STEEL DESIGN I

Section (1)

Components of Structures

+ General Layout

Steel Structures Division

Structural Engineering Department

Faculty of Engineering, Cairo University

Class Code

Attend on Time

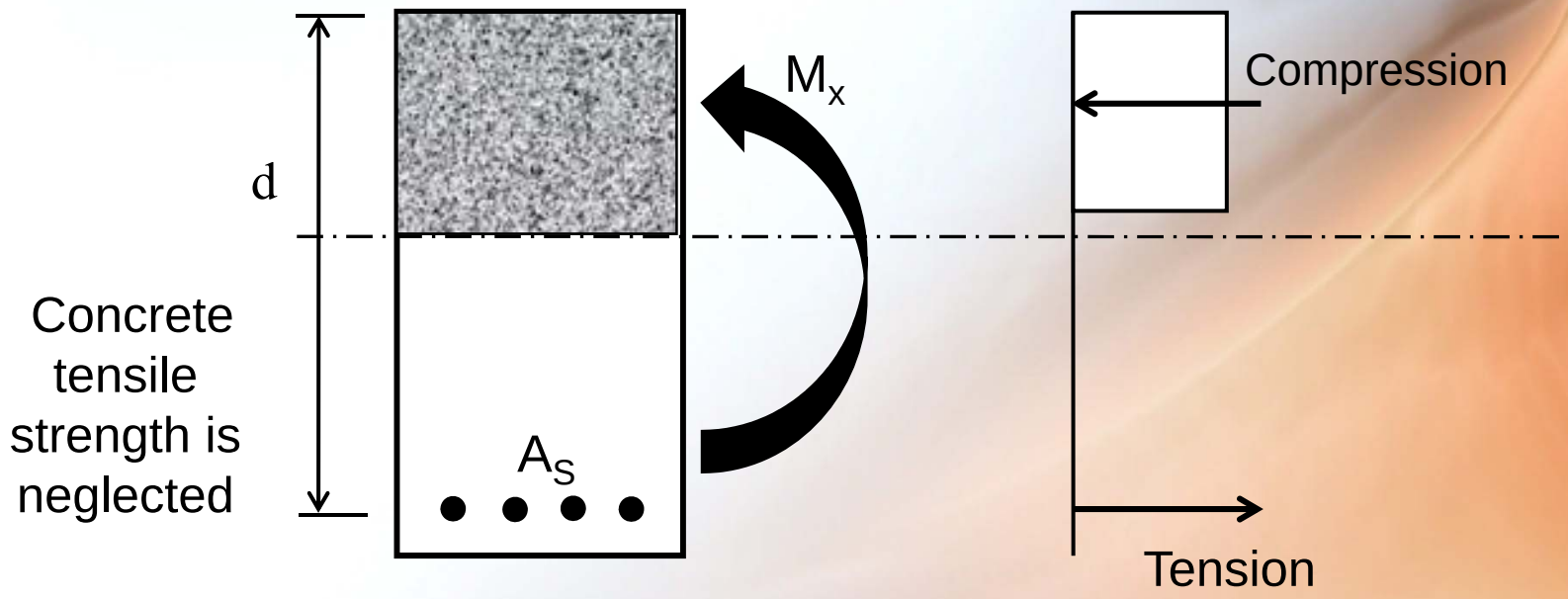
Mutual Respect

Smile ☺

No Cheating is allowed

Introduction

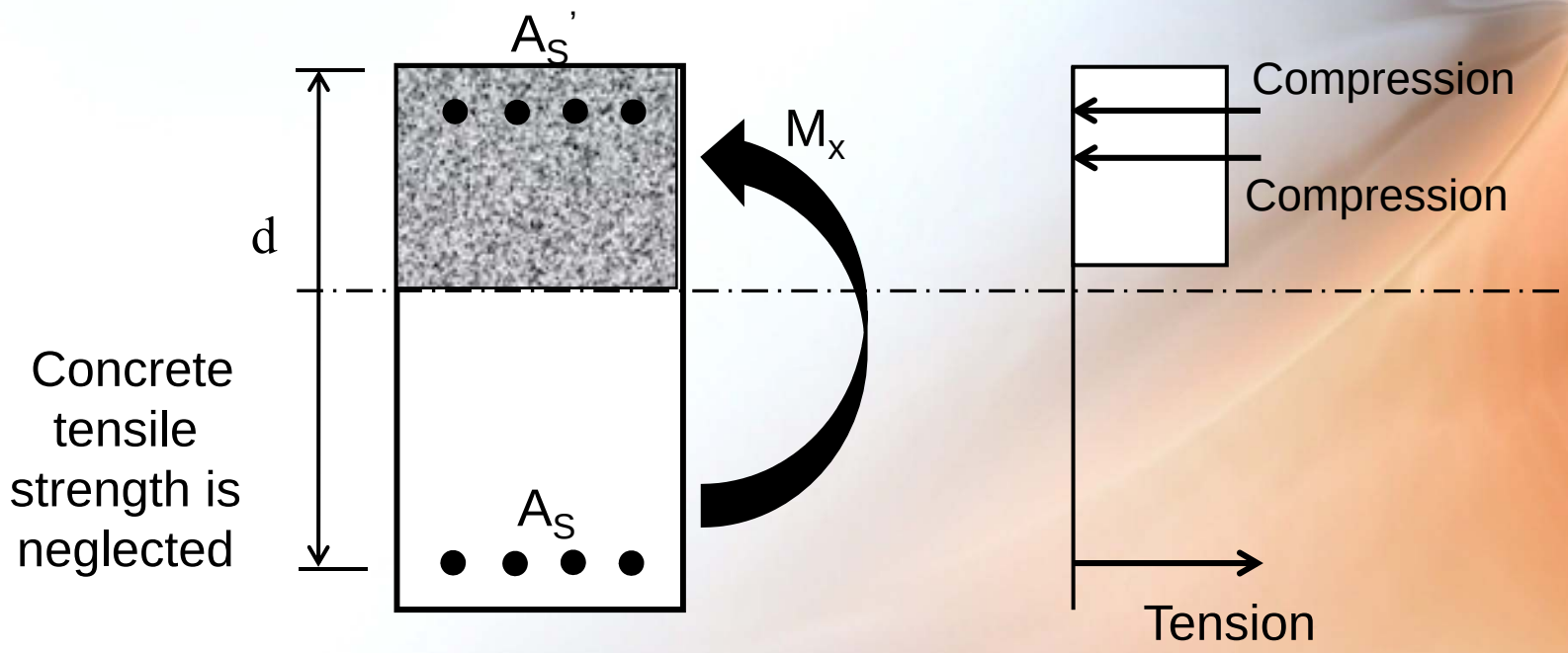
Concrete Beam subjected to Bending Moment around Major Axis



If M_x increases ➔ increase d or A_s

Introduction

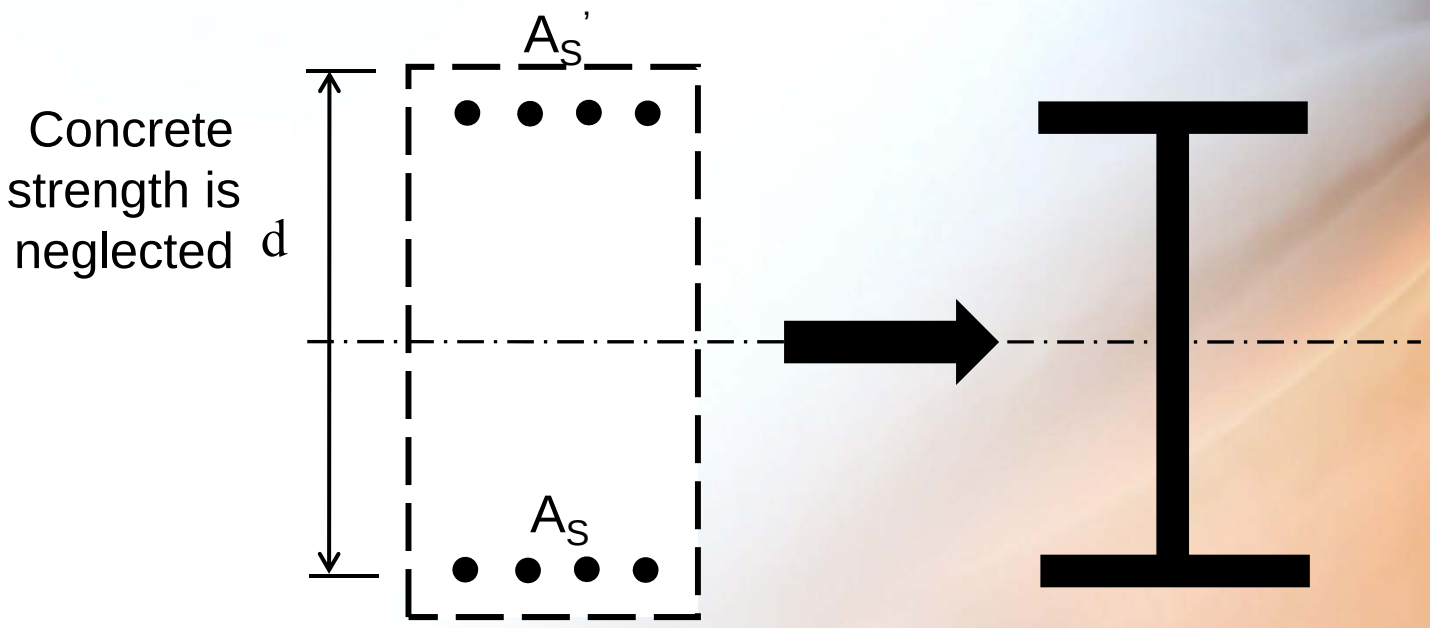
Concrete Beam subjected to Bending Moment around Major Axis



If d is limited & $A_s = A_{smax}$ ➔ Use Compression reinforcement

Introduction

Concrete Beam subjected to Bending Moment around Major Axis



I-Beam Section ➔ usually used for beams and columns in steel structures

Introduction

Types of Buildings with respect to Construction Materials

Timber Building

Concrete Building

Introduction

Types of Buildings with respect to Construction Materials

Combined Steel-Concrete Building

Steel Building

Introduction

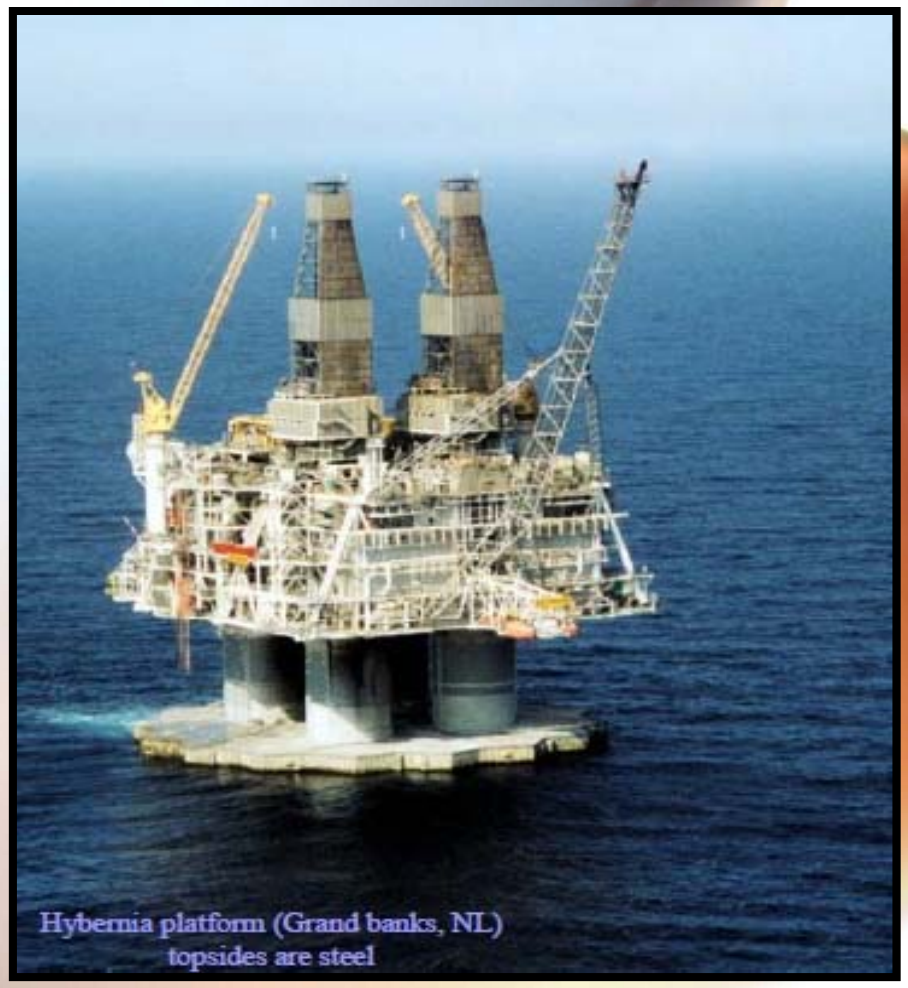
Typical Steel Structures

Industrial Buildings

Introduction

Typical Steel Structures

Multi-storey Bldgs.



Sea Platform

Introduction

Typical Steel Structures

Skyscrapers

Introduction

Typical Steel Structures

Introduction

Typical Steel Structures

Introduction

Typical Steel Structures

Introduction

We will study Industrial Buildings this year

Steel Frame

Steel Truss

Week #	Explanation	Grading
1	Components of structures + general layout	----
2	Components of structures+ general layout	Q. # 1
3	Dead and live loads	Q. # 1
4	Crane + Wind loads	Q. # 2
5	Tension members Example 2.1, 2.2, 2.3 & 2.4	Q. # 3*
6	Compression members Example 3.1, 3.4 & 3.6	Q. # 4 & 5*
7	Axially Loaded Columns Example 3.9 & 3.11	Q. # 6

Week #	Explanation	Grading
8	Midterm Break	----
9	Wind Bracing Systems + Loads	Q. # 7*
10	Beams: Purlins + Side Girts	Q. # 8
11	Beams: CTG + Monorail Example 5.3	Q. # 9
12	Floor Beams Example 5.4	Q. # 10
13	Beam-columns (Alignment chart) Example 6.1	*
14	Beam-columns Example 6.2	Q. # 11

Introduction

- Advantages of Steel:
  - Economy
  - Durability
  - Design Flexibility
  - All Weather Construction
  - Easy Repair
  - 100% Recyclable

Introduction

Preliminary Grading

100%

Term Work

30%

Final Exam

70%

Midterm Exam

15%

Sheets

??%

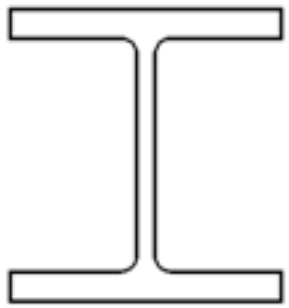
Quizes

??%

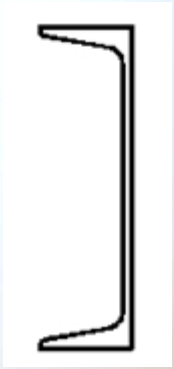
Introduction

- Steel Sections

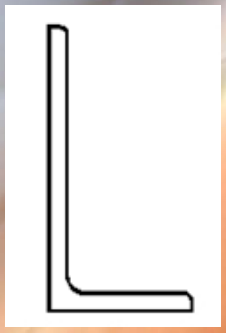
IPE Sections



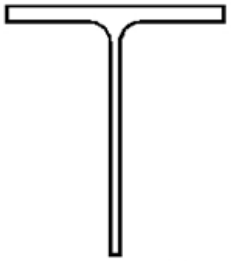
BFI Sections



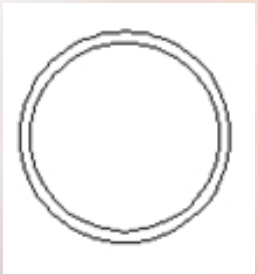
UPN Sections



L Sections



T Sections



PIPE Sections

BOX Sections

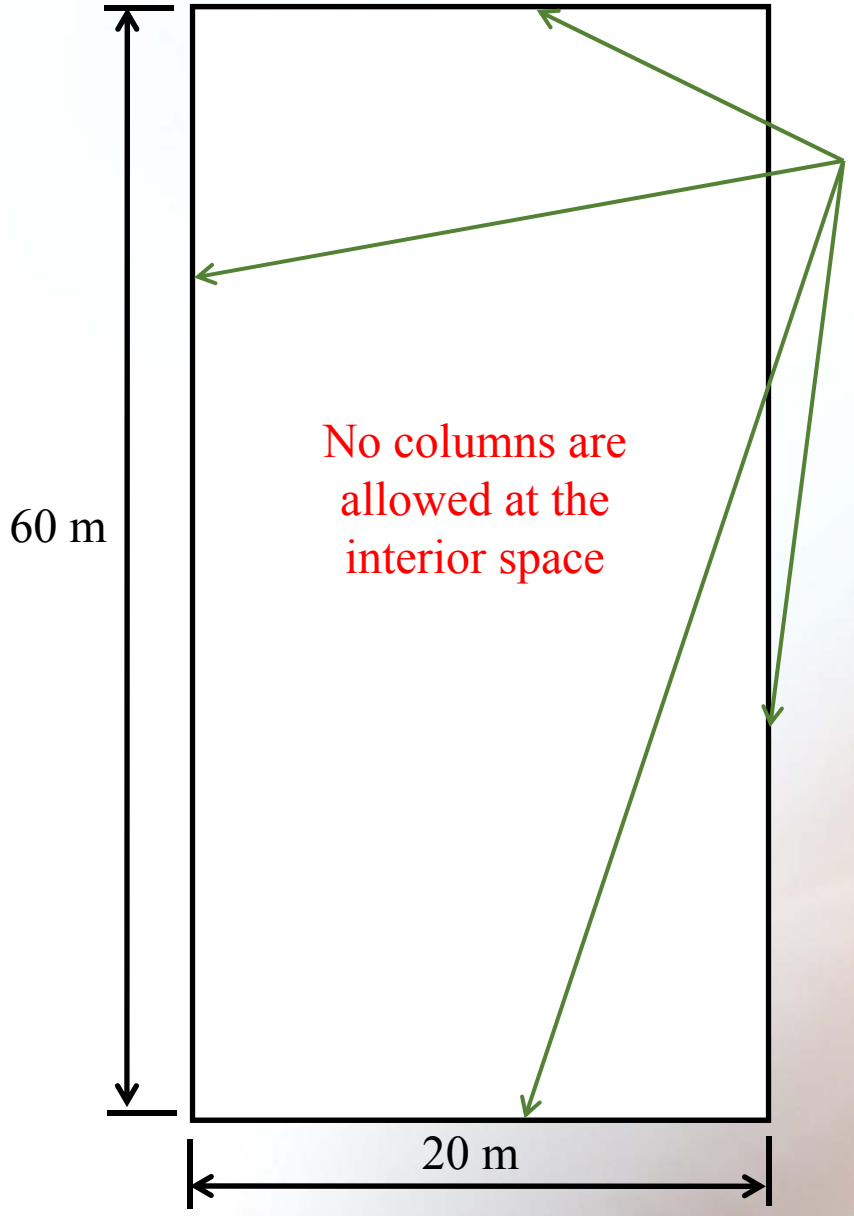
Introduction

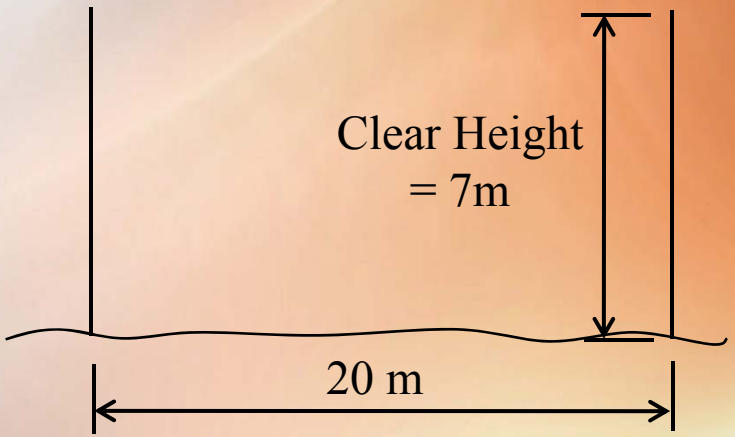
- Steel Sections

General Layout

1. **Types of Main Systems**
2. **Arrangement of Main Systems**
3. **Roof Slope**
4. **Roof Covering Materials**
5. **Side Cover**
6. **End Gables**
7. **Wind Bracing System**

1. Types of Main Systems





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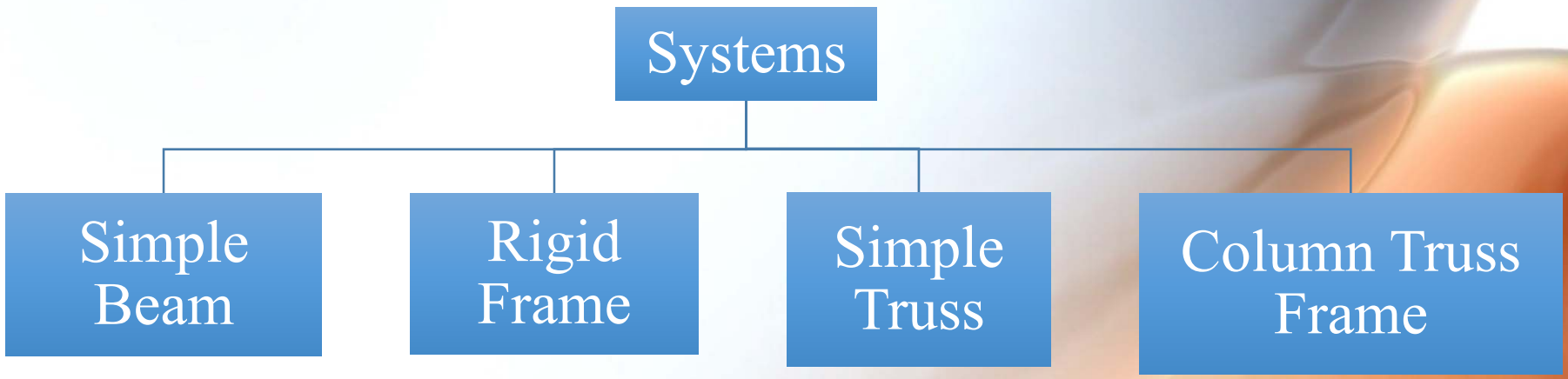

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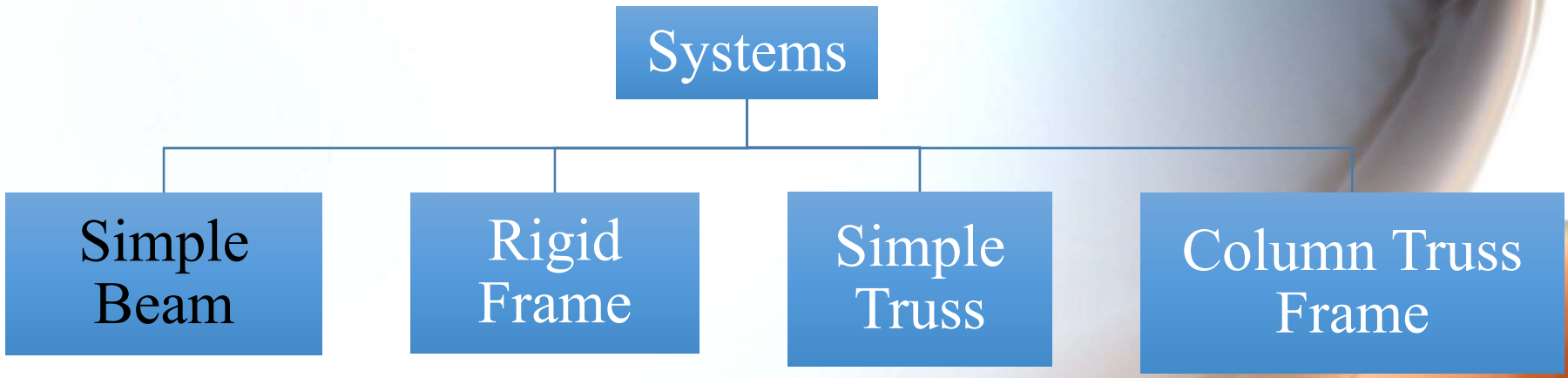

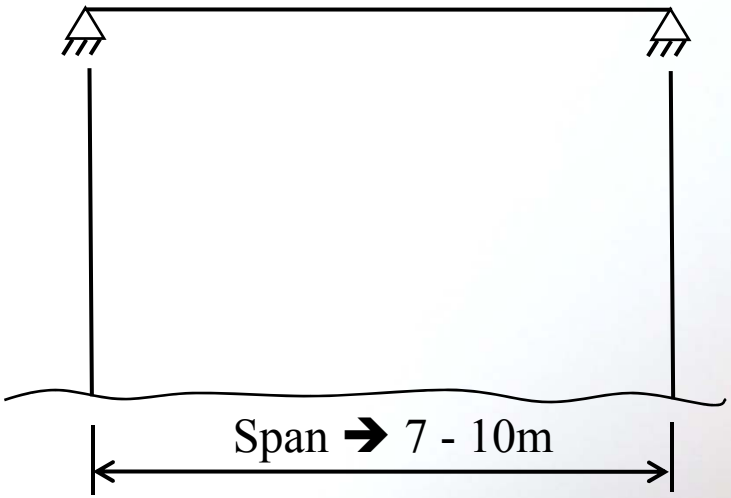

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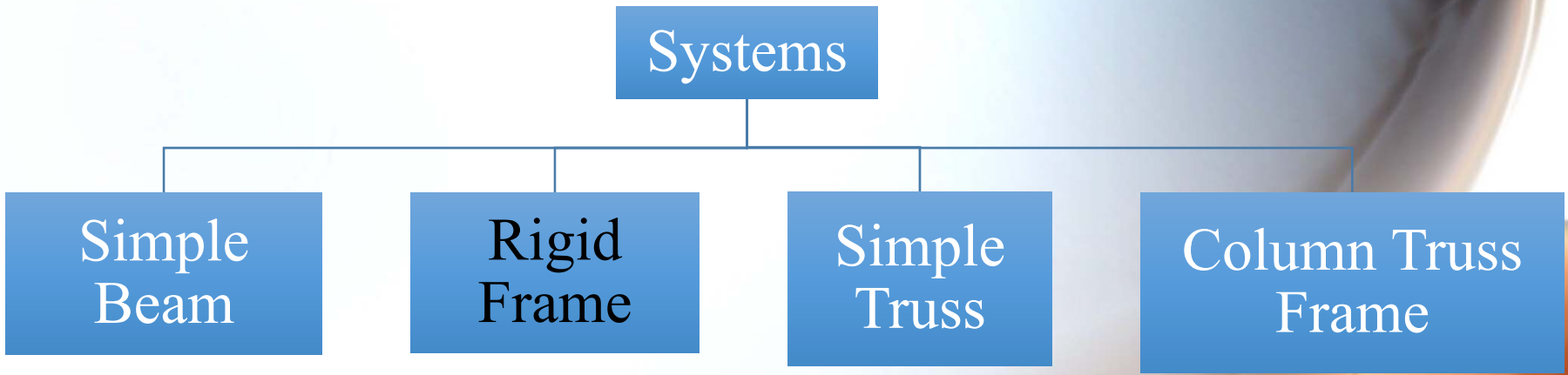

