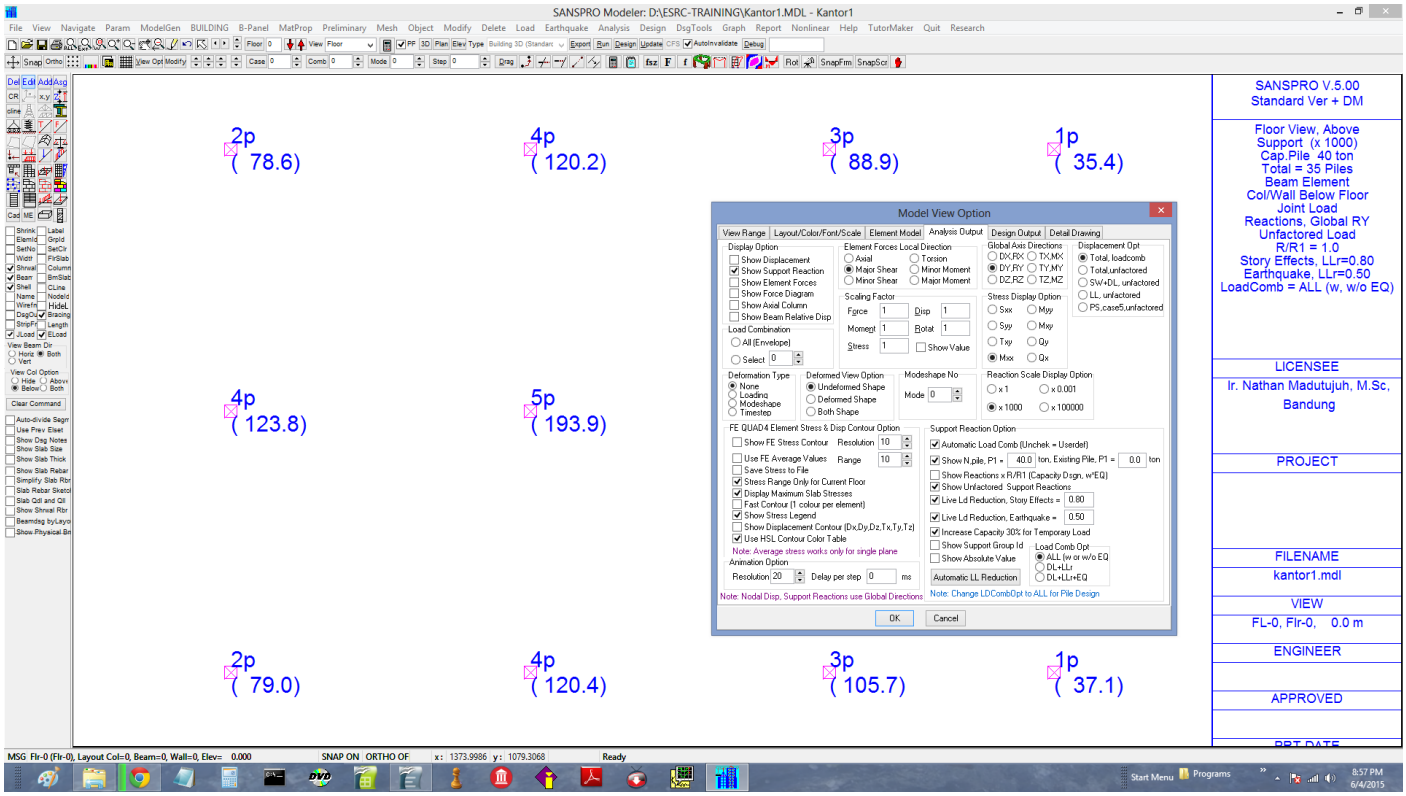
