# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2011/2012

| | | |
|---|---|---|
| COURSE NAME | : | REINFORCED CONCRETE DESIGN |
| COURSE CODE | : | BFC 3113 |
| PROGRAMME | : | BFF |
| EXAMINATION DATE | : | JANUARY 2012 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER **ALL** QUESTION IN **PART A** AND **TWO (2)** QUESTION IN **PART B**<br><br>DESIGN SHOULD BE NASED ON BS8110 |

THIS PAPER CONSISTS OF FOURTEEN (14) PAGES

## PART A: ANSWER ALL QUESTIONS

**Q1** Figure **Q1** shows an upper floor plan for a factory office. The 3 m height brickwall is located along the perimeter of the building. Given the following data:

| | | |
|---|---|---|
| Characteristic strength of concrete | = | 30 $N/mm^2$ |
| Characteristic strength of steel | = | 460 $N/mm^2$ |
| Density of concrete | = | 24 $kN/m^3$ |
| Imposed load | = | 3.5 $kN/m^2$ |
| Finishes | = | 1.0 $kN/m^2$ |
| Brickwall | = | 2.6 $kN/m^2$ |
| Concrete cover for beam | = | 30 mm |
| Concrete cover for slab | = | 20 mm |
| Assume bar diameter for beam (single layer) | = | 20 mm |
| Assume diameter for link | = | 10 mm |
| Assume bar diameter for slab | = | 10 mm |

(a) Calculate maximum load for slab S1 and S2.

(5 marks)

(b) Determine all the bending moments for slab S1.

(6 marks)

(c) Design all the reinforcements for slab S1.

(9 marks)

(d) Sketch the detailing for slab S1.

(3 marks)

(e) Calculate the maximum reaction for Beam 2.

(5 marks)

(f) Illustrate the maximum loads supported by Beam 1.

(6 marks)

(g) Design the main reinforcement for Beam 1 at support B.

(6 marks)

**PART B: ANSWER TWO QUESTIONS ONLY**

**Q2** (a) A double storey bungalow is proposed to be built on the peat soil area. From a structural engineer's point of view, what type of foundation you would like to propose for this building? Discuss **TWO (2)** advantages of the foundation system.

(4 marks)

(b) A four-pile cap supports a maximum factored load of 3000 kN from a column as shown in Figure **Q2**. During the construction, pile 'D' was offset 50 mm. Due to this mistake, axial load carries by each pile was changed. Given the following data:

| | | |
|---|---|---|
| Axial load: | | |
| Pile 'A' | = | 700 kN |
| Pile 'B' | = | 780 kN |
| Pile 'C' | = | 680 kN |
| Pile 'D' | = | 840 kN |
| Overall depth of pile cap | = | 900 mm |
| Strength of concrete | = | 40 $N/mm^2$ |
| Strength of reinforcement | = | 460 $N/mm^2$ |
| Concrete cover | = | 60 mm |
| Assume diameter of bar | = | 20 mm |

(i) Based on beam theory, calculate maximum moment at the critical section for both directions. Ignore selfweight of pile cap and column size.

(8 marks)

(ii) Design all reinforcements.

(8 marks)

(iii) Determine the minimum size of the square column to fulfill the maximum shear check.

(7 marks)

(iv) Sketch the detailing.

(3 marks)

**Q3** Figure **Q3** shows the plan view and cross section of a longitudinal spanning staircase. A 2 m height of brickwall is supported by the landing beam. Given the following data:

| | | |
|---|---|---|
| Riser | = | 175 mm |
| Going | = | 250 mm |
| Waist | = | 200 mm |
| Size of landing beam | = | 150 x 600 mm |
| Characteristic strength of concrete | = | 30 $N/mm^2$ |
| Characteristic strength of steel | = | 460 $N/mm^2$ |
| Concrete cover | = | 20 mm |
| Diameter of main reinforcement | = | 16 mm |
| Finishing and services | = | 1.0 $kN/m^2$ |
| Live load | = | 3.0 $kN/m^2$ |
| Brickwall | = | 2.6 $kN/m^2$ |