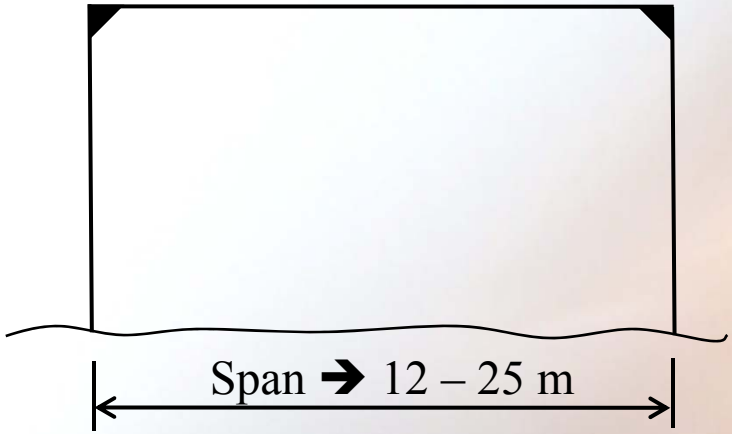

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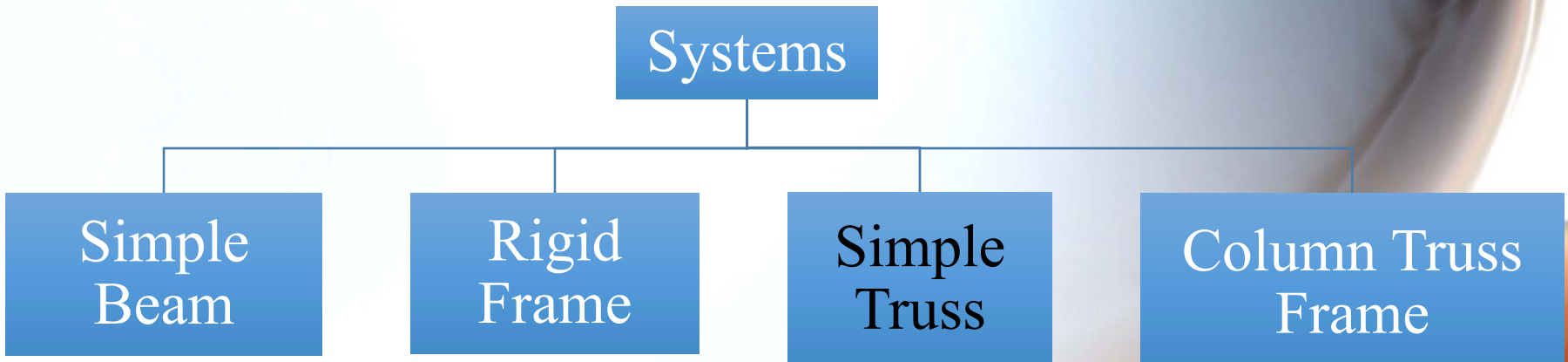
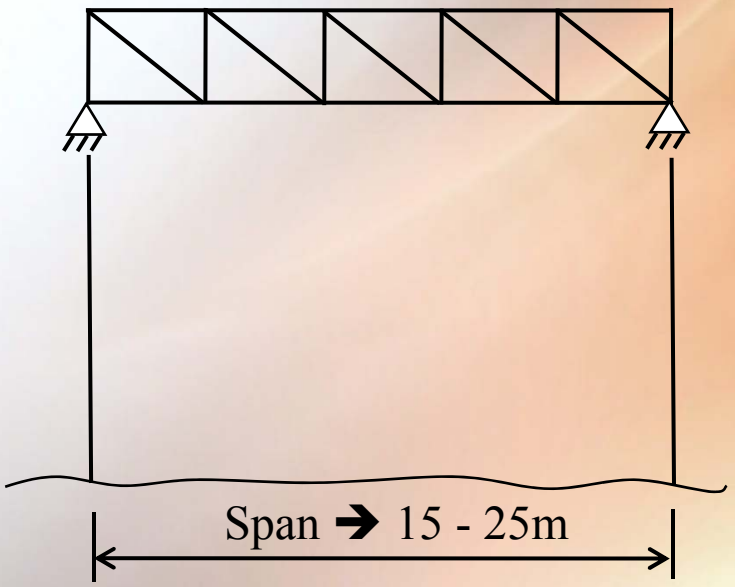
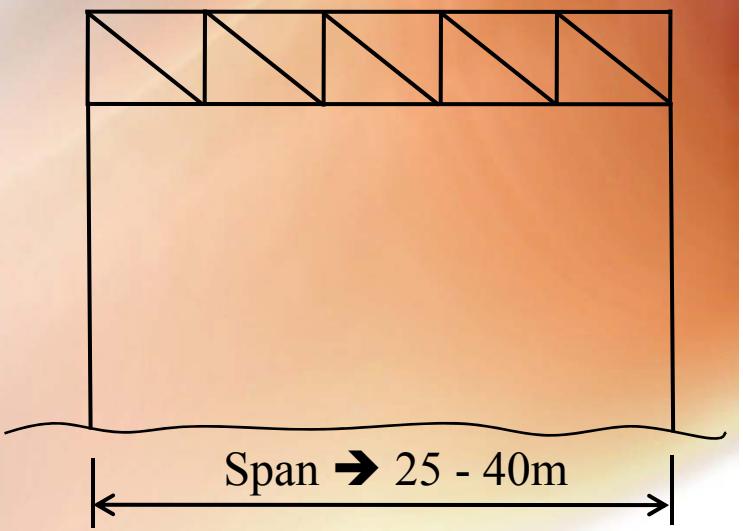




1. Types of Main Systems

- Systems
  - Simple Beam
  - Rigid Frame
  - Simple Truss
  - Column Truss Frame



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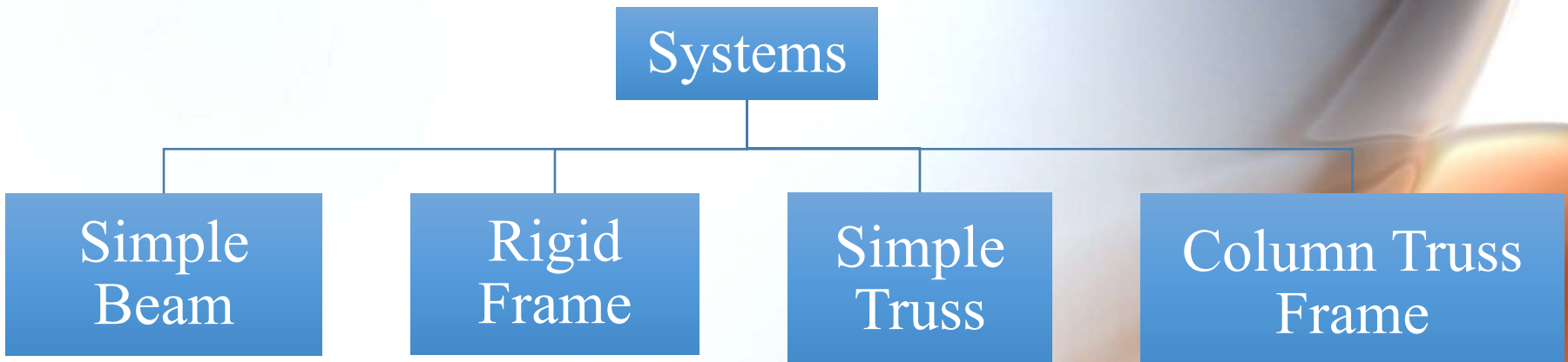


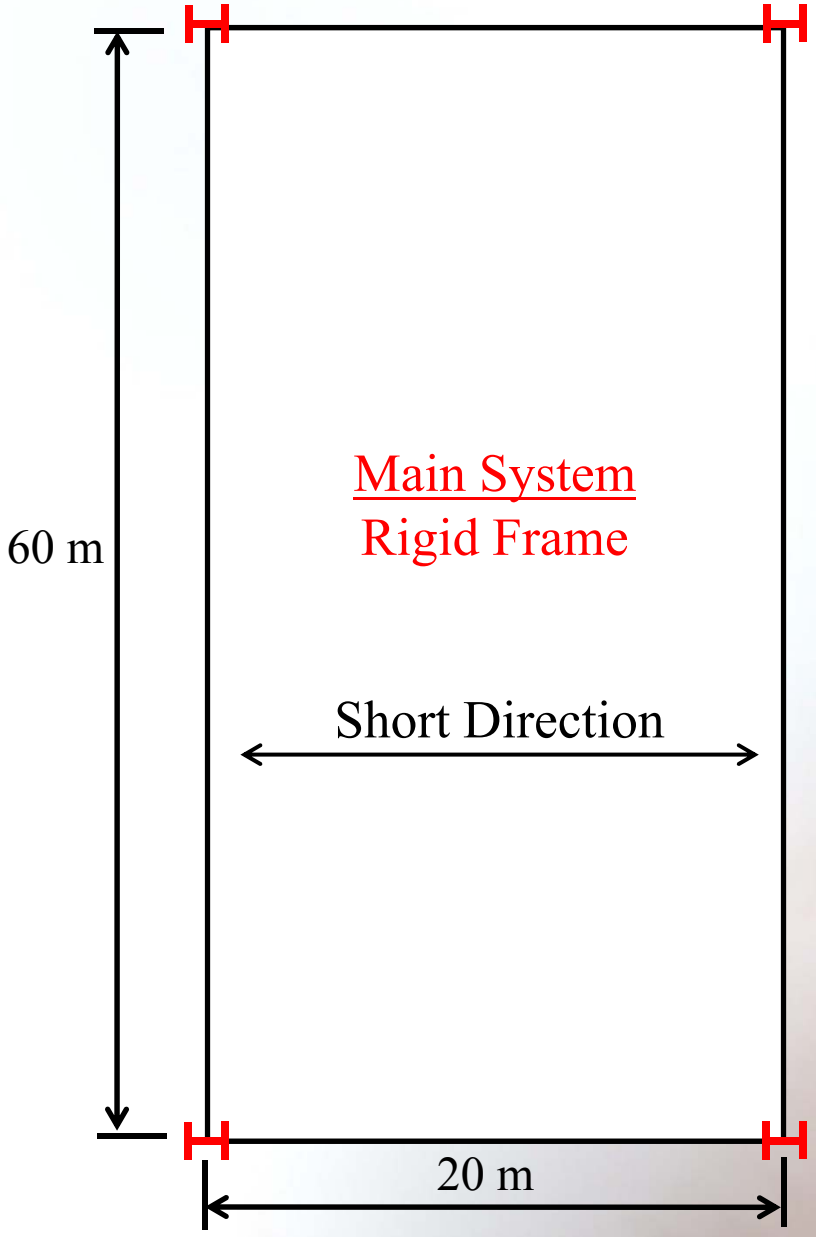
Span ➔ 7 - 10m

Span ➔ 12 – 25 m

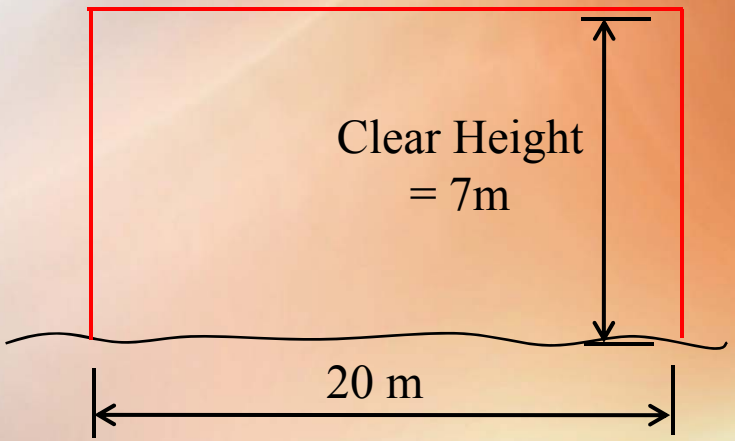
Span ➔ 15 - 25m

Span ➔ 25 - 40m

2. Arrangement of Main System



- Main System parallel to the **Short Direction**
- Spacing (S) = 4 ➔ 7 m



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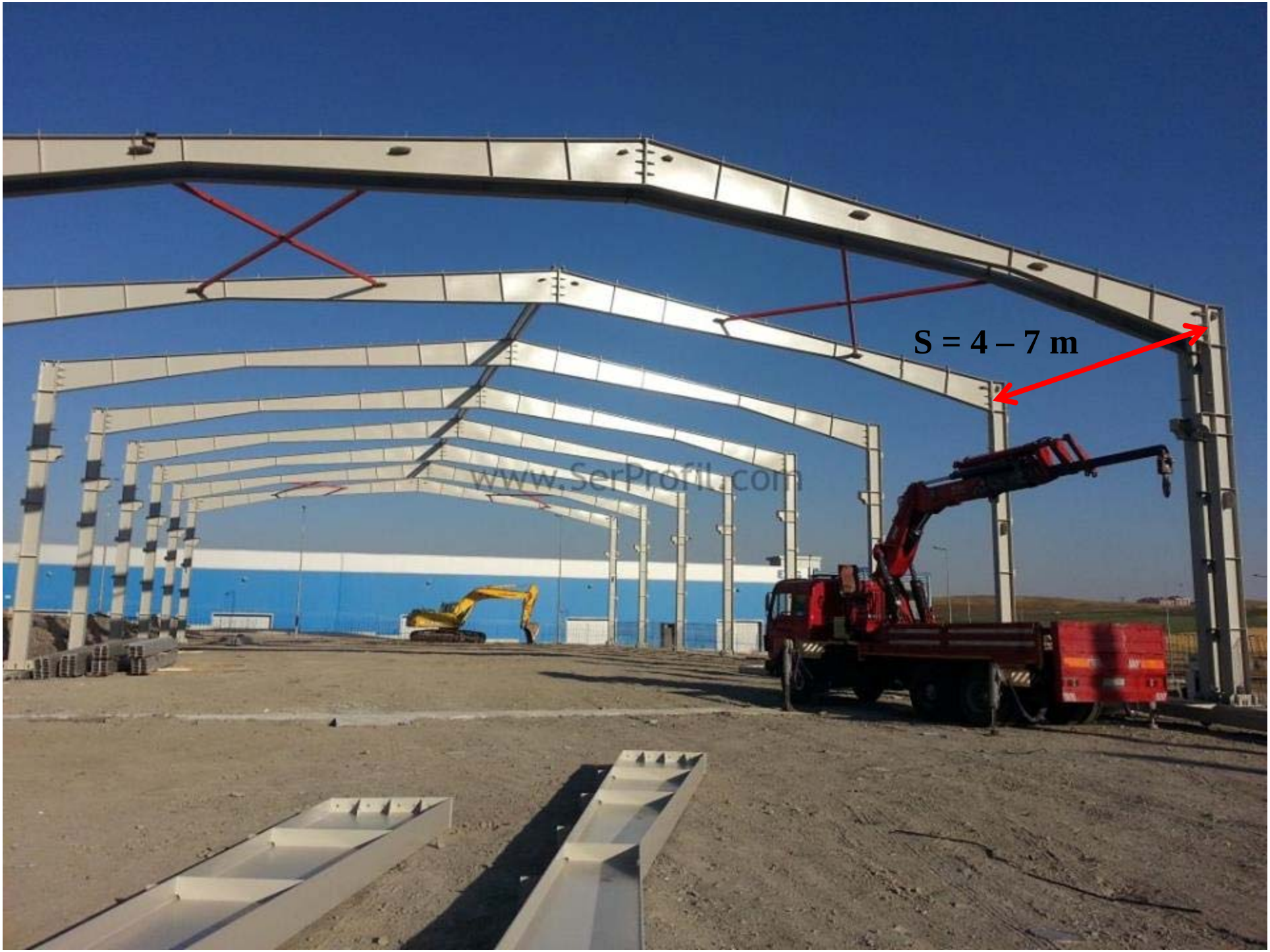
S = 4 – 7 m
www.SerProfil.com

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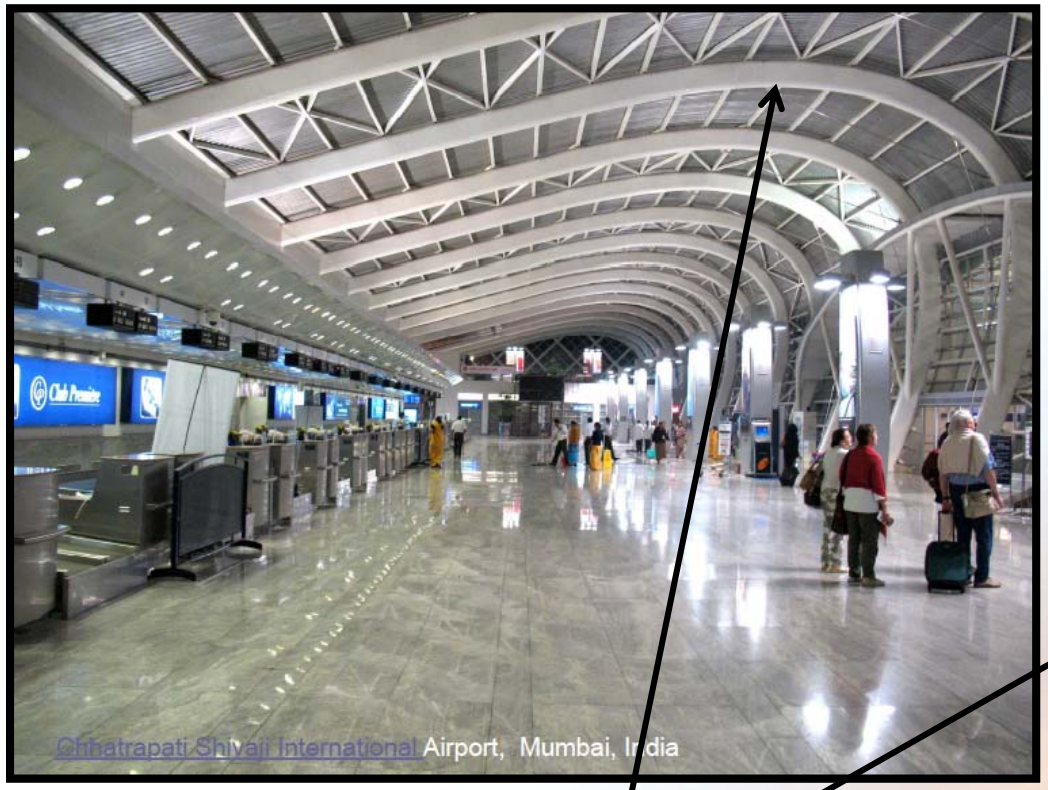

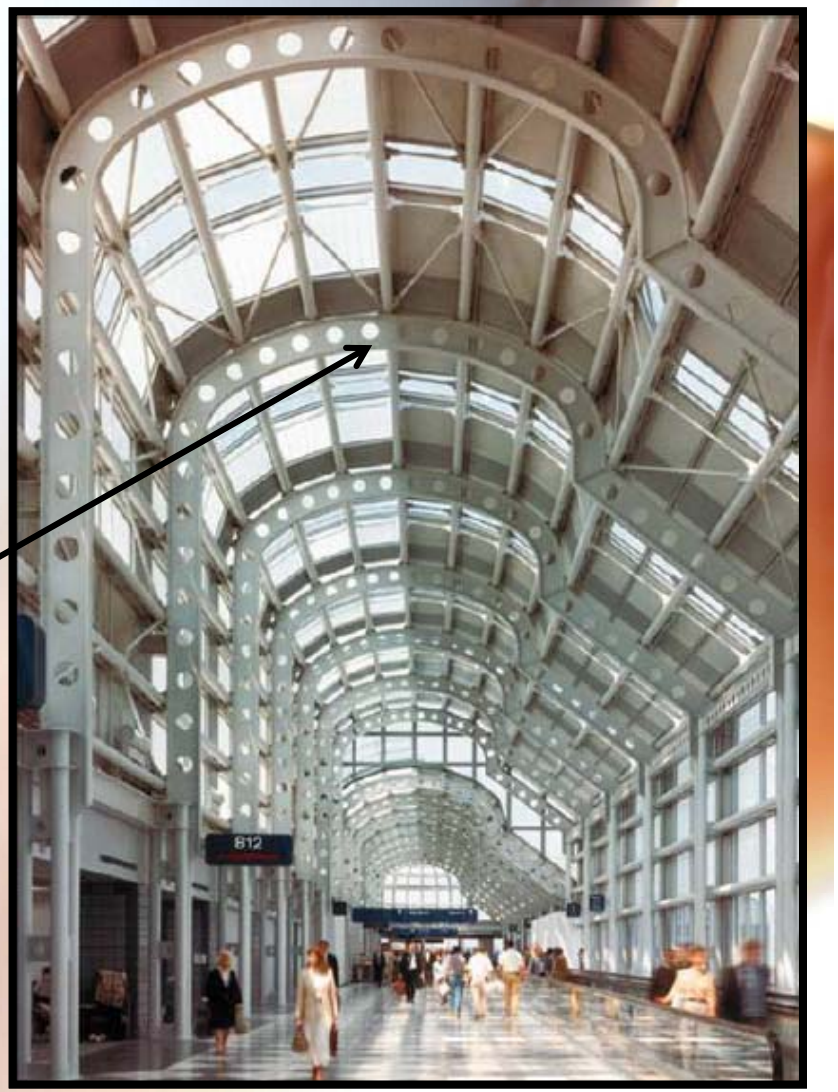

Main System

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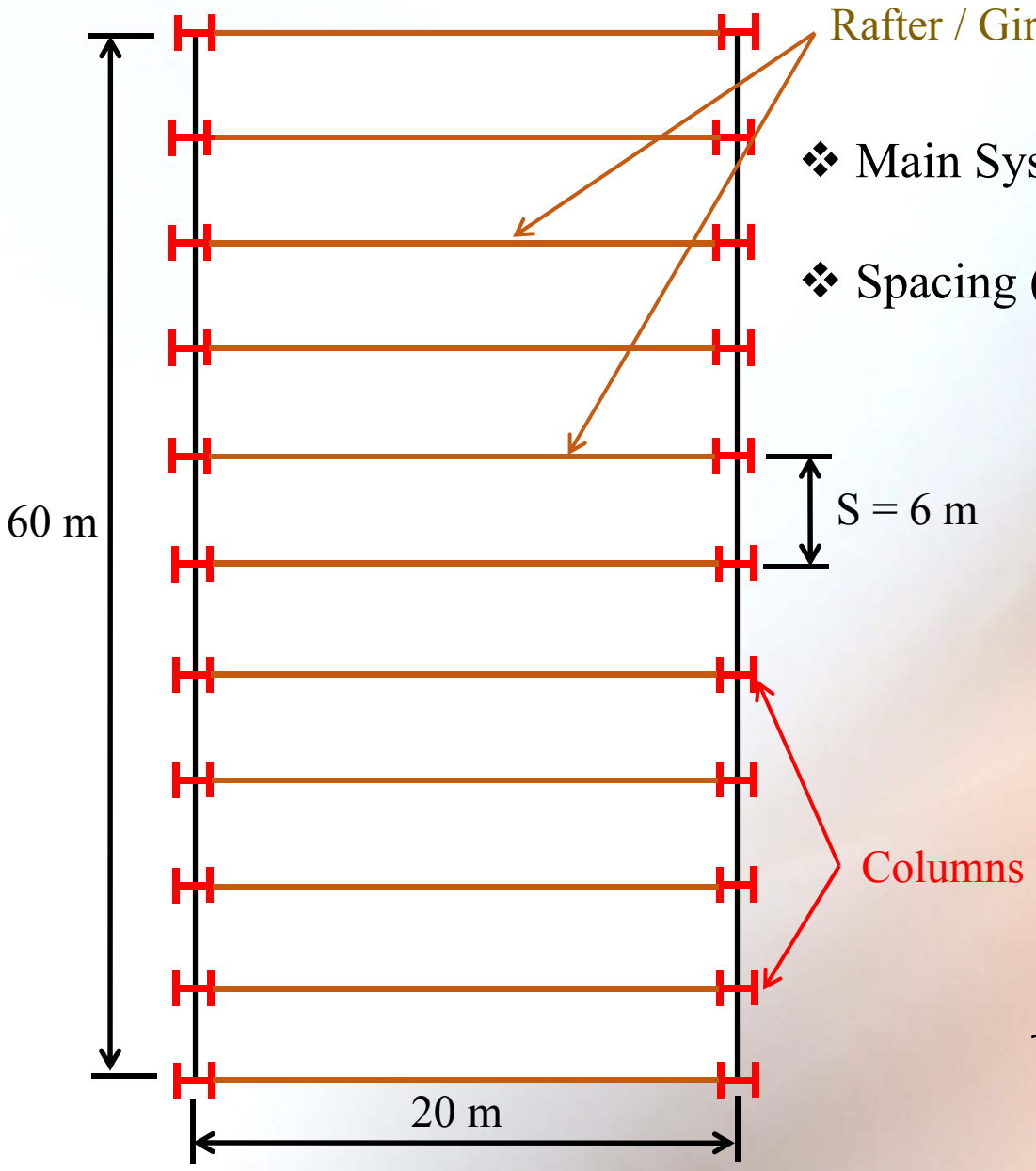

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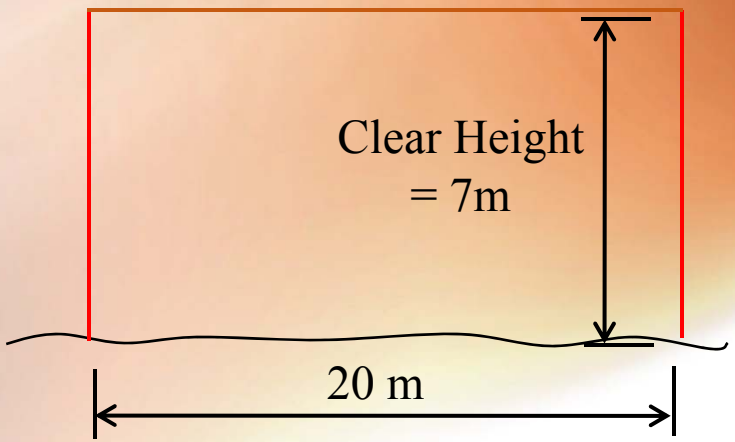
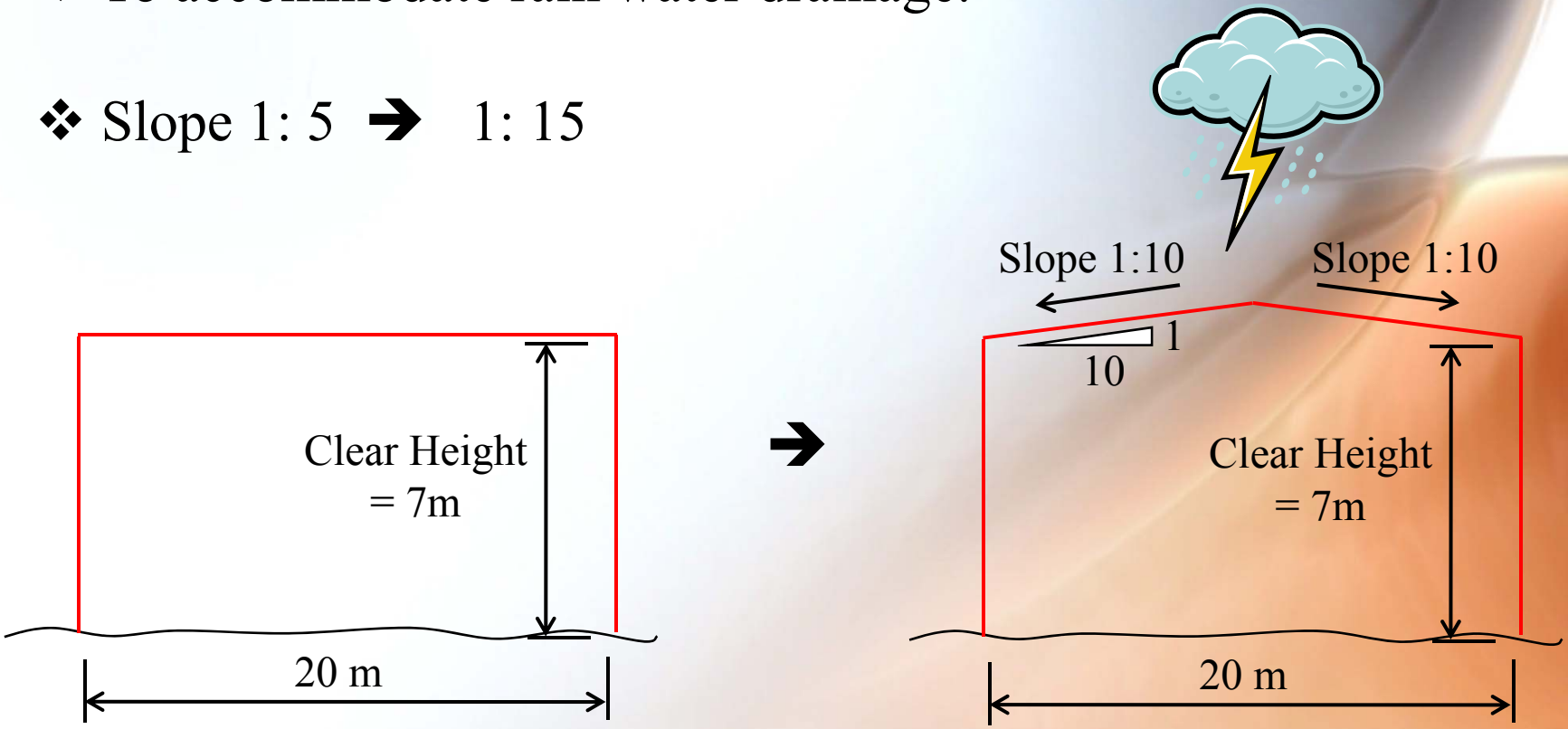


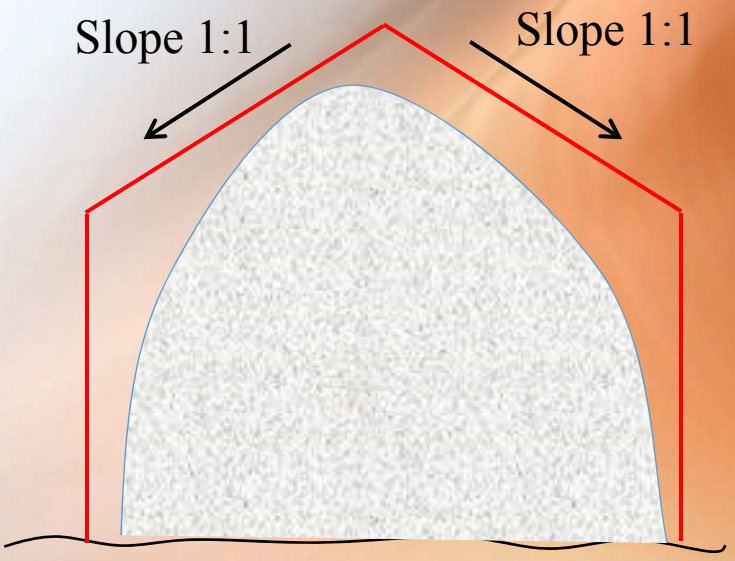
3. Roof Slope

- To accommodate rain water drainage.
- Slope 1: 5 ➔ 1: 15



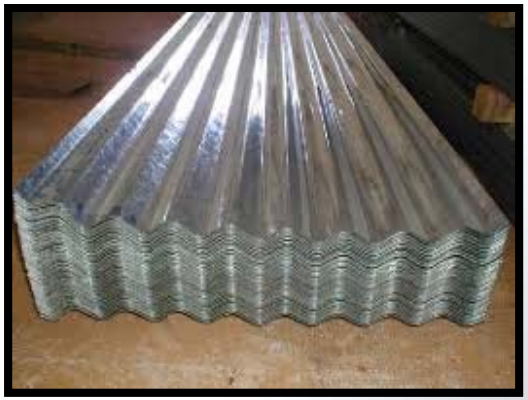
3. Roof Slope

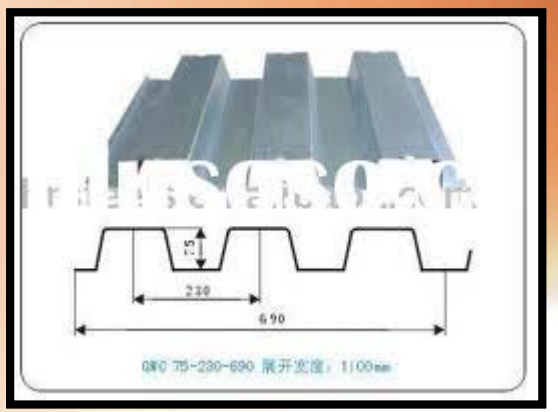
❖ Slope can reach values equal to: (1:1) in case of bulk material storage.