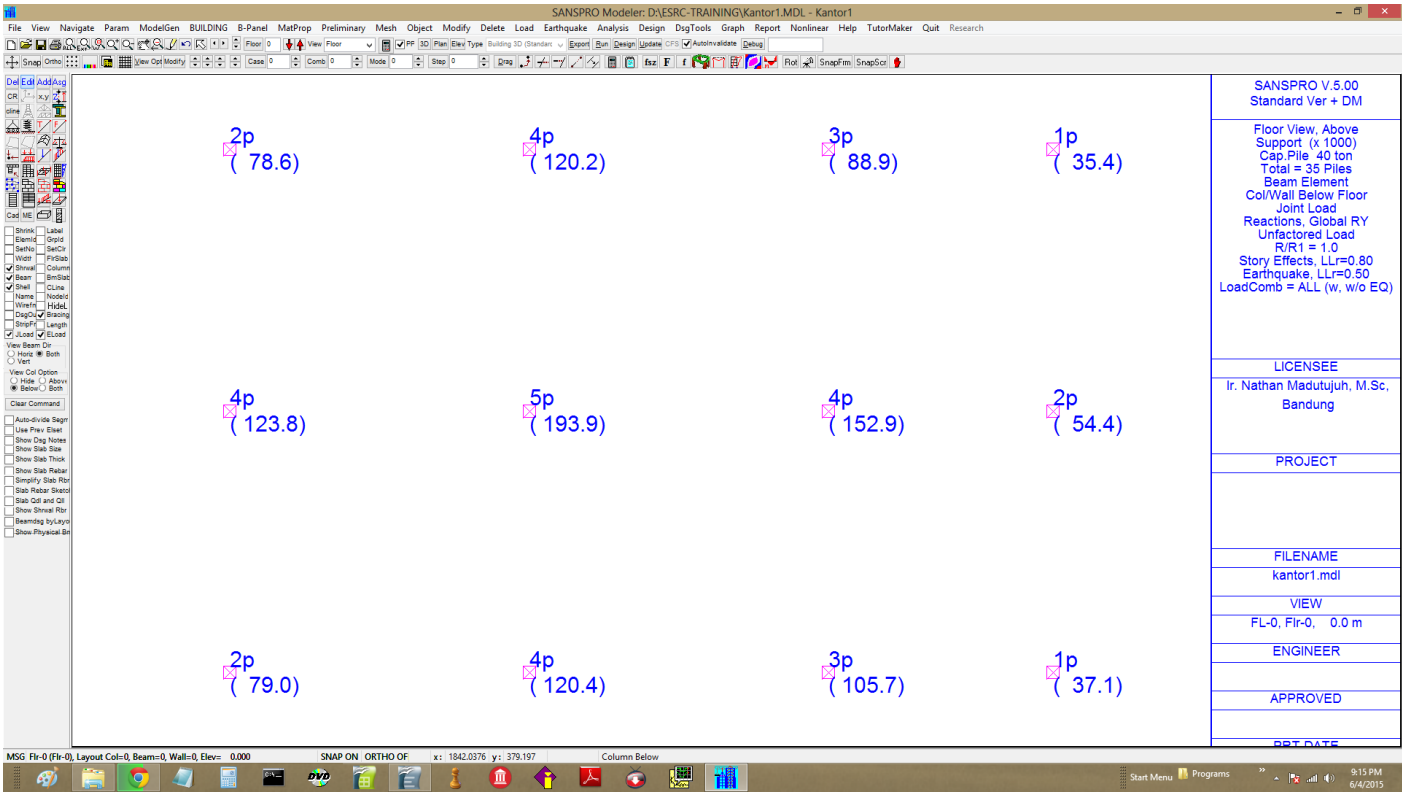
Foundation Design with SANSPRO