(a) Calculate the design load for the staircase and then carry out the analysis.
(8 marks)

(b) Design the staircase.
(5 marks)

(c) Check the deflection and cracking.
(8 marks)

(d) Provide the detailing.
(3 marks)

(e) Calculate the design load for the landing beam.
(3 marks)

(f) Propose an alternative structural system that can be used for the staircase.
(3 marks)

**Q4** An internal reinforced concrete column 'C1' of 300 x 350 mm carries the total factored axial load of 1050 kN as shown in Figure **Q4**. The height of the column in both axes is 4 m. The column is braced and the pad footing is not designed to restrain moment. Given the following data:

| | | |
|---|---|---|
| Characteristics strength of concrete | = | 40 N/mm$^2$ |
| Characteristics strength of main reinforcement | = | 460 N/mm$^2$ |
| Characteristics strength of shear reinforcement | = | 250 N/mm$^2$ |
| Concrete cover | = | 40 mm |
| Diameter of main reinforcement | = | 20 mm |
| Diameter of shear reinforcement | = | 6 mm |

(a) Classify the column as short or slender.

(5 marks)

(b) Determine the minimum moments.

(5 marks)

(c) Design the column 'C1' and draw the detailing.

(15 marks)

(d) What do you think of the required main reinforcement for column 'C1' if the height is increased to 5 m?

(5 marks)

**BAHAGIAN A: JAWAB SEMUA SOALAN**

**S1** Rajah **Q1** menunjukkan sebuah pelan lantai tingkat atas untuk sebuah kilang pejabat. Dinding bata dengan ketinggian 3 m terletak di sepanjang perimeter bangunan ini. Diberikan data berikut:

| | | |
|---|---|---|
| Kekuatan ciri konkrit | = | 30 $N/mm^2$ |
| Kekuatan ciri keluli | = | 460 $N/mm^2$ |
| Ketumpatan konkrit | = | 24 $kN/m^3$ |
| Beban hidup | = | 3.5 $kN/m^2$ |
| Kemasan | = | 1.0 $kN/m^2$ |
| Beban dinding bata | = | 2.6 $kN/m^2$ |
| Penutup konkrit untuk rasuk | = | 30 mm |
| Penutup konkrit untuk papak | = | 20 mm |
| Anggap diameter tetulang untuk rasuk (satu lapisan) | = | 20 mm |
| Anggap diameter untuk perangkai | = | 10 mm |
| Anggap diameter tetulang untuk papak | = | 10 mm |

(a) Kirakan beban maksimum untuk papak S1 dan S2.

(5 marks)

(b) Tentukan semua momen lentur untuk papak S1.

(6 marks)

(c) Rekabentuk semua tetulang untuk papak S1.

(9 marks)

(d) Lakarkan perincian untuk papak S1.

(3 marks)

(e) Kirakan tindakbalas maksimum untuk Rasuk 2.

(5 marks)

(f) Lakarkan beban maksimum yang disokong oleh Rasuk 1.

(6 marks)

(g) Rekabentuk tetulang utama untuk Rasuk 1 di penyokong B.

(6 marks)

**BAHAGIAN B: JAWAB DUA SOALAN SAHAJA**

**S2** (a) Sebuah banglo dua tingkat telah dicadangkan untuk dibina atas kawasan tanah gambut. Daripada pandangan seorang jurutera struktur, apakah jenis penapak yang anda akan cadangkan untuk rumah ini? Bincangkan **DUA (2)** kebaikan untuk sistem penapak ini.

