

ภาคผนวก 2-3

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รายการคำนวณตรวจสอบโครงสร้างหลังคาอาคาร

# ROOF STRUCTURE ANALYSIS



## Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Design by : Somchai Jirawattanakran

Building Name : Finishing and Coating Zone 503A-507

No : P.D.75810

### 1. Geometry Data

Simple Span Length	6.00	m.
Purlin Spacing ,S (@)	2.00	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load ,LL	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120	Kg./m <sup>2</sup>
Angle of Roof	1.7	Deg.

### 1.1 Criteria Properties

Allowable Tensile Stress	$F_b = 0.6F_y =$	2700	ksc.
Allowable Shear Stress	$F_v = 0.4F_y =$	1800	ksc.

### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120	Kg./m		
2.2 Wind Load ,S 2Pn.sin <sup>2</sup> ( $\theta + \sin^2 \theta$ ), Wd	=	14.4	Kg./m		
Wy = 120 cos1.718+Wd	=	134.3	Kg./m	Vy =	134.3 Kg
Wx = 120 sin1.718	=	3.6	Kg./m	Vx =	3.6 Kg
Mx = Wy.L <sup>2</sup> /8	=	604.4	Kg. m		
My = Wx.L <sup>2</sup> /8	=	16.2	Kg. m		
Wx.L <sup>2</sup> /32	=	-	Kg. m ( For Design Sag Rod at Mid Span)		
Required Sx = Mx/Fb	=	22.4	cm <sup>3</sup>		

### 3. Define Steel Member

Use Z20020 Galvanized Steel

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	4500	ksc.
width, bf =	7.4	cm	moment of inertia, Ix =	485.0	cm <sup>4</sup>
depth, d =	20.3	cm	Iy =	81.1	cm <sup>4</sup>
thick of web, tw =	0.20	cm	section modulus, Sx =	47.8	cm <sup>3</sup>
thick of flange, tf =	0.20	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	6.98	cm <sup>2</sup>	radius of gyration, rx =	8.4	cm
			weight, w =	5.74	kg/m

As the section modulus is more than the required section modulus, it is pass

### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress fb= Mx/Sx + 2My/Sy	=	1,529.7	ksc.
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress fv= Vx/At + Vy/Av	=	36.32	ksc.
As the actual shear stress is less than the allowable shear stress, it passed.			

### 5. Deflection Check

Allowable Deflection $\Delta_{allow} = L/180$	=	3.33	cm
Actual Deflection $\delta_{max} = 5W_y L^4 / 384EI$	=	2.23	cm.

As the actual deflection is less than the allowable deflection, it passed.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

## Reference Standard and Material Properties



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A Reference material in the structure of code AISC.1101-64 to AISC.1106-64

- Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc.

A Criteria for consideration

- Define Steel Member

If the Actual Section Modulus ( $S_{x,Actual}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x,Required}$ )

it PASSED

- Determine Tensile and Shearing Stress

If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress

it PASSED

If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress

it PASSED

- Deflection Check

If the Actual Deflection is less than ( $<$ ) the Allowable Deflection,

it PASSED



THE PERFECT GREEN ENERGY SOLUTION





# ROOF STRUCTURE ANALYSIS



## Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
Building Name : Finishing and Coating Zone 508

Design by : Somchai Jirawattanakran  
No : no.75810

### 1. Geometry Data

Simple Span Length	6.00	m.
Purlin Spacing ,S (@)	2.00	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load ,LL	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120	Kg./m <sup>2</sup>
Angle of Roof	1.7	Deg.

### 1.1 Criteria Properties

Allowable Tensile Stress	$F_b = 0.6F_y =$	2700	ksc.
Allowable Shear Stress	$F_v = 0.4F_y =$	1800	ksc.

### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120	Kg./m
2.2 Wind Load ,S.2Pn.sin <sup>2</sup> (1+sin <sup>2</sup> θ), Wd	=	14.4	Kg./m
Wy = 120 cos1.718+Wd	=	134.3	Kg./m
Wx = 120 sin1.718	=	3.6	Kg./m
Mx = Wy.L <sup>2</sup> /8	=	604.4	Kg.-m
My = Wx.L <sup>2</sup> /8	=	16.2	Kg.-m
Wx.L <sup>2</sup> /32	=	-	Kg.-m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	22.4	cm <sup>3</sup>

### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	4500	ksc.
width, bf =	7.4	cm	moment of inertia, Ix =	485.0	cm <sup>4</sup>
depth, d =	20.3	cm	Iy =	81.1	cm <sup>4</sup>
thick of web, tw =	0.20	cm	section modulus, Sx =	47.8	cm <sup>3</sup>
thick of flange, tf =	0.20	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	6.98	cm <sup>2</sup>	radius of gyration, rx =	8.4	cm
			weight, w =	5.74	kg/m

As the section modulus is more than the required section modulus, it is pass

### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	$f_b = M_x/S_x + 2M_y/S_y$	=	1,529.7	ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	$f_v = V_x/I_x + V_y/I_y$	=	36.32	ksc
As the actual shear stress is less than the allowable shear stress, it passed.				

### 5. Deflection Check

Allowable Deflection	$\Delta_{allow} = L/180$	=	3.33	cm.
Actual Deflection	$\delta_{max} = 5W_yL^4/384EI$	=	2.23	cm.

As the actual deflection is less than the allowable deflection, it passed.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

## Reference Standard and Material Properties



A Reference material in the structure of code **พ.ร.บ. 1101-64 to พ.ร.บ. 1106-64**

- Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc.

A Criteria for consideration

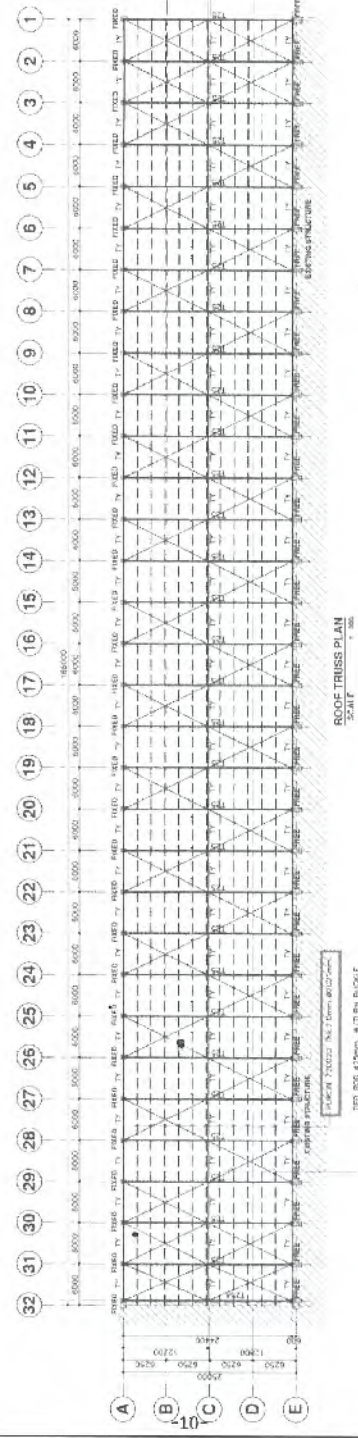
- Define Steel Member  
If the Actual Section Modulus ( $S_{x,actual}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x,required}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design

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## Reference Design



The Perfect Green Energy Solution™

## Solar PV Load

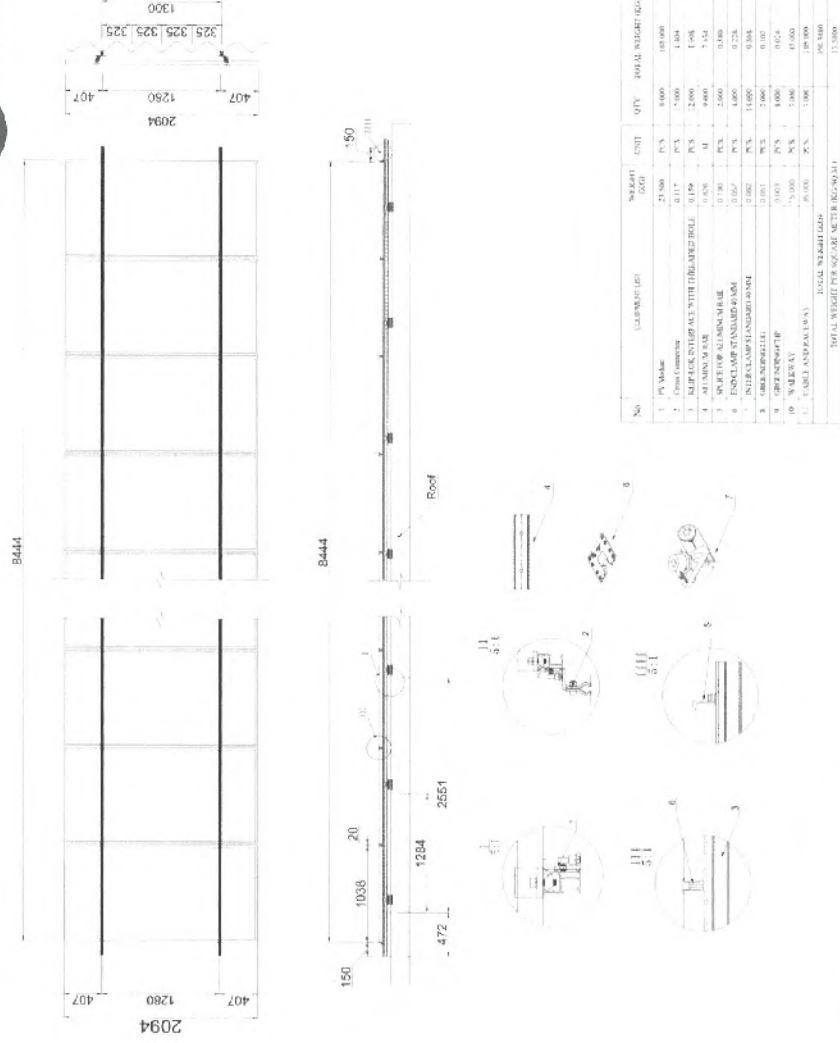
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## Solar PV Load

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# ROOF STRUCTURE ANALYSIS



## Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Design by : Somchai Jirawatlanakran

Building Name : Finishing and Coating Zone 511-513

No : ๓๑.75810

### 1. Geometry Data

Simple Span Length	6.00	m.
Purlin Spacing ,S (@)	2.00	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load ,LL	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120	Kg./m <sup>2</sup>
Angle of Roof	1.7	Deg.

### 1.1 Criteria Properties

Allowable Tensile Stress	$F_b = 0.6F_y =$	2,700	ksc.
Allowable Shear Stress	$F_v = 0.4F_y =$	1,800	ksc.

### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120	Kg./m
2.2 Wind Load ,S 2Pn.sin <sup>2</sup> (1+sin <sup>2</sup> ), Wd	=	14.4	Kg./m
Wy = 120 cos1.718-Wd	=	134.3	Kg./m
Wx = 120 sin1.718	=	3.6	Kg./m
Mx = Wy.L <sup>2</sup> /8	=	604.4	Kg.-m
My = Wx.L <sup>2</sup> /8	=	16.2	Kg.-m
Wx.L <sup>2</sup> /32	=	-	Kg.-m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	22.4	cm <sup>3</sup>

### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	4500	ksc.
width, b' =	7.4	cm	moment of inertia, Ix =	485.0	cm <sup>4</sup>
depth, d =	20.3	cm	Iy =	81.1	cm <sup>4</sup>
thick of web, tw =	0.20	cm	section modulus, Sx =	47.8	cm <sup>3</sup>
thick of flange, tf =	0.20	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	6.98	cm <sup>2</sup>	radius of gyration, rx =	8.4	cm
			weight, w =	5.74	kg/m

As the section modulus is more than the required section modulus, it is pass

### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	$f_b = M_x/S_x = 2M_y/S_y$	=	1,529.7	ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	$f_v = V_x/A_f + V_y/A_w$	=	36.32	ksc
As the actual shear stress is less than the allowable shear stress, it passed.				

### 5. Deflection Check

Allowable Deflection	$\Delta_{allow} = L/180$	=	3.33	cm.
Actual Deflection	$\delta_{max} = 5W_yL^4/384EI_b$	=	2.23	cm.
As the actual deflection is less than the allowable deflection, it passed.				

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

## Reference Standard and Material Properties

➤ Reference material in the structure of code **มผว. 1101-64 to มผว. 1106-64**

- Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc.

➤ Criteria for consideration

- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED



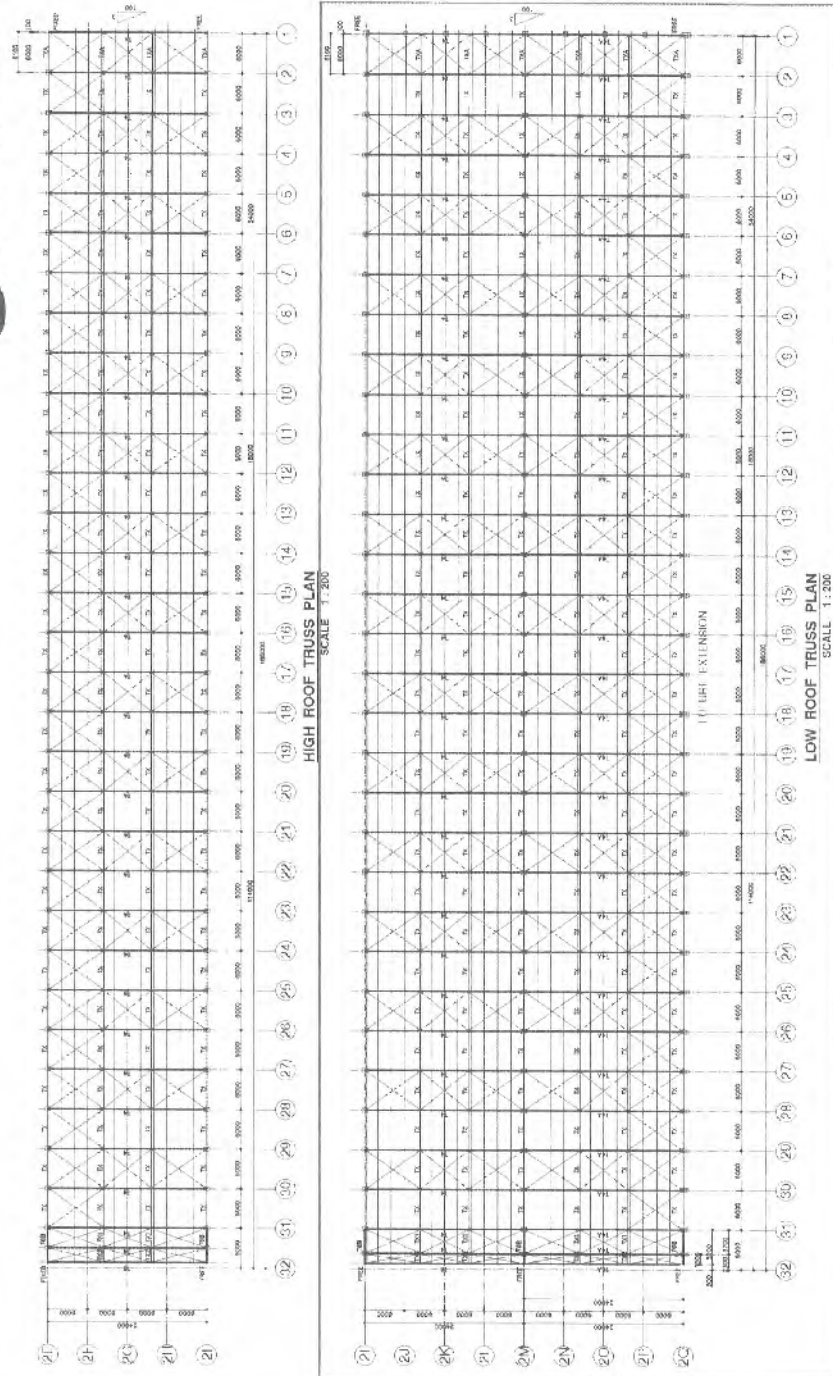


## Reference Design

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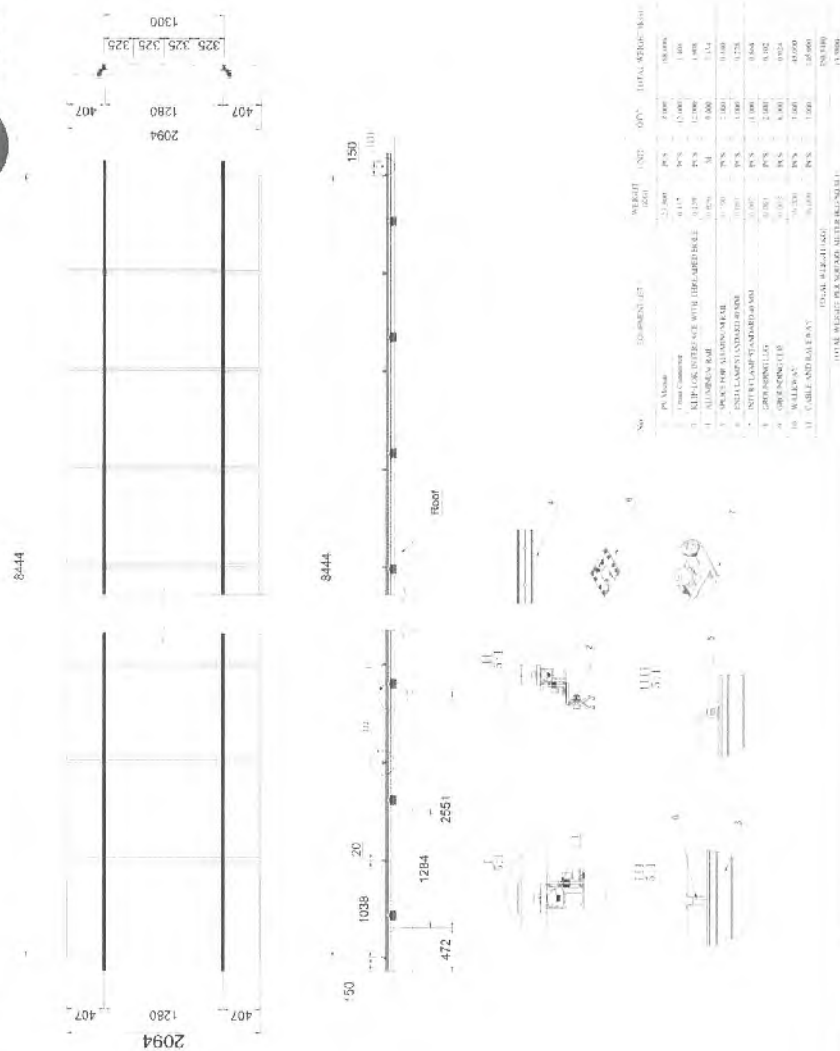
## Reference Design



