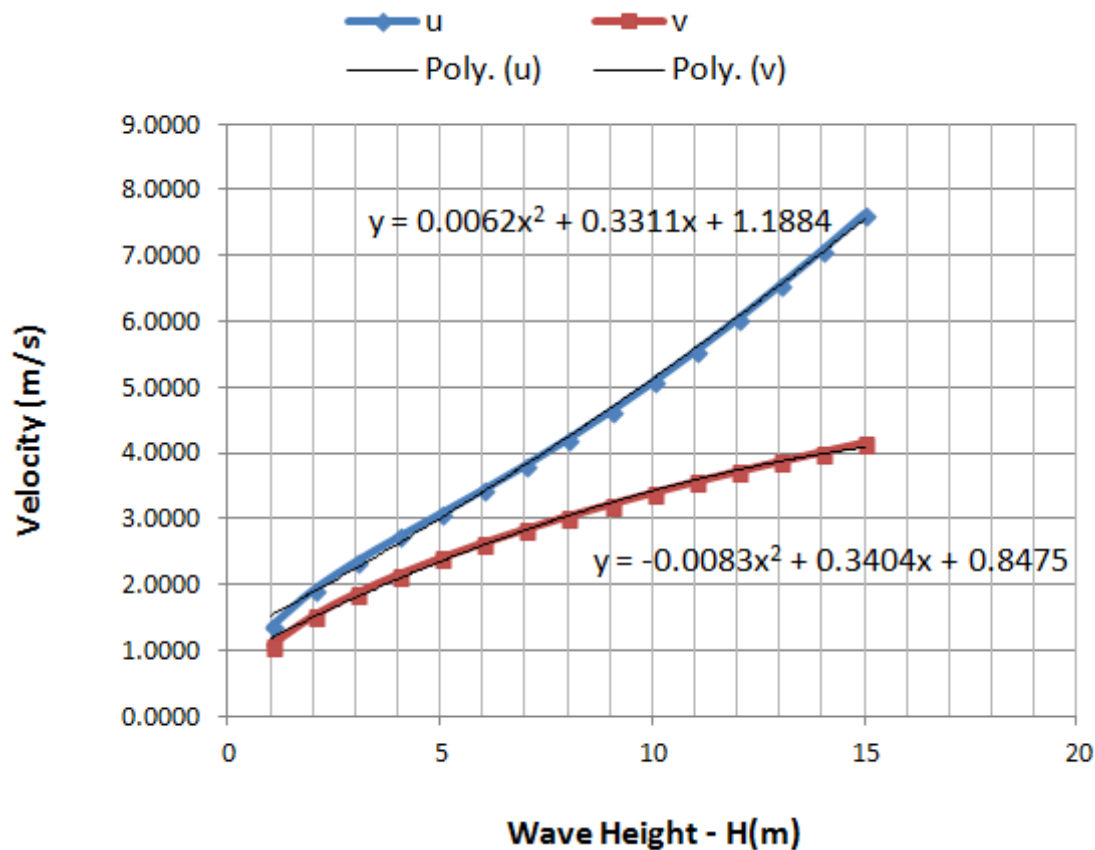


Wave Loading via SAP2000

# Define Wave Load Pattern

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## □ Wave velocity



Wave Loading via SAP2000

# Define Wave Load Pattern

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- Menu -> Display -> Show Load Assigns -> Frame ...