4. Roof Covering Materials

- Covering Material
  - Flexible Cover
    - Corrugated Sheets
    - Sandwich Panels
  - Rigid Cover
    - R.C. slab
    - Precast Units





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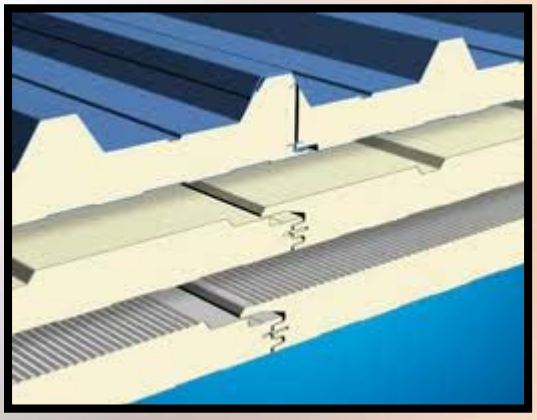

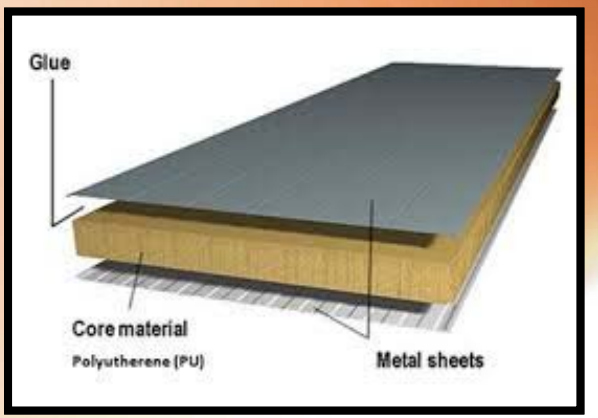

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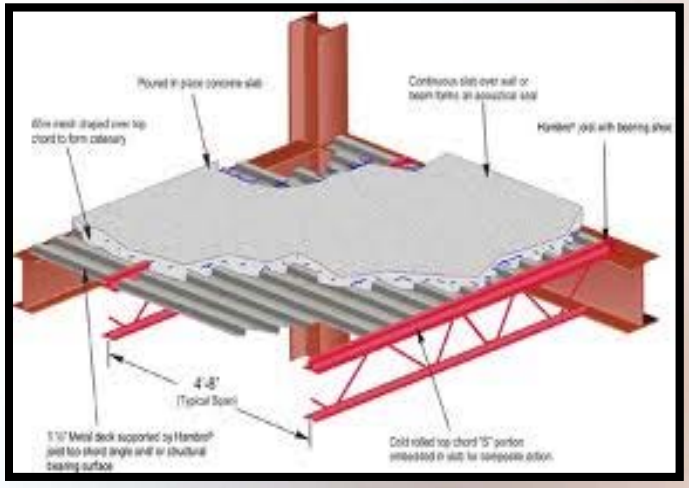

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4. Roof Covering Materials

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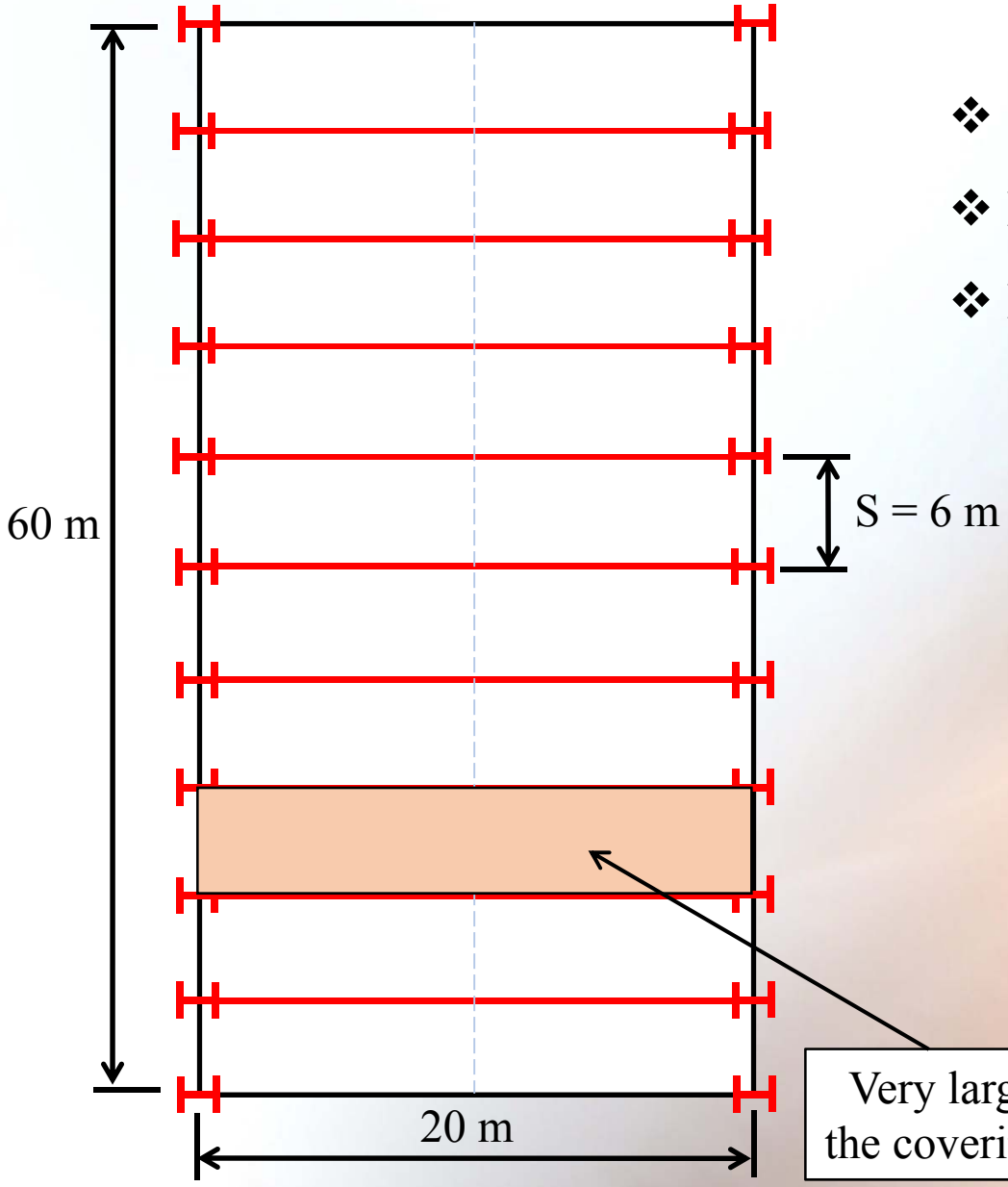
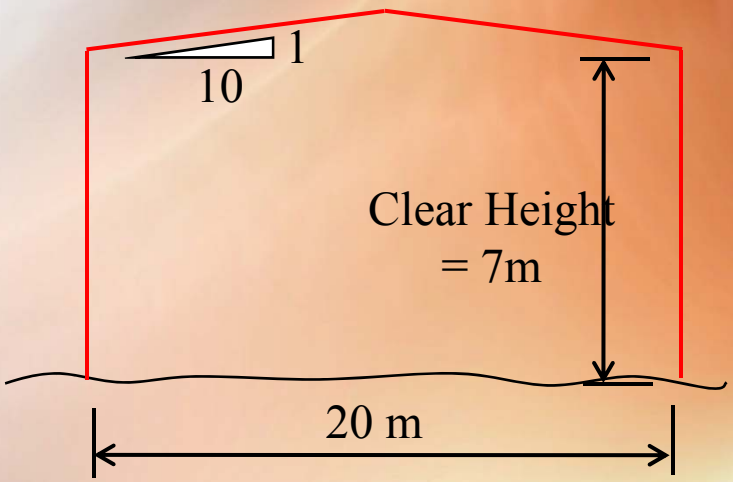
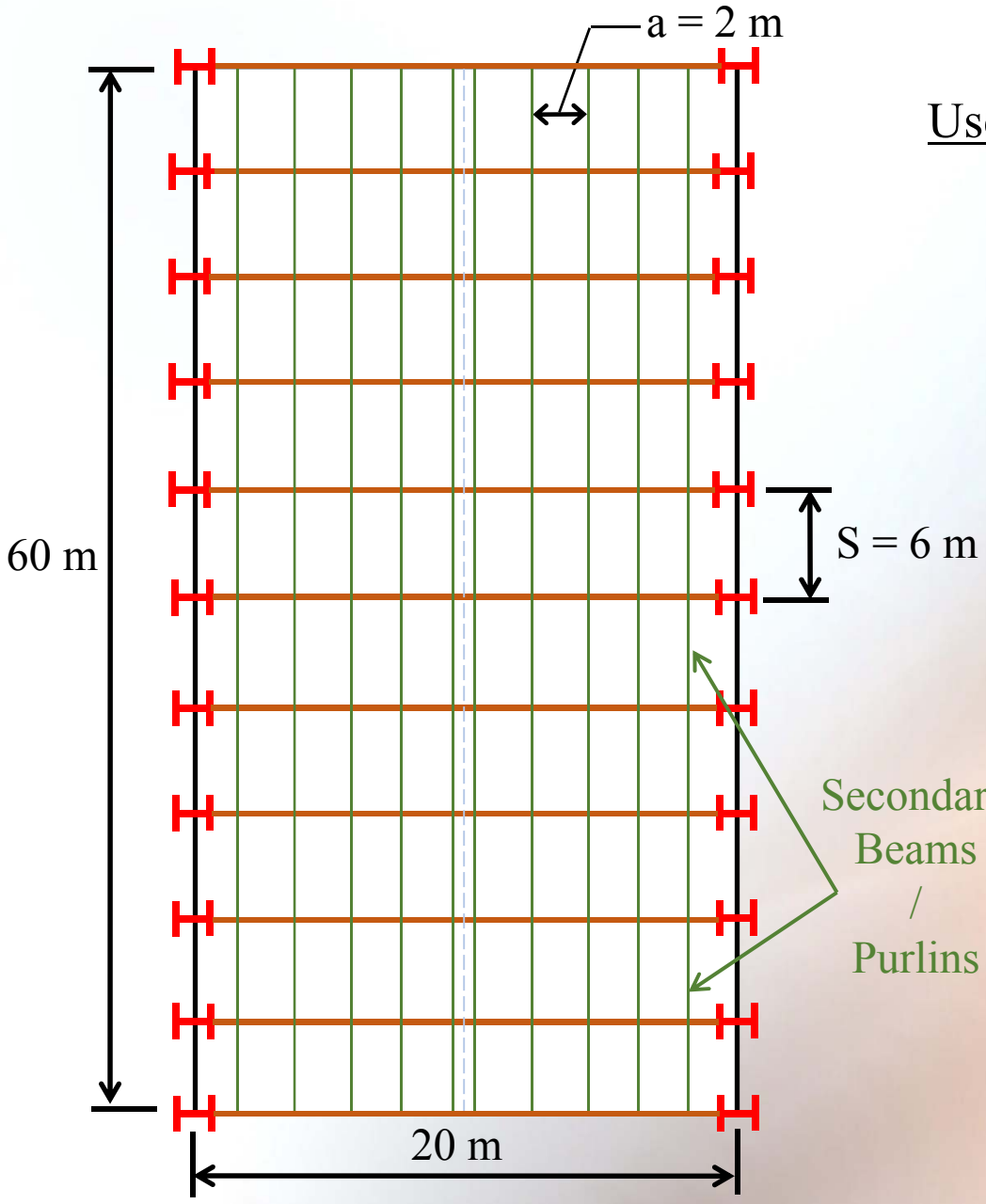


- Spacing bt. secondary beams ➔ a
- For Flexible Roof: $a \leq 2m$
- For Rigid Roof : $a \leq 3m$



Very large area for the covering material ➔ Use Secondary Beams

4. Roof Covering Materials

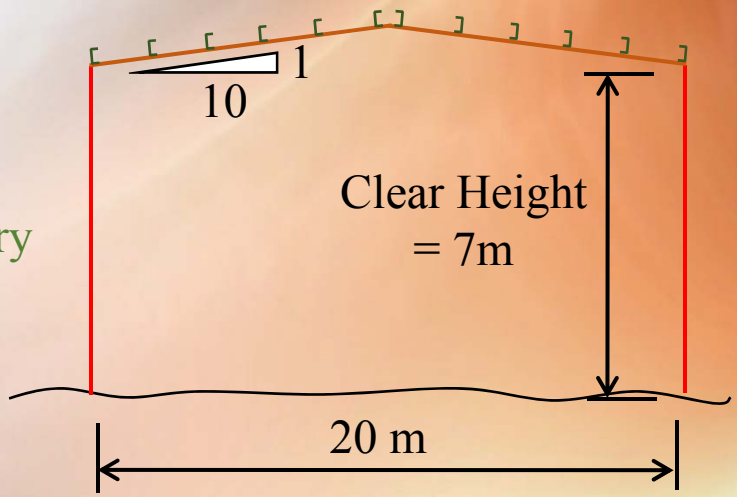


Secondary Beams / Purlins

Used Sections for Purlins:

Channel Section

Z Section



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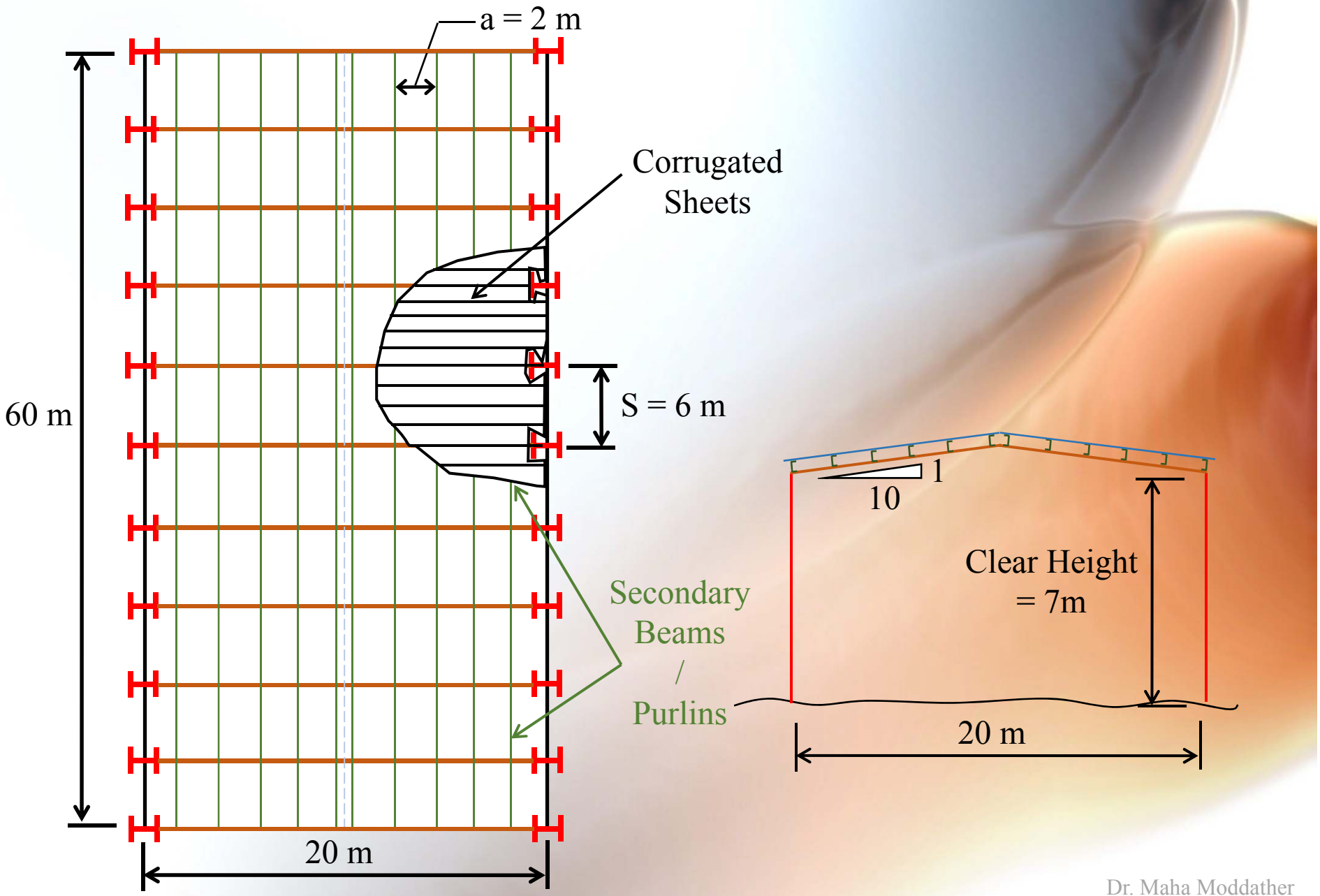

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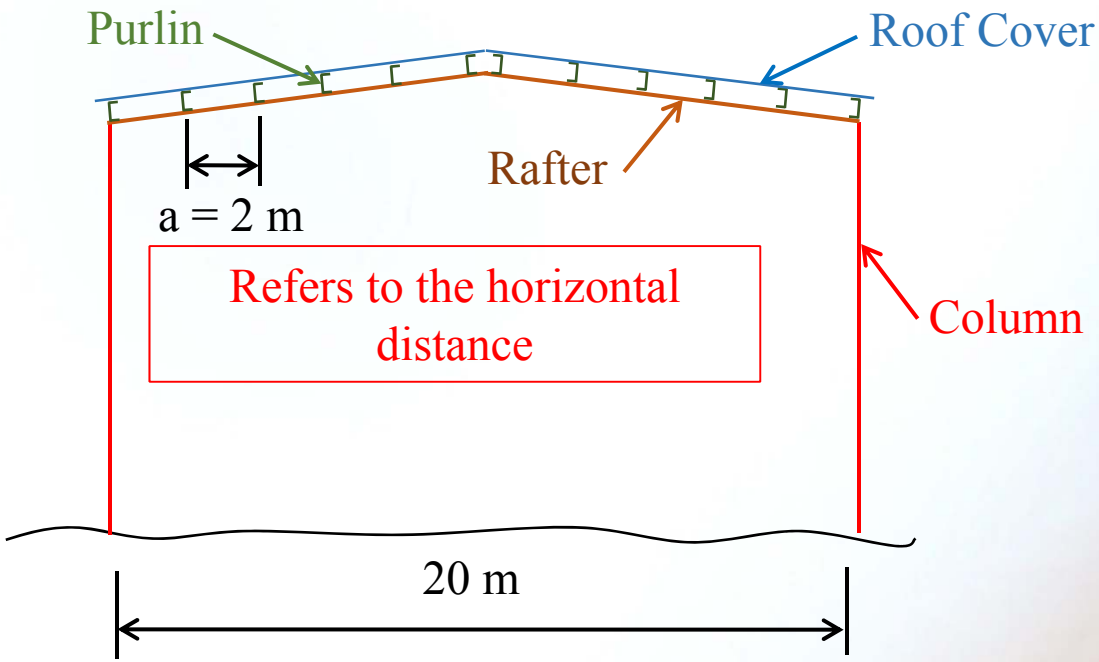
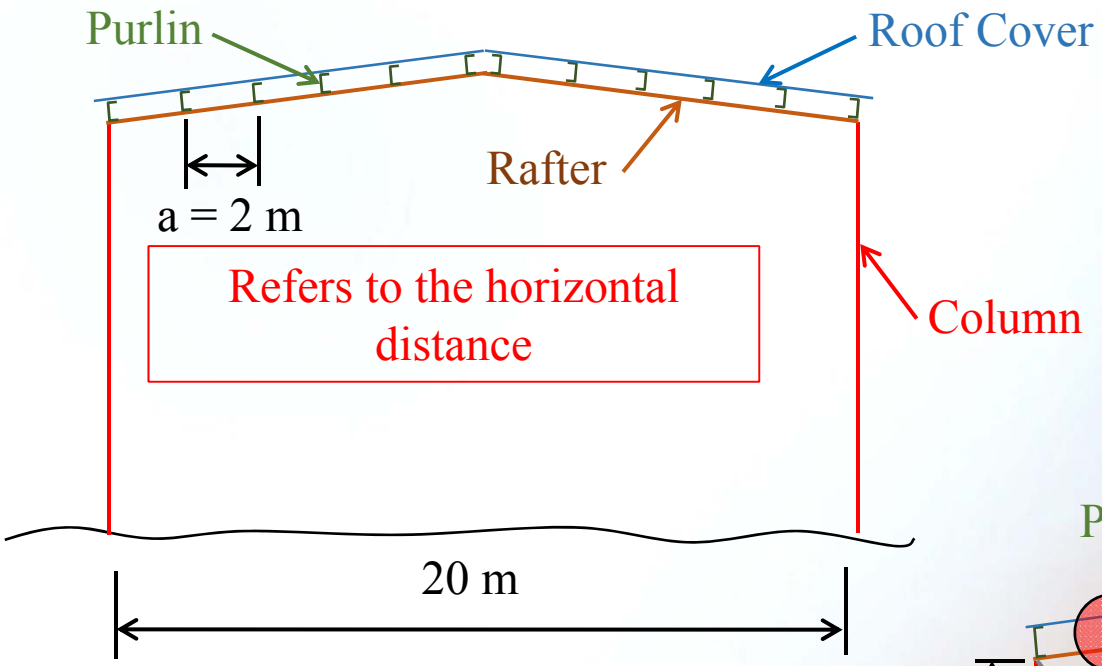
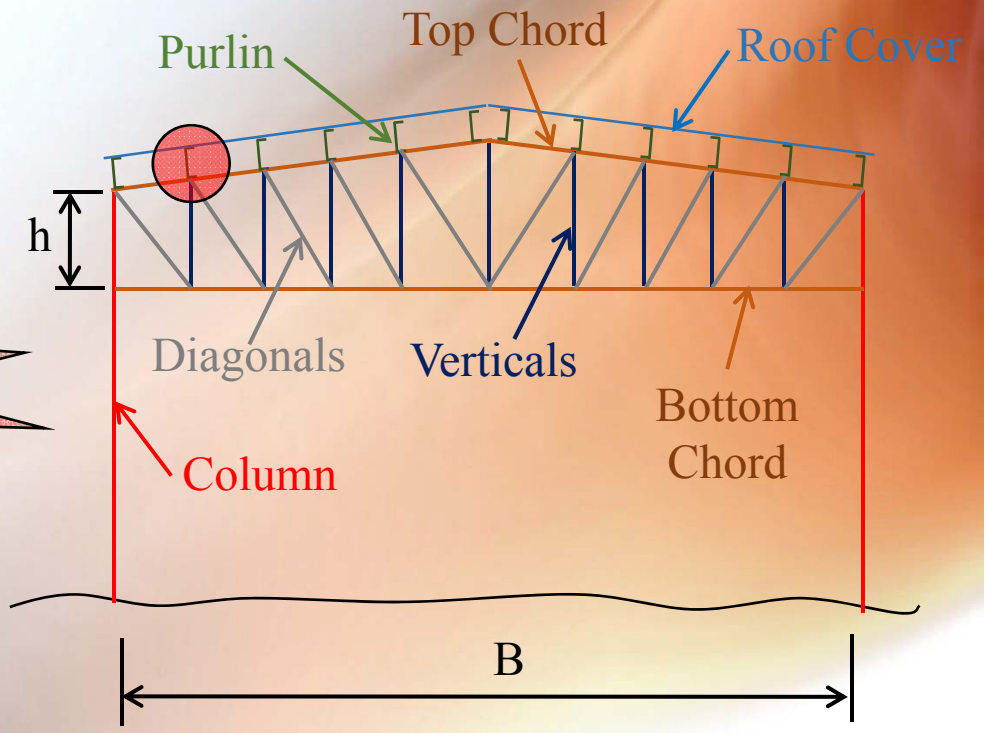