1. Simple Design : Axial Only, No Group Efficiency

[x] Show N,pile, P1 = 40 ton (for Minipile 25x25, 18m, 40 ton axial capacity)
[x] Unfactored Support Reaction
[x] Live Load Reduction, Storry Effects = 0.80 (NF <= 4)
[x] Live Load Reduction, Earthquake = 0.50 (Public space, storage, parking, etc)
Reactions Scale Option = x 1000 (for Ton unit)



Result:



Simplified Foundation Capacity Design:

[x] Show Reactions x R/R1 (Capacity Design with W*EQ)

<u>Reactions Submitted to Geotechnical Engineers (TPKB1):</u>

1. All Load Combination : DL + Llr +/- EQ

For Axial (Ry), Horizontals (Rx, Rz), Moment (Mx, Mz) : 5 pages
[ ] Show Reactions x R/R1 (Capacity Design with W*EQ)

2. DL+LLr (Gravity Load Only)

For Axial (Ry), Horizontals (Rx, Rz), Moment (Mx, Mz) : 5 pages
[ ] Show Reactions x R/R1 (Capacity Design with W*EQ)

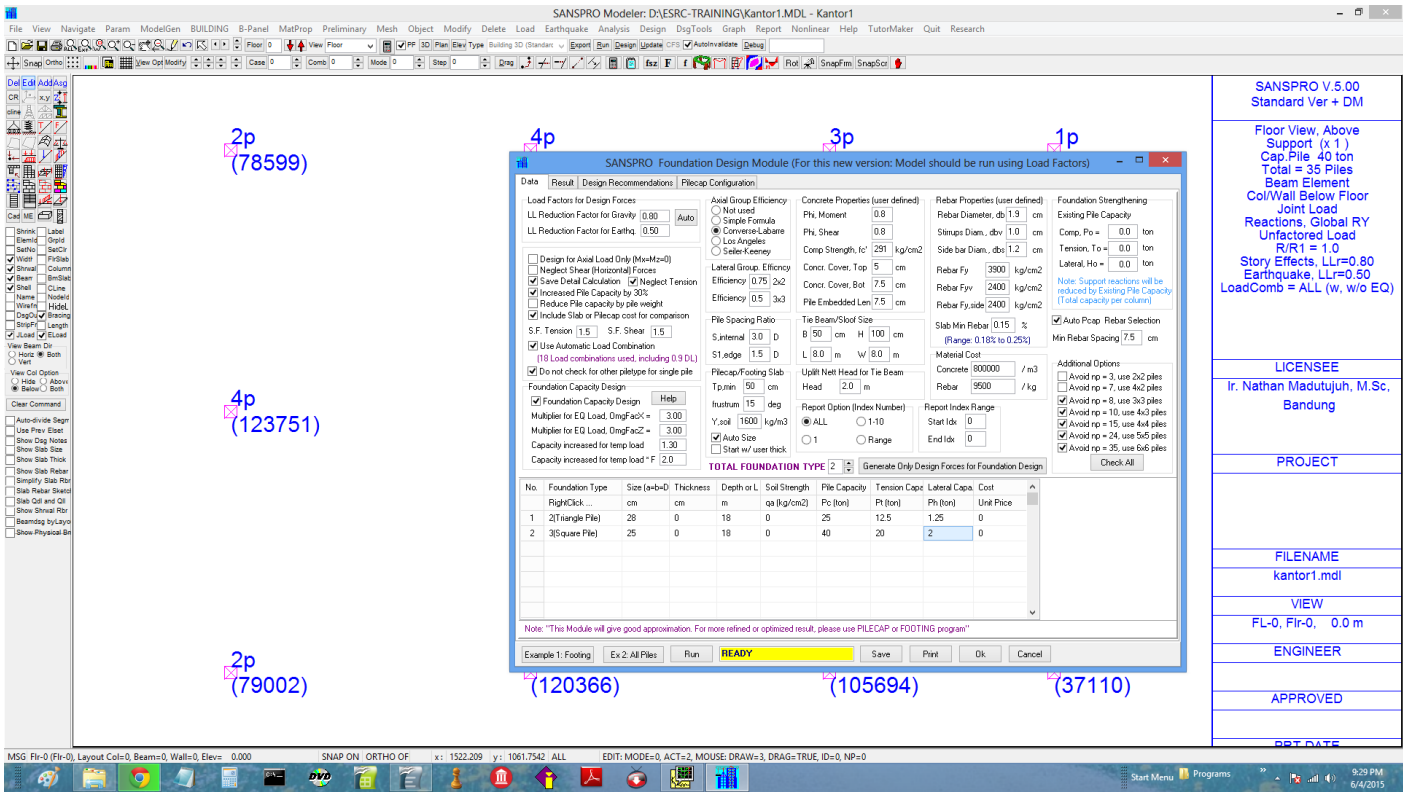
2. DL+LLr + w*EQ

For Axial (Ry), Horizontals (Rx, Rz), Moment (Mx, Mz) : 5 pages
[x] Show Reactions x R/R1 (Capacity Design with W*EQ)

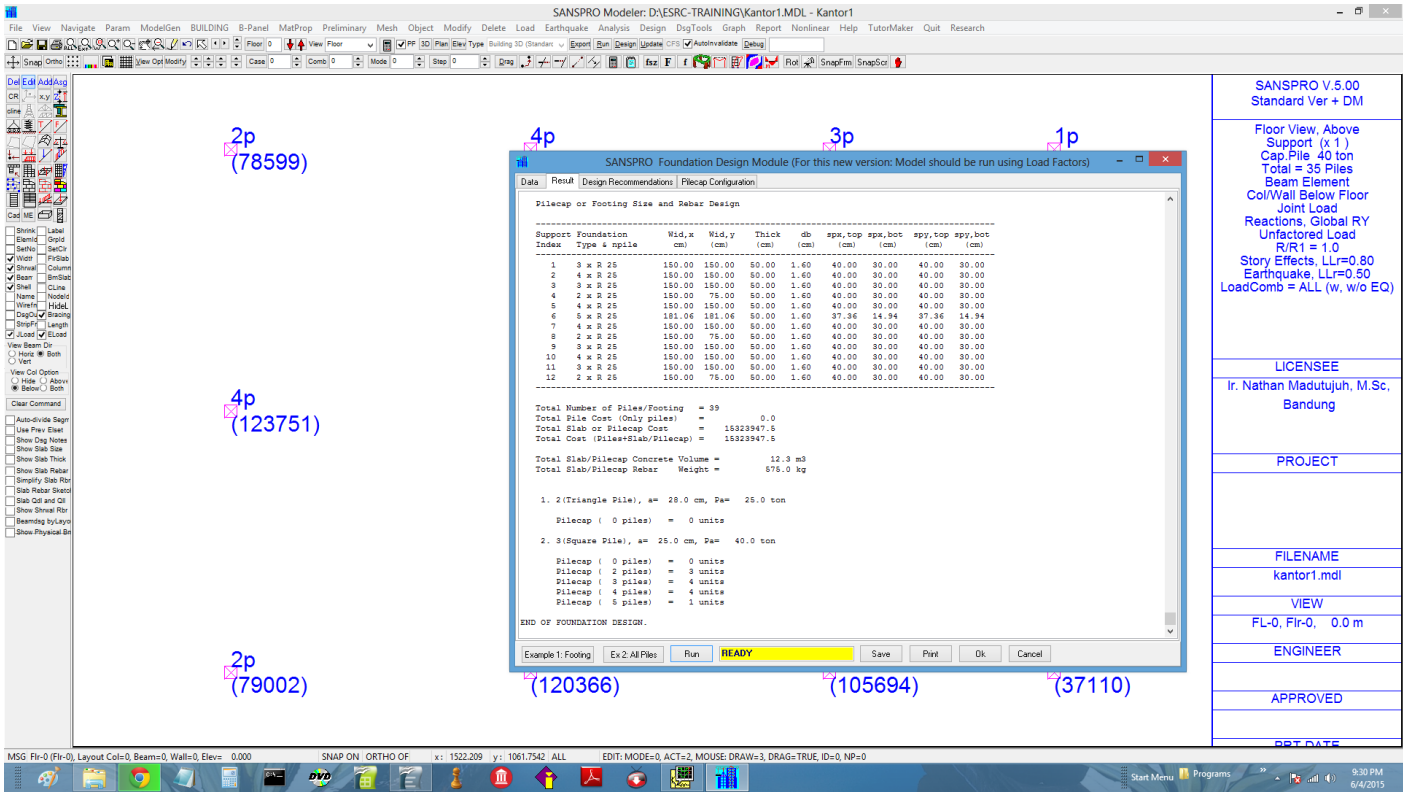
2. **Capacity Design : Axial, Horizontal, Moment Force, Group Efficiency, Pile distance, etc.**