Load Pattern Name: Wave

Load Type

- Span Loading (Forces)  
Coord System: Frame Local
- Span Loading (Moments)  
Coord System: Frame Local
- Gravity Multipliers  
Coord System: GLOBAL
- Temperature Contours
- Temperature Values
- Temperature Gradient 2-2 Contours
- Temperature Gradient 2-2 Values
- Temperature Gradient 3-3 Contours
- Temperature Gradient 3-3 Values
- Deformation Loads
- Target Forces
- Strain Load Values  
Component: [ ]
- Tendon Applied Load Data
- Tendon Calculated Load Data
- Span Wave Loads  
Load Step: 1  
Coord System: Frame Local  
Coord System: Frame Local
- Open Structure Wind Loads  
Coord System: Frame Local

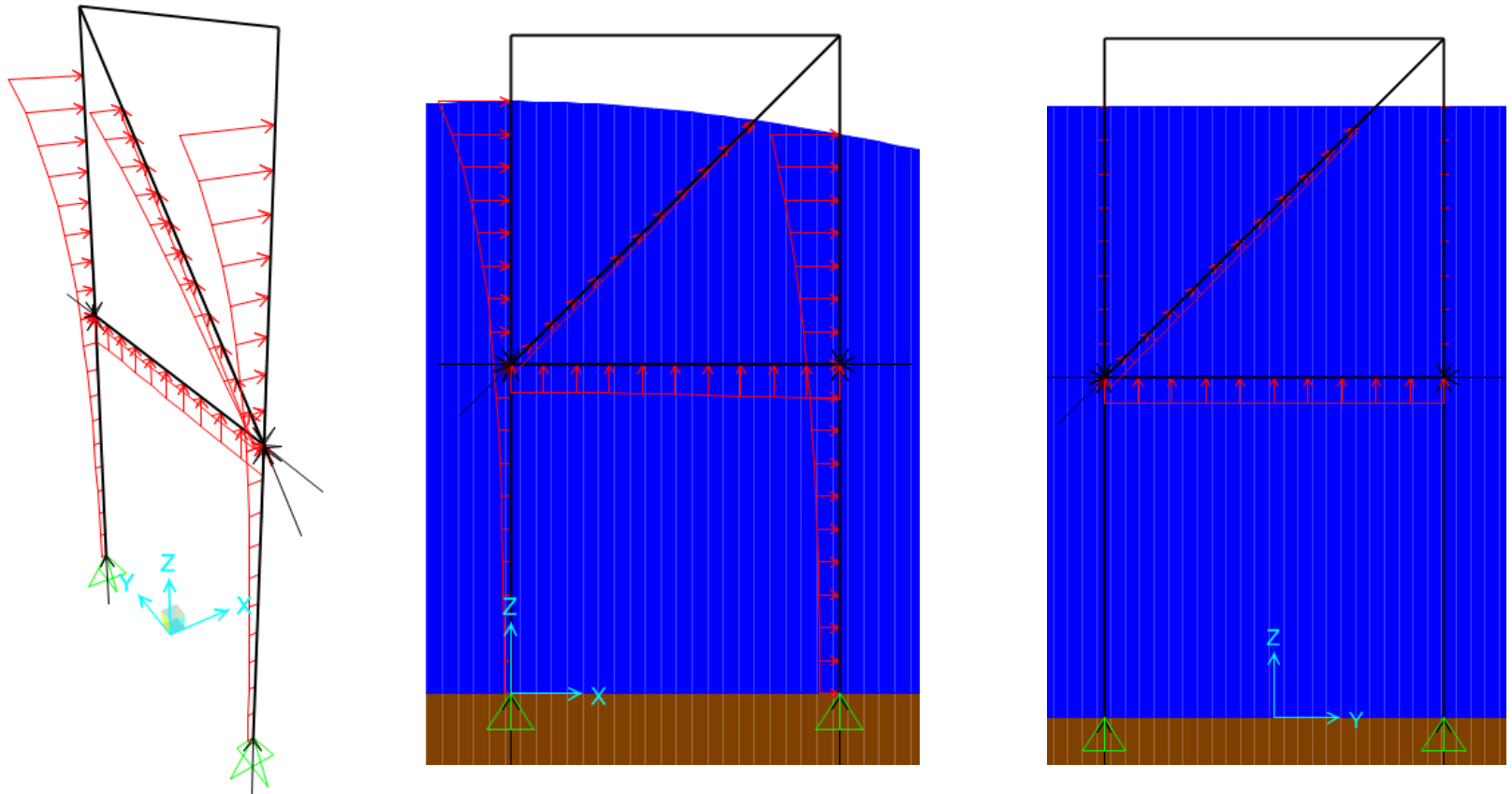
Show Joint Loads with Span Loads  
 Show Span Loading Values