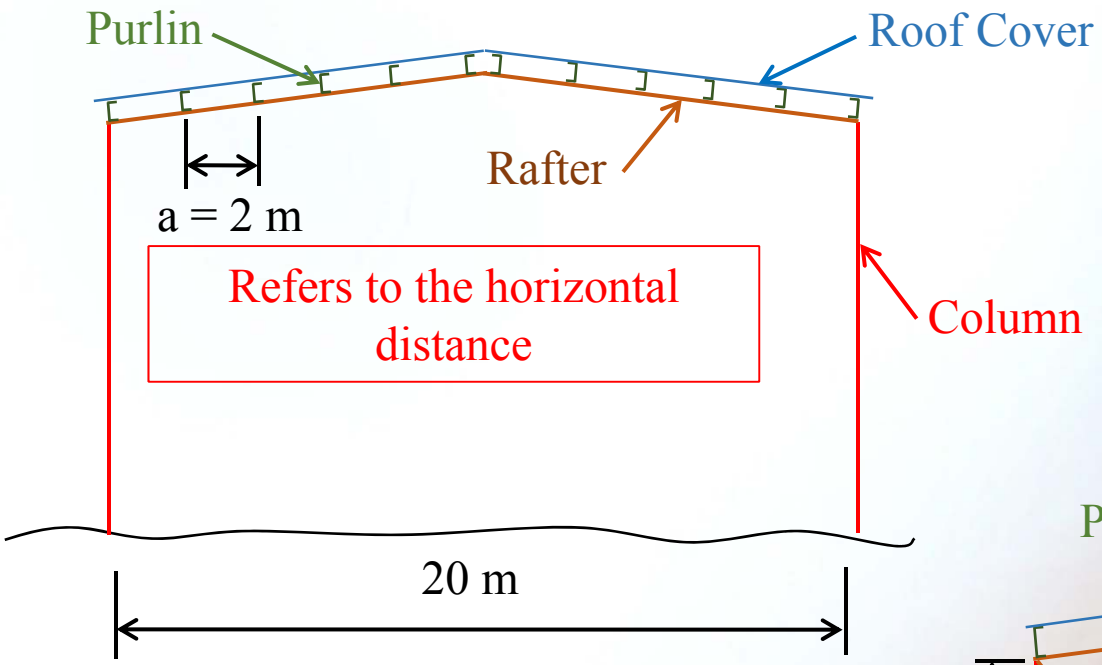
4. Roof Covering Materials



Purlins should be at Truss Joints



4. Roof Covering Materials



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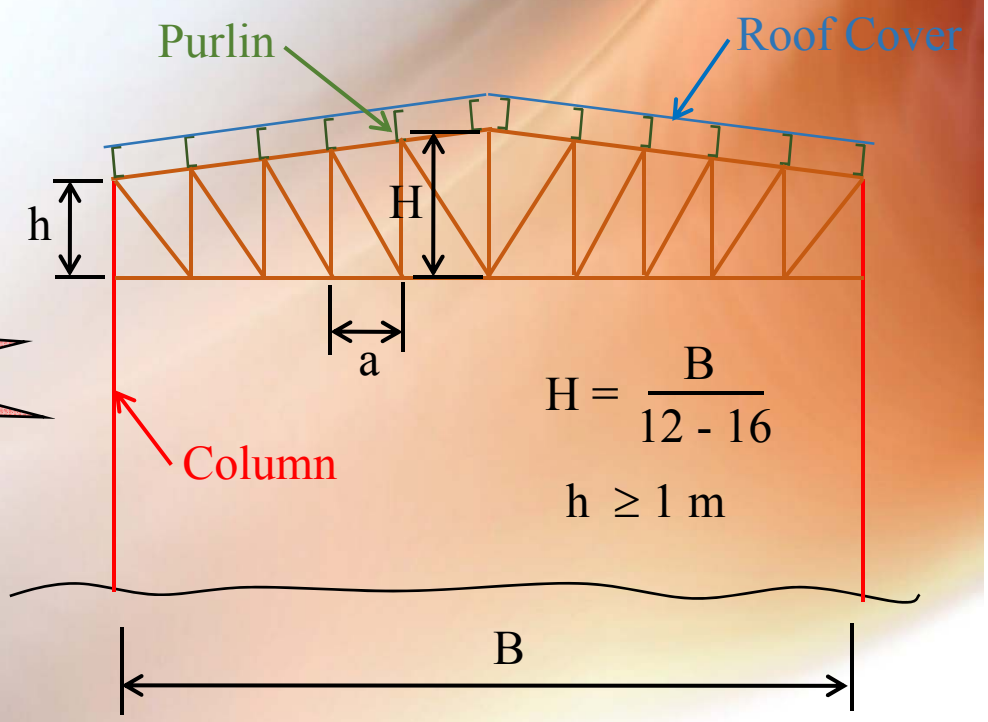

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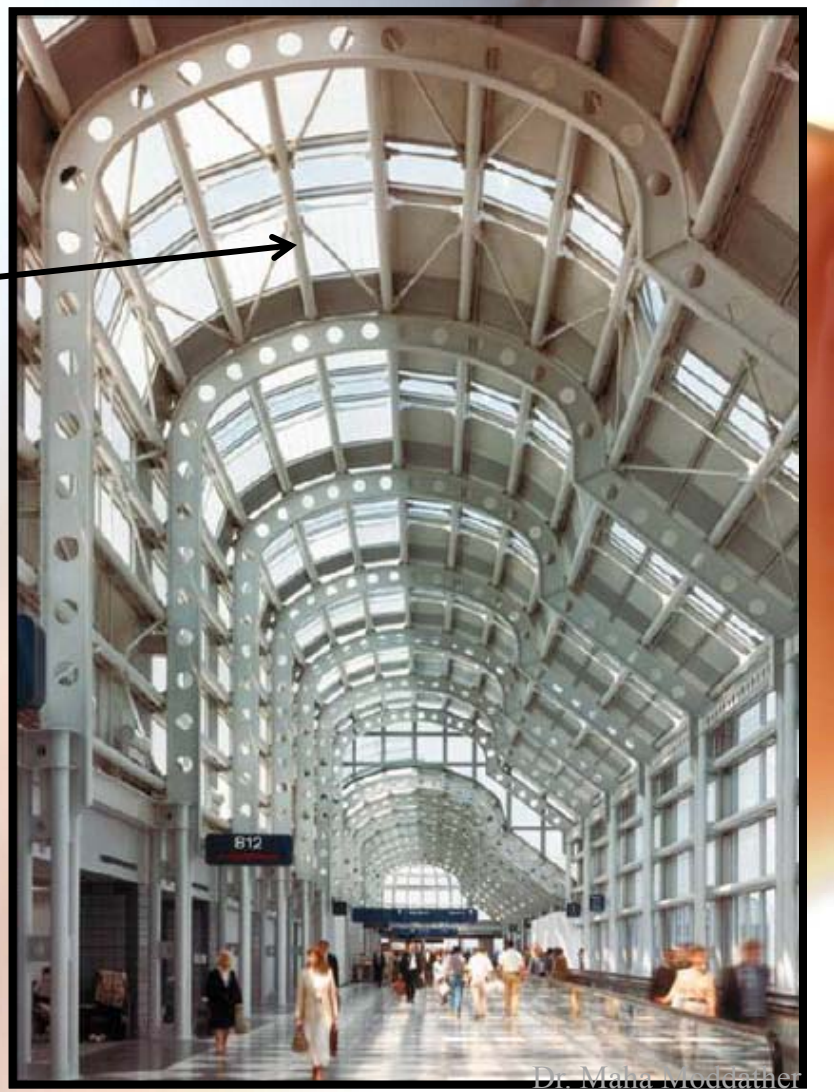
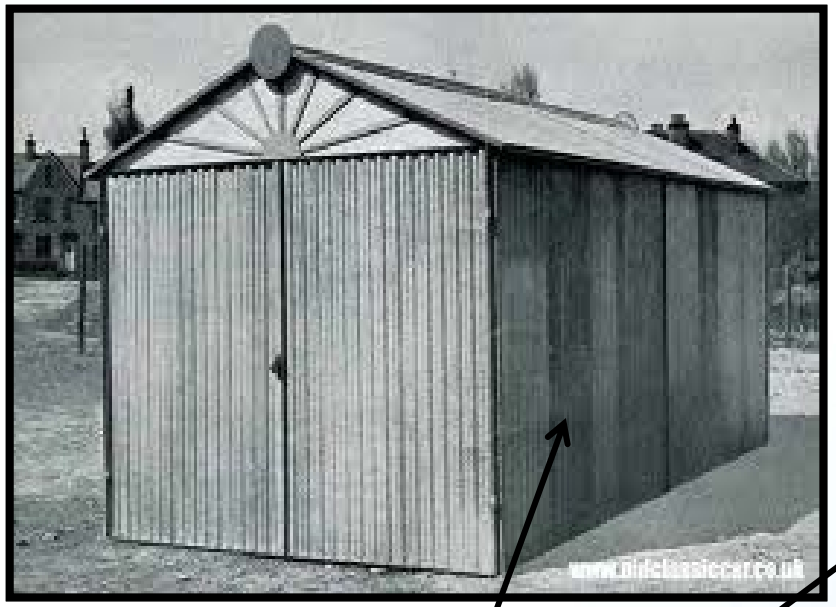



Ahmed
Lashin

5. Side Cover

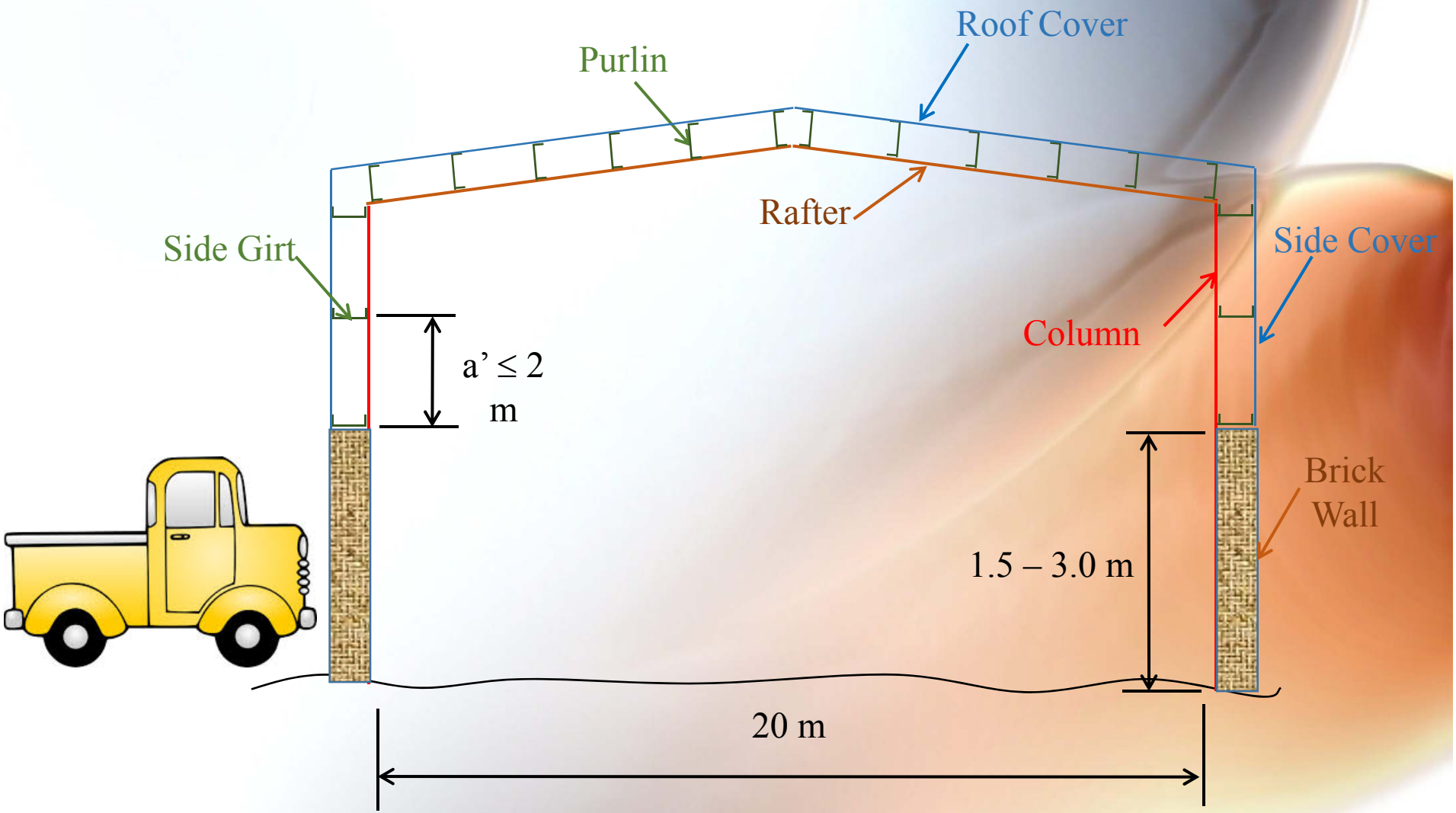


Corrugated Sheets

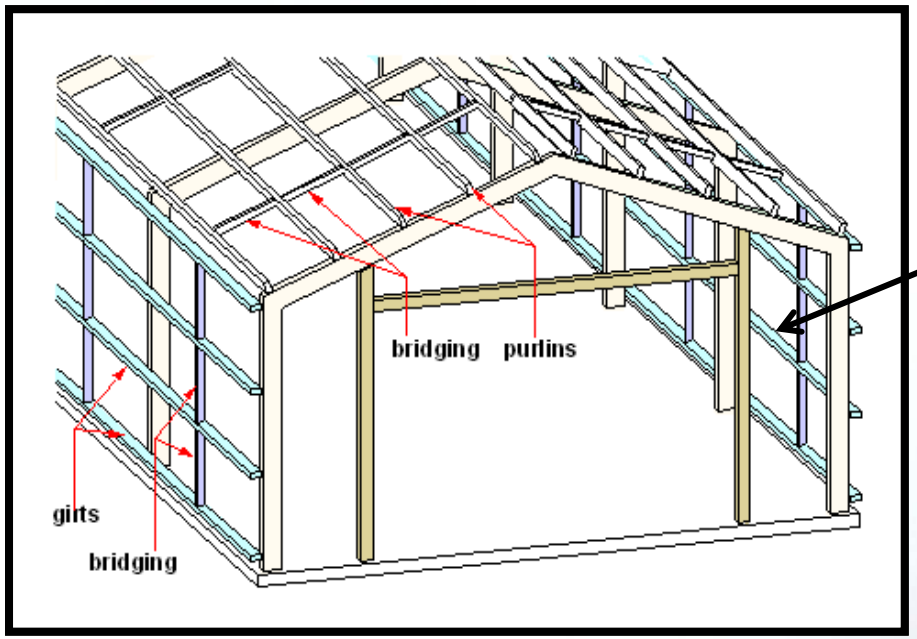
Brick Walls


Ahmed
Lashin

5. Side Cover


Roof Cover
Purlin
Rafter
Side Girt
Side Cover
Column
a' ≤ 2 m
Brick Wall
1.5 – 3.0 m
20 m

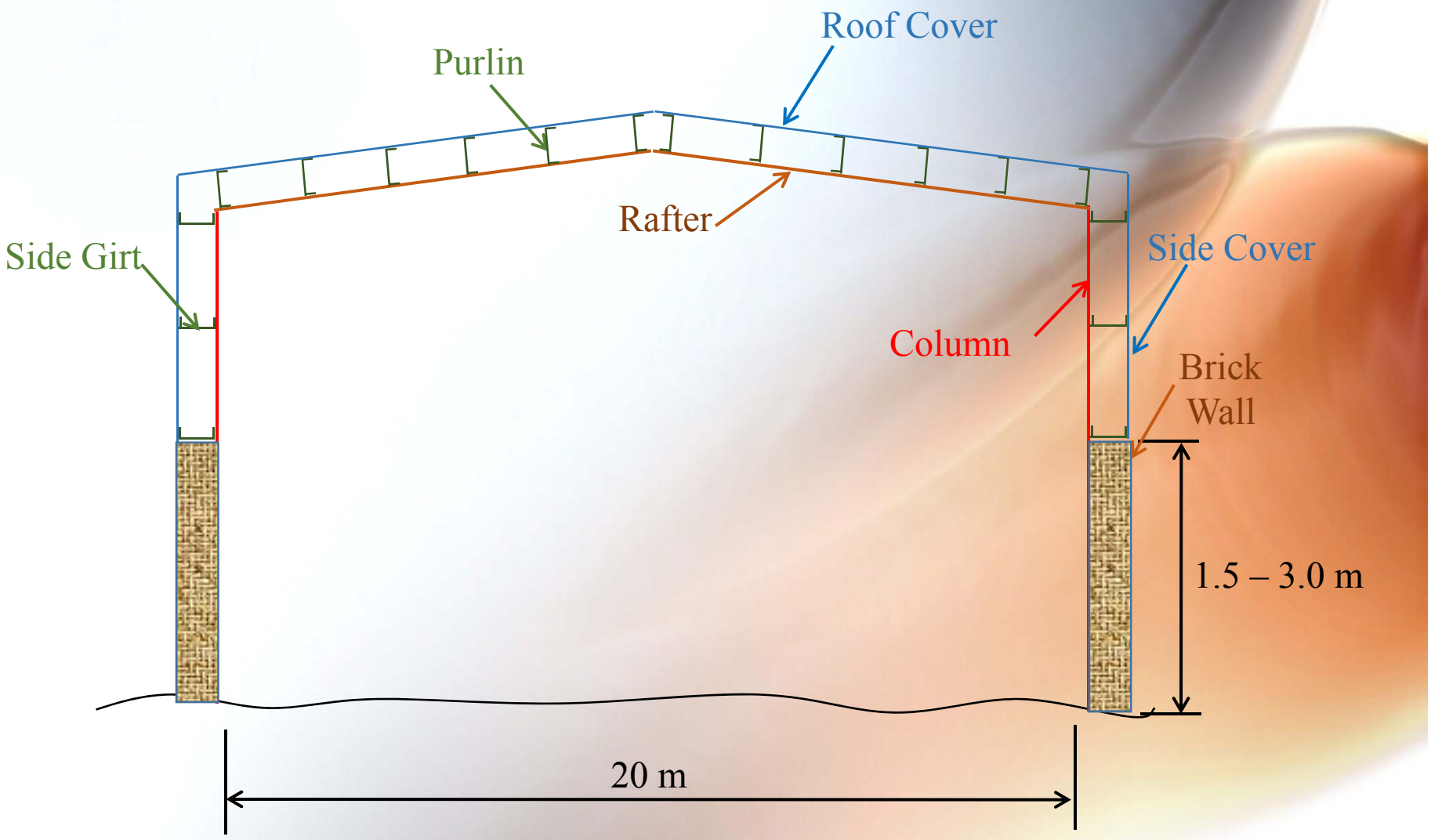
5. Side Cover



Side Girts

6. End Gables

- Add End Gable Columns with spacing 4 – 6 m



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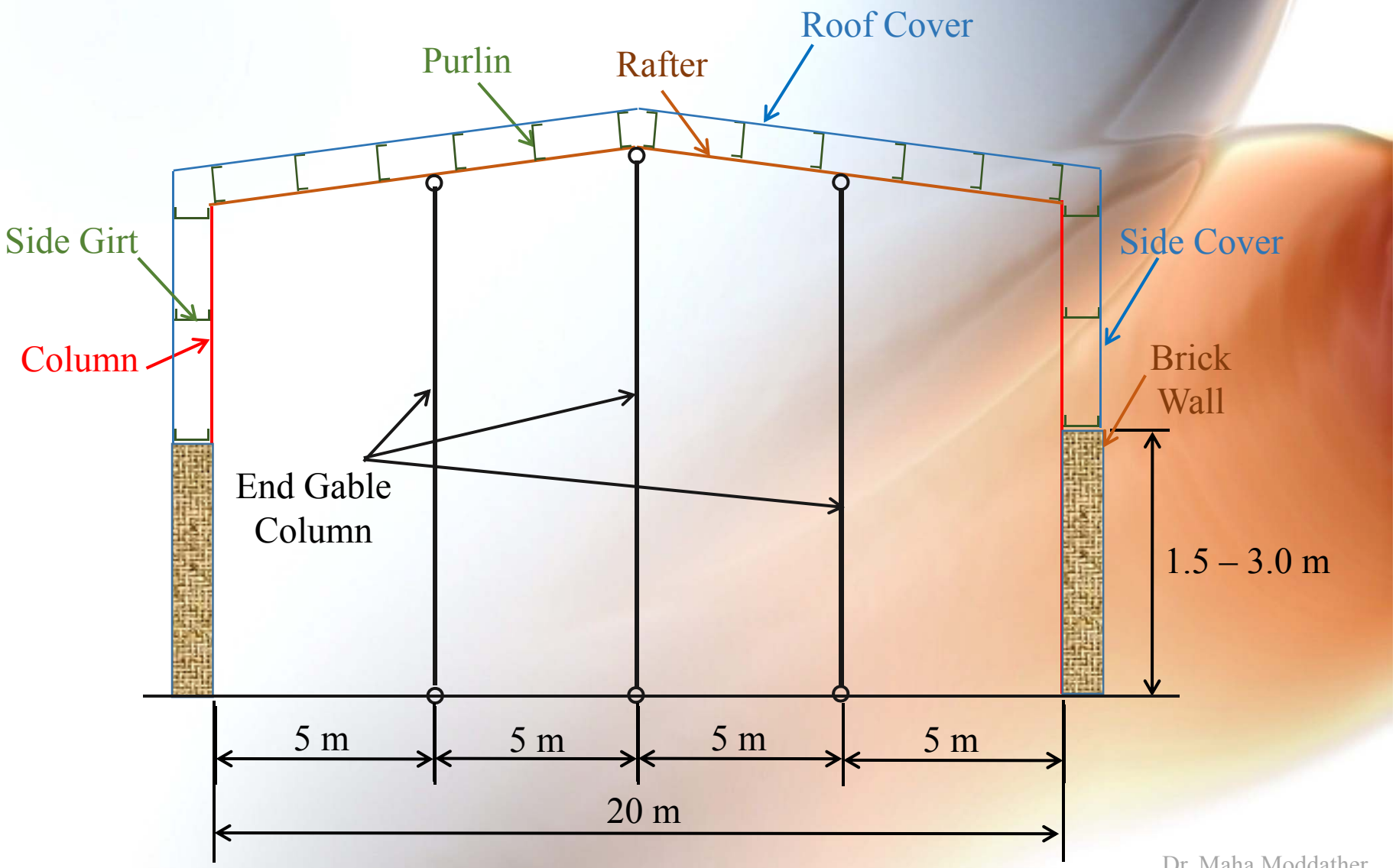
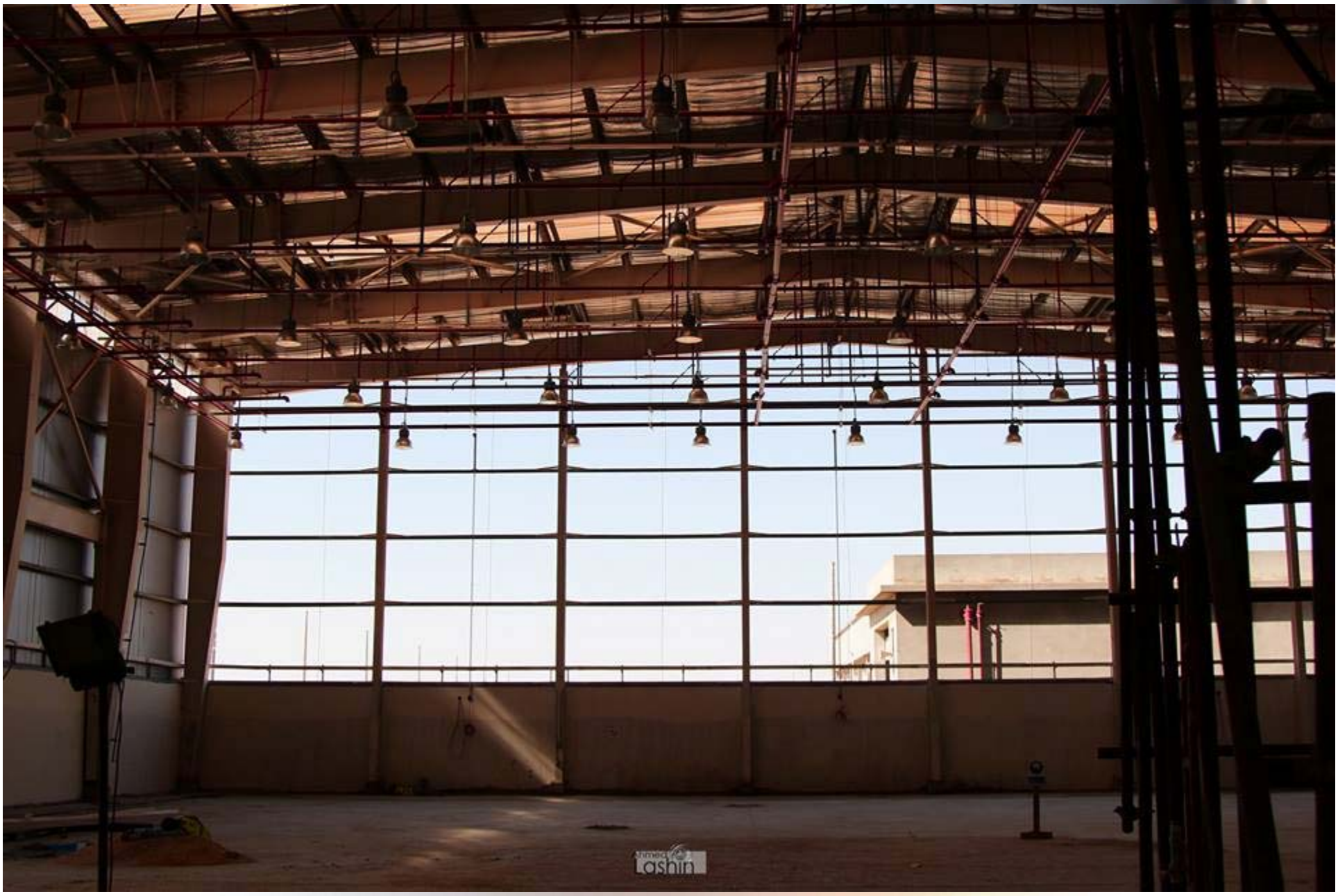
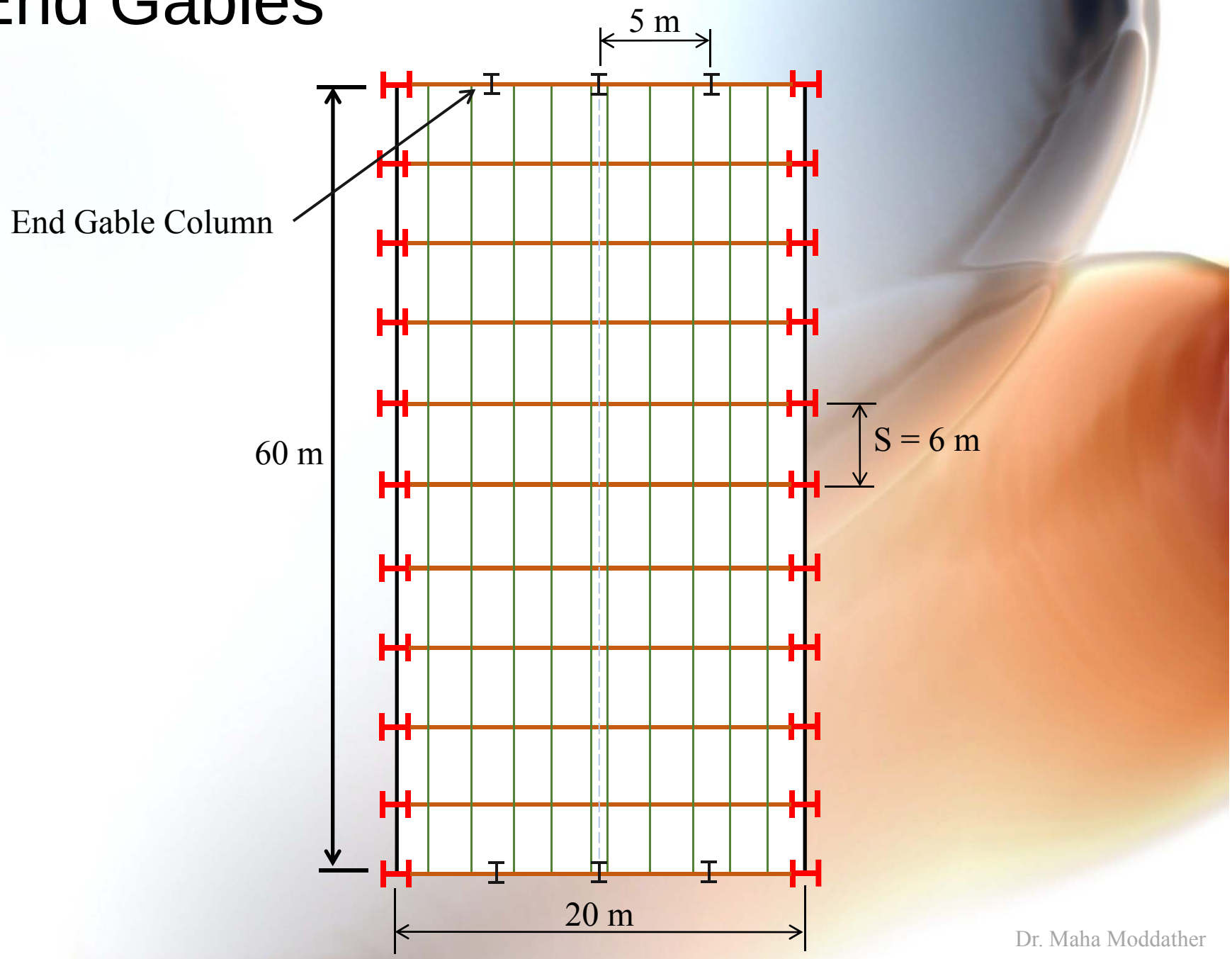
- Add End Gable Columns with spacing 4 – 6 m