[ ] Design for Axial only
[ ] Neglect Horizontal Forces
[x] Neglect Tension Force
[x] Foundation Capacity Design
Axial Group Efficiency = Converse-Labarre

Total Foundation Type = 2
1 = Minipile, Triangle, T28, 18m, Compression = 25 ton, Tension=12.5 ton, Lateral = 1.25 ton
2 = Minipile, Square, R25, 18m, Compression = 40 ton, Tension=20 ton, Lateral = 2.0 ton



Result:



Pilecap or Footing Size and Rebar Design

Support Index	Foundation Type & npile	Wid,x cm)	Wid,y (cm)	Thick (cm)	db (cm)	spx,top (cm)	spx,bot (cm)	spy,top (cm)	spy,bot (cm)
1	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
2	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
3	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
4	2 x R 25	150.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00
5	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
6	5 x R 25	181.06	181.06	50.00	1.60	37.36	14.94	37.36	14.94
7	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
8	2 x R 25	150.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00
9	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
10	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
11	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
12	2 x R 25	150.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00

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Total Number of Piles/Footing   = 39
Total Pile Cost (Only piles)    =            0.0
Total Slab or Pilecap Cost      =    15323947.5
Total Cost (Piles+Slab/Pilecap) =    15323947.5

Total Slab/Pilecap Concrete Volume =          12.3 m3
Total Slab/Pilecap Rebar    Weight =         575.0 kg


 1. 2(Triangle Pile), a=  28.0 cm, Pa=   25.0 ton

    Pilecap (  0 piles)   =   0 units

 2. 3(Square Pile), a=  25.0 cm, Pa=   40.0 ton

    Pilecap (  0 piles)   =   0 units
    Pilecap (  2 piles)   =   3 units
    Pilecap (  3 piles)   =   4 units
    Pilecap (  4 piles)   =   4 units
    Pilecap (  5 piles)   =   1 units
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Visual Foundation Checking

