UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 2
SESSION 2011/2012

COURSE NAME	:	STRUCTURAL CONCRETE DESIGN II
COURSE CODE	:	BFC 3172 / BFC 32802
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN PART A AND **TWO (2)** QUESTIONS IN PART B. DESIGN SHOULD BE BASED ON BS8110.

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES

PART A (ANSWER ALL QUESTIONS)

Q1 (a) Define the prestressed concrete.

(2 marks)

(b) With the aid of sketch, explain the process of pre-tensioning and post-tensioning of prestressed concrete.

(6 marks)

(c) Figure **Q1** shows a class 2 (*Pre-tensioning*) simply supported pre-stressed concrete girders with 20 m span. The girder is subjected to service load of 25 kN/m and does not include the selfweight. Losses of prestressing forces for short term, α and long term, β are 10 % and 20 % respectively. Other data are given as followed.

Prestressing force for tendon 1	=	400 kN
Prestressing force for tendon 2	=	400 kN
Prestressing force for tendon 3	=	400 kN
Concrete grade at transfer	=	C30
Concrete grade at service	=	C40
Moment of inertia	=	$12.85 \times 10^{10} mm^4$
Tendon eccentricity	=	500 mm

(i) Calculate bending moment at transfer, M_i and bending moment at service, M_s of the girder.

(5 marks)

(ii) Calculate and draw stresses distribution at transfer and service of the girder.

(10 marks)

(iii) Compare all the stresses value with the stress limit suggested in BS 8110.

(4 marks)

(d) External prestressing method is one of famous method used for strengthening existing concrete structures. From your opinion, sketch and explain the application of this method.

(3 marks)

PART B (ANSWER TWO QUESTIONS ONLY)

Q2 (a) Explain briefly the differences between transverse and longitudinal span staircase.

(3 marks)

(b) A typical two flights stair is shown in Figure **Q2** are spanning perpendicularly to each other and sharing one common landing. The overall depth of landing and waist of both flights is 150 mm, while the width of going and height of riser are 260 mm and 170 mm respectively. Given the following data:

Characteristic strength of concrete, f_{cu}	=	25 N/mm^2
Characteristic strength of steel, f_y	=	460 N/mm^2
Nominal concrete cover	=	25 mm
Diameter of main reinforcement	=	12 mm
Finishing and handrails	=	1.5 kN/m^2
Characteristic live load, Q_k	=	3.0 kN/m^2

(i) Design the reinforcement required for the stair.

(12 marks)

(ii) Check the shear resistance of the stair.

(6 marks)

(iii) Checks the deflection and cracking of the stair.

(7 marks)

(iv) Provide the detailing of the stair.

(3 marks)

(c) As a design engineer, propose the design solution if the staircase shown in Figure **Q2** is 110 mm built into the wall.

(4 marks)

Q3 (a) Name and explain briefly **Three (3)** types of sub-frame analysis. Draw each of levels to help your explanation.

(9 marks)

(b) Figure **Q3** shows front elevation of a seven storey building which will be built without any braced member. Beams from first to roof floor were subjected to characteristic vertical load of 40 kN/m (including self-weight). The frame subjected to a characteristic horizontal load of 5.0 kN/m also shown in Figure **Q3**. For analysis, the connection between lower columns to foundation can be assumed as fixed to the ground beam level. Based on Clause 3.2.1.3.2(b):

(i) Calculate ultimate horizontal load of each floor and draw the frame with point horizontal load at each floor.

(7 marks)

(ii) Analyze the frame at the roof floor due to the horizontal load.

(8 marks)

(iii) If the same frame was braced with a bracing member, sketch the loading arrangement based on Clause 3.2.1.2.2 (use complete sub-frame analysis) for first (1^{st}) floor and calculate the distribution factor for moment distribution. Given:

Characteristic dead load, G_k	=	30 kN/m
Characteristic imposed load, Q_k	=	10 kN/m
Beam stiffness	=	1.2×10^{-3} m^3
Upper column stiffness	=	0.25×10^{-3} m^3
Lower column stiffness	=	0.21×10^{-3} m^3

(8 marks)

(c) From your opinion, what the differences between continuous beam analysis and sub-frame analysis.