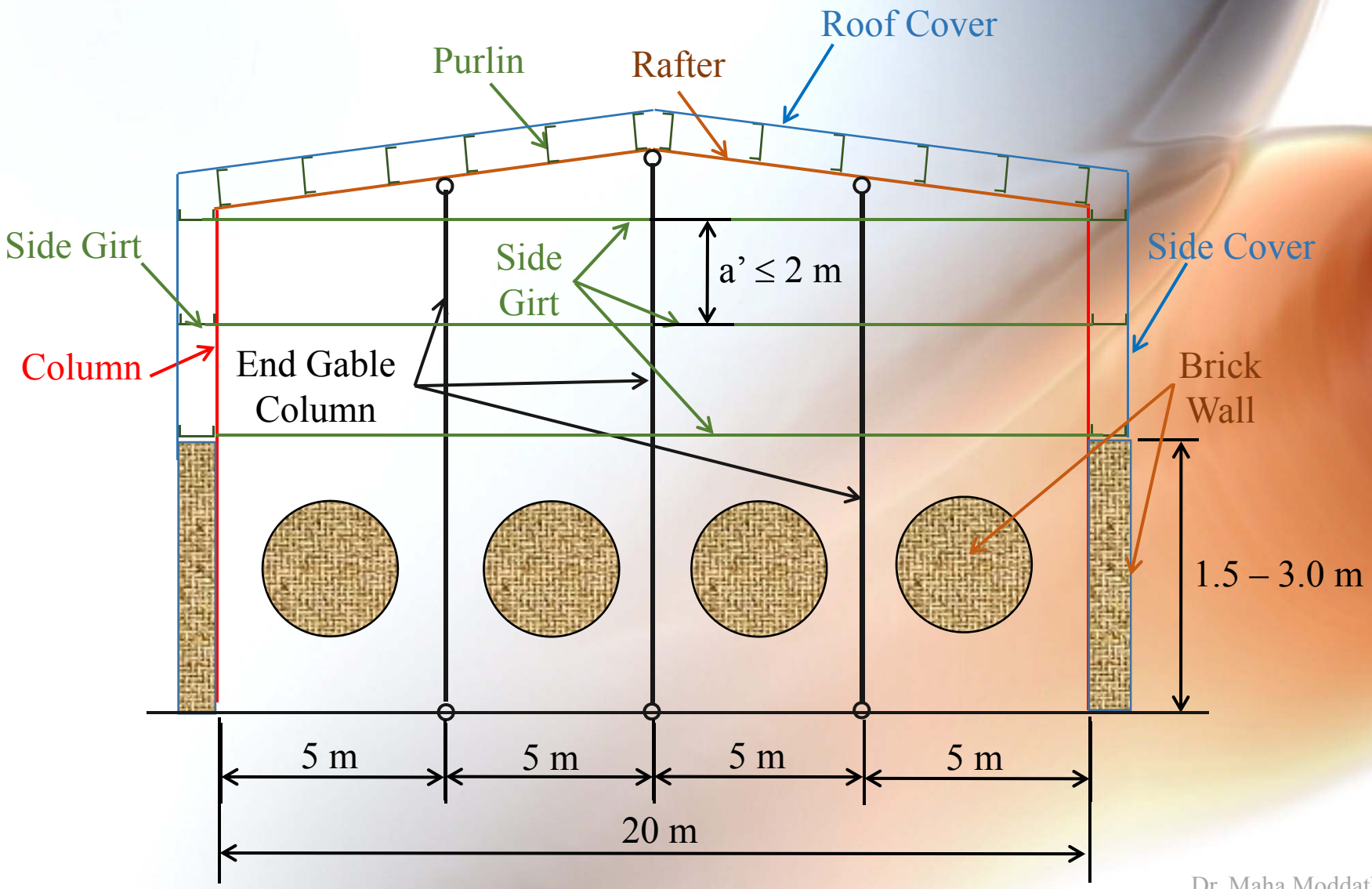
Dr. Maha Moddather

6. End Gables



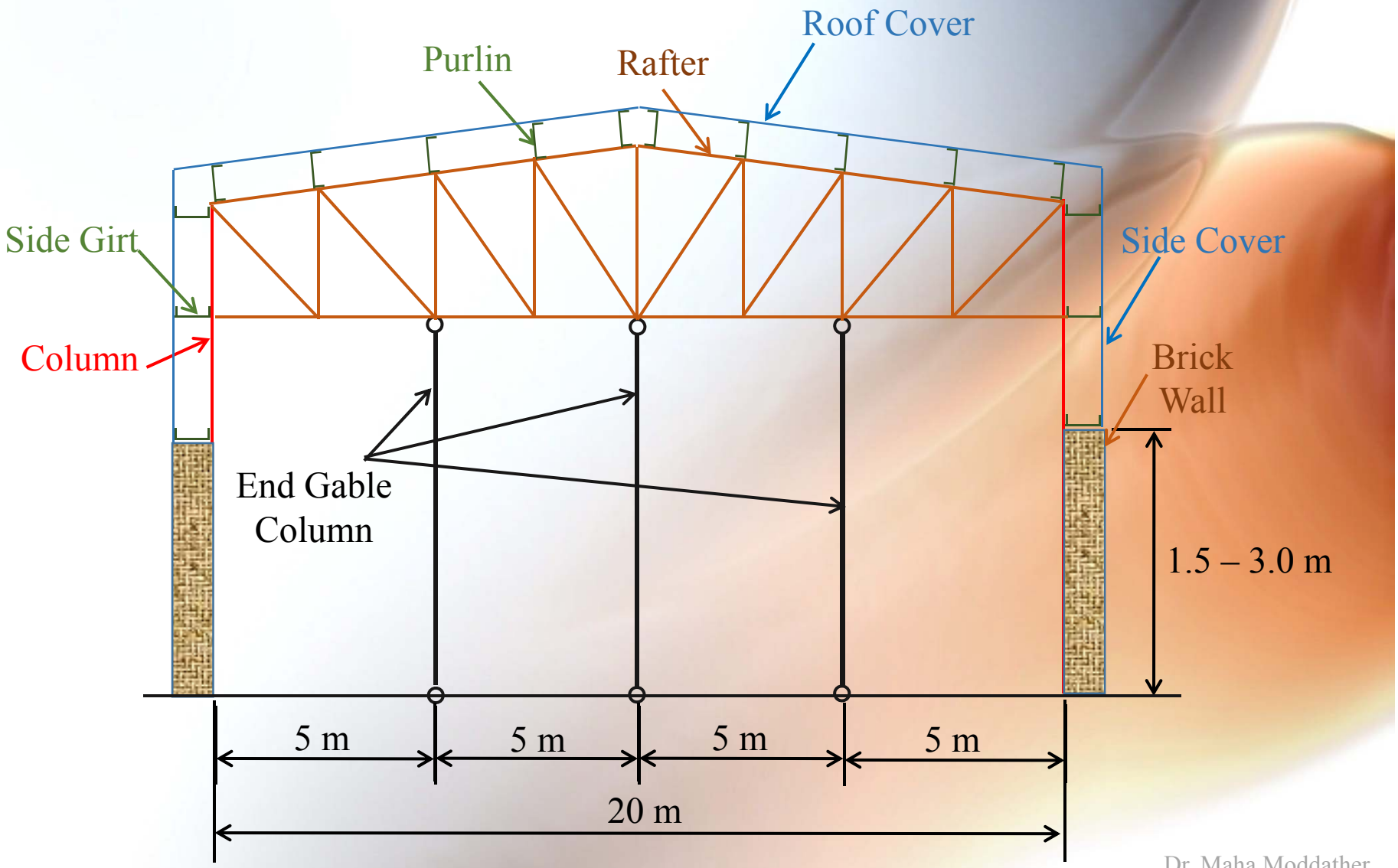
6. End Gables

- Use Side Girts at distance ≤ 2.0 m



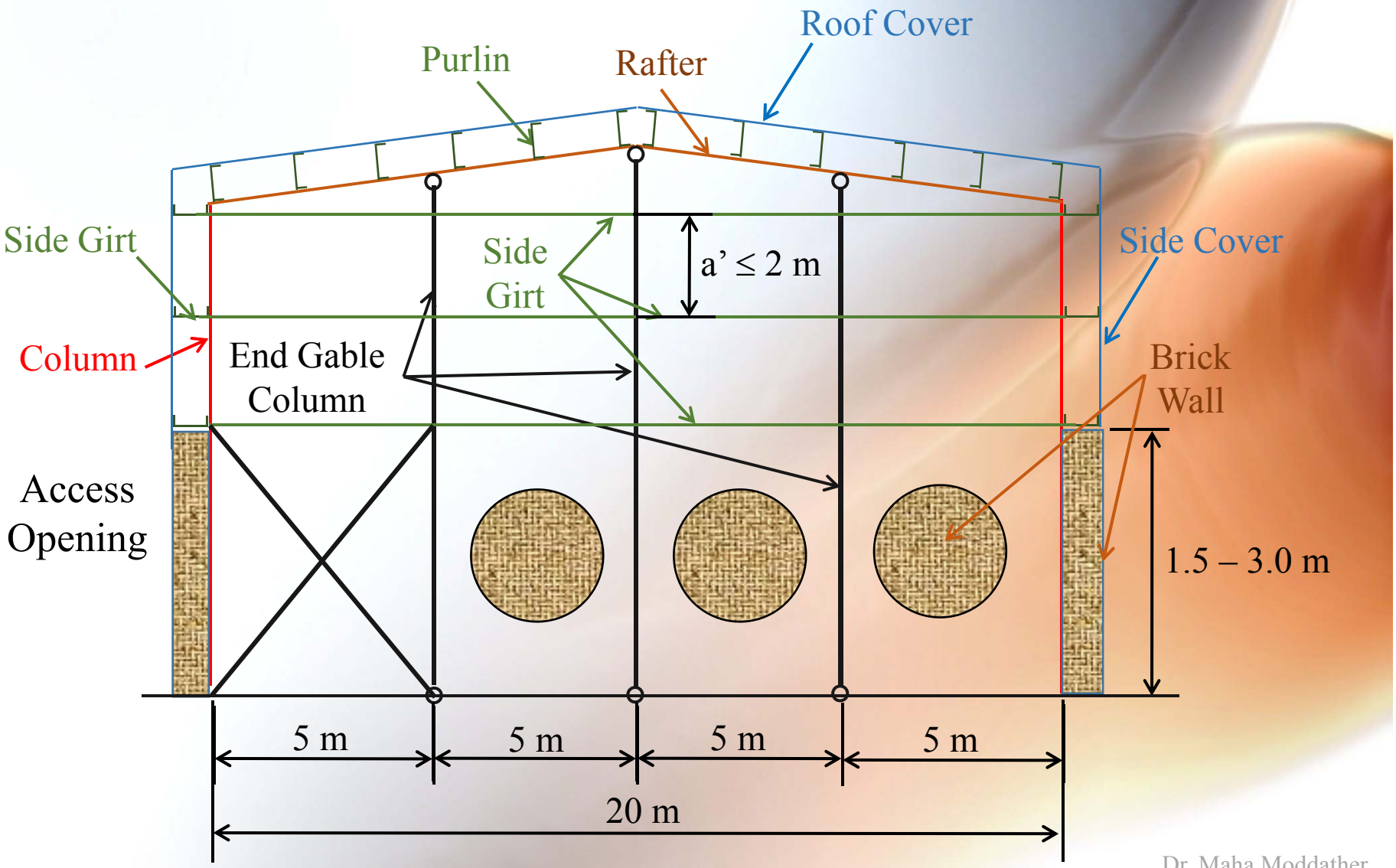
6. End Gables

- For trusses: End Gable Columns at truss Joints



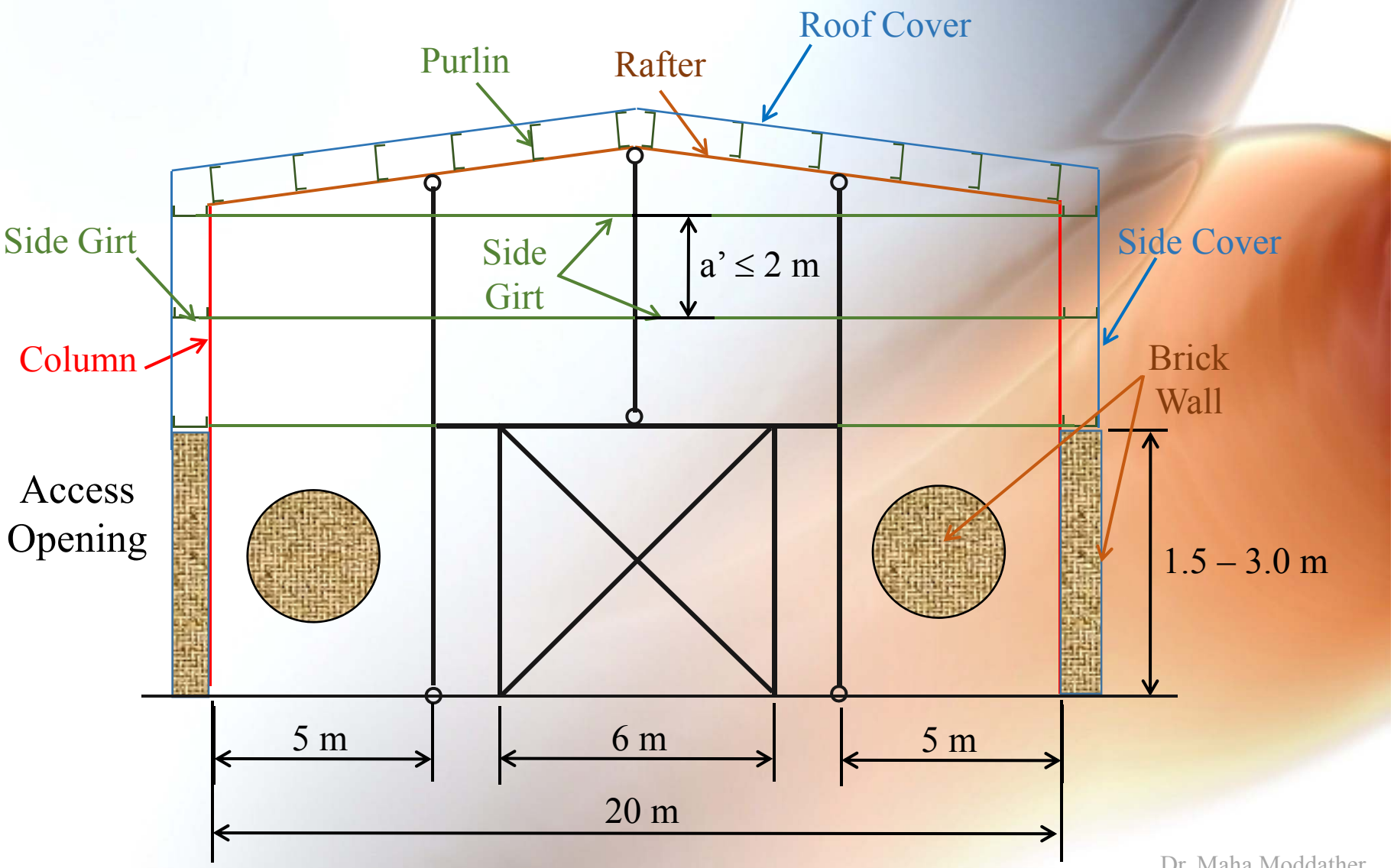
6. End Gables

❑ Access Doors



6. End Gables

❑ Access Doors



6. End Gables

- Types of Doors

Roller Shutter Door

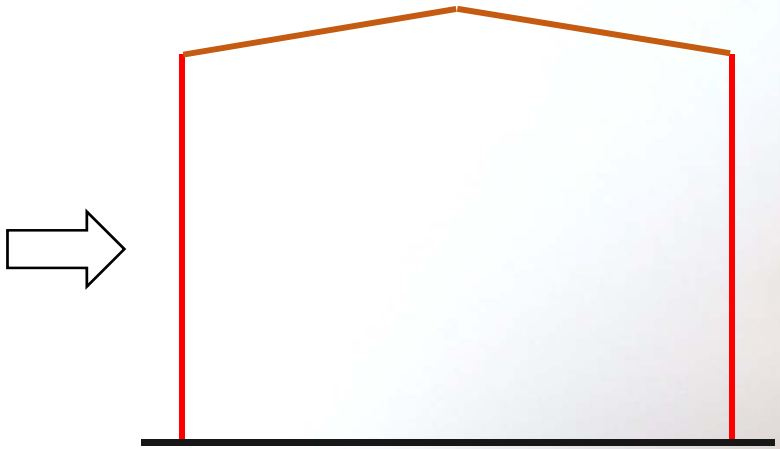
Sliding Door (One side)

Sliding Door (Two side)

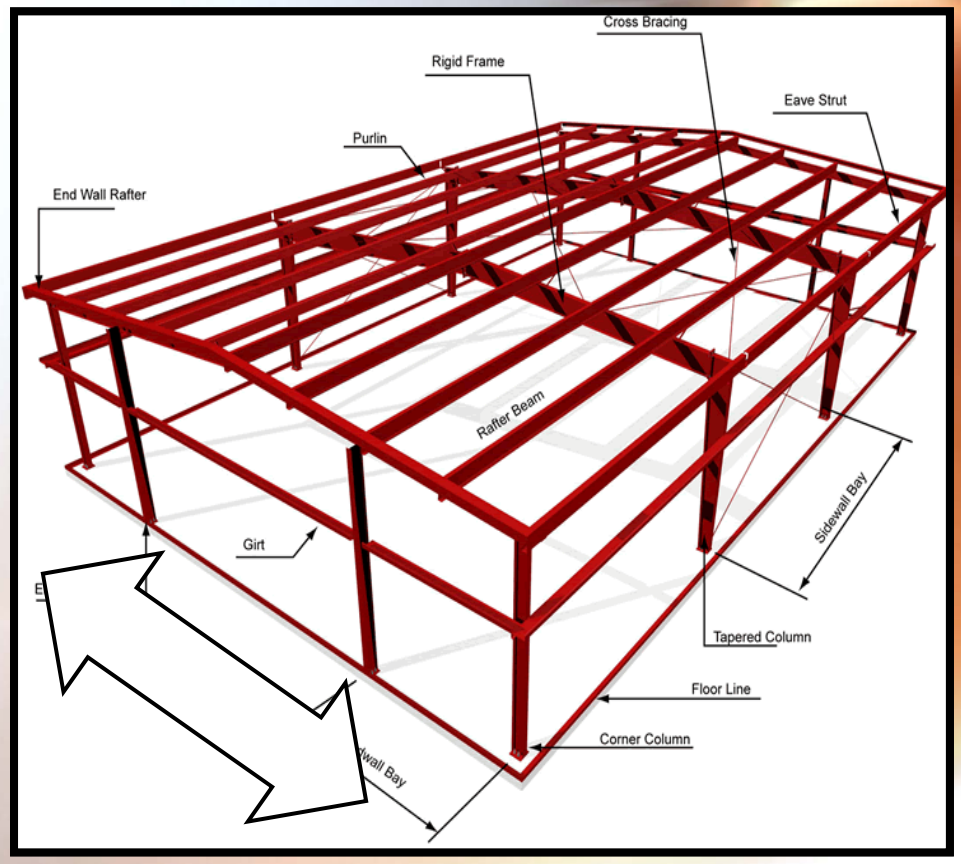
7. Bracing System

- Bracing system is provided to frames to provide stability under the lateral loads.

Frame can support loads in the lateral direction

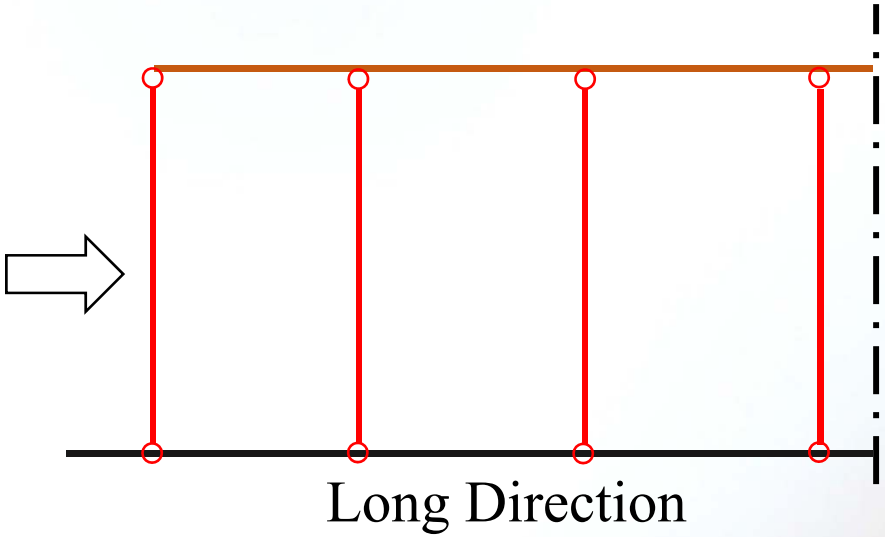


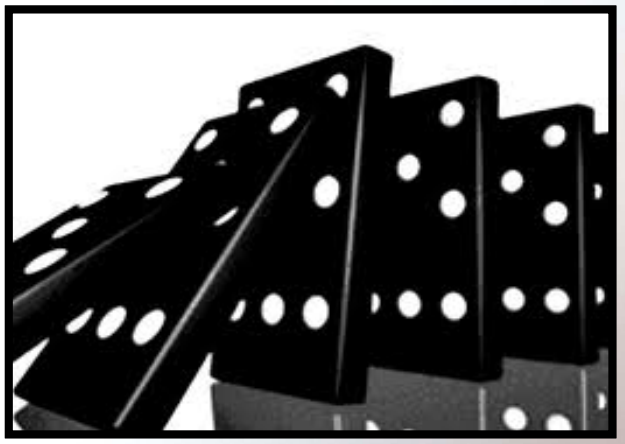
Short Direction

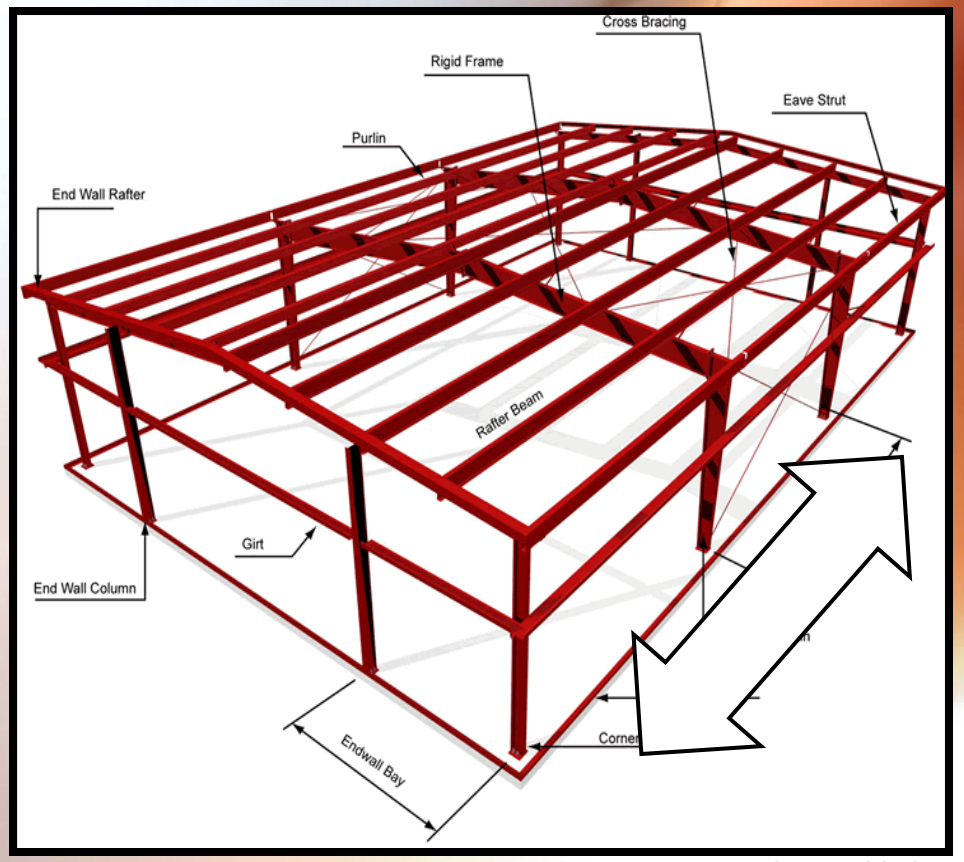


7. Bracing System

- Bracing system is provided to frames to provide stability under the lateral loads.







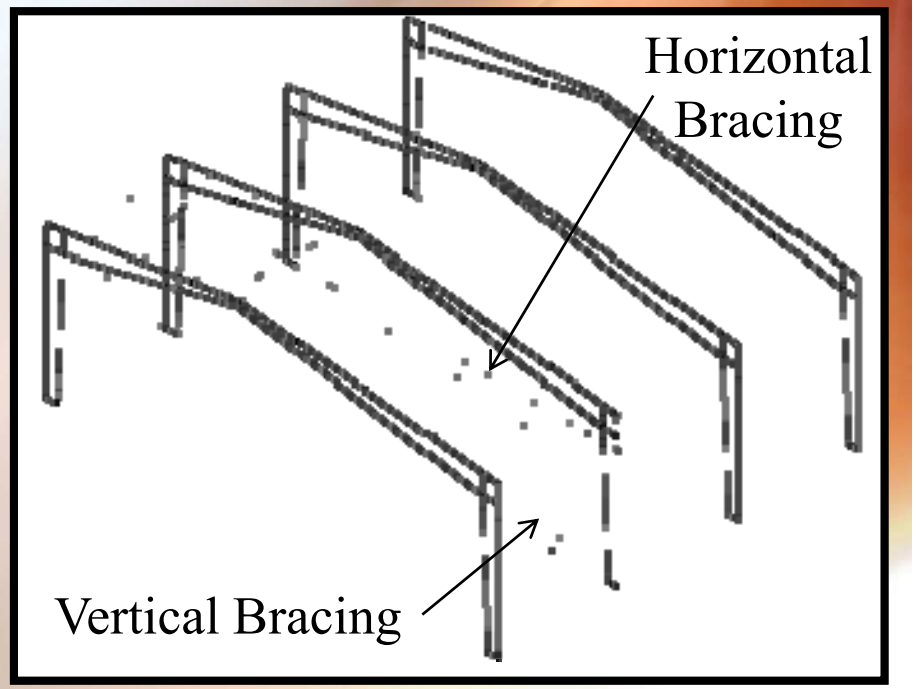
7. Bracing System

- Bracing System includes:
  - **Horizontal Bracing:**

Bracing in a horizontal plane provides a load path to transfer the horizontal forces (wind pressure on the cladding) to the planes of vertical bracing.

  - **Vertical Bracing**

Bracing in vertical planes (between lines of columns) provides load paths to transfer horizontal forces to ground level.