OK Cancel

Wave Loading via SAP2000

# Wave Load on Structure

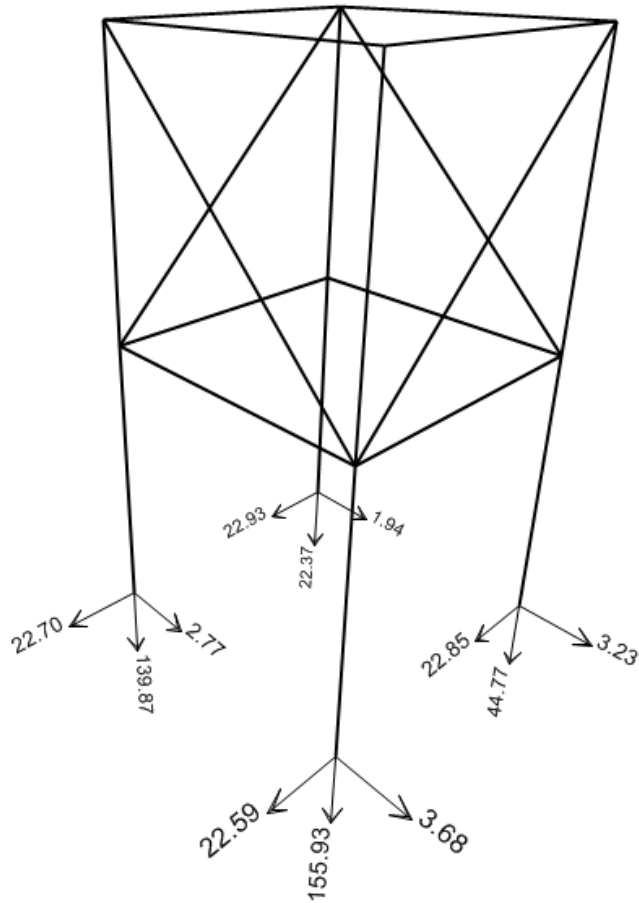
15



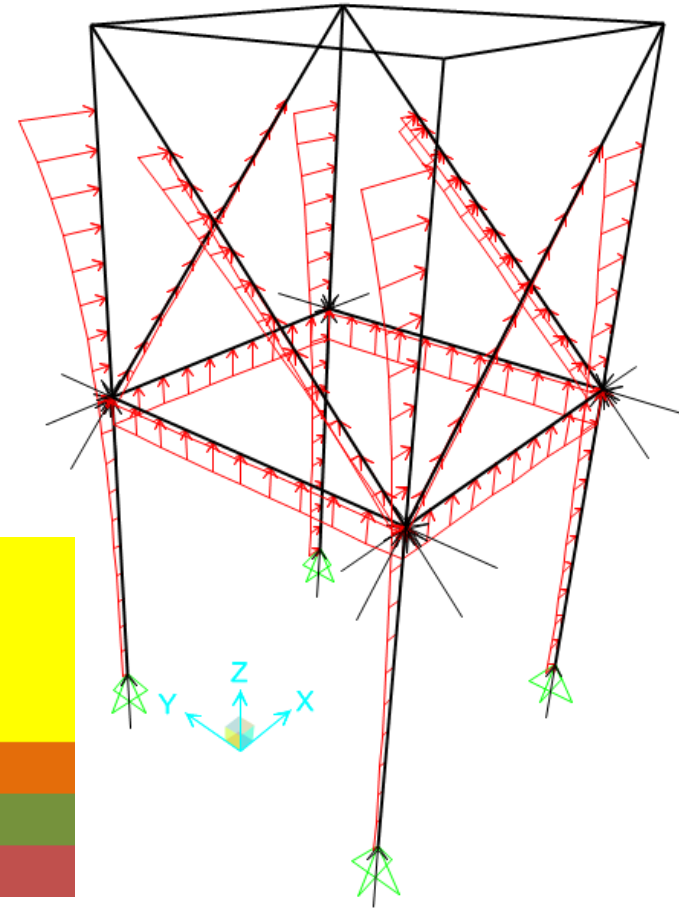
Wave Loading via SAP2000

# Wave Load on Structure

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F1=	22.93	lb
F2=	22.70	lb
F3=	22.59	lb
F4=	22.85	lb
Total=	91.07	lb
Dawson=	83.60	lb
Difference=	8.20	%