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The Perfect Green Energy Solution\*





## ROOF STRUCTURE ANALYSIS



### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
 Building Name : Cold Rolling Zone 1CM

Design by : Somchai Jirawatjanakran  
 No : no.75810

#### 1. Geometry Data

Simple Span Length	6.00 m
Purlin Spacing ,S (@)	2.00 m
Dead load - Metal Sheet ,DL	5 Kg/m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg/m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg/m <sup>2</sup>
Live load ,LL	30 Kg/m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg/m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	2700	ksc
Allowable Shear Stress	Fv = 0.4Fy =	1800	ksc

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)XS	=	120	Kg/m
2.2 Wind Load S/2Pn sin(1+sin <sup>2</sup> θ) Wd	=	14.4	Kg/m
Wy = 120 cos 1.718 + Wd	=	134.3	Kg/m
Wx = 120 sin 1.718	=	3.6	Kg/m
Mx = Wy L <sup>2</sup> /8	=	604.4	Kg-m
My = Wx L <sup>2</sup> /8	=	16.2	Kg-m
Wx L <sup>2</sup> /32	=		Kg-m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	22.4	cm <sup>3</sup>

#### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	4500	ksc.
width, bf =	7.4	cm	moment of inertia, Ix =	485.0	cm <sup>4</sup>
depth, d =	20.3	cm	Iy =	81.1	cm <sup>4</sup>
thick of web, tw =	0.20	cm	section modulus, Sx =	47.8	cm <sup>3</sup>
thick of flange, tf =	0.20	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	6.98	cm <sup>2</sup>	radius of gyration, rx =	8.4	cm
			weight, w =	5.74	kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>t</sub> = Mx/Sx + 2My/Sy	=	1,529.7	ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/Af + Vy/Aw	=	36.32	ksc
As the actual shear stress is less than the allowable shear stress, it passed.				

#### 5. Deflection Check

Allowable Deflection	Δ <sub>allow</sub> = L/180	=	3.33	cm.
Actual Deflection	Δ <sub>max</sub> = 5W <sub>y</sub> L <sup>4</sup> /384Eb	=	2.23	cm.
As the actual deflection is less than the allowable deflection, it passed.				

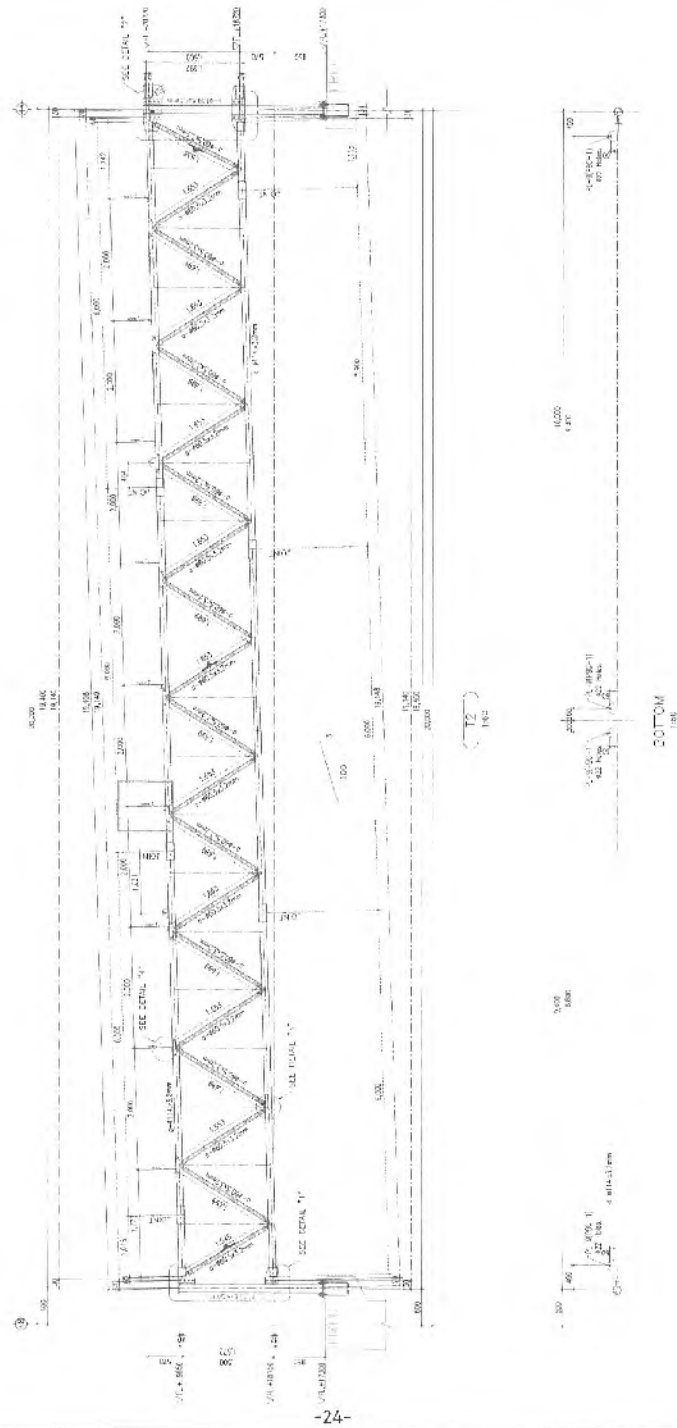
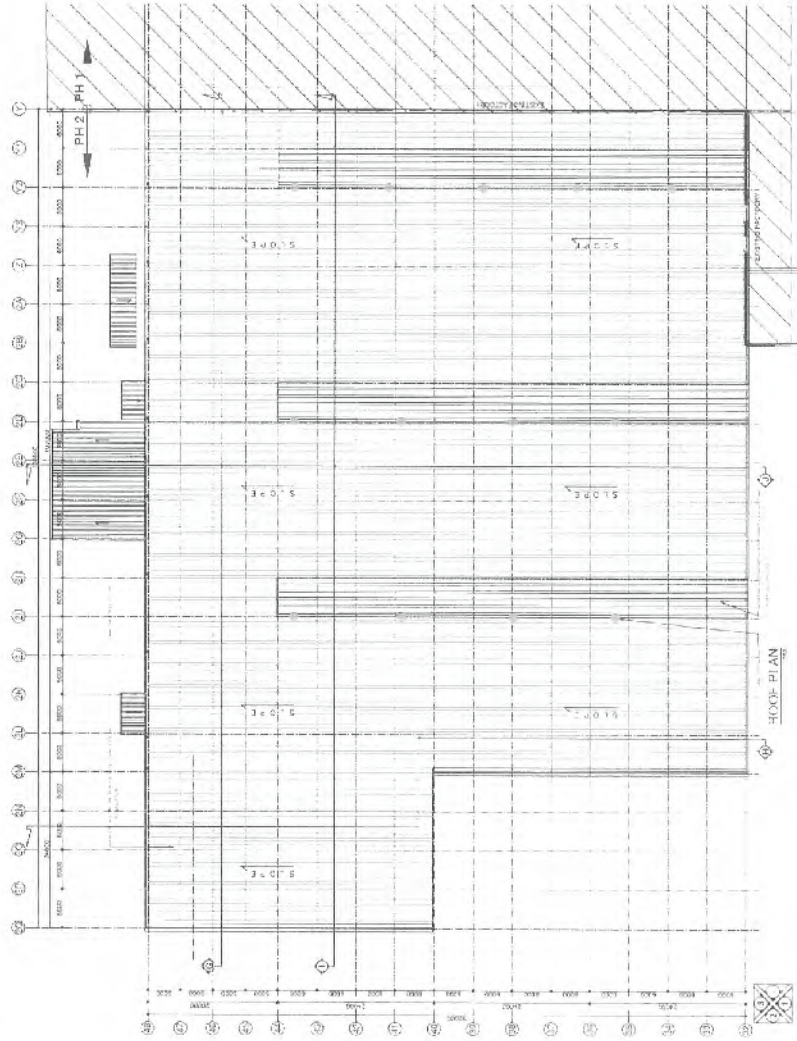
\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*



- Reference material in the structure of code **AS/NZS 1101-64 to AS/NZS 1106-64**
  - Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
  - Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc.
- Criteria for consideration
  - Define Steel Member  
If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it PASSED
  - Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

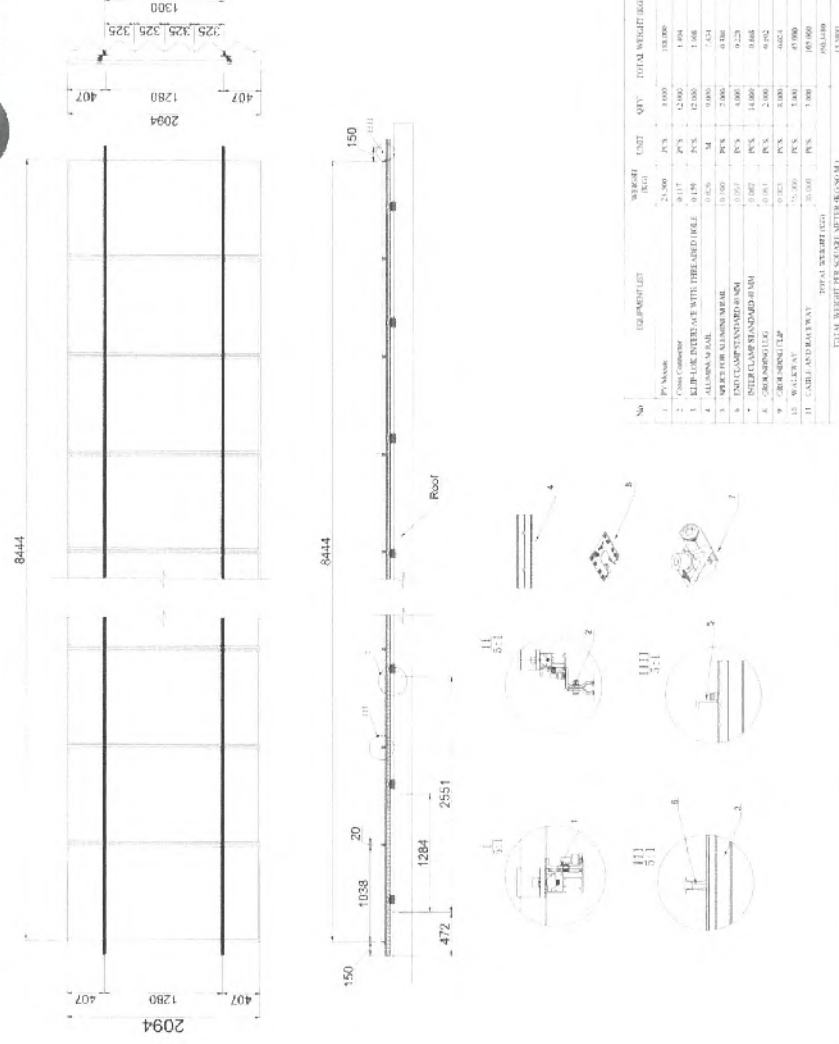
## Reference Design





## Solar PV Load

## Solar PV Load



# ROOF STRUCTURE ANALYSIS



## Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
Building Name : Cold Rolling Zone 2CM

Design by : Somchai Jirawattanakran  
No : no.75810

### 1. Geometry Data

Simple Span Length	6.00	m.
Purlin Spacing , S (@)	2.00	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load , Ll	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120	Kg./m <sup>2</sup>
Angle of Roof	1.7	Deg.

### 1.1 Criteria Properties

Allowable Tensile Stress	$F_b = 0.6F_y =$	2700	ksc.
Allowable Shear Stress	$F_v = 0.4F_y =$	1800	ksc.

### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120	Kg./m
2.2 Wind Load , $S.2Pn.\sin\theta/(1+\sin^2\theta)$ , Wd	=	14.4	Kg./m
Wy = $120 \cos 1.718 + Wd$	=	134.3	Kg./m
Wx = $120 \sin 1.718$	=	3.6	Kg./m
Mx = $Wy.L^2/8$	=	604.4	Kg.-m
My = $Wx.L^2/8$	=	16.2	Kg.-m
$Wx.L^2/32$	=	-	Kg.-m ( For Design Sag Rod at Mid Span)
Required Sx = $Mx/F_b$	=	22.4	cm <sup>3</sup>

### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity Es =	2,100,000	ksc.	Yield Strength, Fy =	4500	ksc.
width, bf =	7.4	cm	moment of inertia, Ix =	485.0	cm <sup>4</sup>
depth, d =	20.3	cm	Iy =	81.1	cm <sup>4</sup>
thick of web, tw =	0.20	cm	section modulus, Sx =	47.8	cm <sup>3</sup>
thick of flange, tf =	0.20	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	6.98	cm <sup>2</sup>	radius of gyration, rx =	8.4	cm
			weight, w =	5.74	kg/m

As the section modulus is more than the required section modulus, it is pass

### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	$f_b = Mx/Sx + 2My/Sy$	=	1,529.7	ksc.
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	$f_v = Vx/At + Vy/Aw$	=	36.32	ksc.
As the actual shear stress is less than the allowable shear stress, it passed.				

### 5. Deflection Check

Allowable Deflection	$\Delta_{allow} = L/180$	=	3.33	cm.
Actual Deflection	$\delta_{max} = 5W_y L^4 / 384EI_b$	=	2.23	cm.

As the actual deflection is less than the allowable deflection, it passed.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely \*\*\*

## Reference Standard and Material Properties



➤ Reference material in the structure of code มผช. 1101-64 to มผช. 1106-64

• Allowable Tensile Stress	$F_b = 0.6F_y =$	2,700	ksc.
• Allowable Shear Stress	$F_v = 0.4F_y =$	1,800	ksc.