(3 marks)

Q4 Figure **Q4** shows front elevation, floor plan and position of column C/3 in a reinforced concrete building where the horizontal load was carried by shear wall. Beam will be build at C/1-4 grid while no beam will be build at 3/A-D grid. Take the size of column of 350 mm x 350 mm with the connection between column and foundation could not carry moment. From analysis of the structure, it was found that column C/3 in level 0-1 carried an axial load of 1300 kN. The moment from level 1 was 40 kNm while moment from level 0 was zero, where bending is about major axis.

(a) Classify whether column C/3 is short or slender.

(14 marks)

(b) Determine ultimate column design moment, M_c

(11 marks)

(c) Given $100A_{sc}/bh = 0.6$ (after K is almost constant), design the main reinforcement and link for column C/3 at level 0-1. Prepare the detailing of the column. Use main reinforcement diameter of 16 mm.

(7 marks)

(d) From your opinion, what the factors that influence in column design?

(3 marks)

Q5 (a) Sketch and explain the used of types of foundation as given below:

(i) Pile foundation
(ii) Combined footing
(iii) Raft foundation

(iv) Pad footing

(6 marks)

(b) A rectangular pad footing as shown in Figure **Q5** is required to support a single column transferring an axial service load which consists of 600 kN dead load and 450 kN live load. Using the data provided,

Characteristic strength of concrete, f_{cu}	=	25 N/mm^2
Characteristic strength of steel, f_y	=	460 N/mm^2
Concrete cover	=	35 mm
Diameter of main reinforcement	=	16 mm
Finishing and services	=	1.5 kN/m^2
Live load	=	5.0 kN/m^2
Column size	=	300 mm x 300 mm
Soil bearing capacity	=	200 N/mm^2

(i) Determine the suitable size of footing with overall depth, h = 450 mm and sketch the footing.

(4 marks)

(ii) Design the reinforcement required.

(8 marks)

(iii) Check the shear resistance of the pad footing.

(10 marks)

(iv) Provide detailing of the footing.

(3 marks)

(c) In the process of pile driven, one of pile within pile group was deviated from its original position about 150 mm. As structural engineer, propose an alternative to solve this problem.

(4 marks)

BAHAGIAN A (JAWAB SEMUA SOALAN)

S1 (a) Berikan definisi konkrit prategasan.

(2 markah)

(b) Dengan berbantukan lakaran, terangkan proses *pre-tensioning* dan *post-tensioning* bagi konkrit prategasan.

(6 markah)

(c) Rajah **Q1** menunjukkan keratan bagi kelas 2 (*Pre-tensioning*) gelegar konkrit prategasan sokong mudah dengan rentang 20 m panjang. Gelegar dikenakan beban khidmat sebanyak 25 kN/m dan tidak termasuk berat sendiri. Kehilangan daya prategangan bagi jangka pendek, α dan jangka panjang, β masing-masing ialah 10% dan 20%. Diberi data-data lain seperti berikut,

Daya prategasan bagi tendon 1	=	400 kN
Daya prategasan bagi tendon 2	=	400 kN
Daya prategasan bagi tendon 3	=	400 kN
Gred konkrit semasa pindah	=	C30
Gred konkrit semasa khidmat	=	C40
Momen sifat tekun	=	$12.85 \times 10^{10}\,mm^4$
Kesipian tendon	=	500 mm

(i) Kirakan momen lentur semasa pindah, M_i dan semasa khidmat, M_s bagi gelegar berkenaan.

(5 markah)

(ii) Kirakan dan lukiskan taburan tegasan semasa pindah dan khidmat bagi gelegar berkenaan.

(10 markah)

(iii) Bandingkan semua nilai tegasan yang diperolehi dengan had tegasan yang dicadangkan di dalam BS 8110.

(4 markah)

(d) Kaedah prategangan luaran merupakan satu kaedah yang sering digunakan di dalam menguatkan struktur konkrit sedia ada. Pada pendapat anda, lakarkan dan terangkan aplikasi kaedah ini.