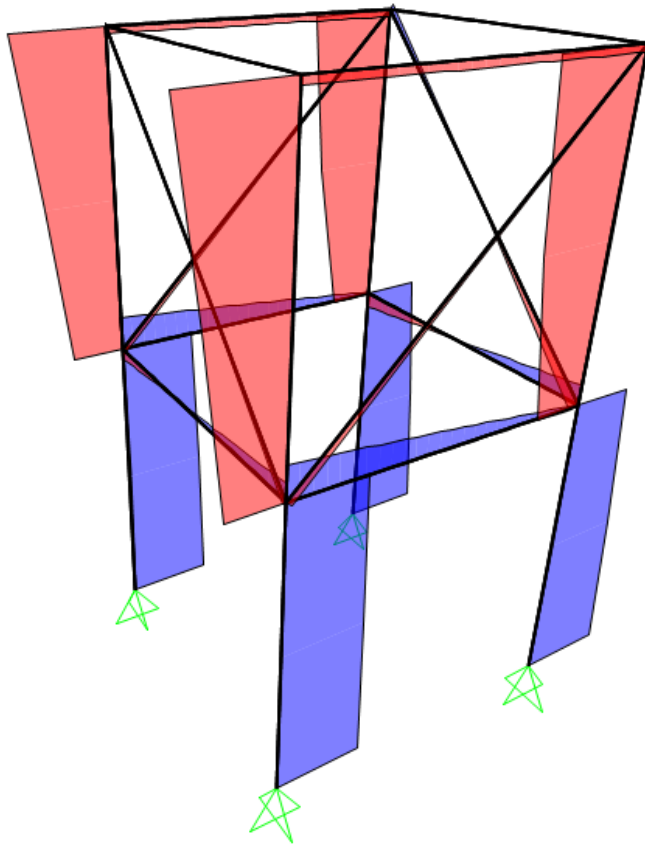


Wave Loading via SAP2000

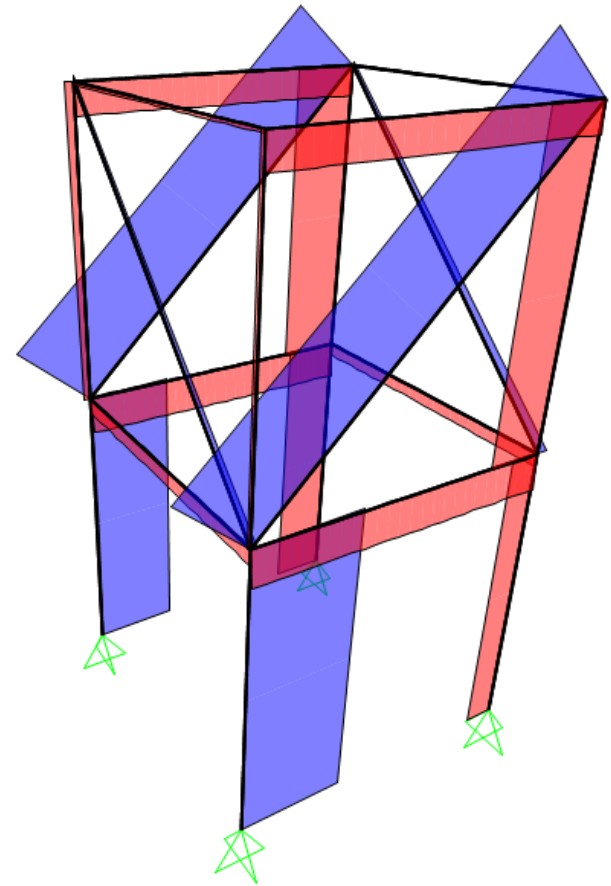


# Wave Load on Structure

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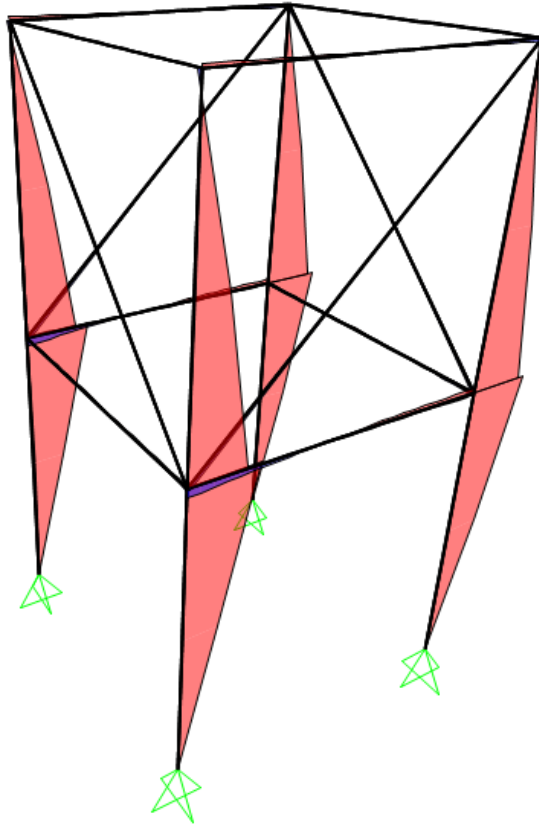