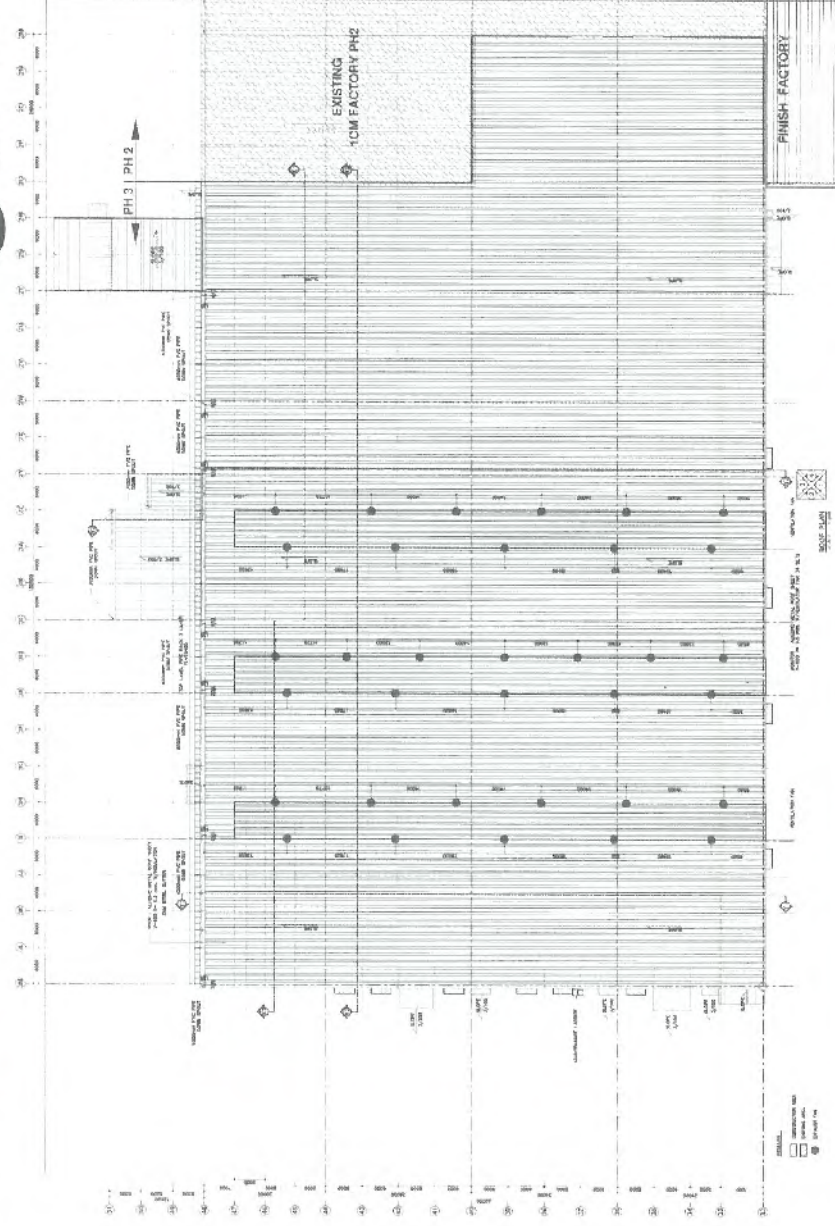
➤ Criteria for consideration

• Define Steel Member	If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ )	it PASSED
• Determine Tensile and Shearing Stress	If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress	it PASSED
	If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress	it PASSED
• Deflection Check	If the Actual Deflection is less than ( $<$ ) the Allowable Deflection,	it PASSED

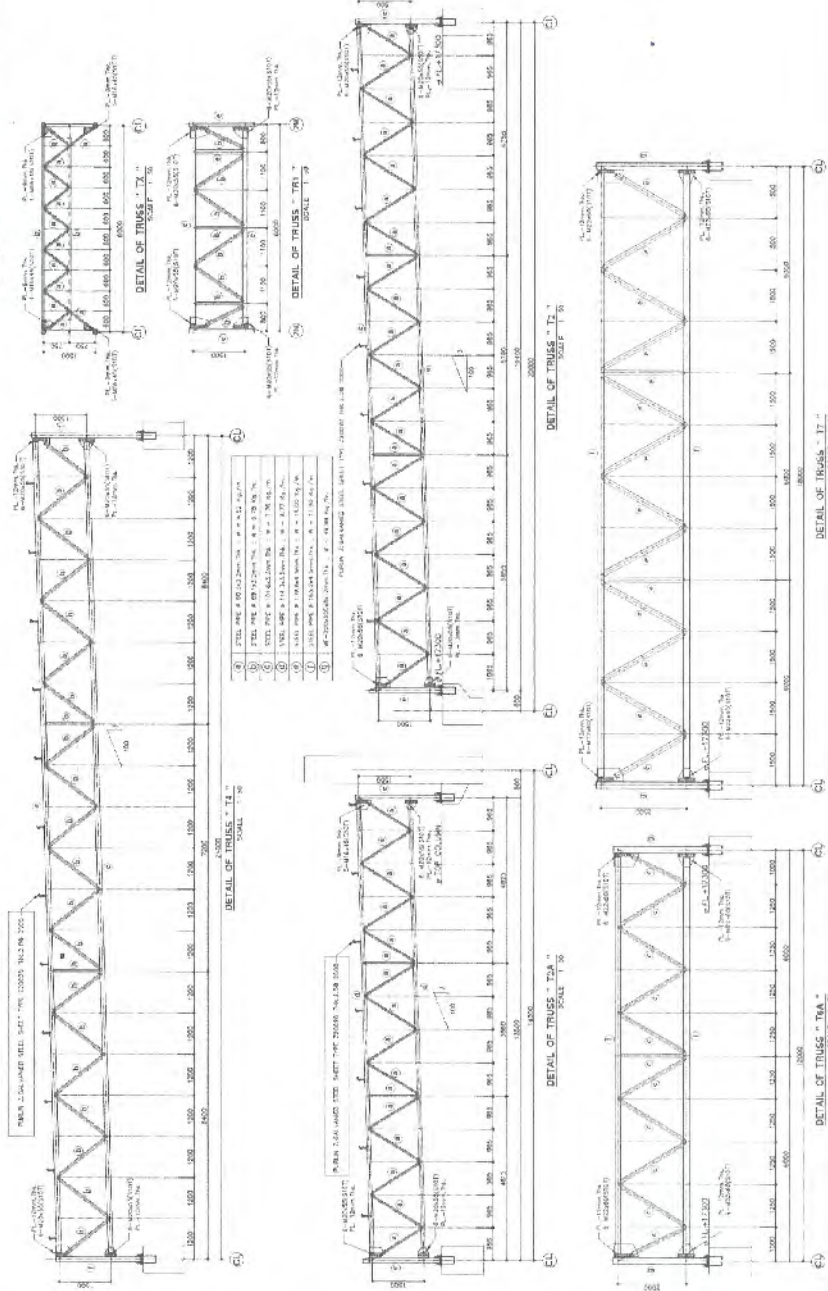


## Reference Design

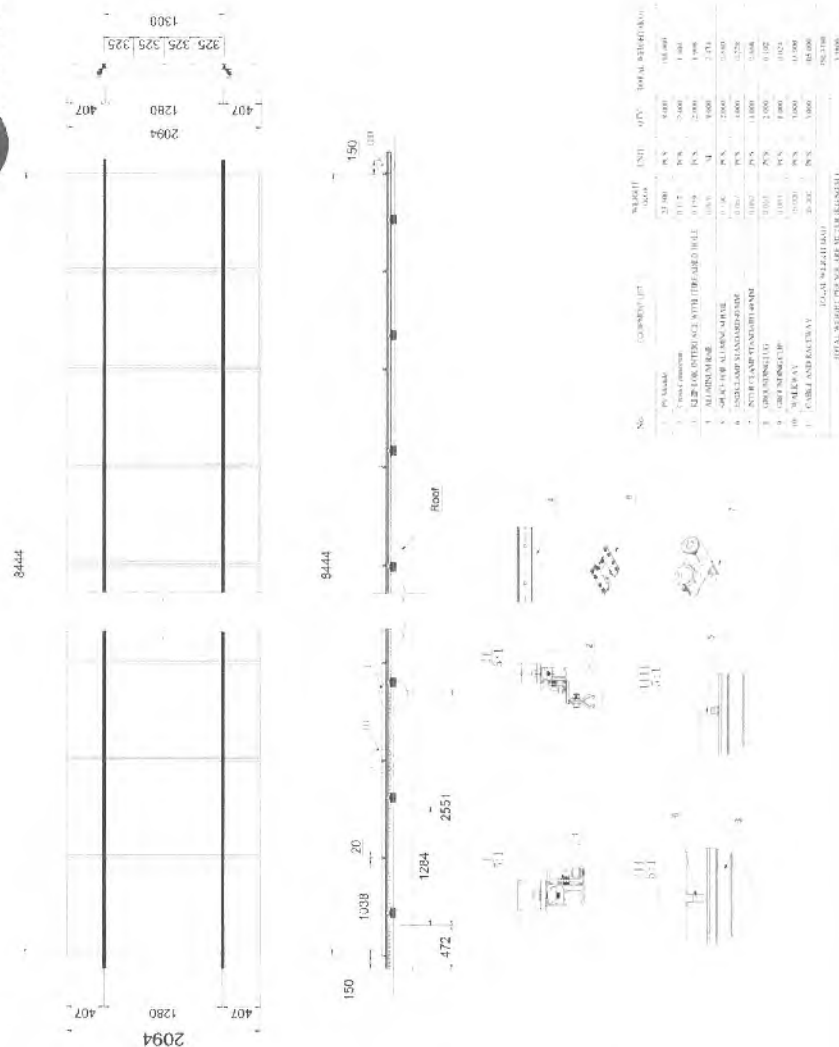
## Reference Design







## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
 Building Name : Cold Rolling Zone 4CA

Design by : Somchai Jirawattanakran  
 No : no.75810

#### 1. Geometry Data

Simple Span Length	6.00 m.
Purlin Spacing ,S (@)	2.00 m.
Dead load - Metal Sheet ,DL	5 Kg/m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg/m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg/m <sup>2</sup>
Live load ,LL	30 Kg/m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg/m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	2700 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	1800 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120 Kg/m	
2.2 Wind Load ,S.2Pn.sin(1+sin <sup>2</sup> θ), Wd	=	14.4 Kg/m	
Wy = 120 cos1.718+Wd	=	134.3 Kg/m	Vy = 134.3 Kg.
Wx = 120 sin1.718	=	3.6 Kg/m	Vx = 3.6 Kg.
Mx = Wy.L <sup>2</sup> /8	=	604.4 Kg.-m	
My = Wx.L <sup>2</sup> /8	=	16.2 Kg.-m	
Wx.L <sup>2</sup> /32	=	- Kg.-m ( For Design Sag Rod at Mid Span)	
Required Sx = Mx/Fb	=	22.4 cm <sup>3</sup>	

#### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity, Es =	2,100,000 ksc.	Yield Strength, Fy =	4500 ksc.
width, bf =	7.4 cm	moment of inertia, Ix =	485.0 cm <sup>4</sup>
depth, d =	20.3 cm	Iy =	81.1 cm <sup>4</sup>
thick of web, tw =	0.20 cm	section modulus, Sx =	47.8 cm <sup>3</sup>
thick of flange, tf =	0.20 cm	Sy =	12.2 cm <sup>3</sup>
section area, Ax =	6.98 cm <sup>2</sup>	radius of gyration, rx =	8.4 cm
		weight, w =	5.74 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>b</sub> = Mx/Sx + 2My/Sy	=	1,529.7 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/At + Vy/Aw	=	36.32 ksc
As the actual shear stress is less than the allowable shear stress, it passed.			

#### 5. Deflection Check

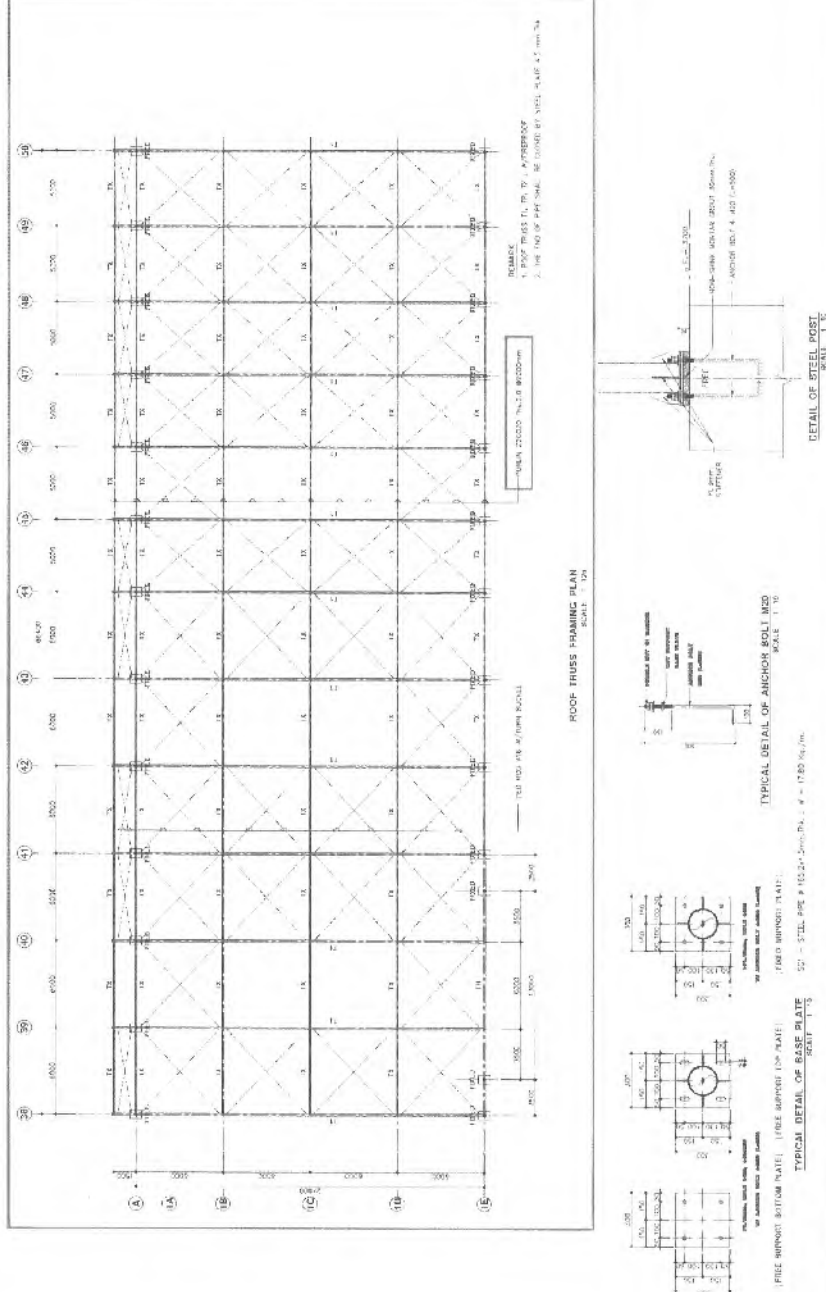
Allowable Deflection	Δ <sub>allow</sub> = L/180	=	3.33 cm.
Actual Deflection	δ <sub>max</sub> = 5W <sub>y</sub> L <sup>4</sup> /384EI	=	2.23 cm.

As the actual deflection is less than the allowable deflection, it passed.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

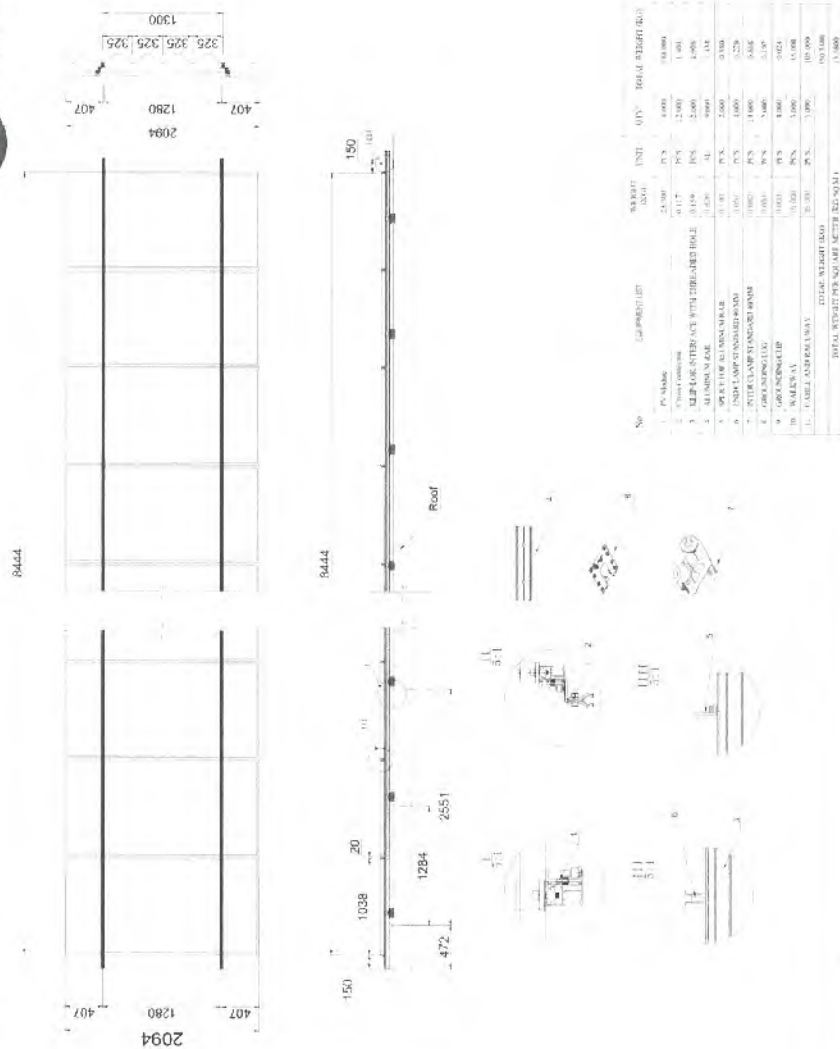
- Reference material in the structure of code **MEM.1101-64** to **MEM.1106-64**
  - Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
  - Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc.
- Criteria for consideration
  - Define Steel Member
    - If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $>=$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it PASSED
  - Determine Tensile and Shearing Stress
    - If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED
    - If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check
    - If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



## Solar PV Load





## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Building Name : Cold Rolling Zone 401-405, 501-502

Design by : Somchai Jirawatianakran

No : no.75810

#### 1. Geometry Data

Simple Span Length	6.25 m.
Purlin Spacing ,S (@)	2.00 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Ph	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	2700 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	1800 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120 Kg./m
2.2 Wind Load ,S 2Ph.sin(1+sin <sup>2</sup> ), Wd	=	14.4 Kg./m
Wy = 120 cos 1.718 + Wd	=	134.3 Kg.
Wx = 120 sin 1.718	=	3.6 Kg./m
Mx = Wy L <sup>2</sup> /8	=	655.8 Kg.-m
My = Wx L <sup>2</sup> /8	=	17.6 Kg.-m
Wx L <sup>2</sup> /32	=	Kg.-m (For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	24.3 cm <sup>3</sup>

#### 3. Define Steel Member

Use **Z20020 Galvanized Steel**

Steel Modulus of Elasticity, Es =	2,100,000 ksc.	Yield Strength, Fy =	4500 ksc.
width, bf =	7.4 cm	moment of inertia, Ix =	485.0 cm <sup>4</sup>
depth, d =	20.3 cm	Iy =	81.1 cm <sup>4</sup>
thick of web, tw =	0.20 cm	section modulus, Sx =	47.8 cm <sup>3</sup>
thick of flange, tf =	0.20 cm	Sy =	12.2 cm <sup>3</sup>
section area, Ax =	6.98 cm <sup>2</sup>	radius of gyration, rx =	8.4 cm
		weight, w =	5.74 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	fb = Mx/Sx + 2My/Sy	=	1,659.9 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress	fv = Vx/Af + Vy/Aw	=	36.32 ksc
As the actual shear stress is less than the allowable shear stress, it passed.			