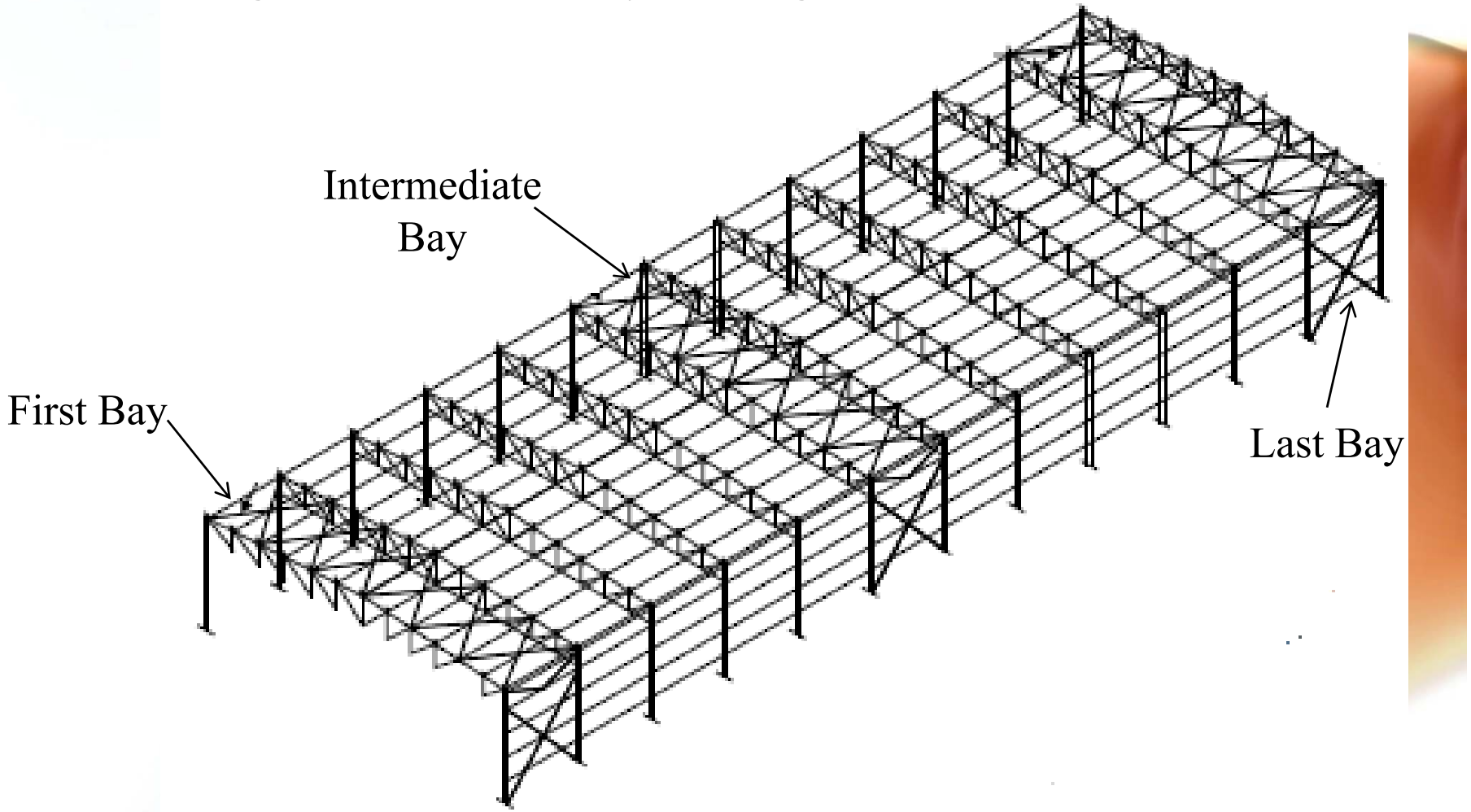
7. Bracing System

Wind Bracing System

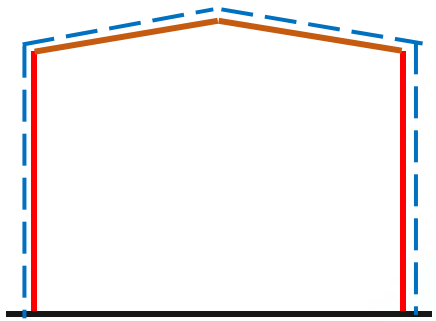
Wind Bracing System

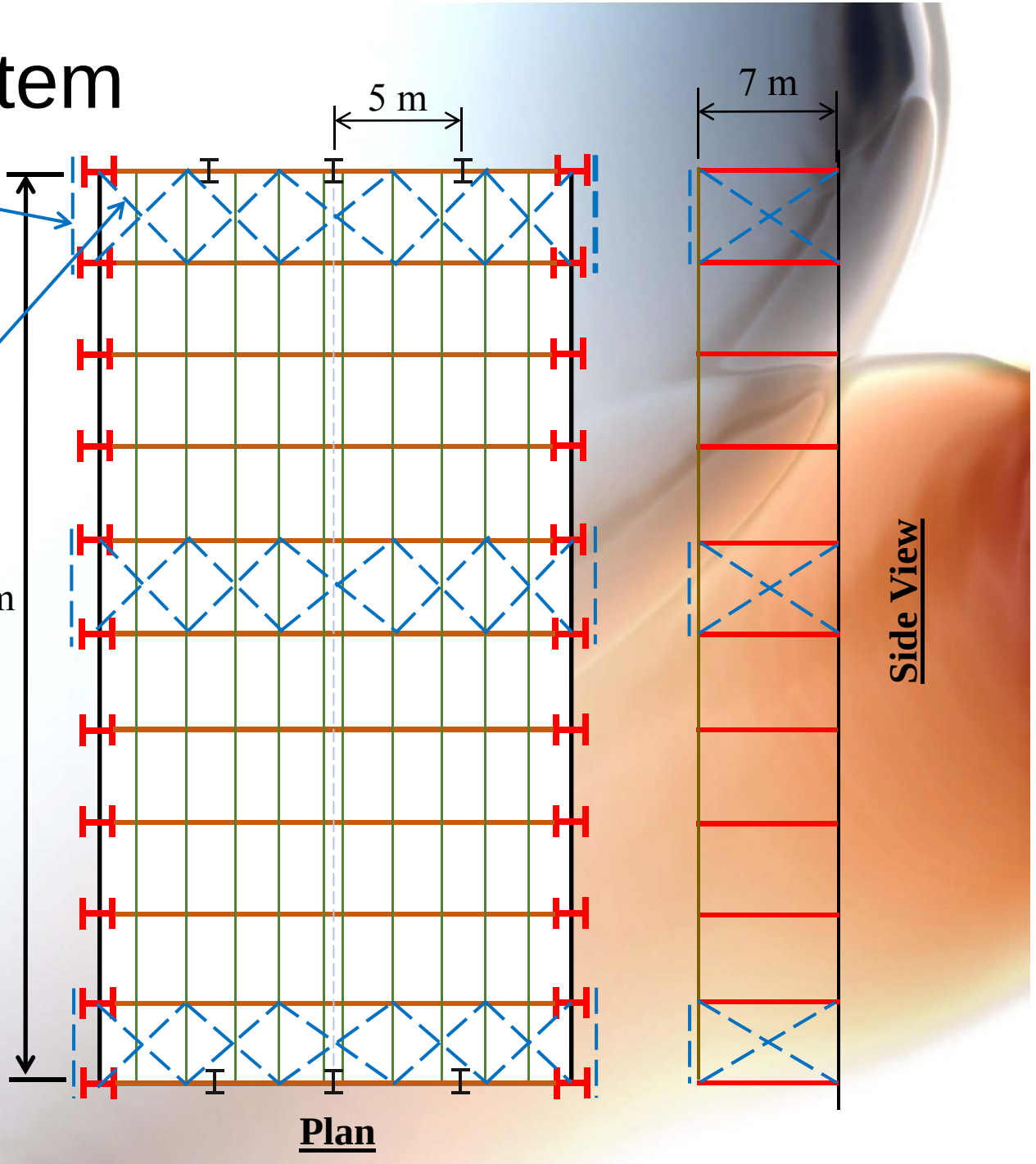
7. Bracing System

- Use Bracing at the First and last bays.
- Use bracing at intermediate bays, if length > 40 m.

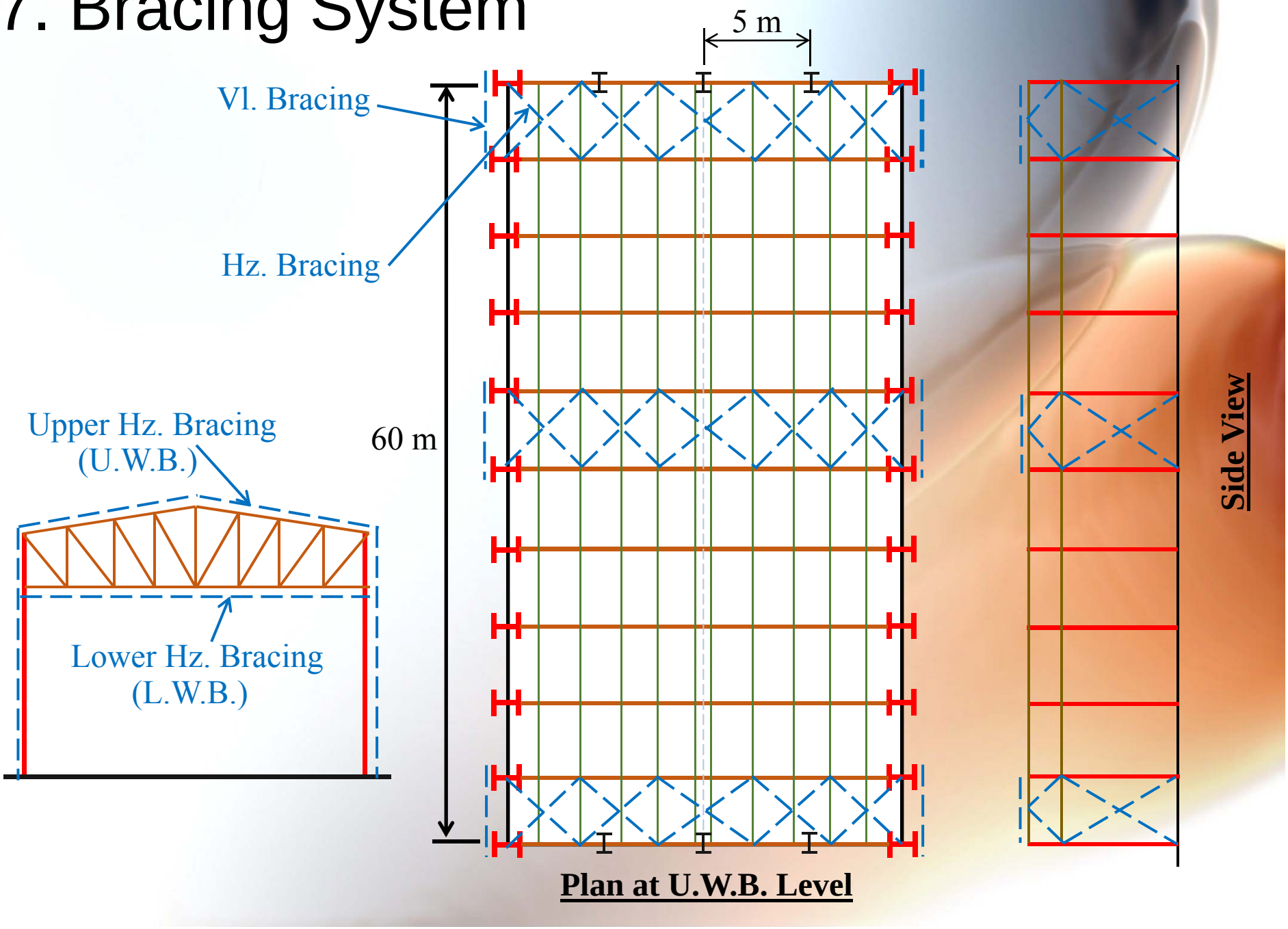


7. Bracing System

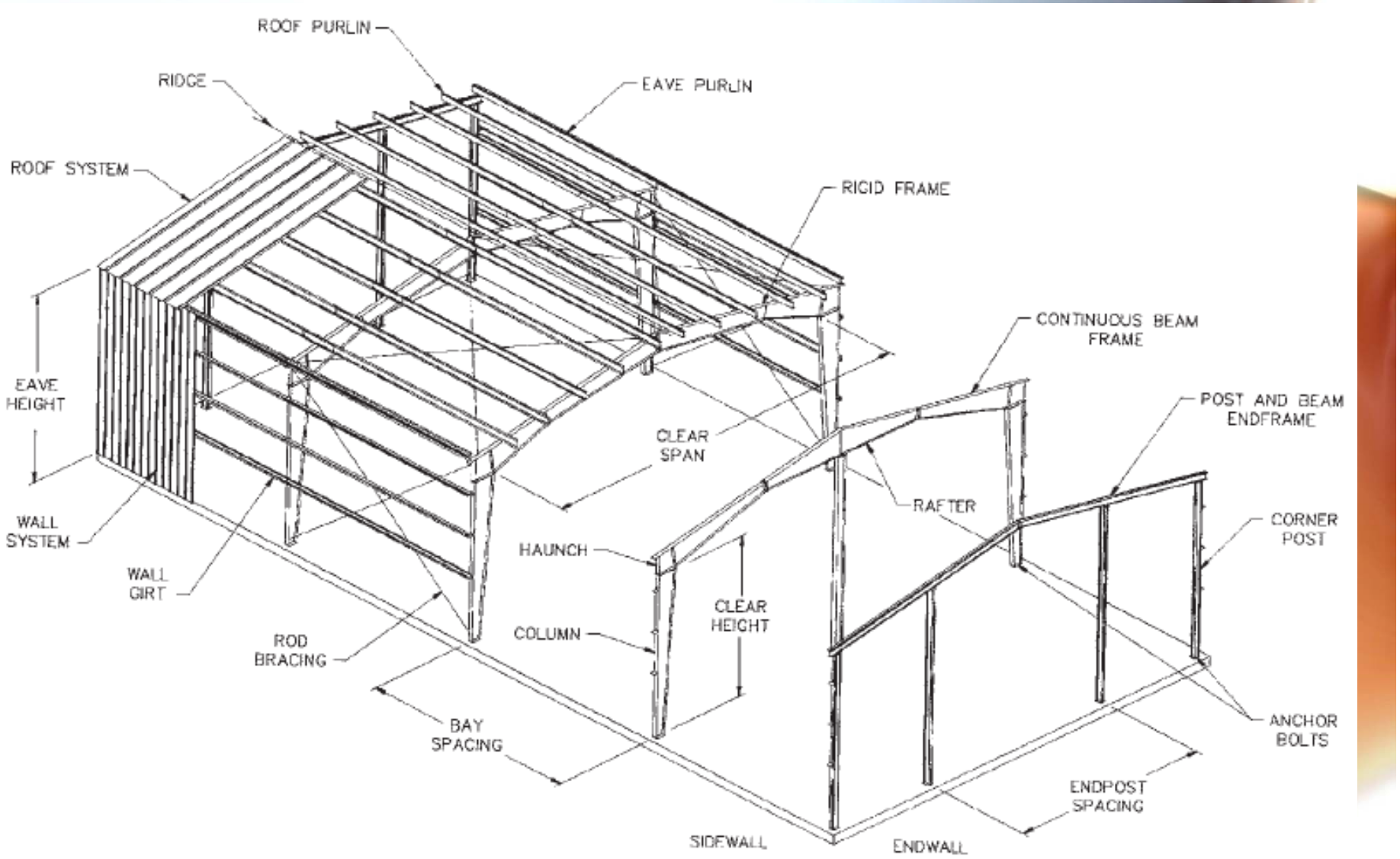




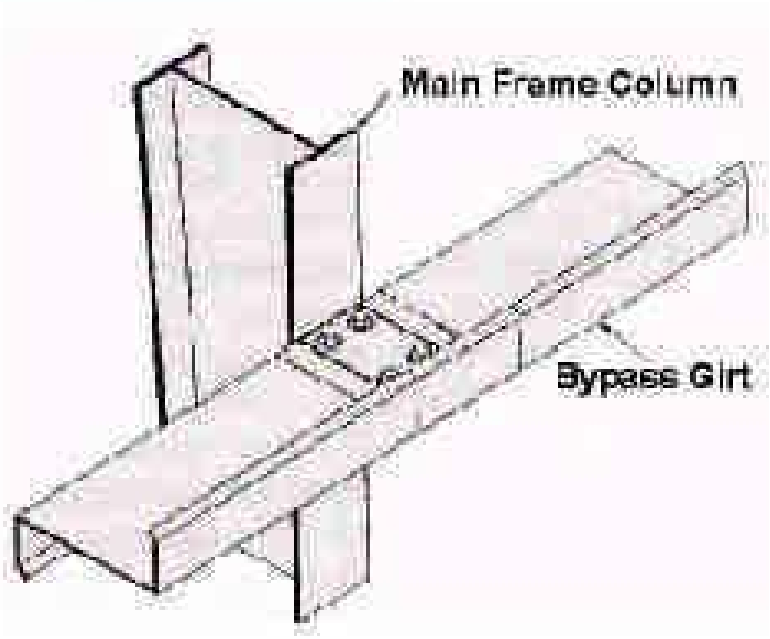
7. Bracing System



Example


ROOF PURLIN
RIDGE
EAVE PURLIN
ROOF SYSTEM
RIGID FRAME
CONTINUOUS BEAM FRAME
EAVE HEIGHT
POST AND BEAM ENDFRAME
CLEAR SPAN
RAFTER
WALL SYSTEM
CORNER POST
HAUNCH
WALL GIRT
CLEAR HEIGHT
COLUMN
ROD BRACING
BAY SPACING
ANCHOR BOLTS
ENDPOST SPACING
SIDEWALL
ENDWALL

Vertical Bracing & Side Cover

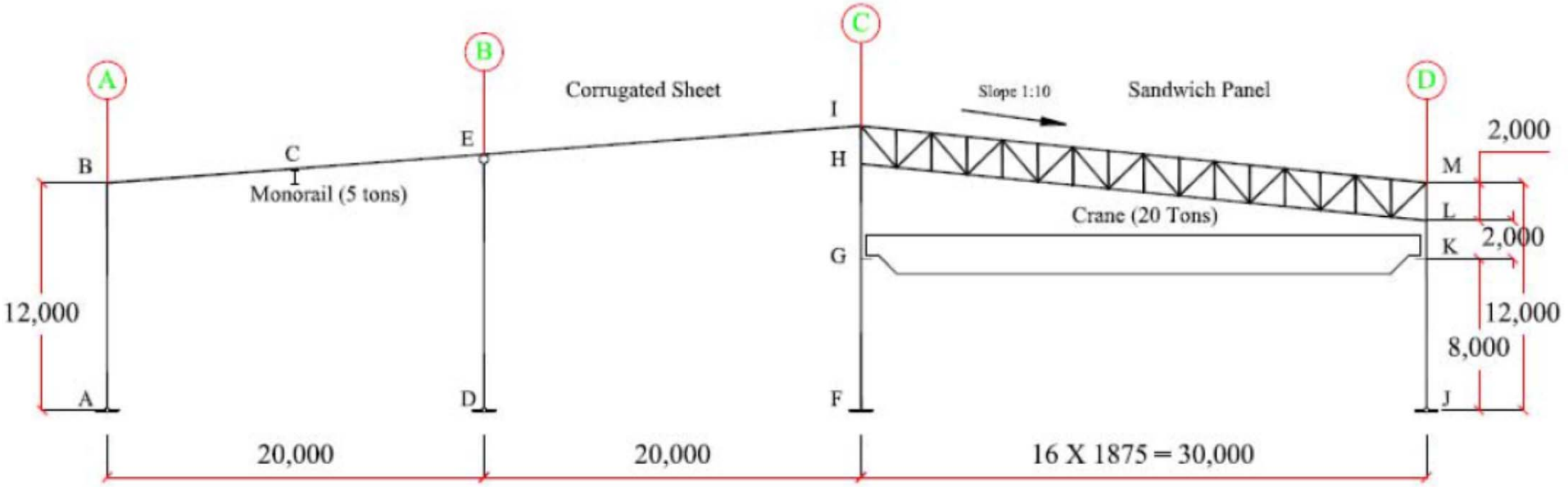


Vertical Bracing

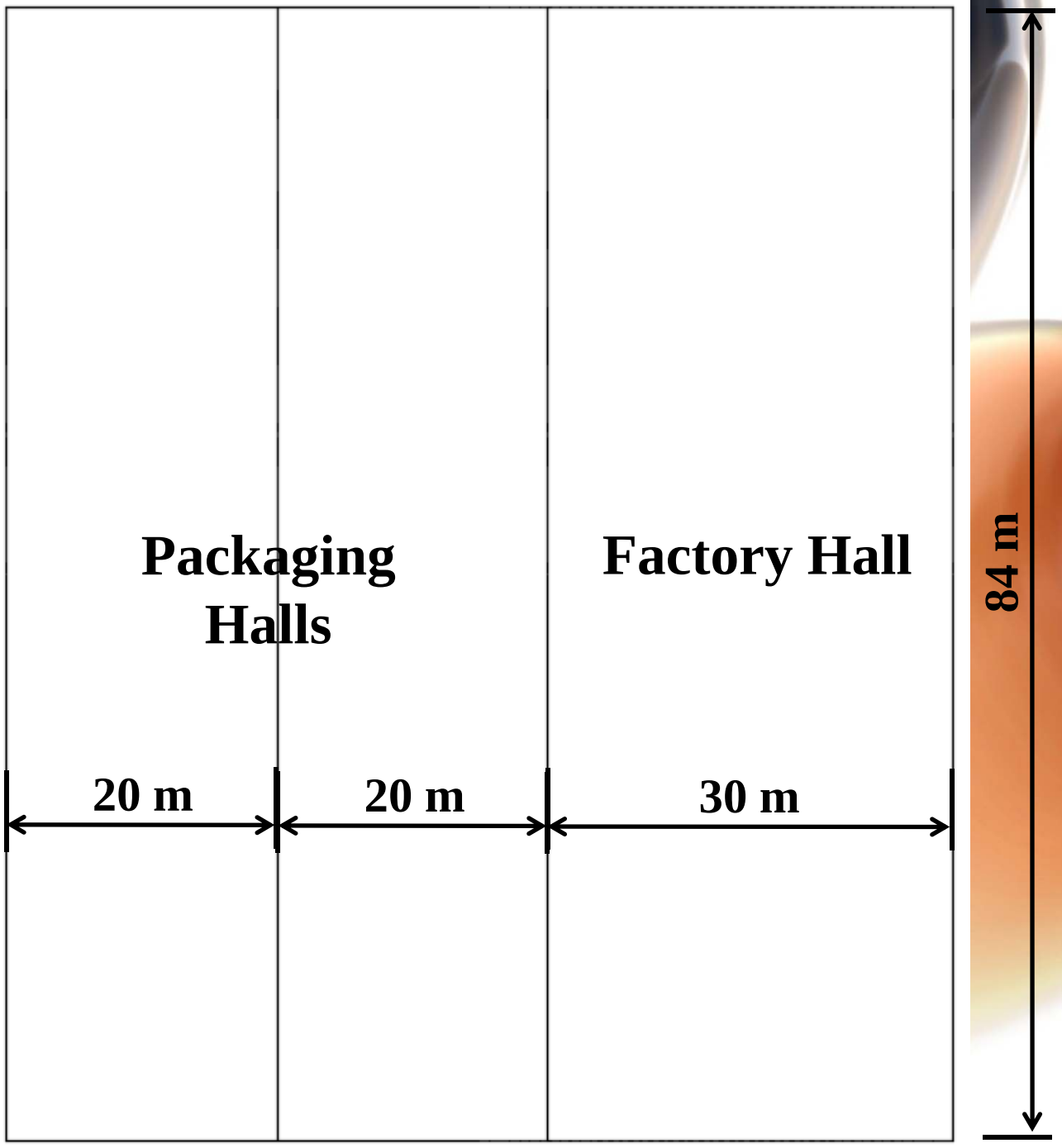
Assignment

An industrial building, constructed in Alexandria, has a foot print area of 70m x 84m and comprises 3 halls: a factory hall and two packaging halls. The 3-bay steel skeleton of the building is shown in the attached figure. The factory bay has a column-truss frame system of 30 m span, and is provided with a 20-ton capacity overhead crane. The packaging bays have a rigid frame system of 20 m span, one of the bays is served by a 5-ton capacity monorail crane. Spacing between frames is 6 m. The building is provided with horizontal and vertical bracing systems. In the plane of the frames, the columns are fixed at F and hinged at A, D and J. Column DE is a hinged hinged column capable of only taken axial load.

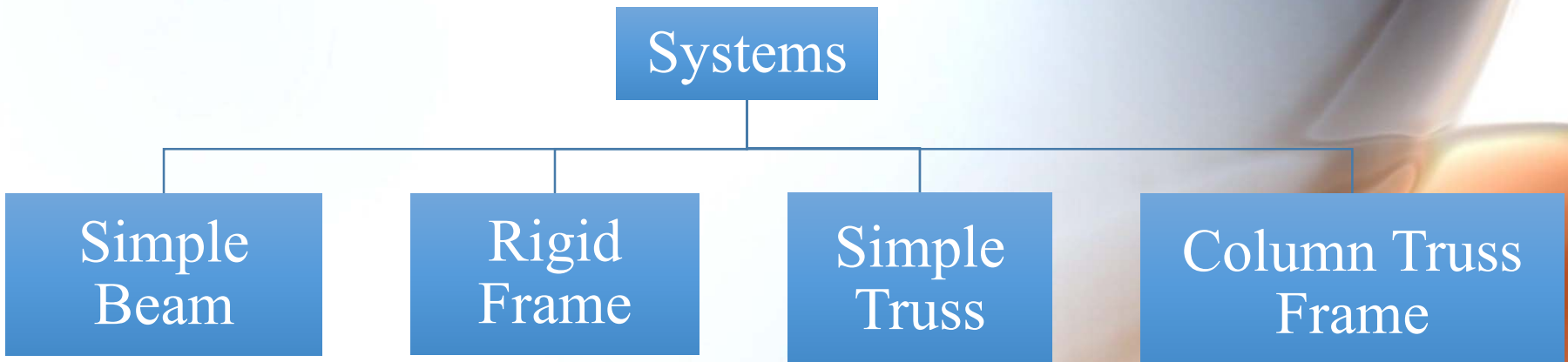
Assignment


A
B
C
D
E
F
G
H
I
J
K
L
M
Corrugated Sheet
Slope 1:10
Sandwich Panel
Monorail (5 tons)
Crane (20 Tons)
2,000
2,000
12,000
12,000
8,000
20,000
20,000
16 X 1875 = 30,000