Shear Force



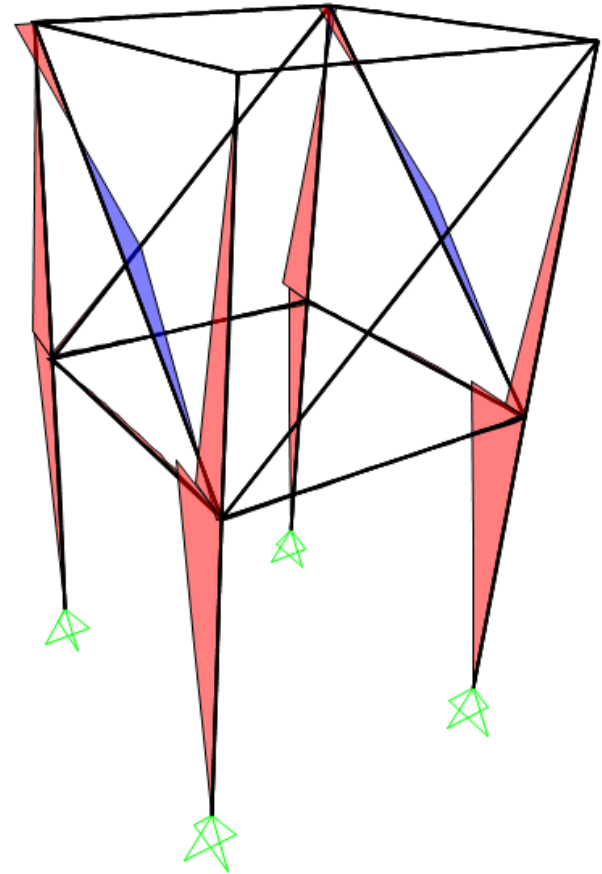
Axial Force

# Wave Load on Structure

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Bending Moment (3-3)



Bending Moment (2-2)