#### 5. Deflection Check

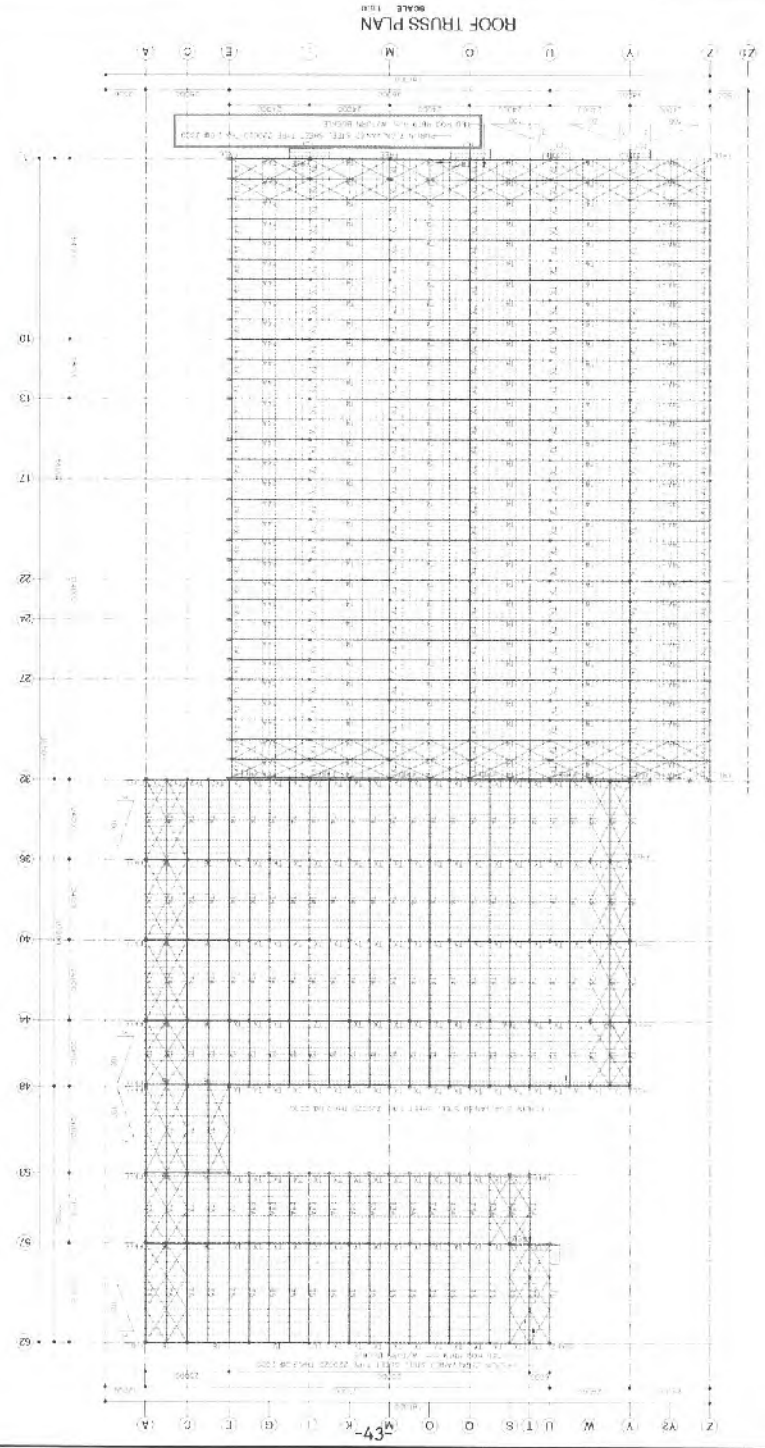
Allowable Deflection	Δ allow = L/180	=	3.47 cm.
Actual Deflection	δ max = 5W <sub>y</sub> L <sup>4</sup> /384EI	=	2.62 cm.

As the actual deflection is less than the allowable deflection, it passed.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

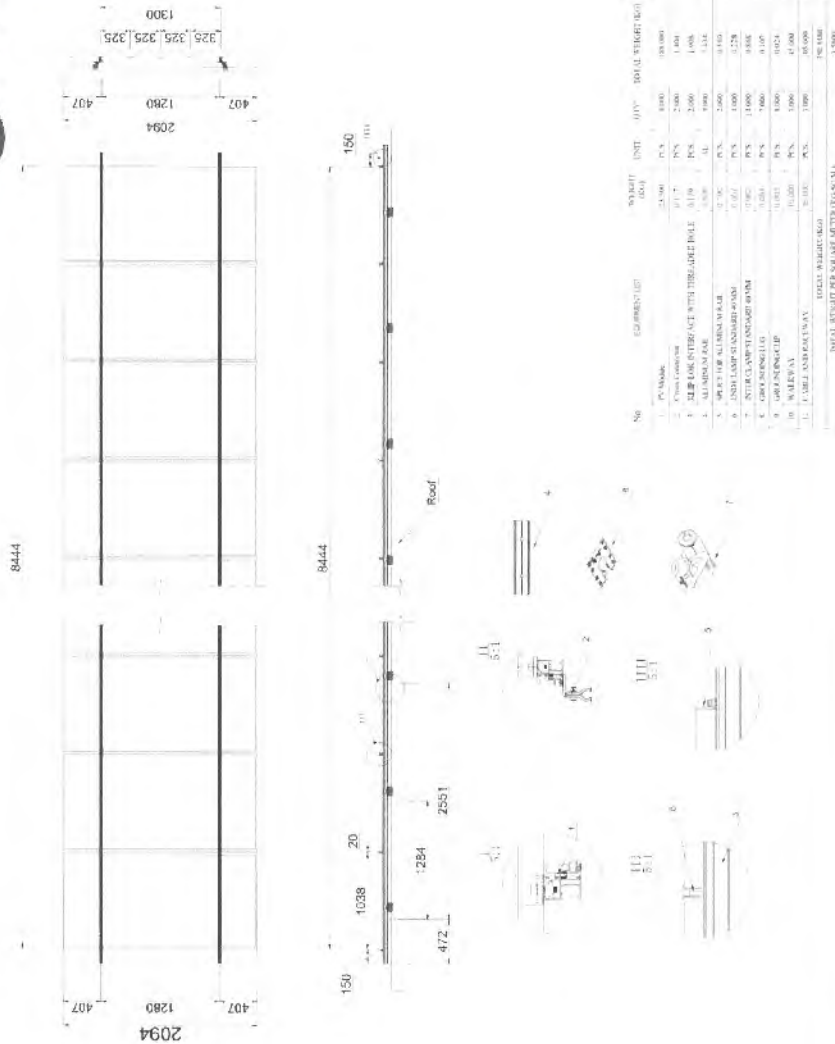
- Reference material in the structure of code **ASME 1101-64** to **ASME 1106-64**
  - Allowable Tensile Stress  $F_b = 0.6F_y = 2,700$  ksc.
  - Allowable Shear Stress  $F_v = 0.4F_y = 1,800$  ksc
- Criteria for consideration
  - Define Steel Member
    - If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
  - Determine Tensile and Shearing Stress
    - If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED
    - If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check
    - If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



# Solar PV Load





## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
Building Name : Hot Rolling Zone 207

Design by : Somchai Jirawattanakran  
No : 207.75810

#### 1. Geometry Data

Simple Span Length	6.00 m.
Purlin Spacing ,S (@)	1.50 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Ft = 0.6Fy =	1440 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	90 Kg./m
2.2 Wind Load ,S.2Pn.sinθ/(1+sin <sup>2</sup> θ), Wd	=	10.8 Kg./m
Wy = 90 cos1.72+Wd	=	100.7 Kg./m
Wx = 90 sin1.72	=	2.7 Kg./m
Mx = Wy.L <sup>2</sup> /8	=	453.4 Kg.-m
My = Wx.L <sup>2</sup> /8	=	12.1 Kg.-m
Wx.L <sup>2</sup> /32	=	- Kg.-m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	31.5 cm <sup>3</sup>

#### 3. Define Steel Member

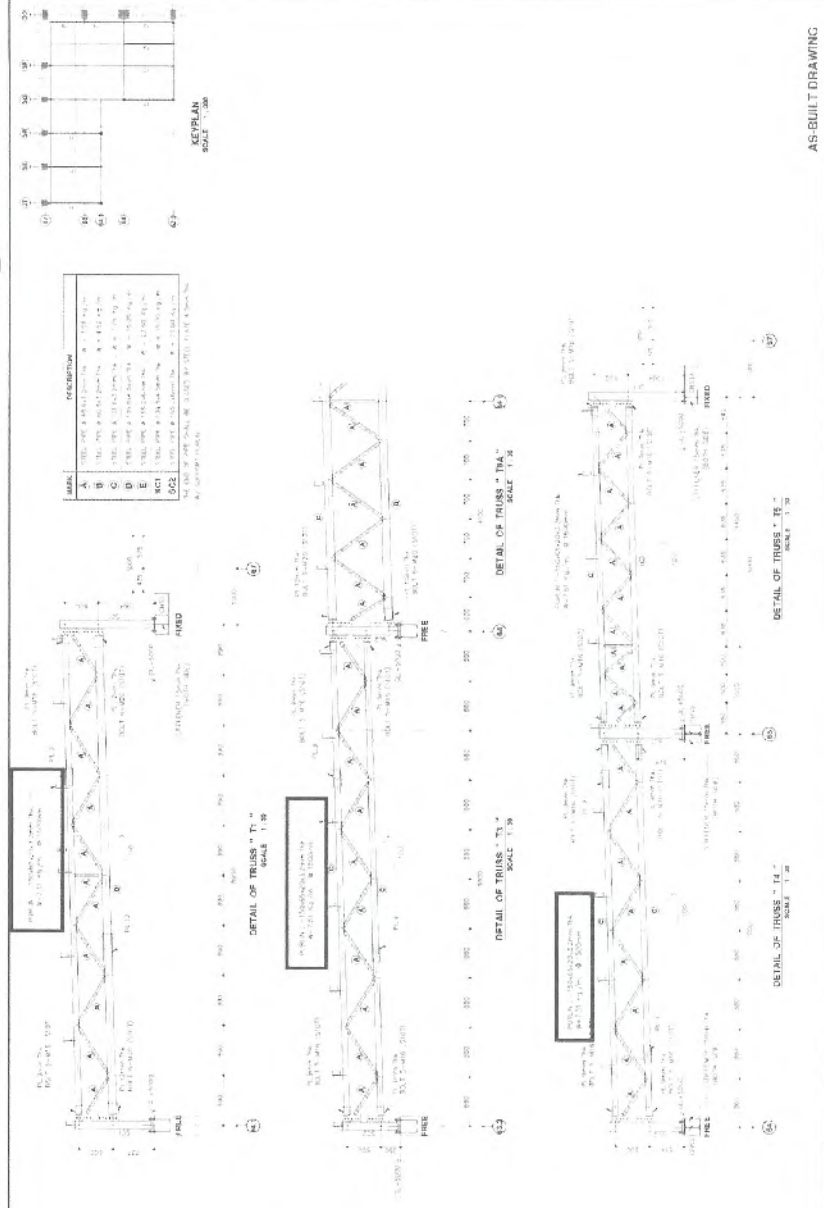
Use C 150x65x20x3.2

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	2400	ksc.
width, bf =	6.5	cm	moment of inertia, Ix =	332.0	cm <sup>4</sup>
depth, d =	15.0	cm	Iy =	53.8	cm <sup>4</sup>
thick of web, tw =	0.32	cm	section modulus, Sx =	44.3	cm <sup>3</sup>
thick of flange, tf =	0.32	cm	Sy =	12.2	cm <sup>3</sup>
section area, Ax =	9.57	cm <sup>2</sup>	radius of gyration, rx =	5.9	cm
			weight, w =	7.51	kg/m

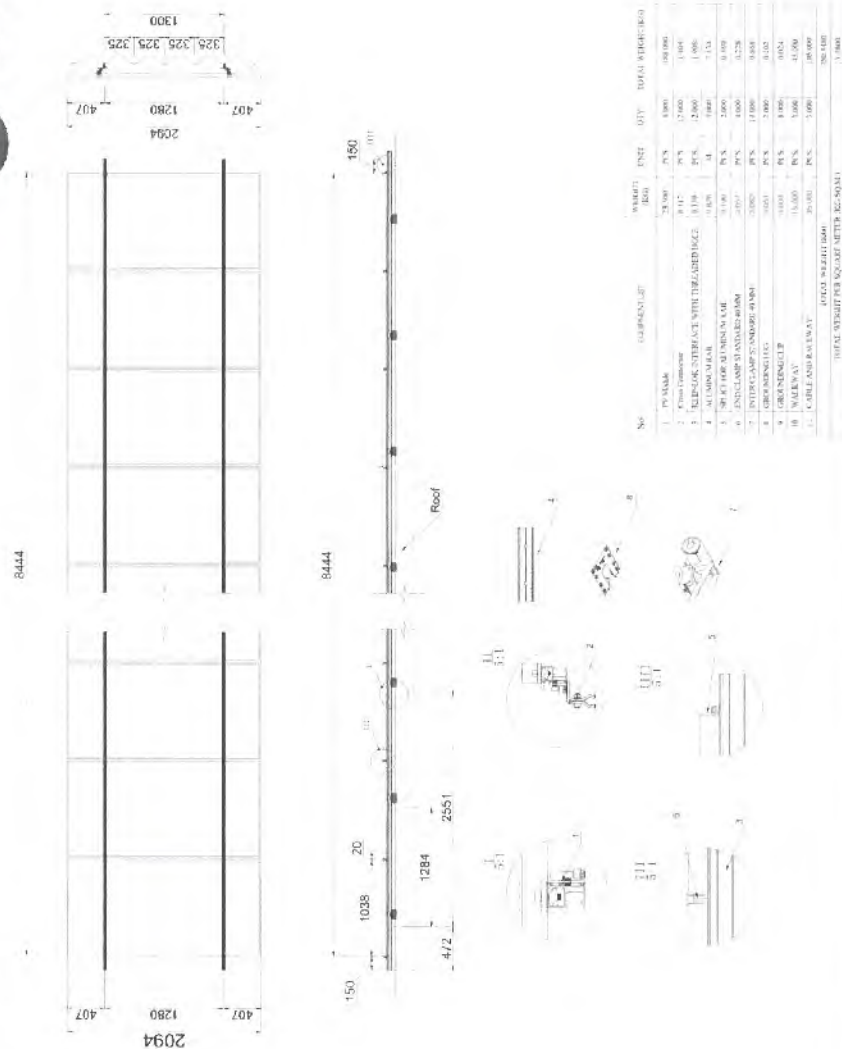


- Reference material in the structure of code  $\text{MFM.1101-64}$  to  $\text{MFM.1106-64}$
- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440 \text{ ksc.}$
  - Allowable Shear Stress  $F_v = 0.4F_y = 960 \text{ ksc.}$
- Criteria for consideration
- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{\text{Actual}}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{\text{Required}}}$ ) it PASSED
  - Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
 Building Name : Hot Rolling Zone 201-206 (Type P1B)

Design by : Somchai Jirawattanakran  
 No : 00.75810

#### 1. Geometry Data

Simple Span Length	5.00 m.
Purlin Spacing ,S (@)	2.00 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pw	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120 Kg./m
2.2 Wind Load ,S.2Pn.sin(1+sin <sup>2</sup> θ), Wd	=	14.4 Kg./m
Wy = 120 cos <sup>2</sup> .72+Wd	=	134.3 Kg./m
Wx = 120 sin <sup>2</sup> .72	=	3.6 Kg./m
Mx = Wy.L <sup>2</sup> /8	=	419.8 Kg.-m
My = Wx.L <sup>2</sup> /8	=	11.2 Kg.-m
Wx.L <sup>3</sup> /32	=	- Kg.-m (For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	29.2 cm <sup>3</sup>

#### 3. Define Steel Member

Use C 150x50x20x3.2

Steel Modulus of Elasticity, Es =	2,100,000 ksc.	Yield Strength, Fy =	2400 ksc.
width, bf =	5.0 cm	moment of inertia, Ix =	280.0 cm <sup>4</sup>
depth, d =	15.0 cm	Iy =	28.3 cm <sup>4</sup>
thick of web, tw =	0.32 cm	section modulus, Sx =	37.4 cm <sup>3</sup>
thick of flange, tf =	0.32 cm	Sy =	8.2 cm <sup>3</sup>
section area, Ax =	9.61 cm <sup>2</sup>	radius of gyration, rx =	5.7 cm
		weight, w =	6.76 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>t</sub> = Mx/Sx + 2My/Sy	=	1,397.2 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/At + Vy/Av	=	79.53 ksc
As the actual shear stress is less than the allowable shear stress, it passed.			