(4 markah)

(b) Satu tukup empat-cerucuk menyokong beban maksimum terfaktor 3000 kN dari sebuah tiang seperti ditunjukkan dalam Rajah **Q2**. Semasa pembinaan, cerucuk 'D' telah mengalami ofset 50 mm. Akibat daripada kesilapan ini, beban paksi yang dibawa oleh setiap cerucuk telah berubah. Diberikan maklumat berikut:

| | | |
|---|---|---|
| Beban paksi: | | |
| Cerucuk 'A' | = | 700 kN |
| Cerucuk 'B' | = | 780 kN |
| Cerucuk 'C' | = | 680 kN |
| Cerucuk 'D' | = | 840 kN |
| Ukurdalam tukup cerucuk | = | 900 mm |
| Kekuatan konkrit | = | 40 $N/mm^2$ |
| Kekuatan tetulang | = | 460 $N/mm^2$ |
| Penutup konkrit | = | 60 mm |
| Anggap diameter tetulang | = | 20 mm |

(i) Berdasarkan teori rasuk, kirakan moment maksimum pada keratan kritikal untuk kedua-dua arah. Abaikan berat sendiri tukup cerucuk saiz tiang.

(8 markah)

(ii) Rekabentuk semua tetulang.

(8 markah)

(iii) Tentukan saiz minimum untuk tiang segiempat sama untuk memuaskan semakan ricih maksimum.

(7 markah)

(iv) Lakarkan perincian.

(3 markah)

**S3** Rajah **Q3** menunjukkan pandangan pelan dan keratan rentas untuk sebuah tangga rentang memanjang. Dinding bata setinggi 2 m disokong oleh rasuk pelantar. Diberikan data berikut:

| | | |
|---|---|---|
| Penaik | = | 175 mm |
| Pemijak | = | 250 mm |
| Cekak | = | 200 mm |
| Saiz untuk rasuk pelantar | = | 150 x 600 mm |
| Kekuatan ciri konkrit | = | 30 $N/mm^2$ |
| Kekuatan ciri tetulang | = | 460 $N/mm^2$ |
| Penutup konkrit | = | 20 mm |
| Diameter tetulang utama | = | 16 mm |
| Kemasan dan servis | = | 1.0 $kN/m^2$ |
| Beban hidup | = | 3.0 $kN/m^2$ |
| Dinding bata | = | 2.6 $kN/m^2$ |

(a) Kirakan beban rekabentuk untuk tangga ini dan kemudian lakukan analisis.
(8 markah)

(b) Rekabentuk tangga tersebut.
(5 markah)

(c) Semak pesongan dan keretakan.
(8 markah)

(d) Sediakan lukisan perincian.
(3 markah)

(e) Kirakan beban rekabentuk untuk rasuk pelantar.
(3 markah)

(f) Cadangkan satu alternatif sistem struktur yang boleh digunakan untuk tangga ini.
(3 markah)

**S4** Sebatang tiang dalaman konkrit bertetulang 'C1' 300 x 350 mm menanggung beban paksi terfaktor 1050 kN seperti ditunjukkan dalam Rajah **Q4**. Ketinggian tiang dalam kedua-dua paksi ialah 4 m. Tiang adalah dirembat dan asas pad tidak direkabentuk untuk merintangi momen. Diberikan data-data berikut:

| | | |
|---|---|---|
| Kekuatan ciri konkrit | = | 40 N/mm$^2$ |
| Kekuatan ciri tetulang | = | 460 N/mm$^2$ |
| Kekuatan ciri tetulang ricih | = | 250 N/mm$^2$ |
| Penutup konkrit | = | 40 mm |
| Diameter tetulang utama | = | 20 mm |
| Diameter tetulang ricih | = | 6 mm |

(a) Kelaskan tiang samada pendek atau langsing.

(5 markah)

(b) Tentukan momen minimum.

(5 markah)

(c) Rekabentuk tiang 'C1' dan lukiskan perinciannya.

(15 markah)

(d) Apakah yang kamu jangka terhadap tetulang yang diperlukan untuk tiang 'C1' jika ketinggiannya ditambah kepada 5 m?