Assignment

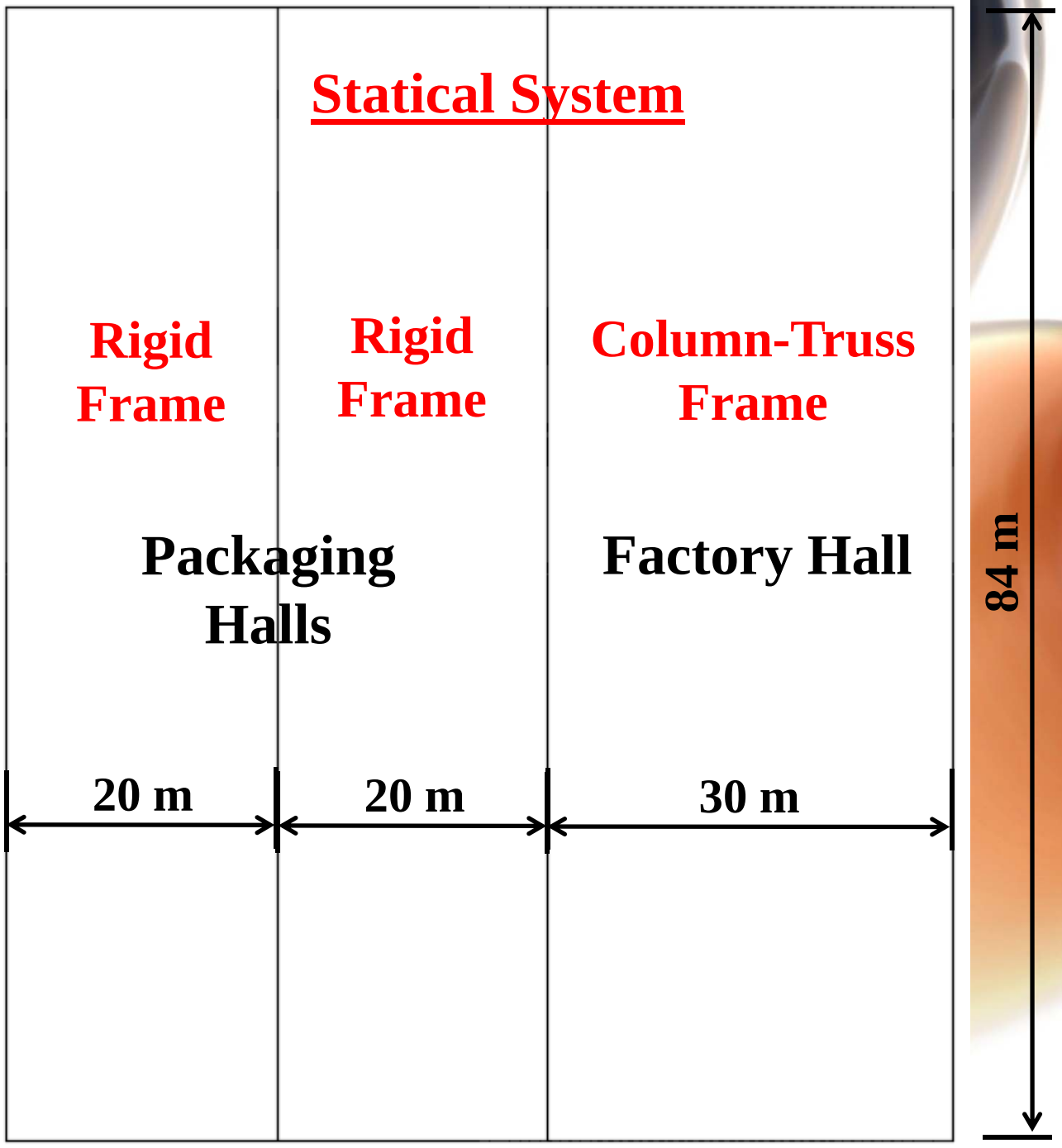


1. Types of Main Systems



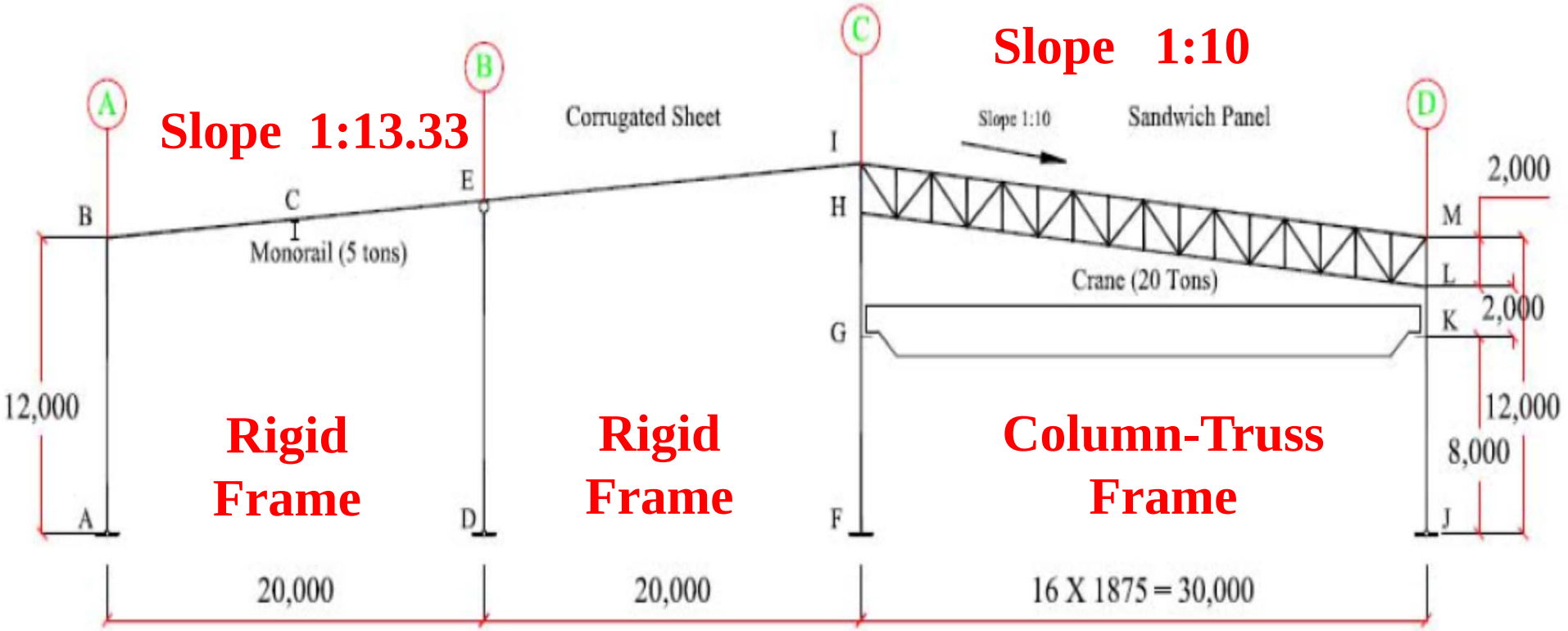
Span ➔ 7 - 10m **Span ➔ 12 – 25 m** **Span ➔ 15 - 25m** **Span ➔ 25 - 40m**

Assignment


Statical System
Rigid Frame
Rigid Frame
Column-Truss Frame
Packaging Halls
Factory Hall
20 m
20 m
30 m
84 m

Assignment

Statical System



Assignment

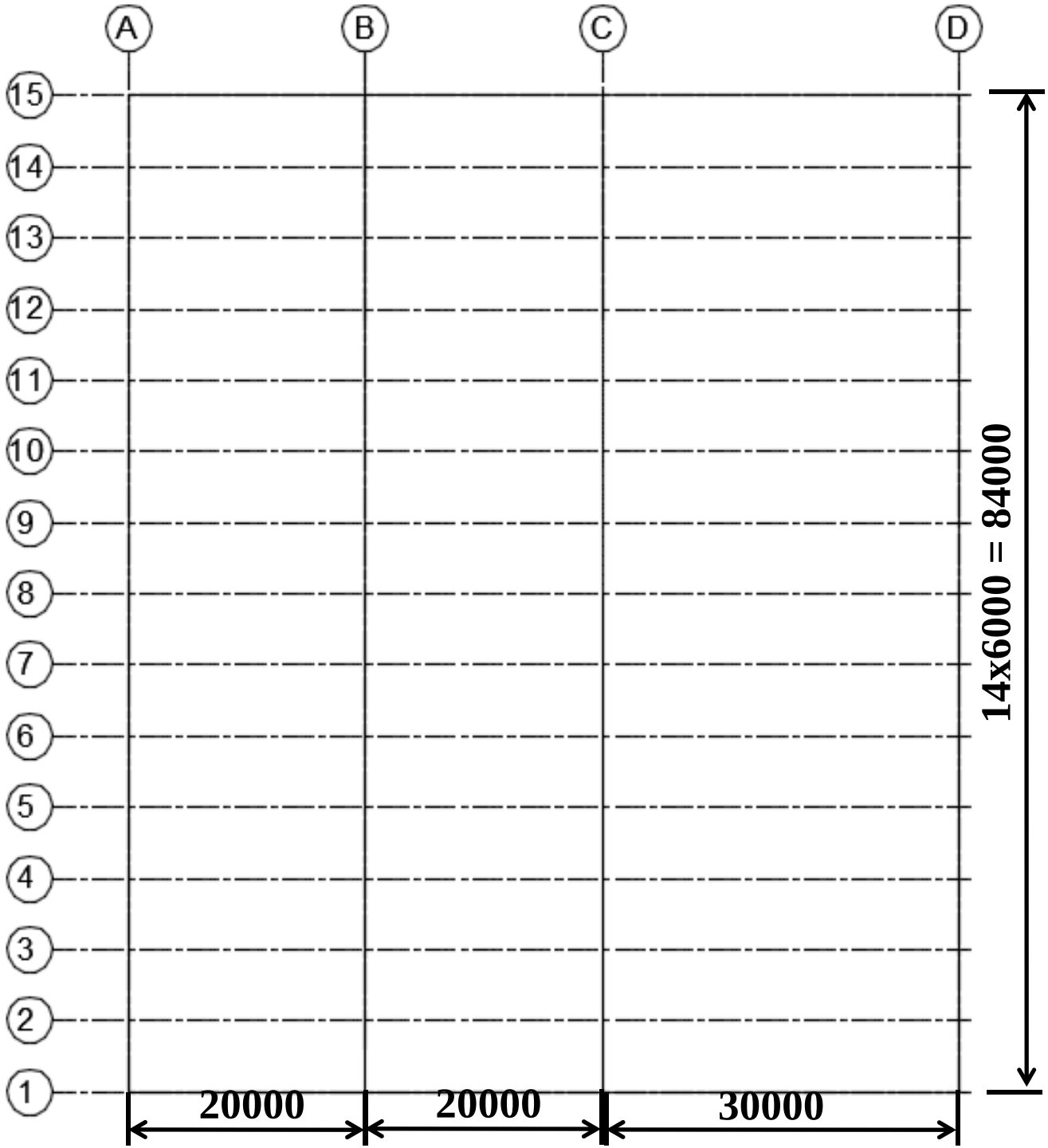
An industrial building, constructed in Alexandria, has a foot print area of 70m x 84m and comprises 3 halls: a **factory hall** and two **packaging halls**. The 3-bay steel skeleton of the building is shown in the attached figure. The factory bay has a column-truss frame system of 30 m span, and is provided with a 20-ton capacity overhead crane. The packaging bays have a rigid frame system of 20 m span, one of the bays is served by a 5-ton capacity monorail crane. **Spacing between frames is 6 m**. The building is provided with horizontal and vertical bracing systems. In the plane of the frames, the columns are fixed at F and hinged at A, D and J. Column DE is a hinged hinged column capable of only taken axial load.

Assignment

- Prepare a General Layout Drawing (**Using A_1 sheet**) [**1:200**]:
  - **Roof Plan:**
    - ✓ **Arrangement of Main System.**
    - ✓ **Arrangement of Purlins.**
    - ✓ **Horizontal Bracing.**
    - ✓ **End Gable Columns**
  - **Main System Elevation.**
  - **End Gable Elevation.**
  - **Side view for Vertical Bracing/ Side Girts.**

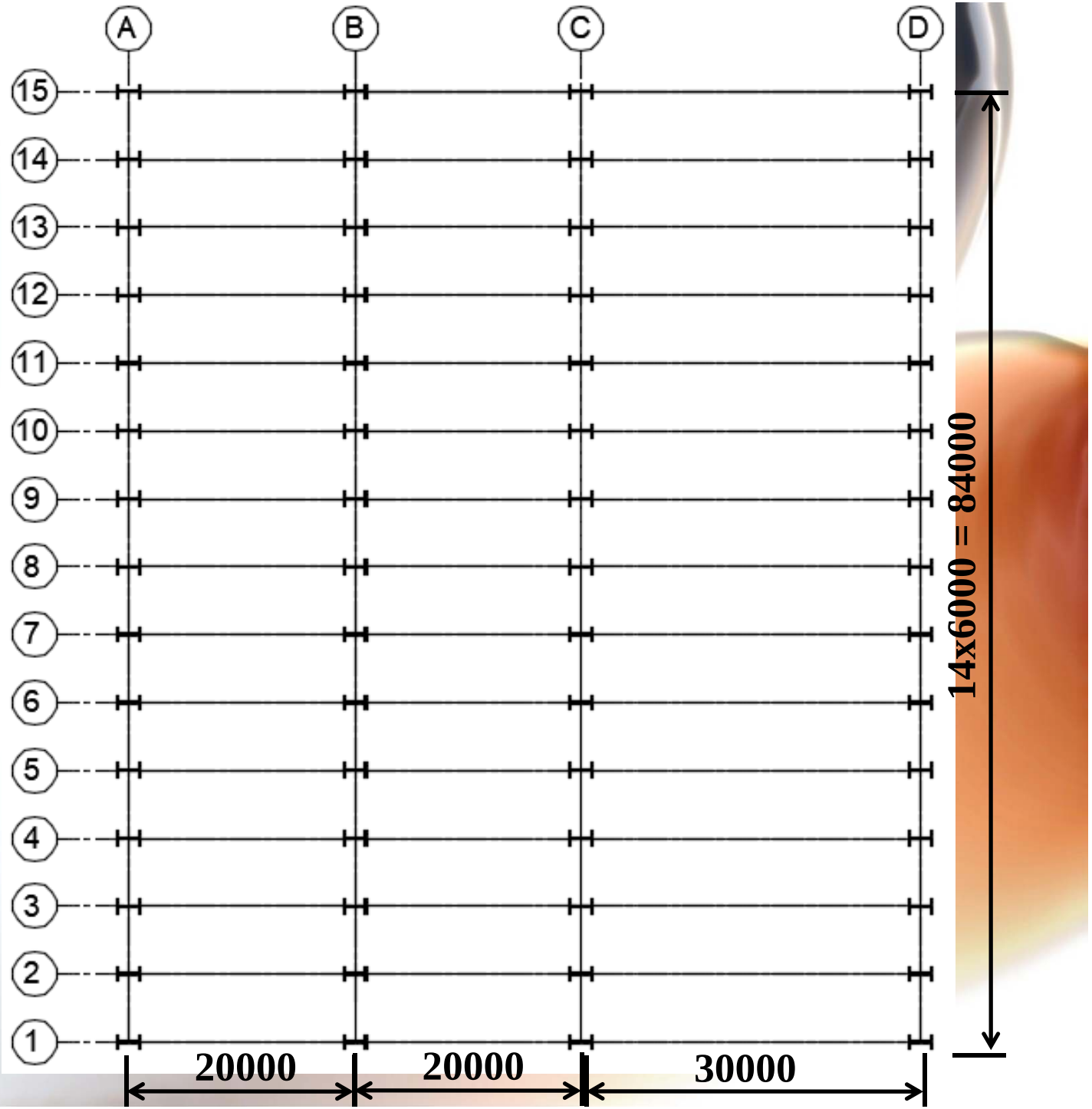
Roof Plan

Spacing
(S) = 6 m



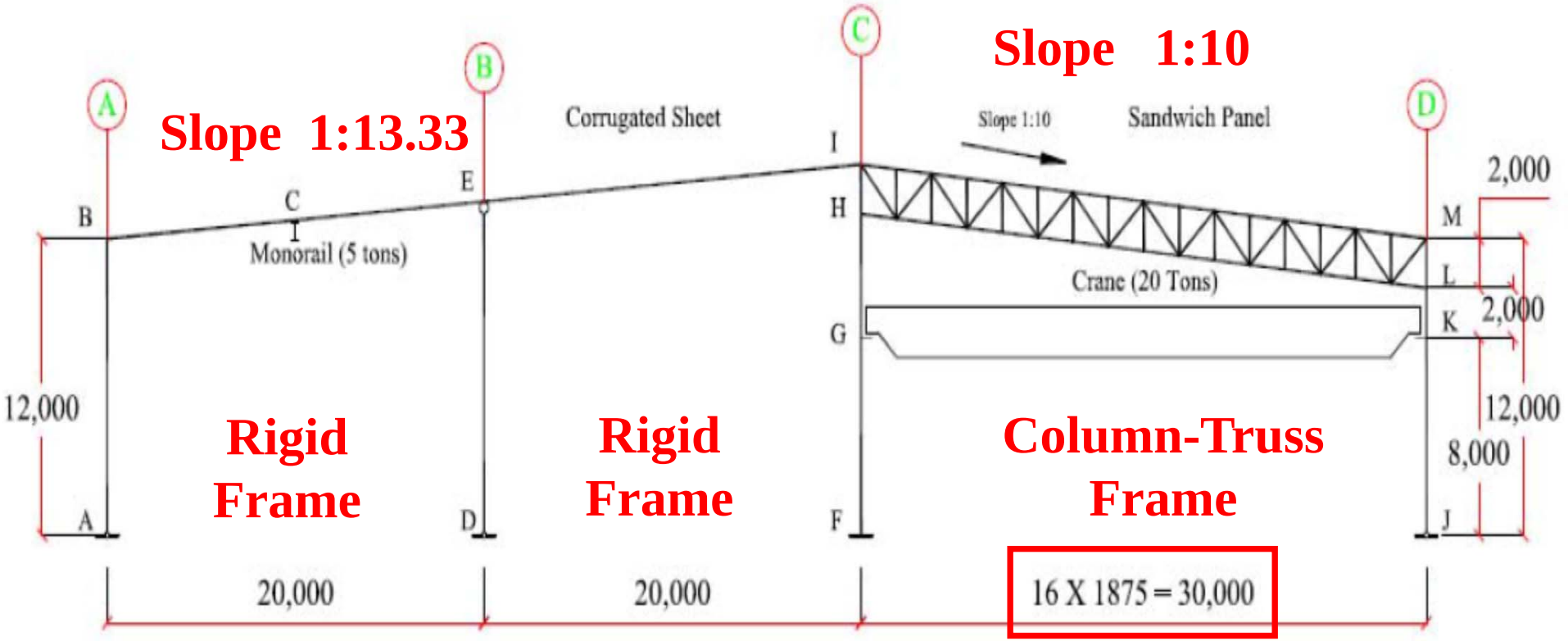
Roof Plan

Arrangement of Main System



Assignment

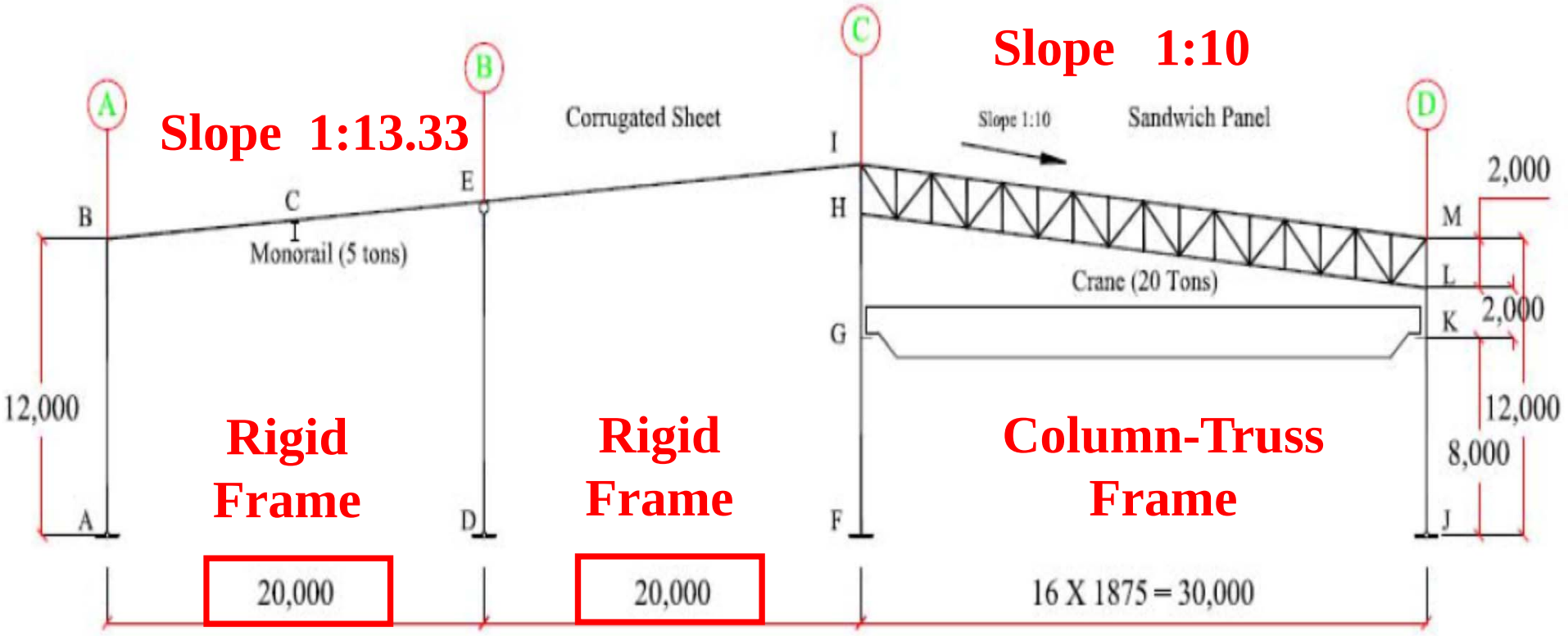
Distance bt. Roof Purlins



Distance bt. Purlins = 1875 mm

Assignment

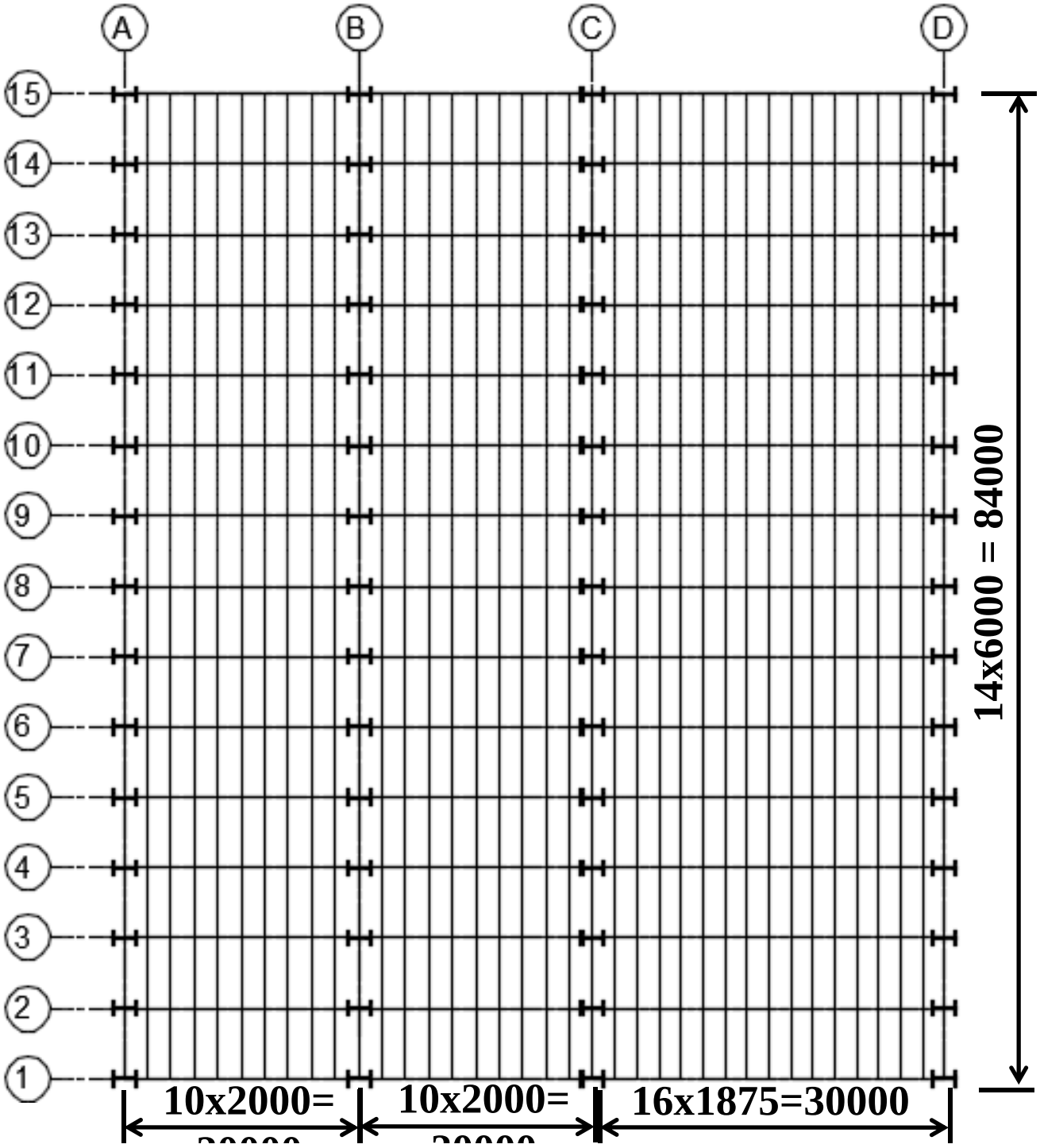
Distance bt. Roof Purlins



Distance bt. Purlins ≤ 2000 mm

Roof Plan

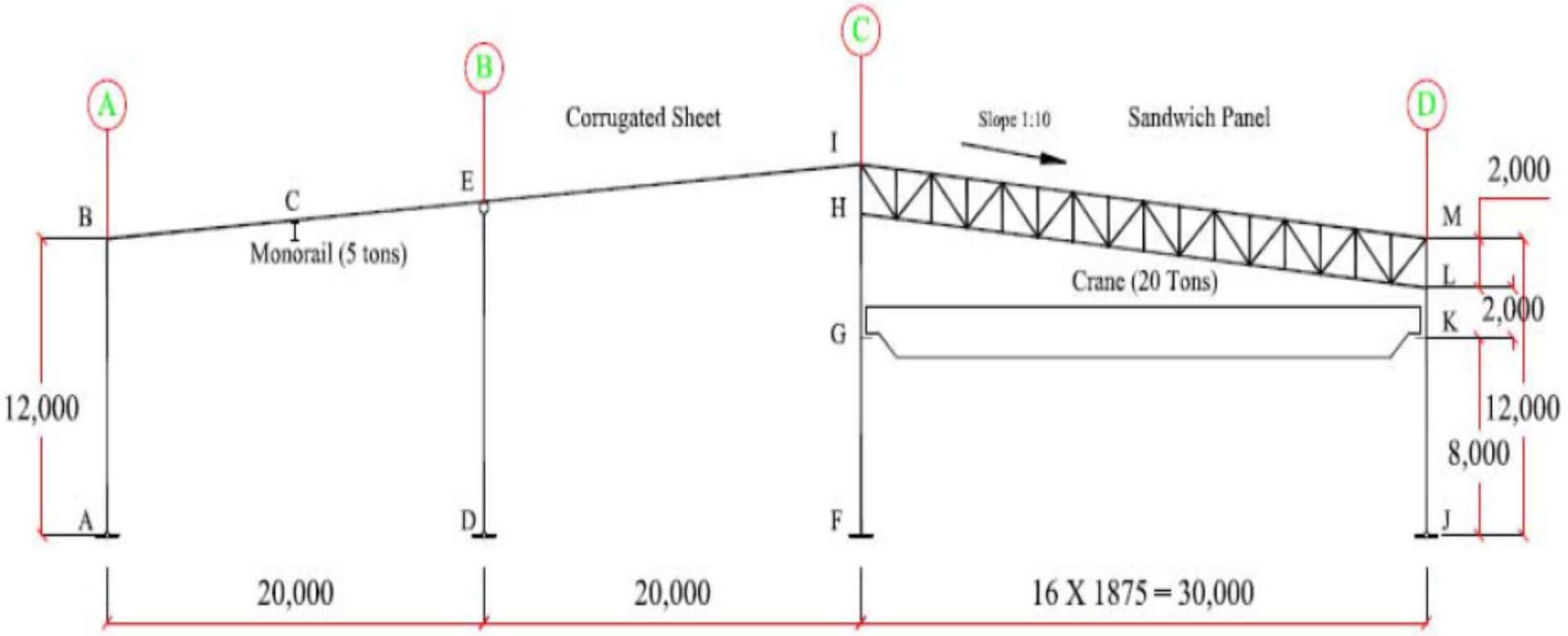
Add Roof Purlins



Assignment

- Prepare a General Layout Drawing (Using A_1 sheet):
  - **Roof Plan:**
    - ✓ **Arrangement of Main System.**
    - ✓ **Arrangement of Purlins.**
    - ✓ **Horizontal Bracing.**
    - ✓ **End Gable Columns**
  - **Main System Elevation.**
  - **End Gable Elevation.**
  - **Side view for Vertical Bracing/ Side Girts.**