#### 5. Deflection Check

Allowable Deflection	Δ <sub>allow</sub> = L/180	=	2.78 cm.
Actual Deflection	δ <sub>max</sub> = 5W <sub>y</sub> L <sup>4</sup> /384EI	=	1.86 cm.
As the actual deflection is less than the allowable deflection, it is pass.			

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely.\*\*\*

➤ Reference material in the structure of code **ΣΕΠ.1101-64** to **ΣΕΠ.1106-64**

- Allowable Tensile Stress  $F_b = 0.6F_y = 1.440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

➤ Criteria for consideration

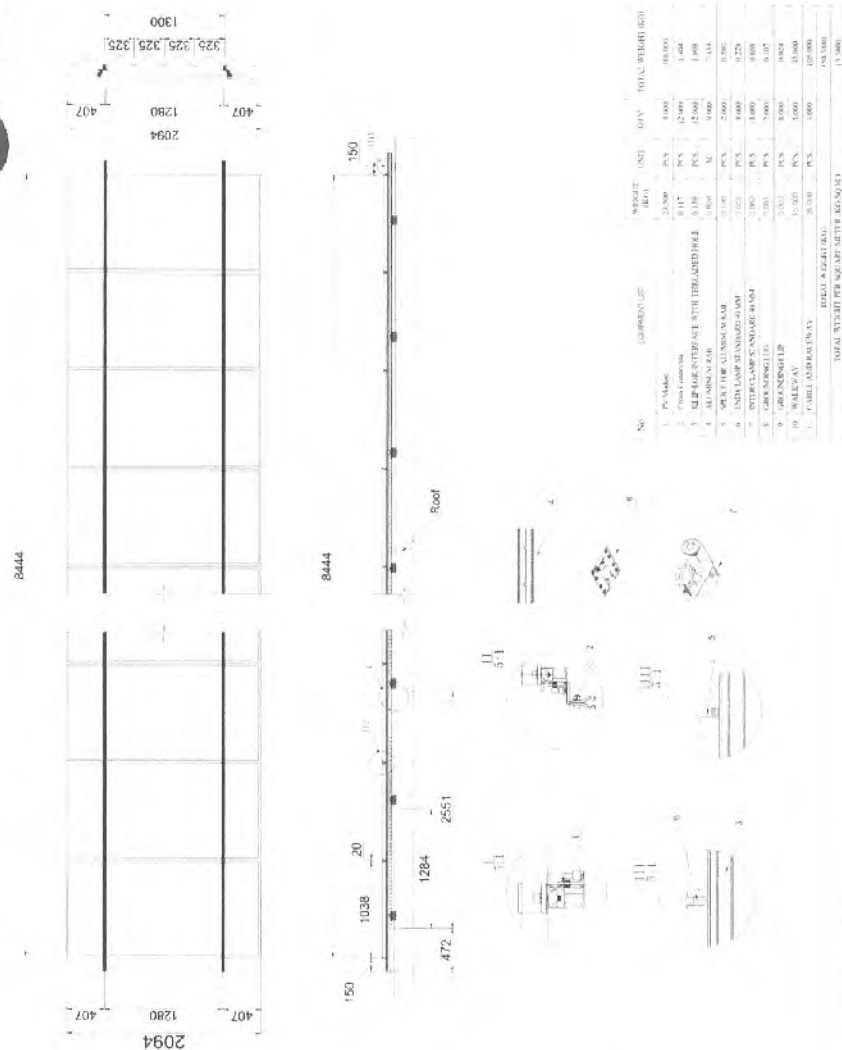
- Define Steel Member  
If the Actual Section Modulus ( $S_{x,actual}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x,required}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design





## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Building Name : Hot Rolling Zone 201-206 (Type P2A)

Design by : Sornchai Jirawattanakran

No : nn.75810

#### 1. Geometry Data

Simple Span Length	5.15 m
Purlin Spacing , S (@)	3.00 m
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440	ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960	ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	180	Kg./m
2.2 Wind Load , S.2Pn sin(1+sin <sup>2</sup> θ), Wd	=	21.6	Kg./m
Wy = 180 cos1.72+Wd	=	201.5	Kg./m
Wx = 180 sin1.72	=	5.4	Kg./m
Mx = Wy.L <sup>2</sup> /8	=	668.0	Kg. m
My = Wx.L <sup>2</sup> /8	=	17.9	Kg. m
Wx.L <sup>2</sup> /32	=	-	Kg. m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	46.4	cm <sup>3</sup>

#### 3. Define Steel Member

Use C 200x75x20x4

Steel Modulus of Elasticity, Es	=	2,100,000	ksc.
width, bf	=	7.5	cm
depth, d	=	20.0	cm
thick of web, tw	=	0.40	cm
thick of flange, tf	=	0.40	cm
section area, Ax	=	14.55	cm <sup>2</sup>
Yield Strength, Fy	=	2400	ksc.
moment of inertia, Ix	=	871.0	cm <sup>4</sup>
Iy	=	100.0	cm <sup>4</sup>
section modulus, Sx	=	87.1	cm <sup>3</sup>
Sy	=	18.9	cm <sup>3</sup>
radius of gyration, rx	=	7.7	cm
weight, w	=	11.40	kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>t</sub> = Mx/Sx + 2My/Sy	=	956.4	ksc.
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/Af + Vy/Aw	=	72.75	ksc.
As the actual shear stress is less than the allowable shear stress, it passed.				

#### 5. Deflection Check

Allowable Deflection	Δ <sub>allow</sub> = L/180	=	2.86	cm.
Actual Deflection	Δ <sub>max</sub> = 5W <sub>y</sub> L <sup>4</sup> /384EI <sub>x</sub>	=	1.01	cm.
As the actual deflection is less than the allowable deflection, it is pass.				

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

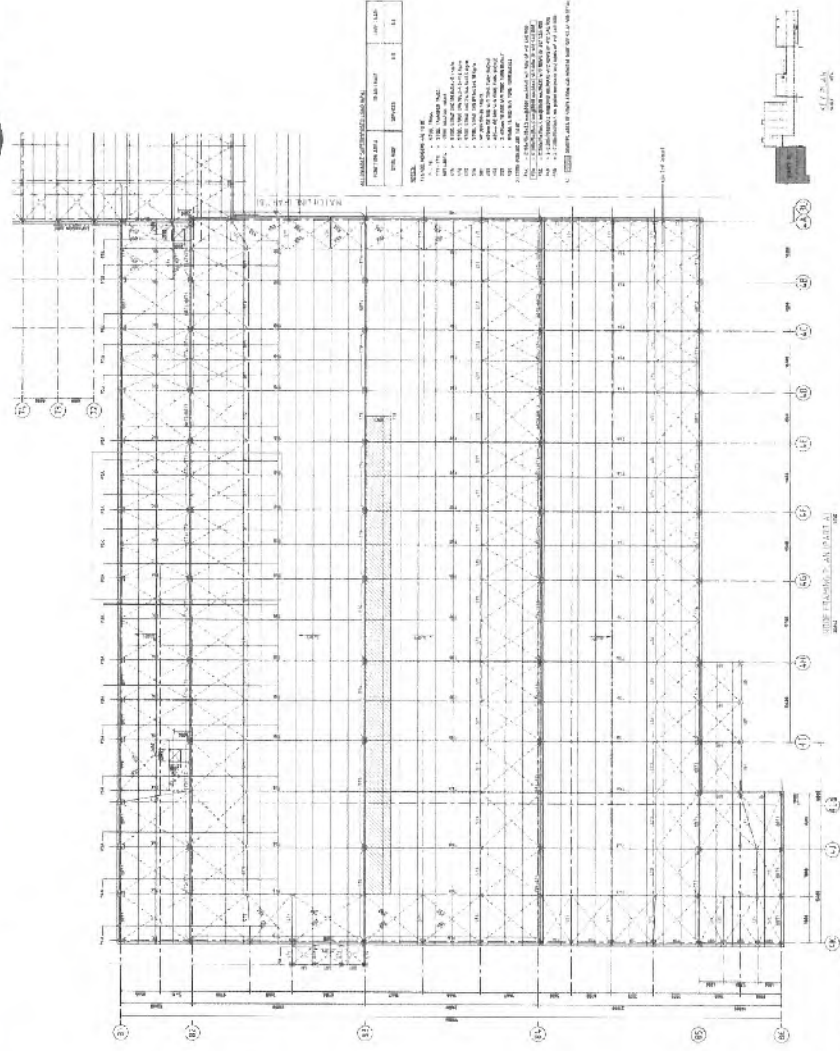
➤ Reference material in the structure of code **AS/NZS 1101-64 to AS/NZS 1106-64**

- Allowable Tensile Stress  $F_t = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc

➤ Criteria for consideration

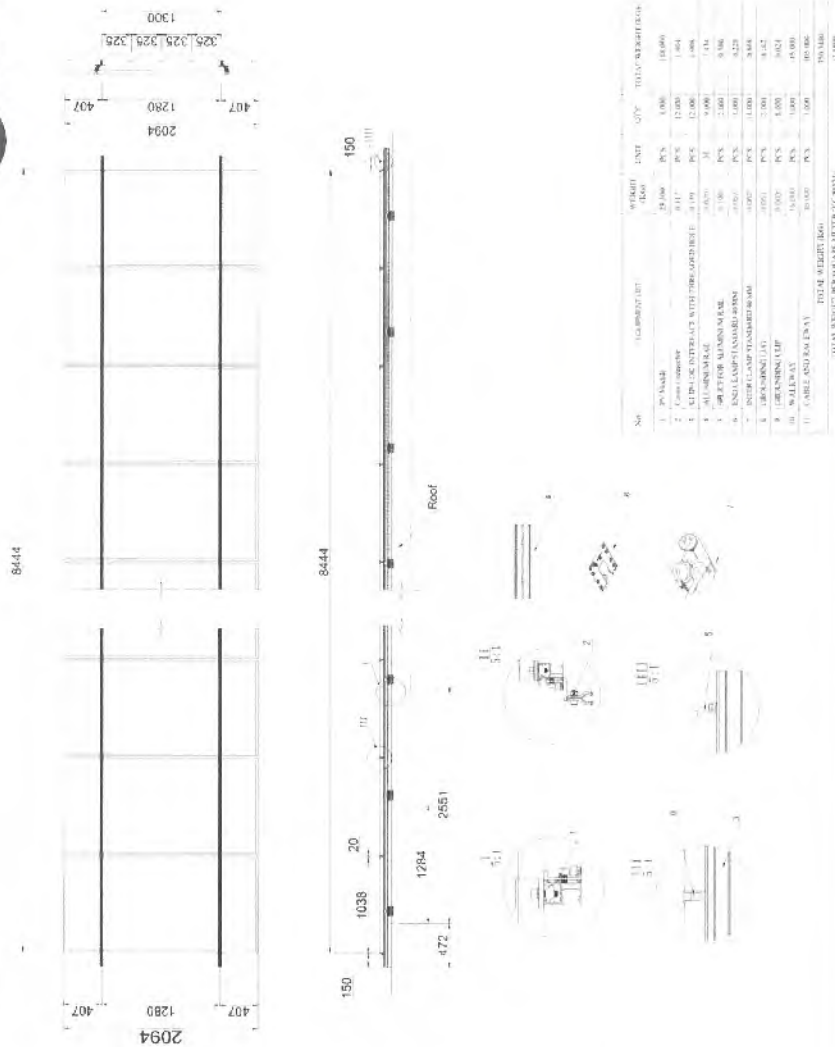
- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it **PASSED**
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it **PASSED**  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it **PASSED**
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it **PASSED**

## Reference Design



## Solar PV Load





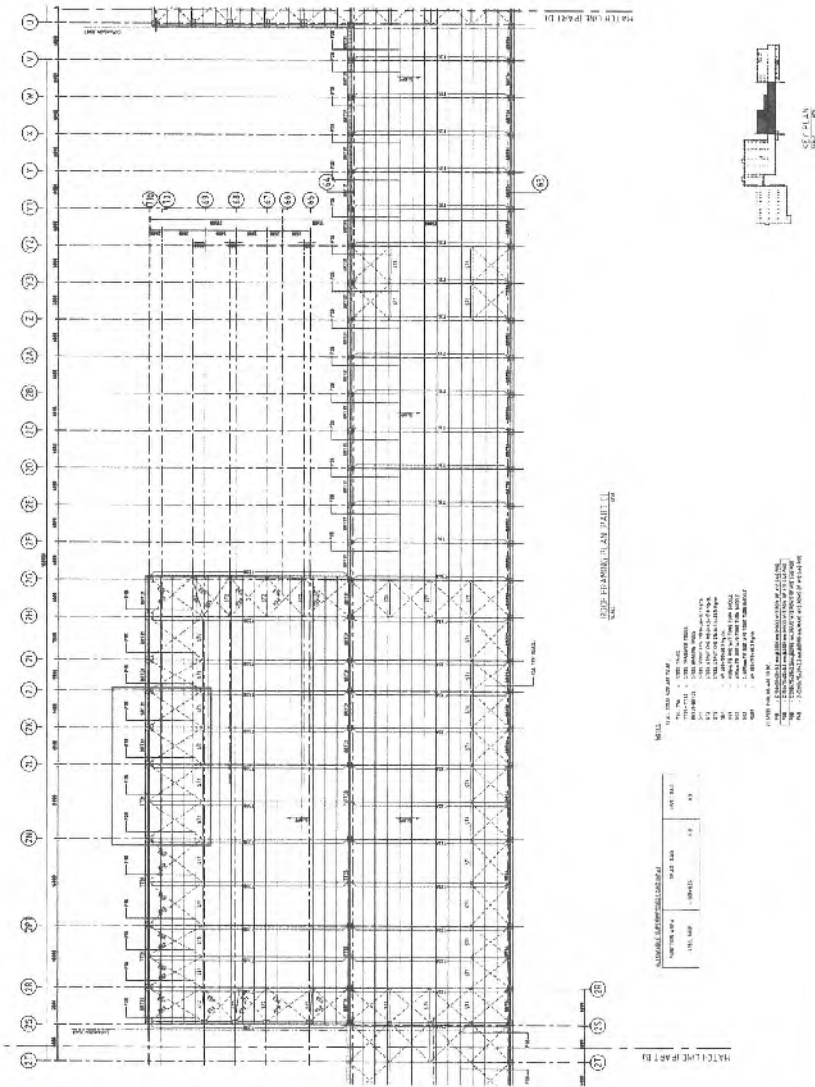
➤ Reference material in the structure of code  $\Sigma \Pi \Pi \Pi$ . 1101-64 to  $\Sigma \Pi \Pi \Pi$ . 1106-64

- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

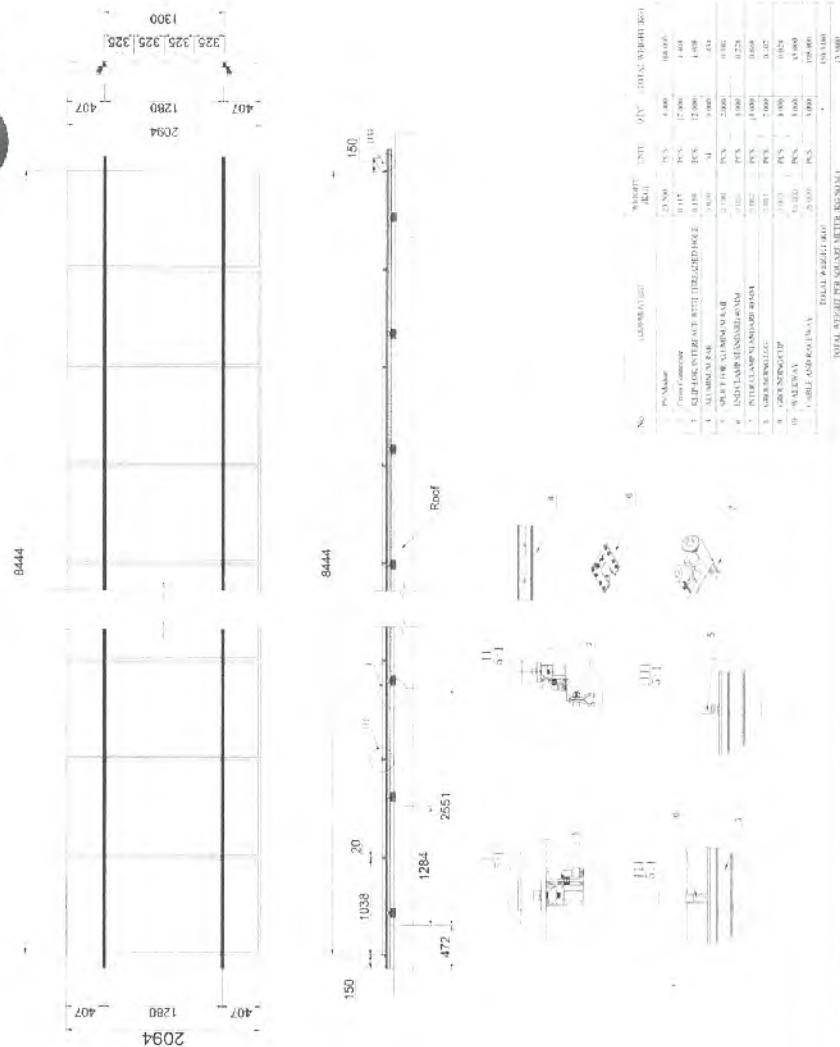
➤ Criteria for consideration

- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Design by : Somchai Jirawattanakran

Building Name : Hot Rolling Zone 201 206 (Type P3A)

No : no.75810

#### 1. Geometry Data

Simple Span Length	6.35	m.
Purlin Spacing ,S (@)	3.00	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load ,LL	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120	Kg./m <sup>2</sup>
Angle of Roof	1.7	Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440	ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960	ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	180	Kg./m
2.2 Wind Load ,S 2Pn sin <sup>2</sup> (1-sin <sup>2</sup> θ), Wd	=	21.8	Kg./m
Wx = 180 cos 1.72 + Wd	=	201.5	Kg./m
Wx = 180 sin 1.72	=	5.4	Kg./m
Mx = Wy L <sup>2</sup> /8	=	1015.6	Kg.-m
My = Wx L <sup>2</sup> /8	=	27.2	Kg.-m
Wx L <sup>2</sup> /32	=	-	Kg.-m (For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	70.5	cm <sup>3</sup>

#### 3. Define Steel Member

Use **C 200x75x20x4.5**

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	2400	ksc.
width, bf =	7.5	cm	moment of inertia, Ix =	963.0	cm <sup>4</sup>
depth, d =	20.0	cm	Iy =	109.0	cm <sup>4</sup>
thick of web, tw =	0.45	cm	section modulus, Sx =	96.3	cm <sup>3</sup>
thick of flange, tf =	0.45	cm	Sy =	20.6	cm <sup>3</sup>
section area, Ax =	16.22	cm <sup>2</sup>	radius of gyration, rx =	7.7	cm
			weight, w =	12.70	kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

$$4.1 \text{ Actual Tensile Stress } f_t = M_x / S_x + 2M_y / S_y = 1,318.9 \text{ ksc}$$

As the actual tensile stress is less than the allowable tensile stress, it passed.

$$4.2 \text{ Actual Shear Stress } f_v = V_x / A_t + V_y / A_w = 80.21 \text{ ksc}$$

As the actual shear stress is less than the allowable shear stress, it passed.