(5 markah)

**FINAL EXAMINATION**

SEMESTER/SESSION : SEMESTER I 2011/2012 PROGRAM : BFF
COURSE NAME : REINFORCED CONCRETE DESIGN COURSE CODE : BFC 3113

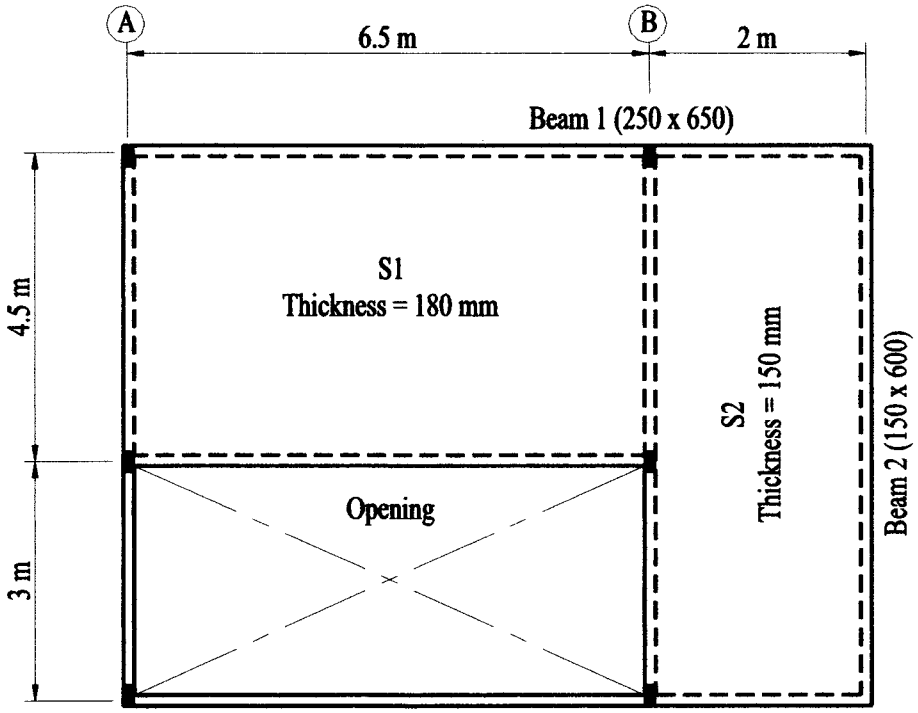
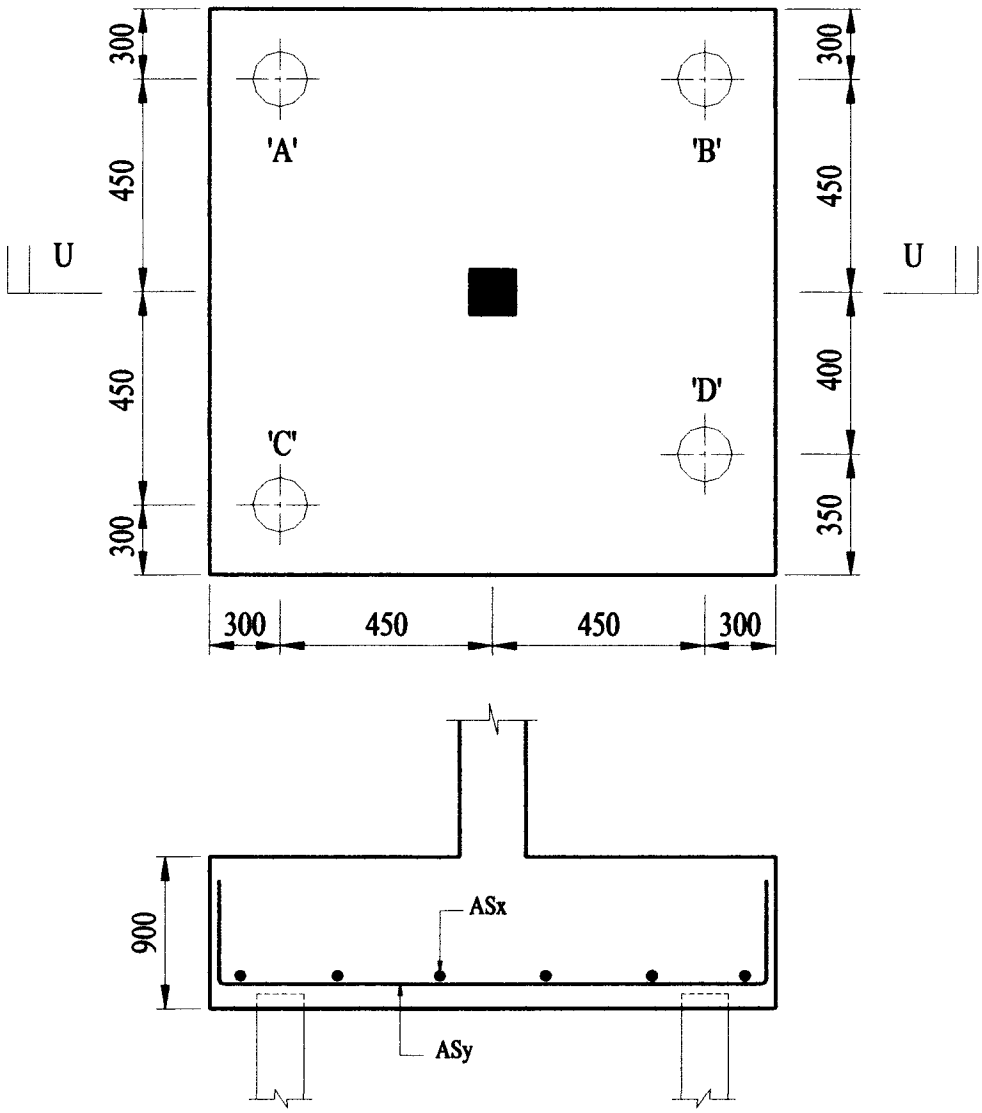