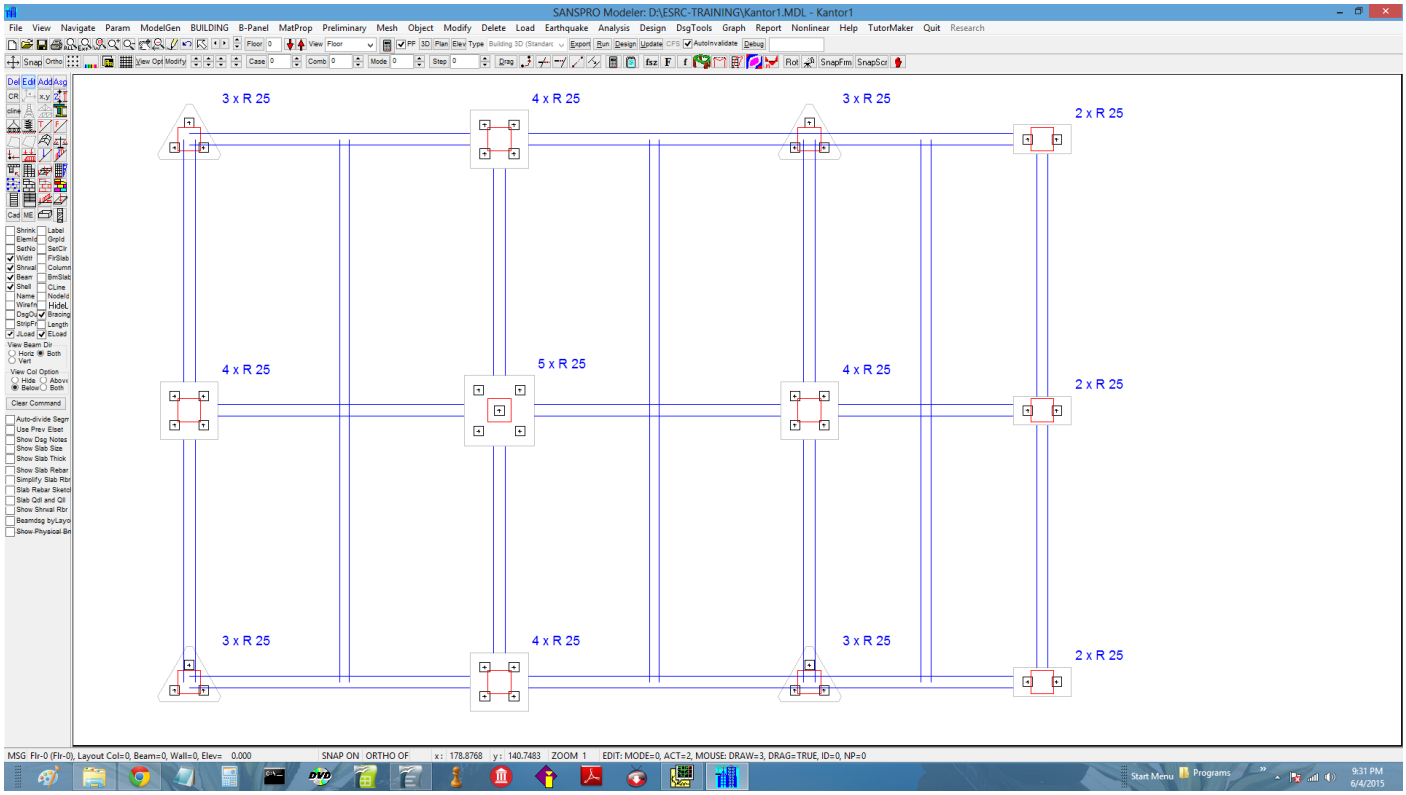
Klik Graph – Detail Drawing

[x] Turn On Detail Drawing (at Top-Left)

Drawing Type = Foundation Drawing
Tie Beam Layout = 1 (Use first floor beam layout, if not provided)

[ ] Show Pile Distance

Klik [OK] then klik menu icon [Width] then zoom it !



The result is the number of piles needed is larger than the simplified design because:

1. Group efficiency will reduce the axial capacity

2. Horizontal forces requires more piles than compression force
   Some Solutions:

   a. Use pile with large lateral capacity or inclined pile
   b. Replace and compact the first 1-2m top soil layer with sand or gravel.
   c. Horizontal forces can be neglected if there is basement floor

If we neglect the horizontal forces, the result will be close to the simplified design.