#### 5. Deflection Check

$$\text{Allowable Deflection } \Delta_{\text{allow}} = L/180 = 3.53 \text{ cm.}$$

$$\text{Actual Deflection } \delta_{\text{max}} = 5W_y L^4 / 384EI = 2.11 \text{ cm.}$$

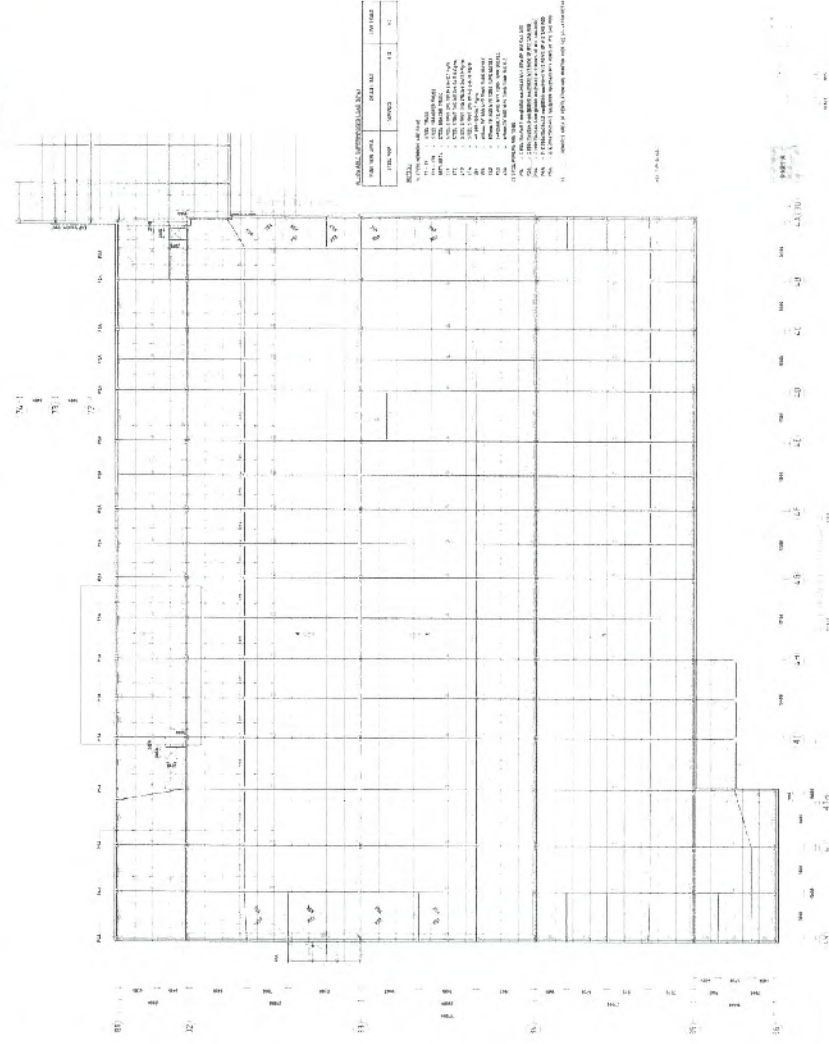
As the actual deflection is less than the allowable deflection, it is pass.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*



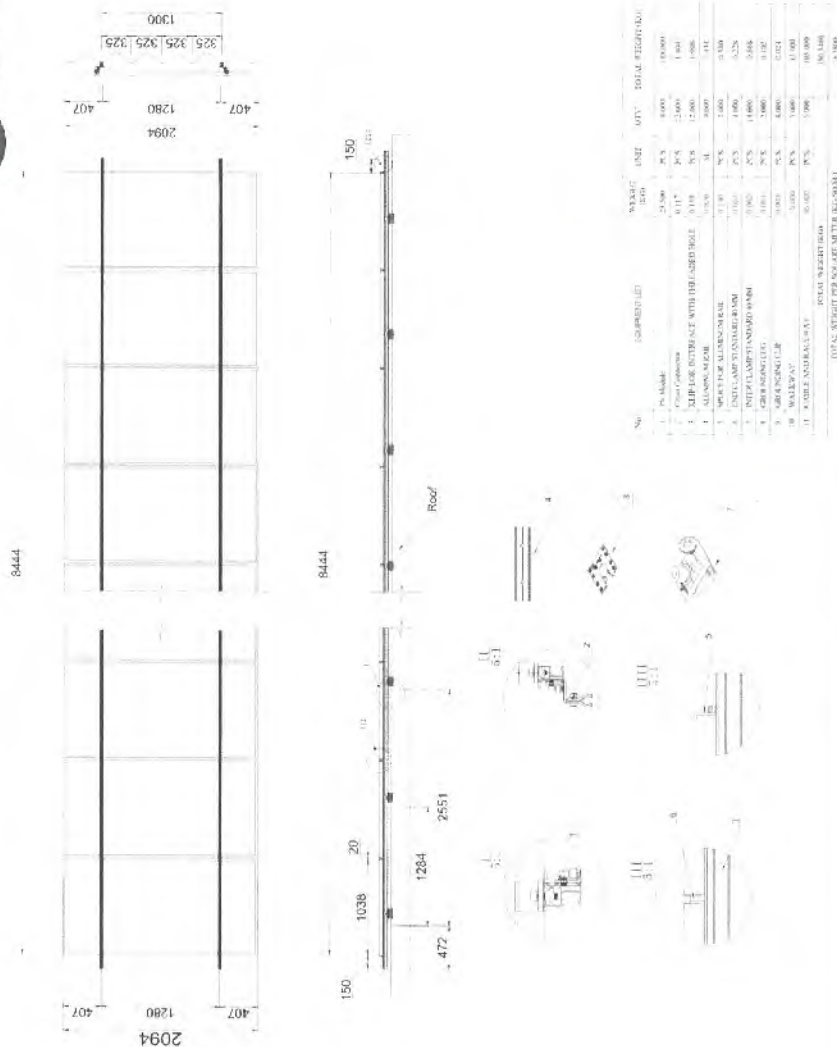
- Reference material in the structure of code **норм. 1101-64 to ннн 1106-64**
  - Allowable Tensile Stress  $F_b = 0.6F_y = 1.440$  ksc.
  - Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.
- Criteria for consideration
  - Define Steel Member  
If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
  - Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



"The Perfect Green Energy Solution"

## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Design by : Somchai Jirawattanakran

Building Name : Hot Rolling Zone 201-206 (Type P3B)

No : no.75810

#### 1. Geometry Data

Simple Span Length	7.00 m.
Purlin Spacing ,S (@)	2.00 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	120 Kg./m
2.2 Wind Load S.2Pn.sin <sup>2</sup> (1+sin <sup>2</sup> ), Wd	=	14.4 Kg./m
Wy = 120 cos 1.72 + Wd	=	134.3 Kg./m
Wx = 120 sin 1.72	=	3.6 Kg./m
Mx = Wy.L <sup>2</sup> /8	=	822.8 Kg.-m
My = Wx.L <sup>2</sup> /8	=	22.0 Kg.-m
Wx.L <sup>2</sup> /32	=	Kg.-m (For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	57.1 cm <sup>3</sup>

#### 3. Define Steel Member

Use C 200x75x20x3.2

Steel Modulus of Elasticity, Es =	2,100,000 ksc.	Yield Strength, Fy =	2400 ksc.
width, bf =	7.5 cm	moment of inertia, Ix =	716.0 cm <sup>4</sup>
depth, d =	20.0 cm	Iy =	64.1 cm <sup>4</sup>
thick of web, tw =	0.32 cm	section modulus, Sx =	71.6 cm <sup>3</sup>
thick of flange, tf =	0.32 cm	Sy =	15.8 cm <sup>3</sup>
section area, Ax =	11.81 cm <sup>2</sup>	radius of gyration rx =	7.8 cm
		weight, w =	9.27 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress fb= Mx/Sx + 2My/Sy	=	1,428.3 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.		
4.2 Actual Shear Stress fv= Vx/At + Vy/Av	=	81.63 ksc
As the actual shear stress is less than the allowable shear stress, it passed.		

#### 5. Deflection Check

Allowable Deflection Δ allow = L/180	=	3.89 cm.
Actual Deflection δ max = 5Wyl <sup>4</sup> /384EI	=	2.79 cm.

As the actual deflection is less than the allowable deflection, it is pass.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

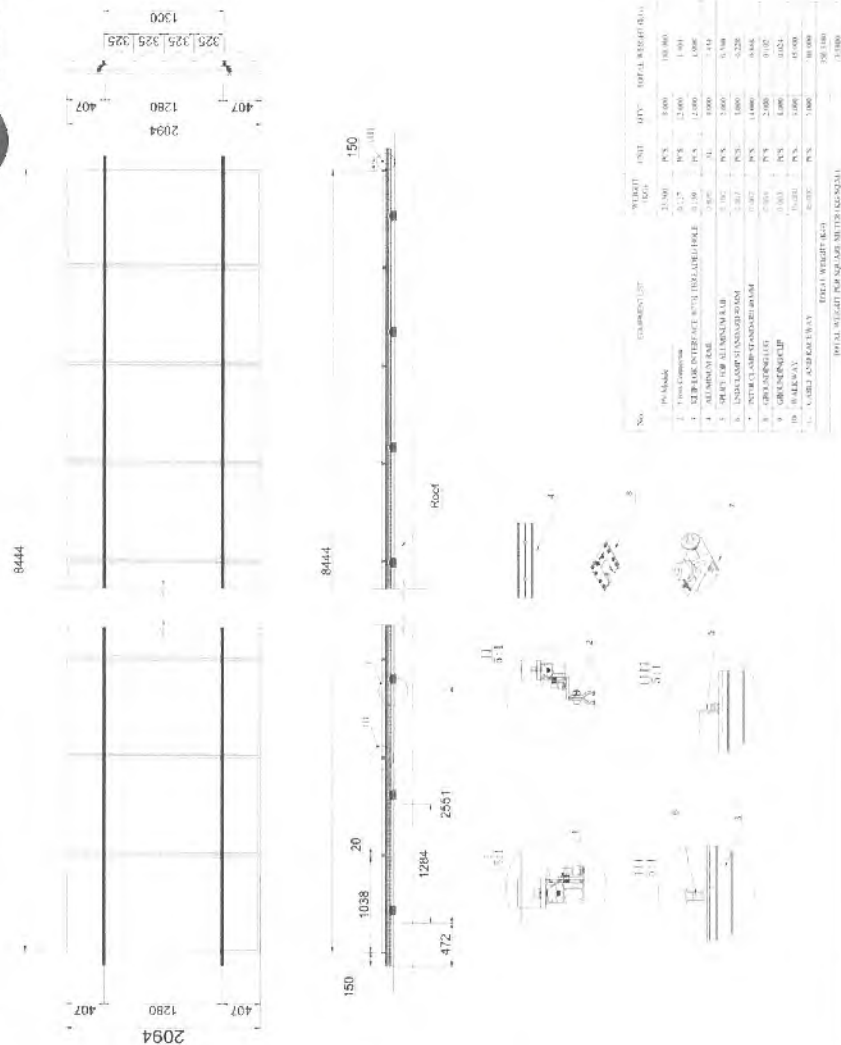
- Reference material in the structure of code **ннн.1101-64** to **ннн.1106-64**
  - Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
  - Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.
- Criteria for consideration
  - Define Steel Member
    - If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
  - Determine Tensile and Shearing Stress
    - If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED
    - If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
  - Deflection Check
    - If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design





## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
 Building Name : Warehouse

Design by : Somchai Jirawattanakran  
 No : No./3810

#### 1. Geometry Data

Simple Span Length	5.33 m.
Purlin Spacing ,S (@)	2.50 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	120 Kg./m <sup>2</sup>
Angle of Roof	1.7 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	150 Kg./m
2.2 Wind Load ,S.2Pn.sinθ(1+sin <sup>2</sup> θ), Wd	=	18.0 Kg./m
Wy = 150 cos <sup>2</sup> .72+Wd	=	167.9 Kg./m
Wx = 150 sin <sup>2</sup> .72	=	4.5 Kg./m
Mx = Wy.L <sup>2</sup> /8	=	596.3 Kg.-m
My = Wx.L <sup>2</sup> /8	=	16.0 Kg.-m
Wx.L <sup>2</sup> /32	=	Kg.-m ( For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	41.4 cm <sup>3</sup>

#### 3. Define Steel Member

Use C 200x75x20x3.2

Steel Modulus of Elasticity, Es =	2,100,000 ksc.	Yield Strength, Fy =	2400 ksc.
width, bf =	7.5 cm	moment of inertia, Ix =	716.0 cm <sup>4</sup>
depth, d =	20.0 cm	Iy =	84.1 cm <sup>4</sup>
thick of web, tw =	0.32 cm	section modulus, Sx =	71.6 cm <sup>3</sup>
thick of flange, tf =	0.32 cm	Sy =	15.8 cm <sup>3</sup>
section area, Ax =	11.81 cm <sup>2</sup>	radius of gyration, rx =	7.8 cm
		weight , w =	9.27 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>t</sub> = Mx/Sx + 2My/Sy	=	1,035.1 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/At + Vy/Av	=	77.70 ksc
As the actual shear stress is less than the allowable shear stress, it passed.			

#### 5. Deflection Check

Allowable Deflection	Δ allow = L/180	=	2.96 cm.
Actual Deflection	Δ max = 5W <sub>y</sub> L <sup>4</sup> /384EI	=	1.17 cm.