Main System Elevation



Assignment

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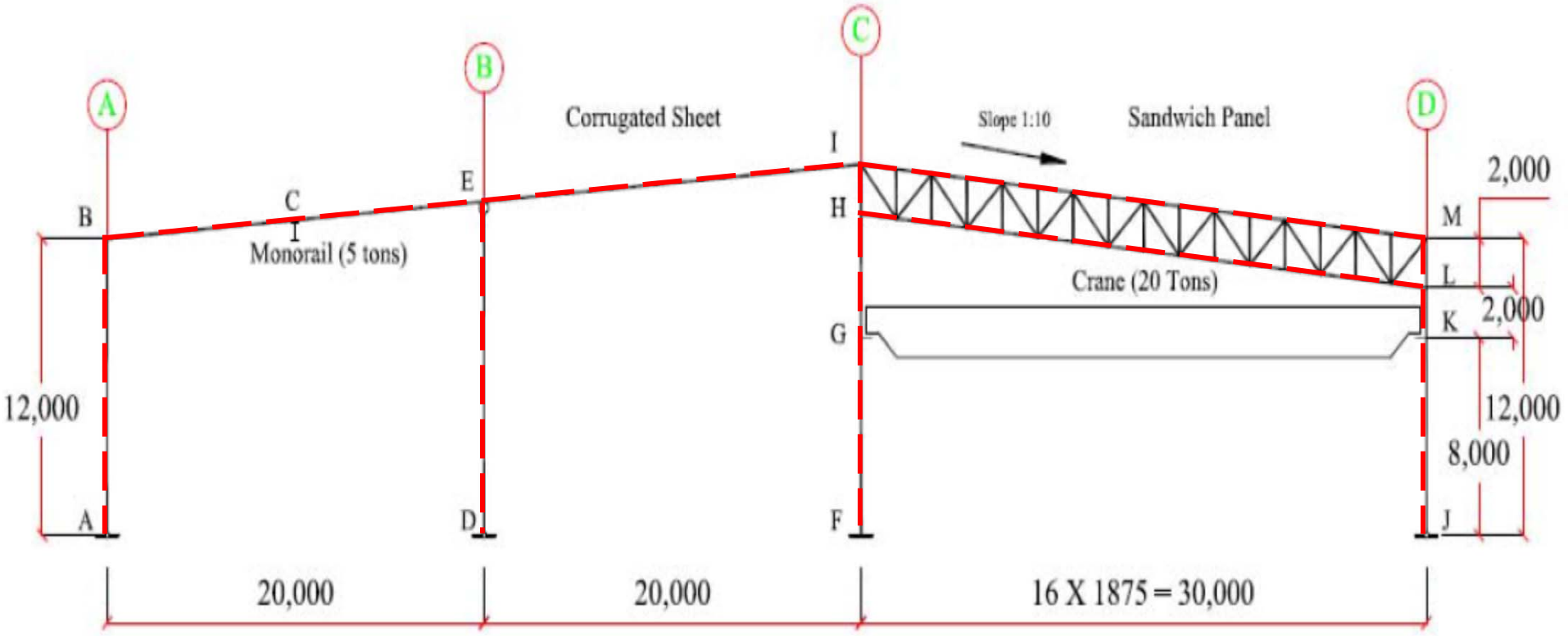
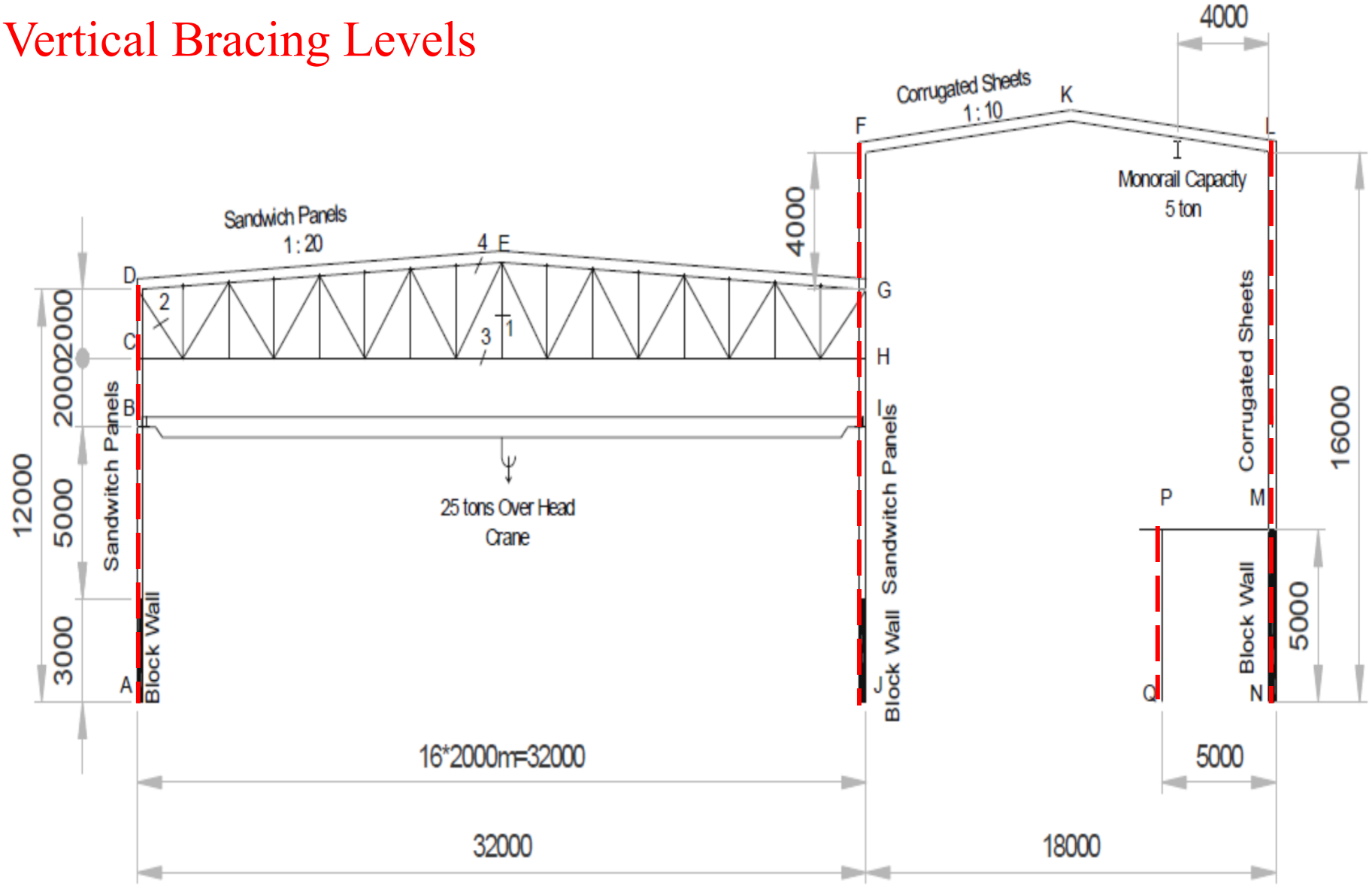
Hz. & Vertical Bracing Systems



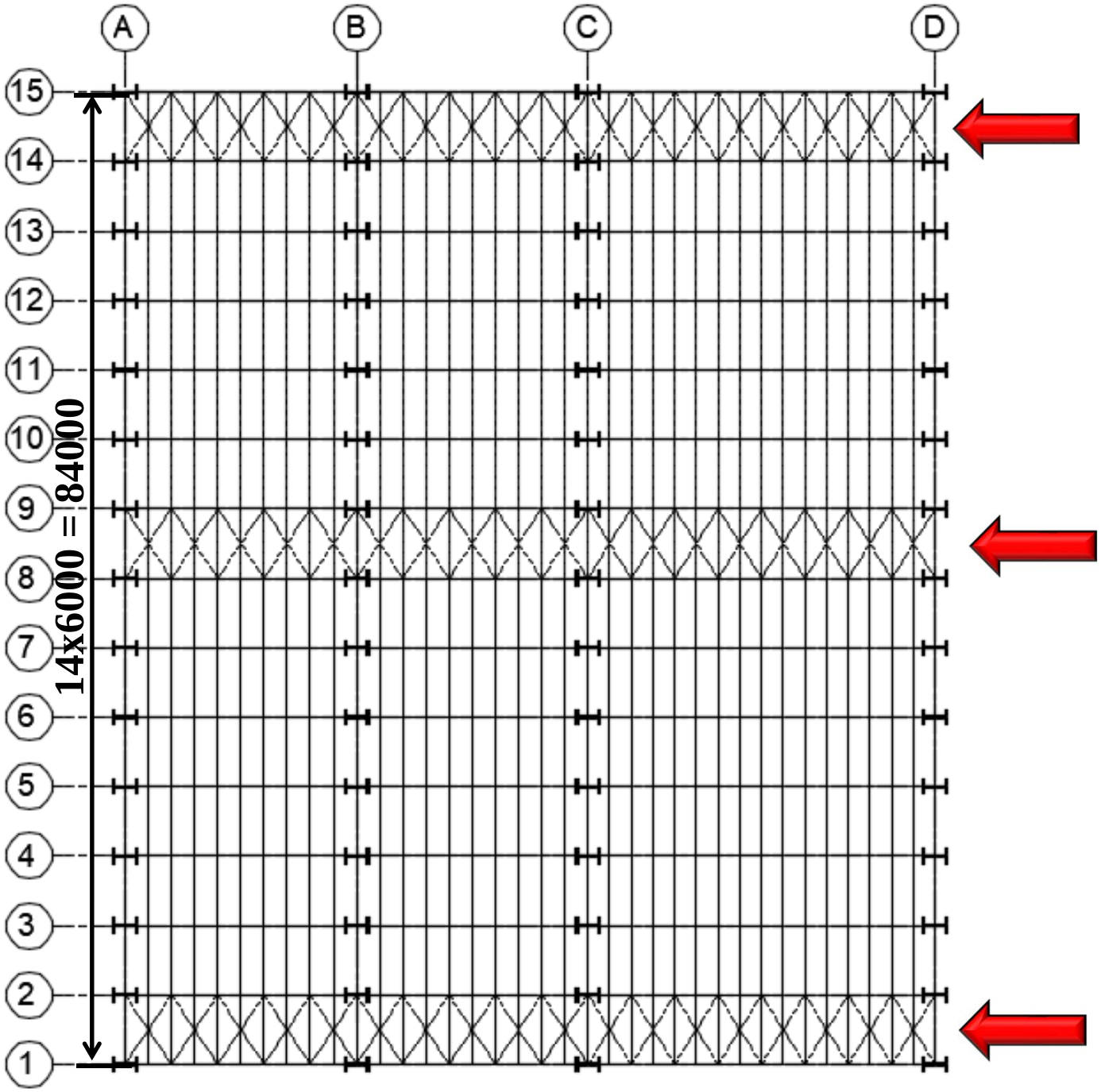
Assignment

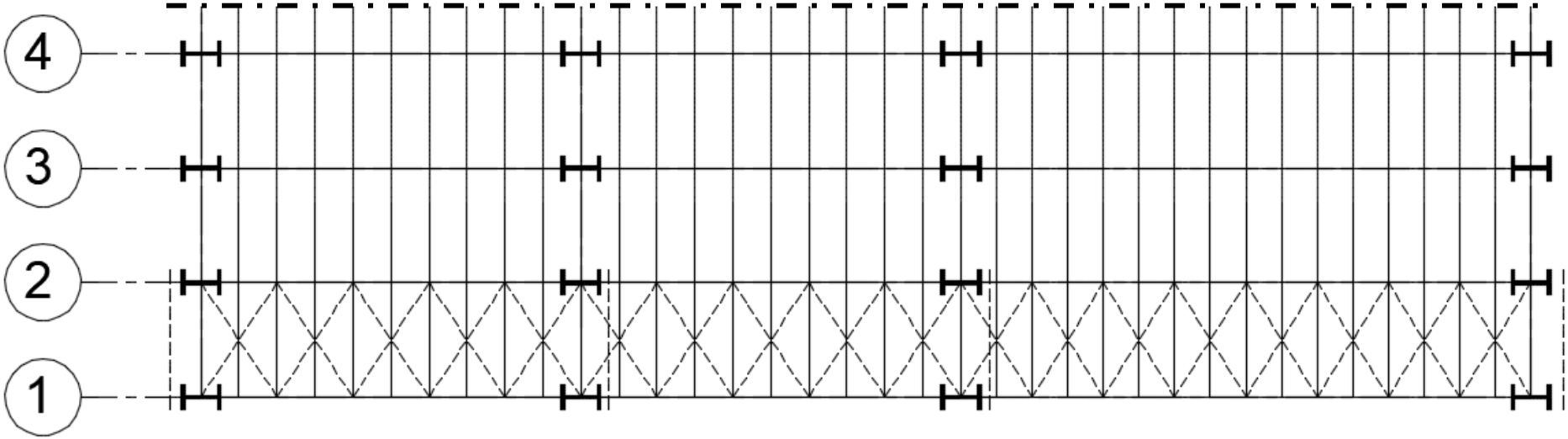
Vertical Bracing Levels



Roof Plan

Add Bracing
(Hz. And Vl.)



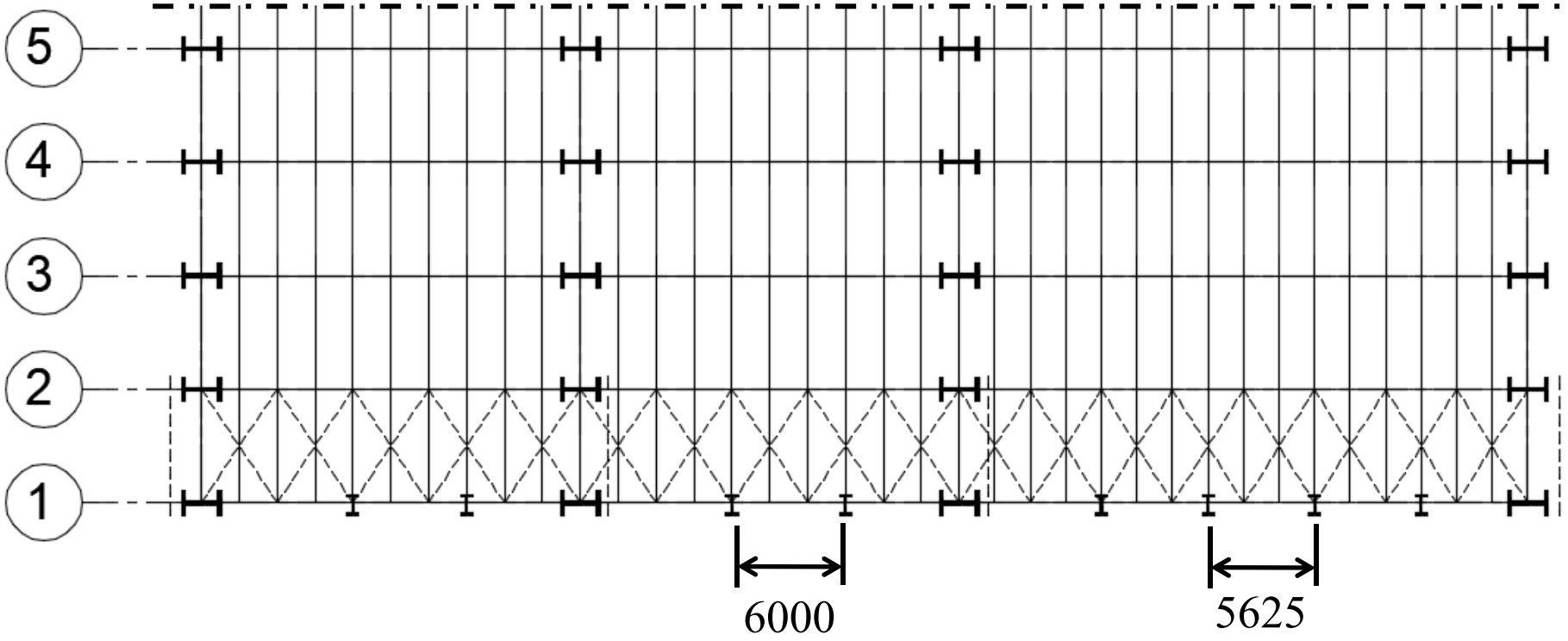


Roof Plan

Add Bracing (Hz. And Vl.)

Roof Plan

Add End Gable Columns



Assignment

- Prepare a General Layout Drawing (Using A_1 sheet):
  - **Roof Plan:**
    - ✓ **Arrangement of Main System.**
    - ✓ **Arrangement of Purlins.**
    - ✓ **Horizontal Bracing.**
    - ✓ **End Gable Columns**
  - **Main System Elevation.**
  - **End Gable Elevation.**
  - **Side view for Vertical Bracing/ Side Girts.**

End Gable

Formation of Corrugated Sheets

Formation of Corrugated Sheets

Formation of Corrugated Sheets

Roof Plan

Main column

Rafter

Roof purlins

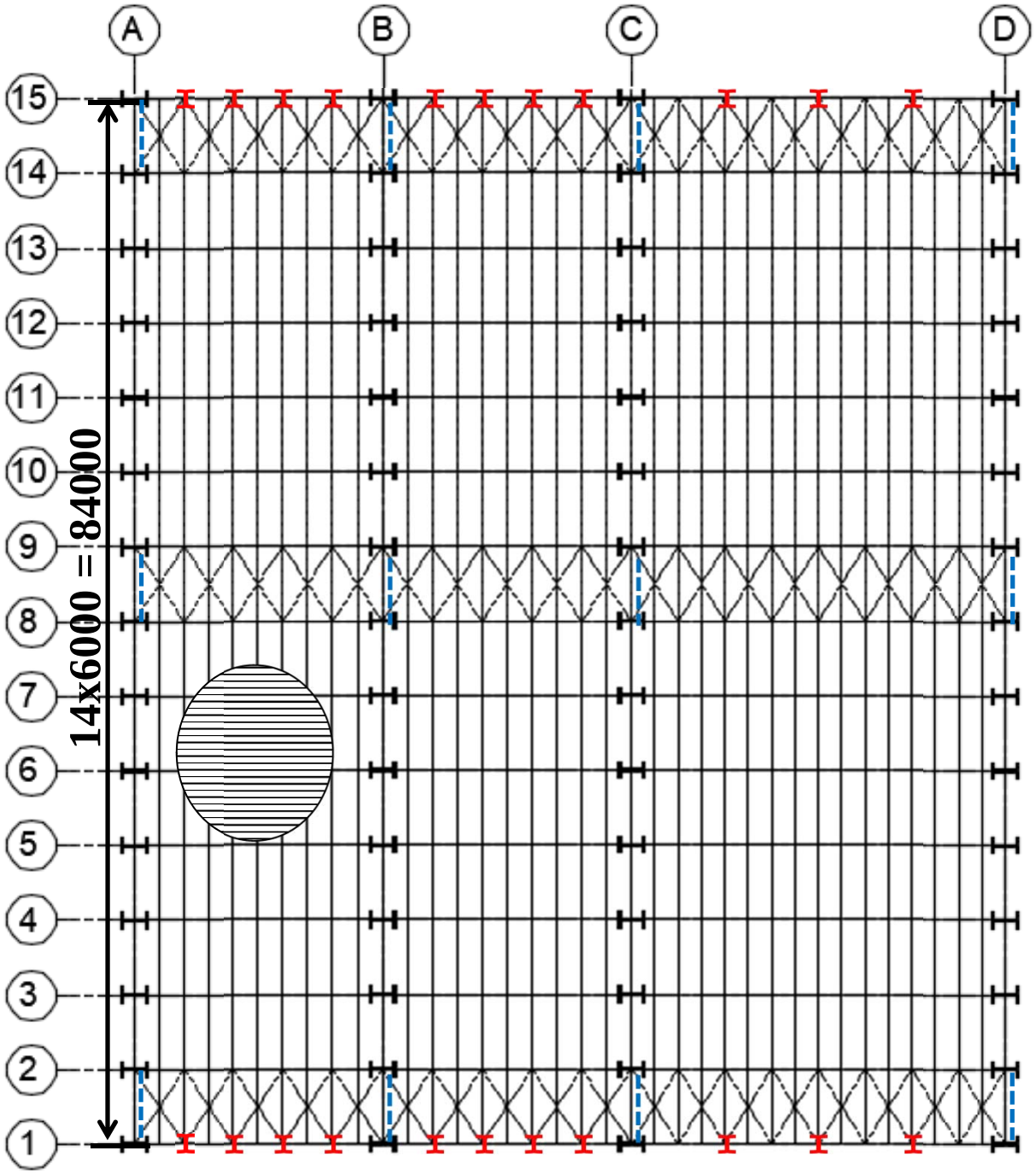
Cladding

End gable col.

Vertical bracing

Axes

Dimensions

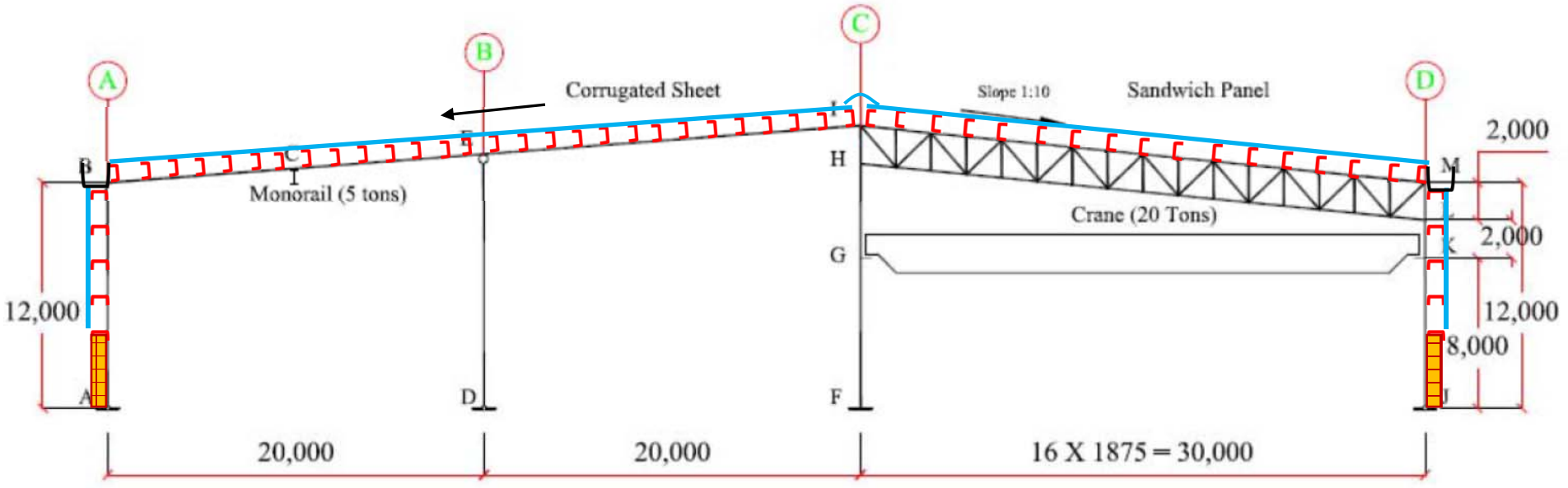


Typical Elevation

Elevation, Pulins, Side girts
Cladding, Rain Gutter, Slope

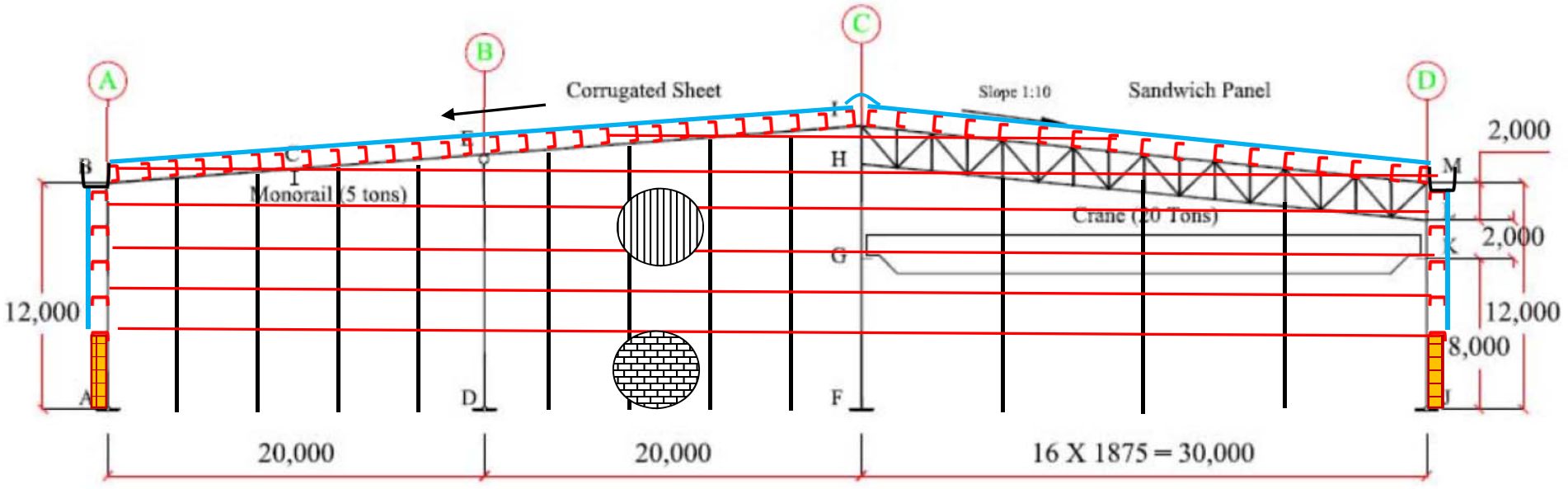
Axes, Dimensions

Notice that: At truss bay end-gable columns meets roof purlin and horizontal bracing joint



Elevation End Gable

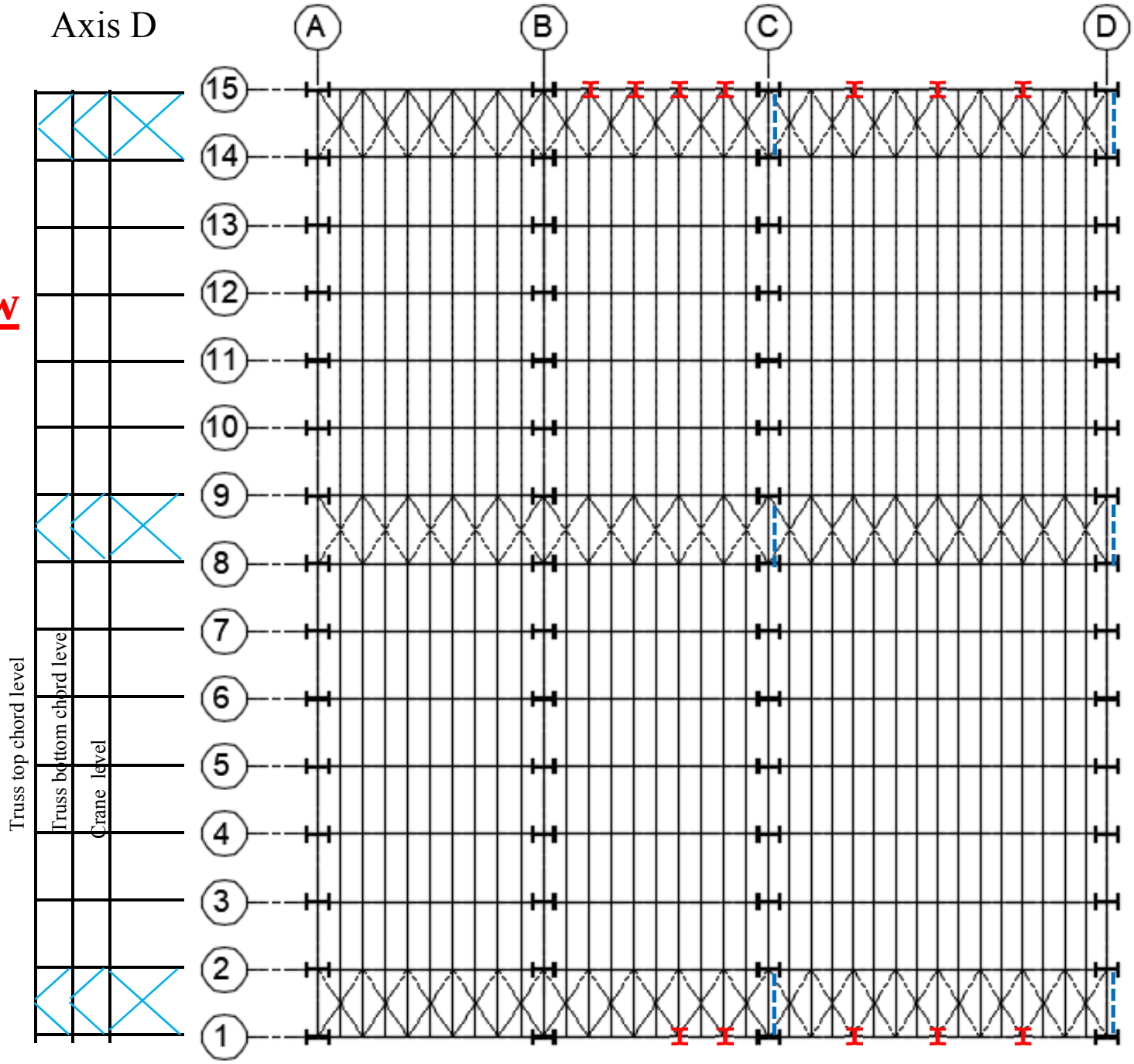
Elevation, Pulins, Side girts
Cladding, Rain Gutter, Slope
End-gable column, doors,
Axes, Dimensions



Side View
Bracing
Struts

Another View
Cladding

Axes
Dimensions



Side View
Bracing
Struts

Another View
Cladding

Axes
Dimensions

Missing Items
Side cladding
Adjust col height
Dimensions