Support Index	Foundation Type & npile	Wid,x cm)	Wid,y (cm)	Thick (cm)	db (cm)	spx,top (cm)	spx,bot (cm)	spy,top (cm)	spy,bot (cm)
1	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
2	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
3	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
4	1 x R 25	75.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00
5	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
6	5 x R 25	181.06	181.06	50.00	1.60	37.36	14.94	37.36	14.94
7	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
8	2 x R 25	150.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00
9	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
10	4 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
11	3 x R 25	150.00	150.00	50.00	1.60	40.00	30.00	40.00	30.00
12	1 x R 25	75.00	75.00	50.00	1.60	40.00	30.00	40.00	30.00

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Total Number of Piles/Footing   = 37
Total Pile Cost (Only piles)    =           0.0
Total Slab or Pilecap Cost      =    14647535.1
Total Cost (Piles+Slab/Pilecap) =    14647535.1

Total Slab/Pilecap Concrete Volume =          11.8 m3
Total Slab/Pilecap Rebar    Weight =         551.2 kg
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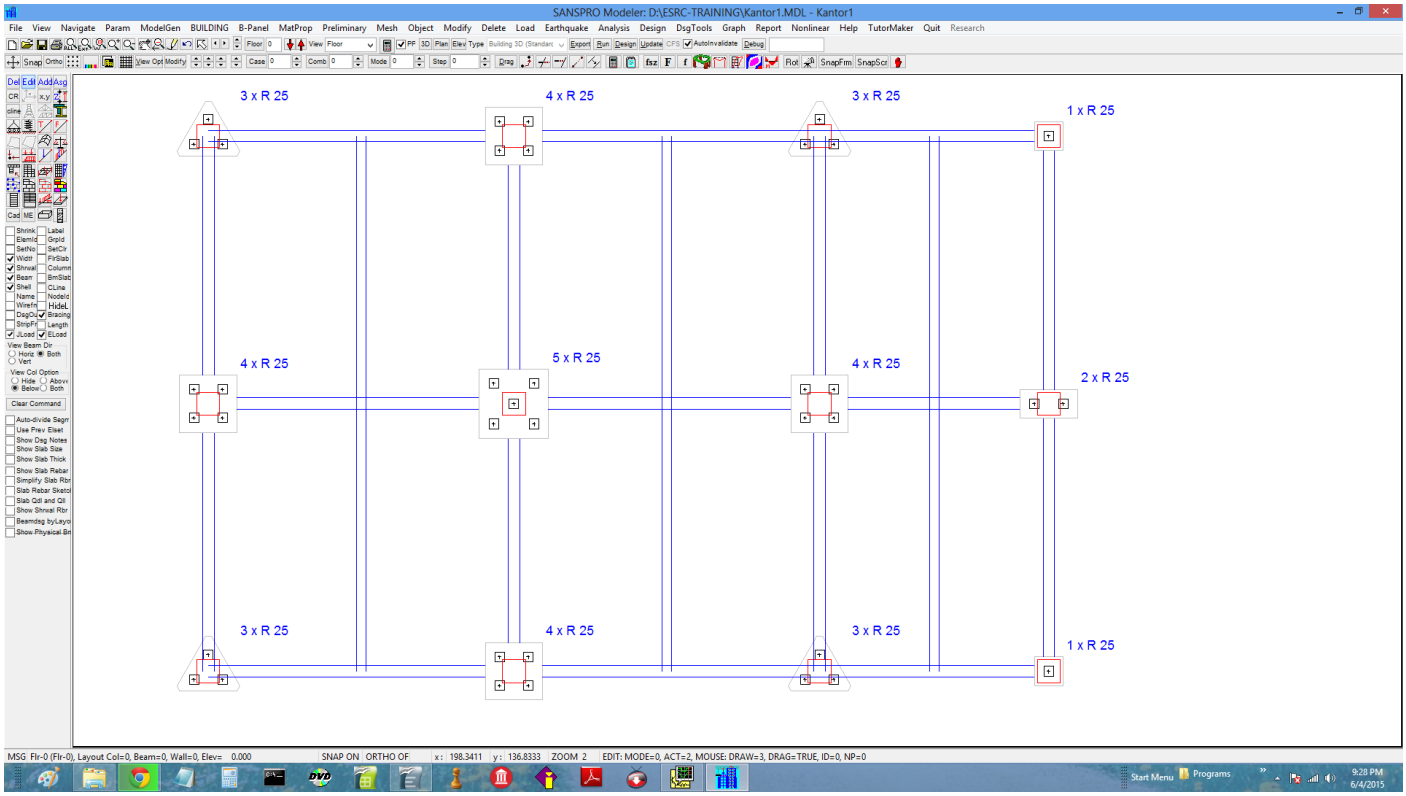
1. 2(Triangle Pile), a= 28.0 cm, Pa= 25.0 ton