As the actual deflection is less than the allowable deflection, it is pass.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

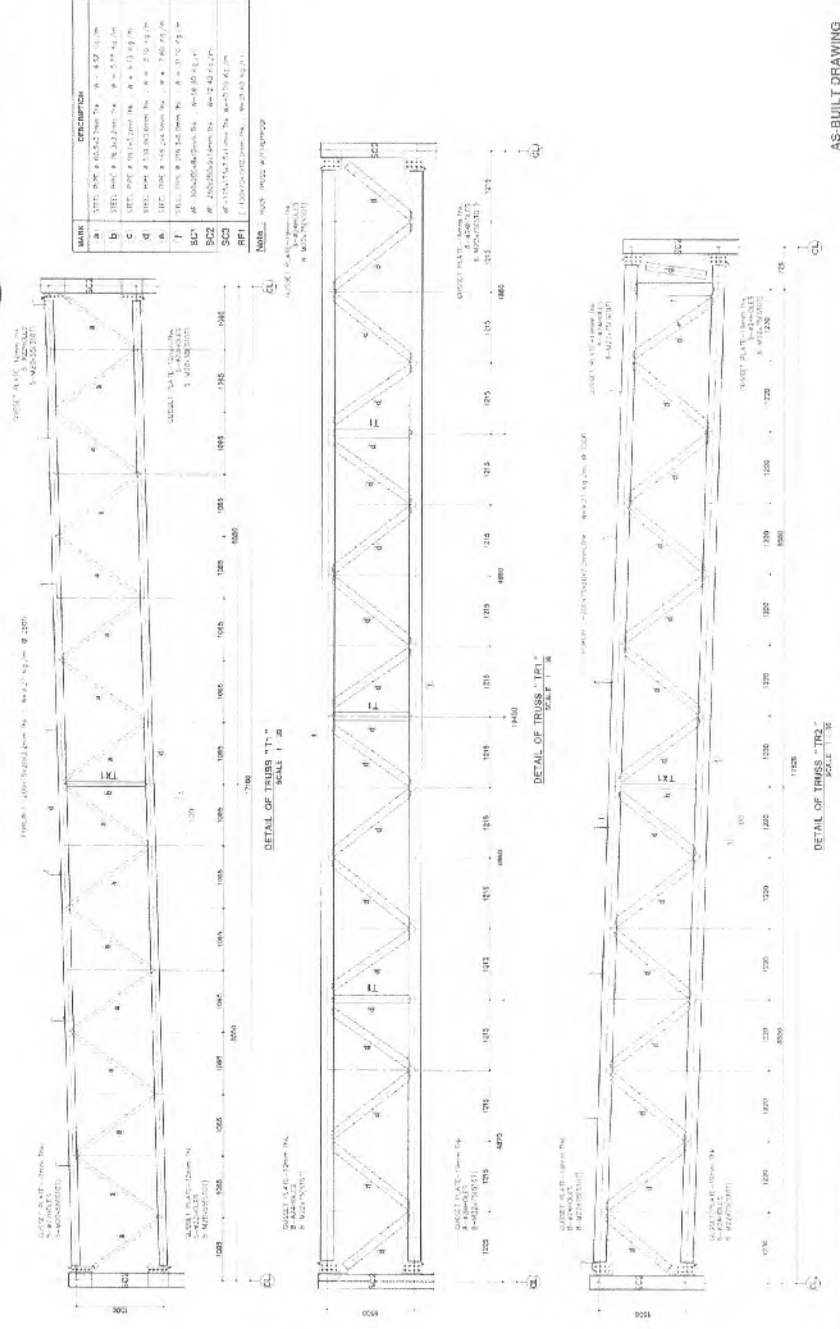
➤ Reference material in the structure of code **AS/NZS 1101-64 to AS/NZS 1106-64**

- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

➤ Criteria for consideration

- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

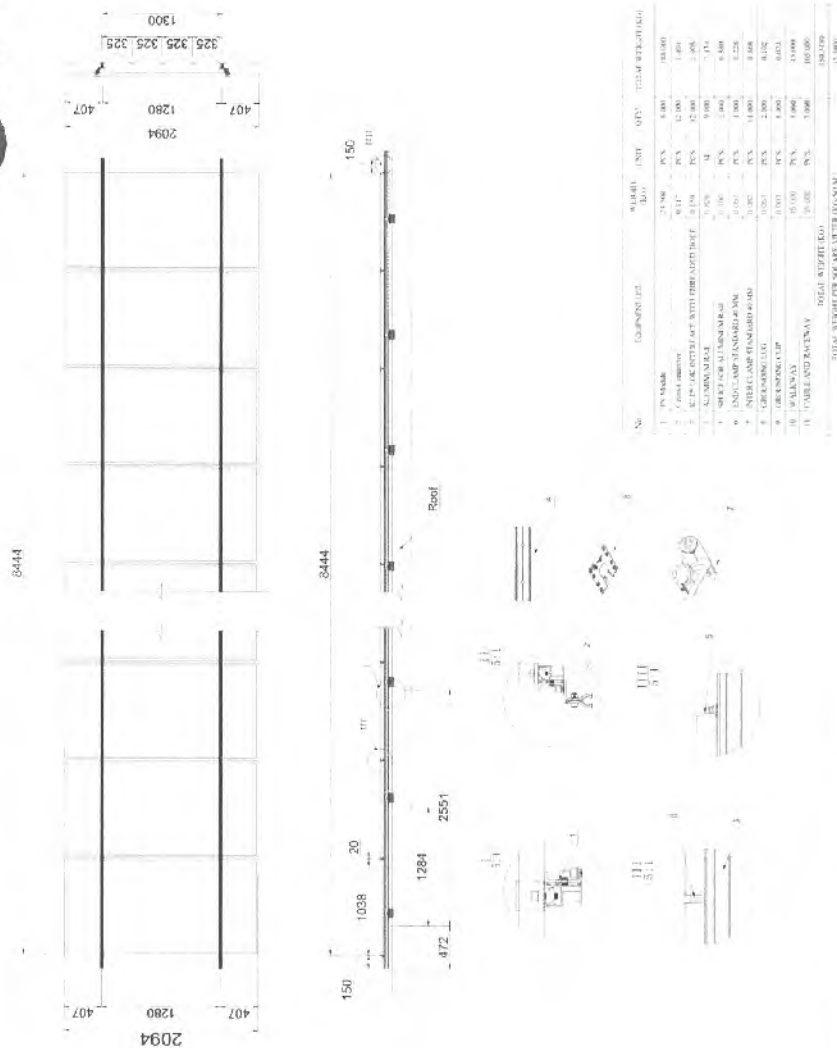
## Reference Design



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## Solar PV Load





## ROOF STRUCTURE ANALYSIS



### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Building Name: Office

Design by : Somchai Jirawattanakran

No. 00.75810

### 1.Geometry Data

Simple Span Length	6.00	m
Purlin Spacing ,S (@)	1.45	m
Dead load - Metal Sheet ,DL	5	Kg/m <sup>2</sup>
Dead load - M&E System ,DL	0	Kg/m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg/m <sup>2</sup>
Live load ,LL	30	Kg/m <sup>2</sup>
Pressure of Wind Load Pn	50	Kg/m <sup>2</sup>
Angle of Roof	1.9	Deg.

### 1.1 Criteria Properties

Allowable Tensile Stress	$F_b = 0.6F_y =$	1440	ksc.
Allowable Shear Stress	$F_v = 0.4F_y =$	960	ksc

## 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL)xS	=	73	Kg/m		
2.2 Wind Load , S 2Pn sinθ/(1+sin²θ), Wd	=	4.8	Kg/m		
Wy = 72.5 cos1.9+Wd	=	77.3	Kg/m	Vy =	231.8 Kg
Wx = 72.5 sin1.9	=	2.4	Kg/m	Vx =	7.2 Kg
Mx = Wy.L²/8	=	347.7	Kg-m		
My = Wx.L²/8	=	10.8	Kg-m		
Wx.L²/32	=	-	Kg-m ( For Design Sag Rod at Mid Span)		
Required Sx = Mx/Fb	=	24.1	cm³		

### 3. Define Steel Member

Use C 150x50x20x3.2

Steel Modulus of Elasticity, Es =	2,100,000	ksc	Yield Strength, Fy =	2400	ksc
width, bf =	5.0	cm	moment of inertia, Ix =	280.0	cm <sup>4</sup>
depth, d =	15.0	cm	Iy =	28.3	cm <sup>4</sup>
thick of web, tw =	0.32	cm	section modulus, Sx =	37.4	cm <sup>3</sup>
thick of flange, tf =	0.32	cm	Sy =	8.2	cm <sup>3</sup>
section area, Ax =	8.61	cm <sup>2</sup>	radius of gyration, rx =	5.7	cm
			weight, w =	6.76	kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4.Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress  $f_b = Mx/S_x + 2My/S_y = 1.193.6 \text{ ksc}$

As the actual tensile stress is less than the allowable tensile stress, it passed.

4.2 Actual Shear Stress	$f_v = V_x/A_f + V_y/A_w$	=	55.61 ksc
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As the actual shear stress is less than the allowable shear stress, it passed.

### 5. Deflection Check

$$\Delta_{allow} = L/180 = 3.33 \text{ cm}$$

Actual Deflection	$\delta_{\max} = 5W_yL^4/384EI_z$	=	2.22 cm
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As the actual deflection is less than the allowable deflection, it is pass.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

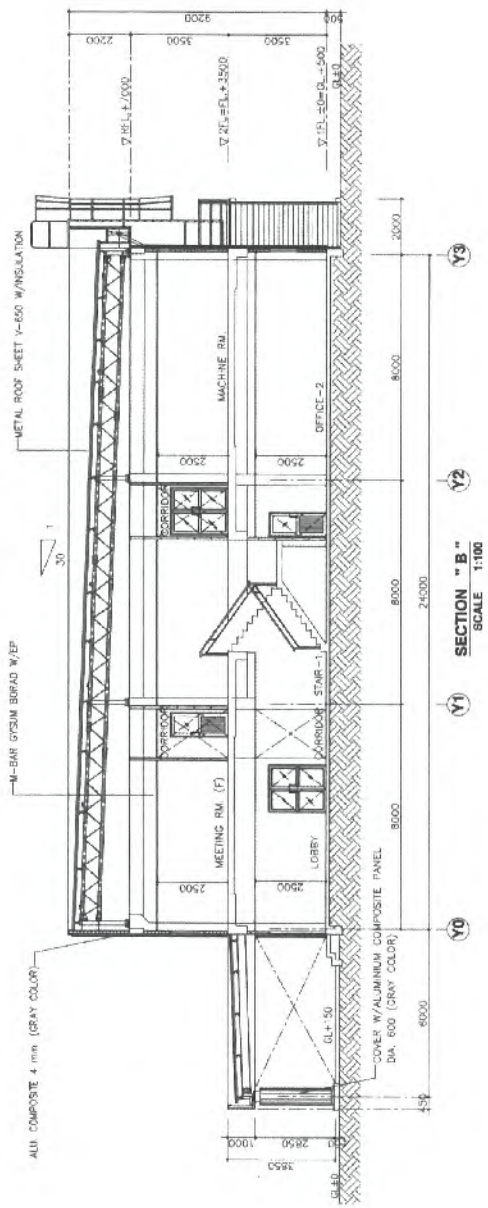
➤ Reference material in the structure of code 1101-64 to 1106-64

- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

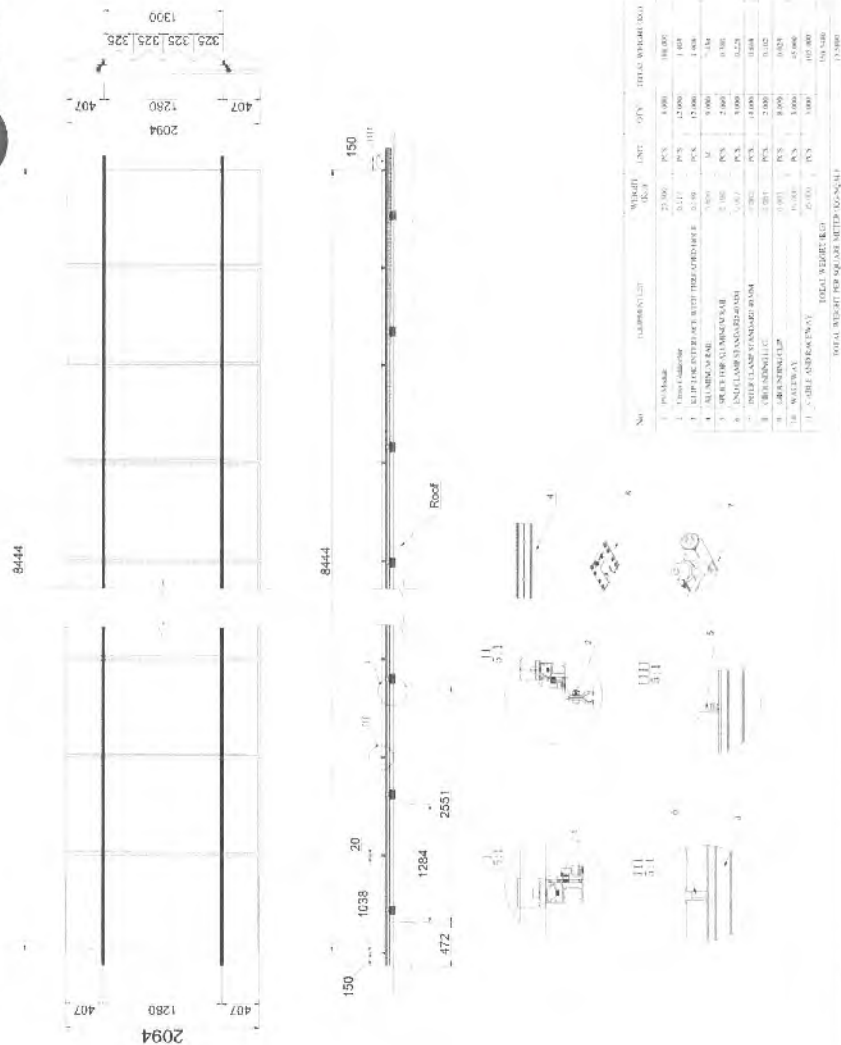
➤ Criteria for consideration

- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



## Solar PV Load



## ROOF STRUCTURE ANALYSIS



### Purlin Design Calculation

Project Name : UACJ Solar Rooftop  
 Building Name : UT1

Design by : Somchai Jirawatanaakran  
 No : no.75810

#### 1. Geometry Data

Simple Span Length	6.00 m.
Purlin Spacing ,S (@)	1.50 m.
Dead load - Metal Sheet ,DL	5 Kg./m <sup>2</sup>
Dead load - M&E System ,DL	0 Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15 Kg./m <sup>2</sup>
Live load ,LL	30 Kg./m <sup>2</sup>
Pressure of Wind Load ,Pn	50 Kg./m <sup>2</sup>
Angle of Roof	1.9 Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440 ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960 ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL) x S	=	75 Kg./m
2.2 Wind Load ,S.2Pn.sinθ(1+sin <sup>2</sup> θ), Wd	=	5.0 Kg./m
Wy = 75 cos 1.9 + Wd	=	79.9 Kg./m
Wx = 75 sin 1.9	=	2.5 Kg./m
Mx = Wy.L <sup>2</sup> /8	=	359.7 Kg.-m
My = Wx.L <sup>2</sup> /8	=	11.2 Kg.-m
Wx.L <sup>2</sup> /32	=	- Kg.-m (For Design Sag Rod at Mid Span)
Required Sx = Mx/Fb	=	25.0 cm <sup>3</sup>

#### 3. Define Steel Member

Use **C 150x50x20x3.2**

Steel Modulus of Elasticity Es =	2,100,000 ksc.	Yield Strength, Fy =	2400 ksc.
width, bf =	5.0 cm	moment of inertia, Ix =	280.0 cm <sup>4</sup>
depth, d =	15.0 cm	Iy =	28.3 cm <sup>4</sup>
thick of web, tw =	0.32 cm	section modulus, Sx =	37.4 cm <sup>3</sup>
thick of flange, tf =	0.32 cm	Sy =	8.2 cm <sup>3</sup>
section area, Ax =	8.61 cm <sup>2</sup>	radius of gyration, rx =	5.7 cm
		weight, w =	6.76 kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>b</sub> = Mx/Sx + 2My/Sy	=	1,234.8 ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.			
4.2 Actual Shear Stress	f <sub>v</sub> = Vx/At + Vy/Av	=	57.52 ksc
As the actual shear stress is less than the allowable shear stress, it passed.			

#### 5. Deflection Check

Allowable Deflection	Δ <sub>allow</sub> = L/180	=	3.33 cm.
Actual Deflection	δ <sub>max</sub> = 5Wyl <sup>4</sup> /384EI	=	2.29 cm.
As the actual deflection is less than the allowable deflection, it is pass.			