**FIGURE Q1**

**FINAL EXAMINATION**

SEMESTER/SESSION : SEMESTER I 2011/2012
COURSE NAME : REINFORCED CONCRETE DESIGN
PROGRAM : BFF
COURSE CODE : BFC 3113




Section U-U

**FIGURE Q2**

**FINAL EXAMINATION**

SEMESTER/SESSION : SEMESTER I 2011/2012 PROGRAM : BFF
COURSE NAME : REINFORCED CONCRETE DESIGN COURSE CODE : BFC 3113

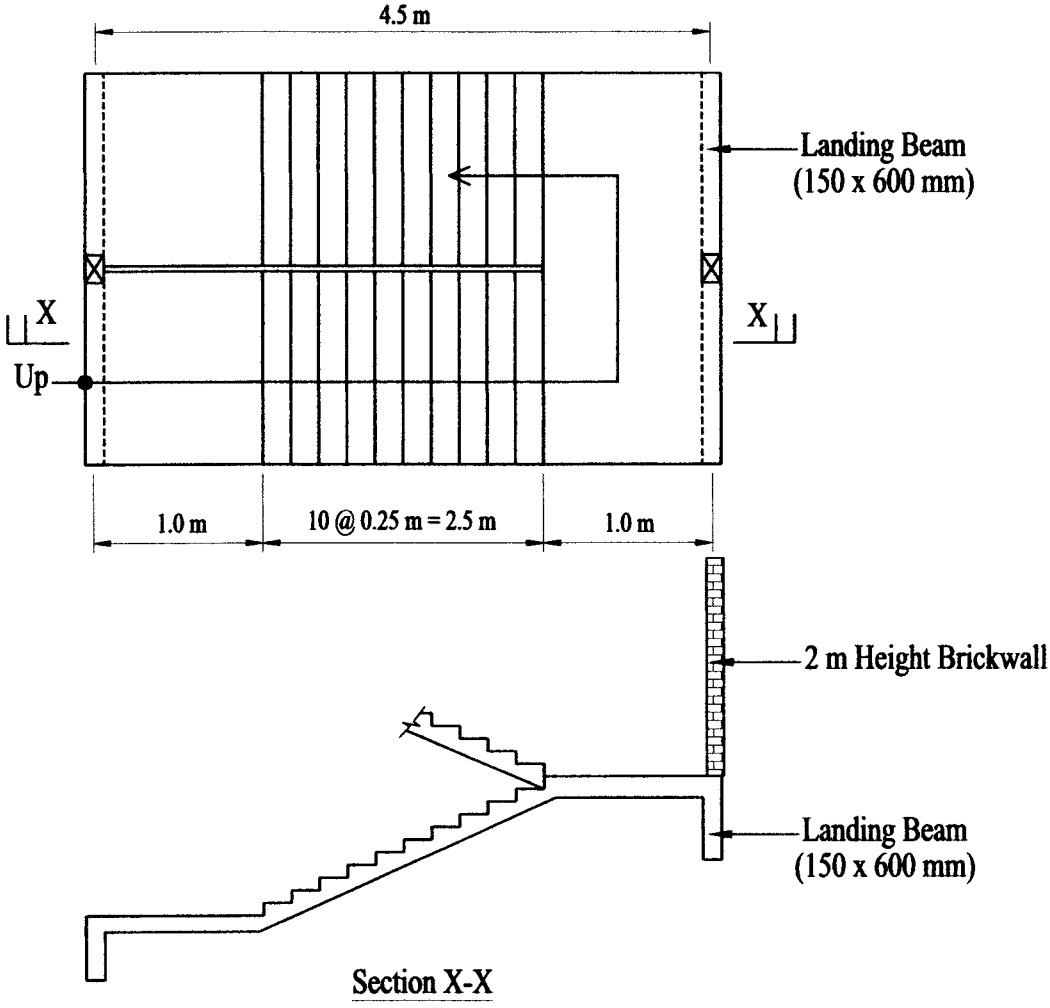
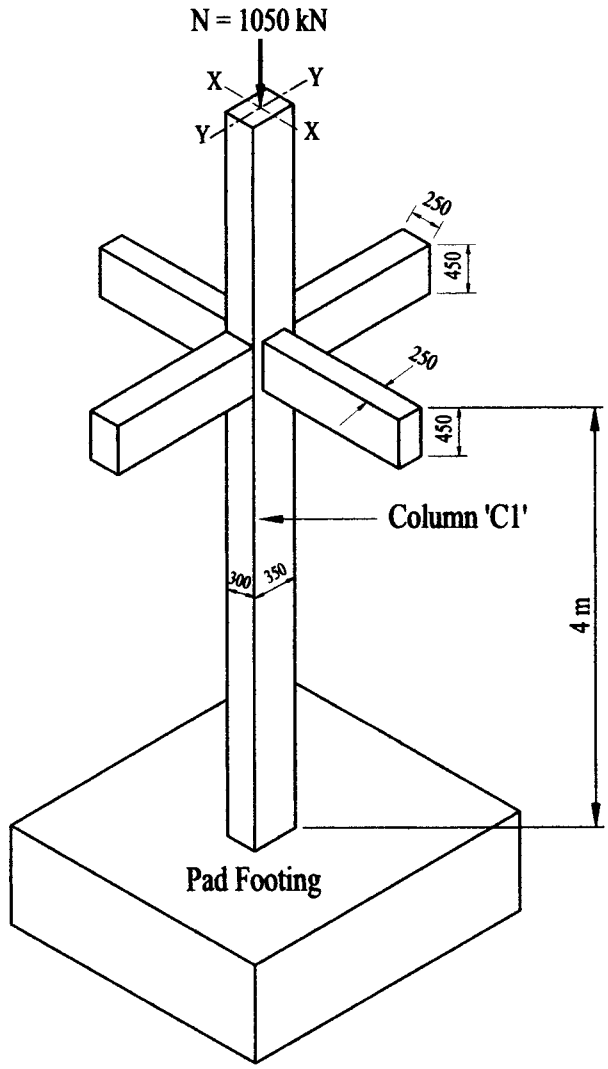
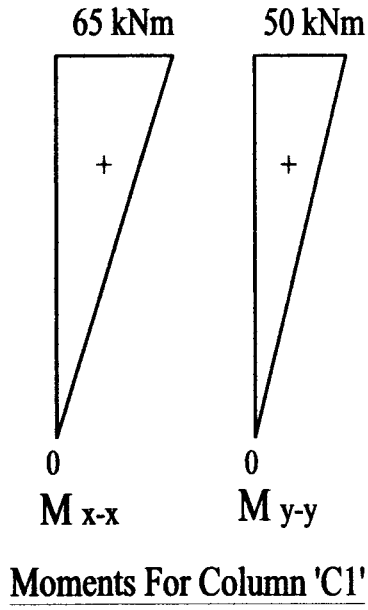