   Pilecap (0 piles) = 0 units

2. 3(Square Pile), a= 25.0 cm, Pa= 40.0 ton

   Pilecap (0 piles) = 0 units
   Pilecap (1 piles) = 2 units
   Pilecap (2 piles) = 1 units
   Pilecap (3 piles) = 4 units
   Pilecap (4 piles) = 4 units
   Pilecap (5 piles) = 1 units



Notes on Foundation Design:

1. **Typical Foundation Capacity**

Mini Pile	**Axial capacity (ton)**
T28	25-30
T32	30-40
R20	25-30
R25	30-40

Precast Pile	
R30	40-60
R35	40-60
R40	50-70
R45	60-90

Bored Pile	
D30	30-40
D40	40-60
D50	50-70
D60	90-150
D80	150-250
D100	300-600
D120	500-800

Spun Pile	
D60	90-150
D80	150-250

Franki Pile	
D50	70-120 ton

Tension pile capacity = 50% of axial capacity
Lateral pile capacity = 5% of axial capacity
Minimum diameter or size of Pile = L/100 (L=30m, minimum size = 30 cm)
Pile-Pile distance = 3 to 6 D, Pile-Edge distance = 1.5 to 3 D

Note: This values are just rough estimation, consult geotechnical engineer for more accurate one.

2. **For location with potential for liquefaction**

Earthquake magnitude > MW6
Layer of loose sand (Nspt < 25) is thicker than 3m
High ground water level

Usually found at : Coastal cities (Padang, Ende, Maumere, etc)

a. Pile foundation must go through the liquefaction layer to bedrock layer
b. Friction within and above liquefaction layer must be set to zero
   (Reduction in pile capacity)
c. Use raft foundation or raft-pile to reduce large differential settlement due to liquefaction

3. **For location with very soft soil at top layer, resisting large load**

   Usually found at: Mine storage area

   Pile load capacity will be reduced by Negative Skin Friction (around 20-50%)
   Pile must go through the bedrock
   Use raft or raft-pile to reduce large differential settlement

4. **For location with expansive soil**

   Usually found at : area with high plasticity of soil
   Signs: not flat surface, differential settlement of ground slab, cracking of ceramic tile

   Additional test : Swelling test

   - Swelling pressure can be from 0.1 to maximum of 15 ton/m2
   - Pile load capacity will be reduced significantly by expansive soil (20-50%)
   - Layer of expansive soil can be at top layer or middle layer of soil
   - Expansive soil at top layer can be deactivated by mixing with cement or lime.
   - Pilecap must be separated with ground slab with gap filled with tar or flexible material
   - Surrounding soil must be kept from direct contact with surface or rain water

5. **For location with very soft soil, very deep bedrock**

   - Use raft foundation or raft pile
   - Use Caisson system (Pondasi laba-laba, cakar ayam, etc)
   - Use Floating foundation

   Raft contribution for raft-pile system must be considered zero
   Raft foundation must be design as elastic system (with omega factor)

6. **For location with shallow stiff soil**

   - Use raft foundation or raft pile
   - Use Caisson system (Pondasi laba-laba, cakar ayam, etc)
   - Use Floating foundation

   Reduce load by weight of excavated soil when calculating bearing pressure of raft

   Raft contribution for raft-pile system is maximum 25% of the total load

   Raft foundation must be design as elastic system (with omega factor)