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*



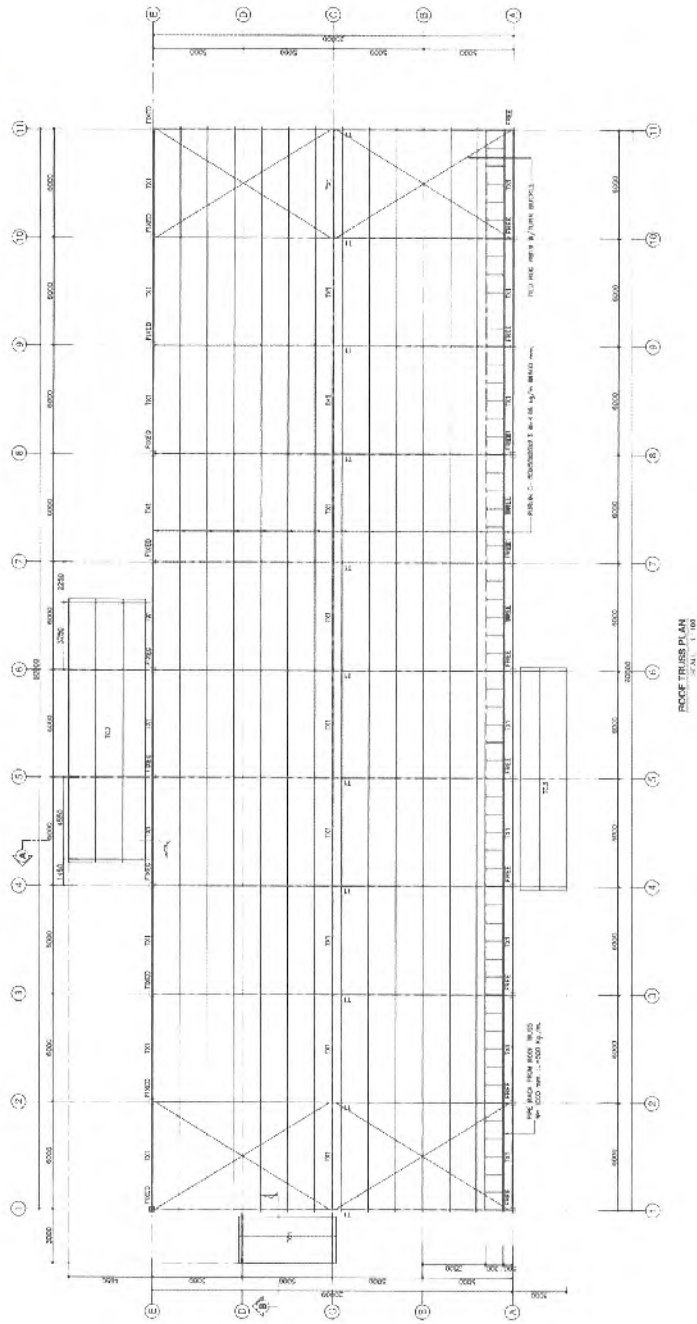
➤ Reference material in the structure of code 1101-64 to 1106-64

- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

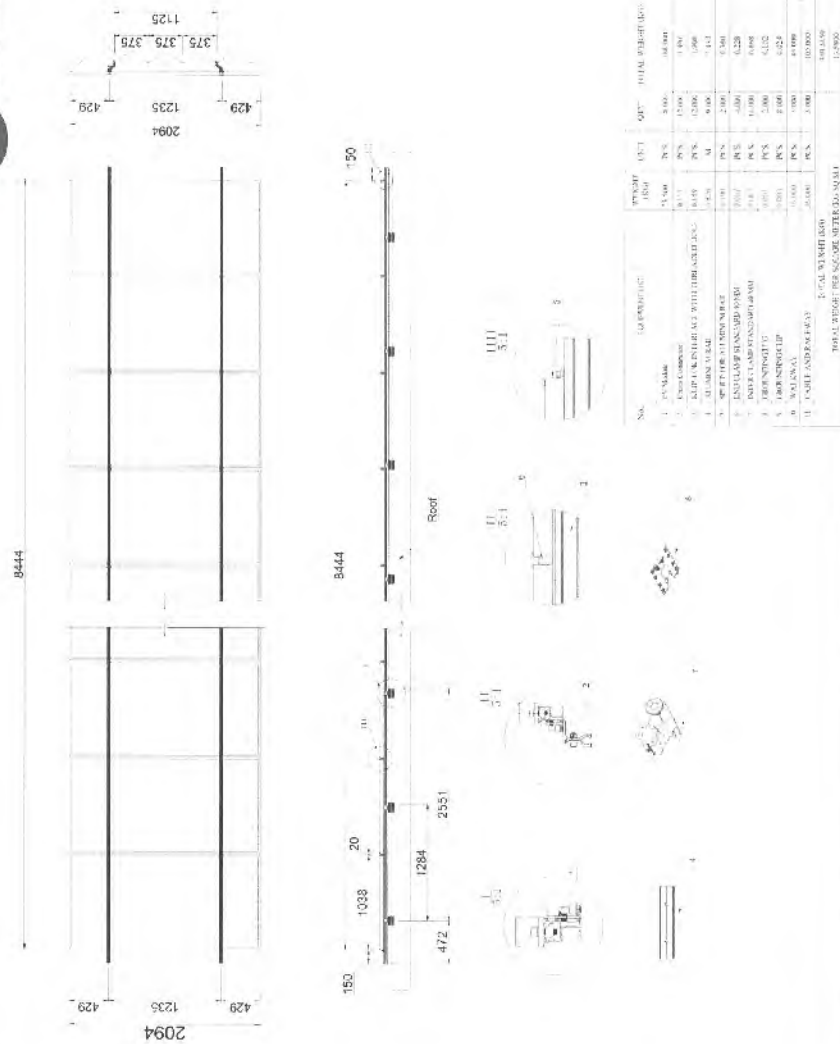
➤ Criteria for consideration

- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{Actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{Required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design



## Solar PV Load



## ROOF STRUCTURE ANALYSIS

### Purlin Design Calculation

Project Name : UACJ Solar Rooftop

Building Name : UT2

Design by : Somchai Jirawattanakran

No : 319.75310

#### 1. Geometry Data

Simple Span Length	7.10	m.
Purlin Spacing ,S (@)	1.50	m.
Dead load - Metal Sheet ,DL	5	Kg./m <sup>2</sup>
Dead load - M&E System ,DL	10	Kg./m <sup>2</sup>
Dead load - Solar PV System ,DL	15	Kg./m <sup>2</sup>
Live load ,LL	30	Kg./m <sup>2</sup>
Pressure of Wind Load ,Pr	50	Kg./m <sup>2</sup>
Angle of Roof	3.0	Deg.

#### 1.1 Criteria Properties

Allowable Tensile Stress	Fb = 0.6Fy =	1440	ksc.
Allowable Shear Stress	Fv = 0.4Fy =	960	ksc.

#### 2. Calculation Gravity Loads on Purlin

2.1 Summary Load (DL+LL) x S	=	90	Kg./m
2.2 Wind Load ,S.2Ph.sinφ(1+sin <sup>2</sup> ), Wd	=	7.8	Kg./m
W <sub>y</sub> = 90 cos3 + Wd	=	97.7	Kg./m
W <sub>x</sub> = 90 sin3	=	4.7	Kg./m
M <sub>x</sub> = W <sub>y</sub> .L <sup>2</sup> /8	=	615.6	Kg.-m
M <sub>y</sub> = W <sub>x</sub> .L <sup>2</sup> /8	=	29.7	Kg.-m
W <sub>x</sub> .L <sup>2</sup> /32	=	-	Kg.-m ( For Design Sag Rod at Mid Span)
Required S <sub>x</sub> = M <sub>x</sub> /Fb	=	42.3	cm <sup>3</sup>

#### 3. Define Steel Member

Use **C 200x75x20x3.2**

Steel Modulus of Elasticity, Es =	2,100,000	ksc.	Yield Strength, Fy =	2400	ksc.
width, bf =	7.5	cm	moment of inertia, Ix =	716.0	cm <sup>4</sup>
depth, d =	20.0	cm	Iy =	84.1	cm <sup>4</sup>
thick of web, tw =	0.32	cm	section modulus, Sx =	71.6	cm <sup>3</sup>
thick of flange, tf =	0.32	cm	Sy =	15.8	cm <sup>3</sup>
section area, Ax =	11.81	cm <sup>2</sup>	radius of gyration, rx =	7.8	cm
			weight , w =	9.27	kg/m

As the section modulus is more than the required section modulus, it is pass

#### 4. Determine Tensile and Shearing Stress

4.1 Actual Tensile Stress	f <sub>b</sub> = M <sub>x</sub> /S <sub>x</sub> + 2M <sub>y</sub> /S <sub>y</sub>	=	1,235.3	ksc
As the actual tensile stress is less than the allowable tensile stress, it passed.				
4.2 Actual Shear Stress	f <sub>v</sub> = V <sub>x</sub> /A <sub>f</sub> + V <sub>y</sub> /A <sub>w</sub>	=	63.60	ksc
As the actual shear stress is less than the allowable shear stress, it passed.				

#### 5. Deflection Check

Allowable Deflection	Δ <sub>allow</sub> = L/180	=	3.94	cm.
Actual Deflection	δ <sub>max</sub> = 5W <sub>y</sub> L <sup>4</sup> /384EI <sub>x</sub>	=	2.15	cm.

As the actual deflection is less than the allowable deflection, it is pass.

\*\*\* Therefore, the purlin shall be able to withstand the additional load safely. \*\*\*

➤ Reference material in the structure of code  $\mathbb{M}\mathbb{M}.1101-64$  to  $\mathbb{M}\mathbb{M}.1106-64$

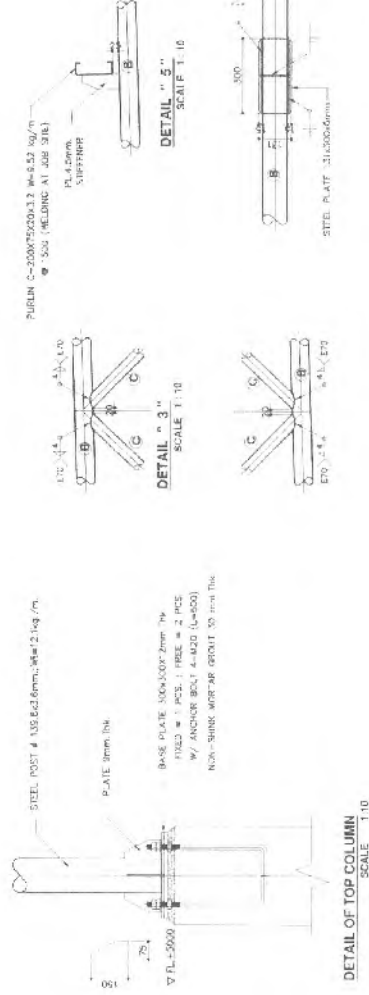
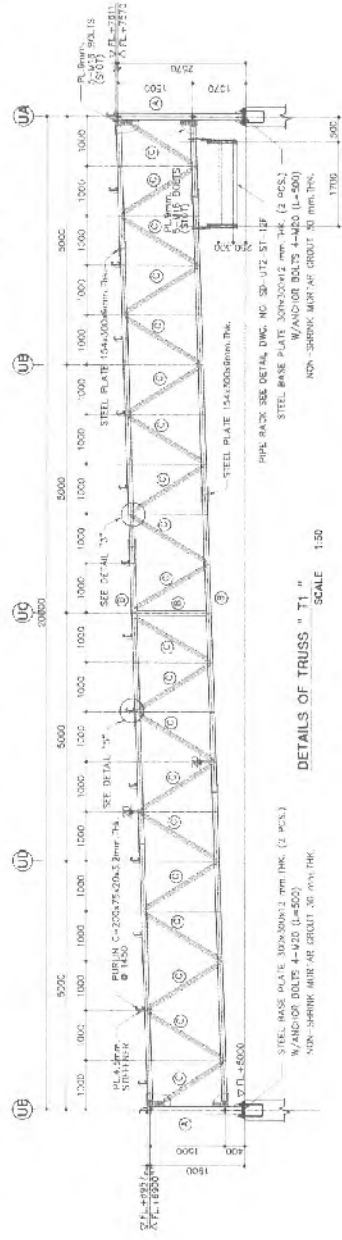
- Allowable Tensile Stress  $F_b = 0.6F_y = 1,440$  ksc.
- Allowable Shear Stress  $F_v = 0.4F_y = 960$  ksc.

➤ Criteria for consideration

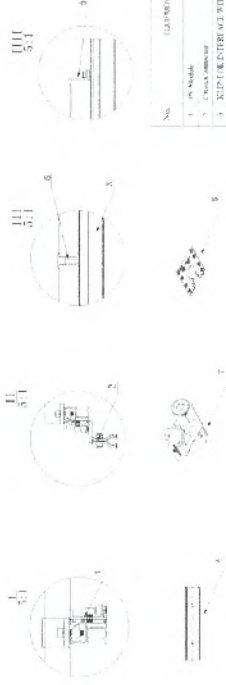
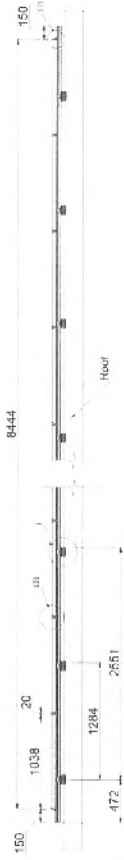
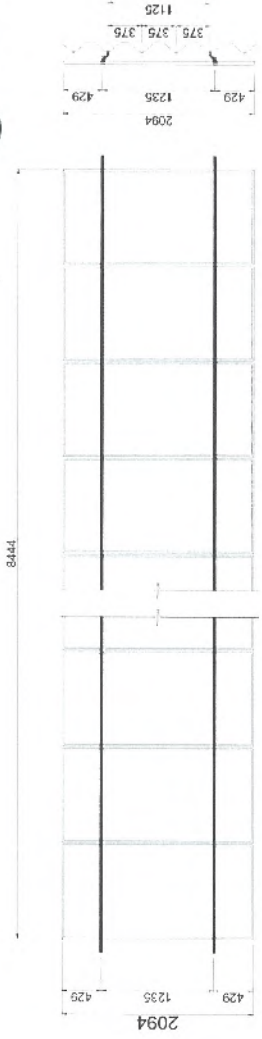
- Define Steel Member  
If the Actual Section Modulus ( $S_{x_{actual}}$ ) must be greater or equal ( $\geq$ ) Required Section Modulus ( $S_{x_{required}}$ ) it PASSED
- Determine Tensile and Shearing Stress  
If the Actual Tensile Stress is less than ( $<$ ) the Allowable Tensile Stress it PASSED  
If the Actual Shear Stress is less than ( $<$ ) the Allowable Shear Stress it PASSED
- Deflection Check  
If the Actual Deflection is less than ( $<$ ) the Allowable Deflection, it PASSED

## Reference Design





## Solar PV Load



No.	DESCRIPTION (mm)	WEIGHT (kg)	QTY	TOTAL WEIGHT (kg)
1	10" Module	25.500	100	2550.00
2	10" Module	25.500	100	2550.00
3	10" Module	25.500	100	2550.00
4	10" Module	25.500	100	2550.00
5	10" Module	25.500	100	2550.00
6	10" Module	25.500	100	2550.00
7	10" Module	25.500	100	2550.00
8	10" Module	25.500	100	2550.00
9	10" Module	25.500	100	2550.00
10	10" Module	25.500	100	2550.00
11	10" Module	25.500	100	2550.00
12	10" Module	25.500	100	2550.00
13	10" Module	25.500	100	2550.00
14	10" Module	25.500	100	2550.00
15	10" Module	25.500	100	2550.00
16	10" Module	25.500	100	2550.00
17	10" Module	25.500	100	2550.00
18	10" Module	25.500	100	2550.00
19	10" Module	25.500	100	2550.00
20	10" Module	25.500	100	2550.00
21	10" Module	25.500	100	2550.00
22	10" Module	25.500	100	2550.00
23	10" Module	25.500	100	2550.00
24	10" Module	25.500	100	2550.00
25	10" Module	25.500	100	2550.00
26	10" Module	25.500	100	2550.00
27	10" Module	25.500	100	2550.00
28	10" Module	25.500	100	2550.00
29	10" Module	25.500	100	2550.00
30	10" Module	25.500	100	2550.00
31	10" Module	25.500	100	2550.00
32	10" Module	25.500	100	2550.00
33	10" Module	25.500	100	2550.00
34	10" Module	25.500	100	2550.00
35	10" Module	25.500	100	2550.00
36	10" Module	25.500	100	2550.00
37	10" Module	25.500	100	2550.00
38	10" Module	25.500	100	2550.00
39	10" Module	25.500	100	2550.00
40	10" Module	25.500	100	2550.00
41	10" Module	25.500	100	2550.00
42	10" Module	25.500	100	2550.00
43	10" Module	25.500	100	2550.00
44	10" Module	25.500	100	2550.00
45	10" Module	25.500	100	2550.00
46	10" Module	25.500	100	2550.00
47	10" Module	25.500	100	2550.00
48	10" Module	25.500	100	2550.00
49	10" Module	25.500	100	2550.00
50	10" Module	25.500	100	2550.00
51	10" Module	25.500	100	2550.00
52	10" Module	25.500	100	2550.00
53	10" Module	25.500	100	2550.00
54	10" Module	25.500	100	2550.00
55	10" Module	25.500	100	2550.00
56	10" Module	25.500	100	2550.00
57	10" Module	25.500	100	2550.00
58	10" Module	25.500	100	2550.00
59	10" Module	25.500	100	2550.00
60	10" Module	25.500	100	2550.00
61	10" Module	25.500	100	2550.00
62	10" Module	25.500	100	2550.00
63	10" Module	25.500	100	2550.00
64	10" Module	25.500	100	2550.00
65	10" Module	25.500	100	2550.00
66	10" Module	25.500	100	2550.00
67	10" Module	25.500	100	2550.00
68	10" Module	25.500	100	2550.00
69	10" Module	25.500	100	2550.00
70	10" Module	25.500	100	2550.00
71	10" Module	25.500	100	2550.00
72	10" Module	25.500	100	2550.00
73	10" Module	25.500	100	2550.00
74	10" Module	25.500	100	2550.00
75	10" Module	25.500	100	2550.00
76	10" Module	25.500	100	2550.00
77	10" Module	25.500	100	2550.00
78	10" Module	25.500	100	2550.00
79	10" Module	25.500	100	2550.00
80	10" Module	25.500	100	2550.00
81	10" Module	25.500	100	2550.00
82	10" Module	25.500	100	2550.00
83	10" Module	25.500	100	2550.00
84	10" Module	25.500	100	2550.00
85	10" Module	25.500	100	2550.00
86	10" Module	25.500	100	2550.00
87	10" Module	25.500	100	2550.00
88	10" Module	25.500	100	2550.00
89	10" Module	25.500	100	2550.00
90	10" Module	25.500	100	2550.00
91	10" Module	25.500	100	2550.00
92	10" Module	25.500	100	2550.00
93	10" Module	25.500	100	2550.00
94	10" Module	25.500	100	2550.00
95	10" Module	25.500	100	2550.00
96	10" Module	25.500	100	2550.00
97	10" Module	25.500	100	2550.00
98	10" Module	25.500	100	2550.00
99	10" Module	25.500	100	2550.00
100	10" Module	25.500	100	2550.00