**FIGURE Q3**

**FINAL EXAMINATION**

| | | | |
|---|---|---|---|
| SEMESTER/SESSION | : SEMESTER I 2011/2012 | PROGRAM | : BFF |
| COURSE NAME | : REINFORCED CONCRETE DESIGN | COURSE CODE | : BFC 3113 |




Moments For Column 'C1'

**FIGURE Q4**

# Appendix (Cross Sectional Area of Reinforcement)

**Table 1:** Cross Sectional Area ($mm^2$) according to Size and Numbers of Bar

| Bar Size (mm) | Number of bar | | | | | | | | Perimeter (mm) |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 6 | 28.3 | 56.6 | 84.9 | 113 | 141 | 170 | 198 | 226 | 18.9 |
| 8 | 50.3 | 101 | 151 | 201 | 251 | 302 | 352 | 402 | 25.1 |
| 10 | 78.6 | 157 | 236 | 314 | 393 | 471 | 550 | 629 | 31.4 |
| 12 | 113 | 226 | 339 | 453 | 566 | 679 | 792 | 905 | 37.7 |
| 16 | 201 | 402 | 603 | 805 | 1006 | 1207 | 1408 | 1609 | 50.3 |
| 20 | 314 | 629 | 943 | 1257 | 1571 | 1886 | 2200 | 2514 | 62.9 |
| 25 | 491 | 982 | 1473 | 1964 | 2455 | 2946 | 3438 | 3929 | 78.6 |
| 32 | 805 | 1609 | 2414 | 3218 | 4023 | 4827 | 5632 | 6437 | 100.6 |
| 40 | 1257 | 2514 | 3771 | 5029 | 6286 | 7543 | 8800 | 10057 | 125.7 |

**Table 2:** Cross Sectional Area ($mm^2$) for every meter width at distance between bar

| Bar Size (mm) | Distance between Bar (mm) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 50 | 75 | 100 | 125 | 150 | 175 | 200 | 250 | 300 |
| 6 | 566 | 377 | 283 | 226 | 189 | 162 | 141 | 113 | 94 |
| 8 | 1006 | 670 | 503 | 402 | 335 | 287 | 251 | 201 | 168 |
| 10 | 1571 | 1048 | 786 | 629 | 524 | 449 | 393 | 314 | 262 |
| 12 | 2263 | 1509 | 1131 | 905 | 754 | 647 | 566 | 453 | 377 |
| 16 | 4023 | 2682 | 2011 | 1609 | 1341 | 1149 | 1006 | 805 | 670 |
| 20 | 6286 | 4190 | 3143 | 2514 | 2095 | 1796 | 1571 | 1257 | 1048 |
| 25 | 9821 | 6548 | 4911 | 3929 | 3274 | 2806 | 2455 | 1964 | 1637 |
| 32 | 16091 | 10728 | 8046 | 6437 | 5364 | 4598 | 4023 | 3218 | 2682 |
| 40 | 25143 | 16762 | 12571 | 10057 | 8381 | 7184 | 6286 | 5029 | 4190 |