(3 markah)

BAHAGIAN B (JAWAB DUA SOALAN SAHAJA)

S2 (a) Terangkan secara ringkas perbezaan di antara tangga melintang dan tangga menegak.

(3 markah)

(b) Tipikal tangga yang mempunyai dua kenaikan seperti yang ditunjukkan di dalam Rajah **Q2** merentang secara serenjang antara satu sama lain dan berkongsi pelantar yang sama. Ketebalan cekak untuk kedua-dua kenaikan ialah 150 mm, sementara lebar jejak ialah 260 mm dan tinggi kenaikan ialah 170 mm. Diberi data berikut:

Kekuatan ciri konkrit, f_{cu}	=	25 N/mm^2
Kekuatan ciri keluli, f_y	=	460 N/mm^2
Penutup konkrit	=	25 mm
Diameter tetulang utama	=	12 mm
Kemasan dan rel tangan	=	1.5 kN/m^2
Beban hidup, Q_k	=	3.0 kN/m^2

(i) Rekabentuk tetulang yang diperlukan bagi tangga.

(12 markah)

(ii) Semak rintangan ricih bagi tangga.

(6 markah)

(iv) Semak pesongan dan keretakan bagi tangga.

(7 markah)

(iv) Sediakan perincian tetulang bagi tangga.

(3 markah)

(c) Sebagai jurutera rekabentuk, cadangkan penyelesaian rekabentuk sekiranya tangga seperti yang ditunjukkan di dalam Rajah **Q2** di tanam 110 mm ke dalam dinding.

(4 markah)

S3 (a) Namakan dan terangkan secara ringkas **Tiga (3)** jenis analisis sub-kerangka. Lakarkan setiap satu bagi membantu penerangan anda.

(9 markah)

(b) Rajah **Q3** menunjukkan pandangan hadapan sebuah bangunan tujuh tingkat yang akan dibina tanpa sebarang anggota perembat. Rasuk-rasuk dari tingkat satu ke bumbung dikenakan beban ciri sebesar 40 kN/m (termasuk berat sendiri). Kerangka tersebut juga dikenakan beban ciri ufuk sebanyak 5.0 kN/m. Untuk tujuan analisis, sambungan antara tiang paling bawah dengan asas boleh dianggap sebagai terikat tegar dengan rasuk aras tanah. Berdasarkan Fasal 3.2.1.3.2(b):

(i) Kira beban ufuk muktamad bagi setiap tingkat dan lukiskan rajah kerangka tersebut.

(7 markah)

(ii) Analisis kerangka tersebut pada aras bumbung disebabkan oleh beban ufuk.

(8 markah)

(iii) Jika kerangka yang sama disediakan dengan anggota perembat, lakarkan susunan beban berdasarkan Klausa 3.2.1.2.2 (gunakan analisis sub-kerangka penuh) bagi aras satu dan kirakan faktor agihan bagi agihan momen. Diberi:

Beban mati ciri, G_k	=	30 kN/m
Beban kenaan ciri, Q_k	=	10 kN/m
Kekukuhan rasuk	=	1.2×10^{-3} m^3
Kekukuhan tiang atas	=	0.25×10^{-3} m^3
Kekukuhan tiang bawah	=	0.21×10^{-3} m^3

(8 markah)

(c) Pada pendapat anda, apakah perbezaan antara analisis rasuk selanjar dan analisis sub-kerangka.

(3 markah)

S4 Rajah **Q4** menunjukkan pandangan hadapan, pelan lantai dan kedudukan tiang C/3 dalam sebuah bangunan konkrit tetulang, di mana semua beban ufuknya ditanggung oleh dinding ricih. Rasuk-rasuk hanya terdapat pada grid C/1-4 sahaja, manakala pada grid 3/A-D tiada rasuk disediakan. Gunakan saiz tiang 350 mm x 350 mm dengan sambungan antara tiang dengan penapak tidak berupaya menanggung momen. Daripada analisis struktur, didapati tiang C/3 menanggung beban paksi sebanyak 1300 kN bagi aras 0-1. Manakala bagi momen, didapati momen sebanyak 40 kNm pada aras 1 dan sifar pada aras 0 dimana lenturan berlaku pada paksi utama.

(a) Klasifikasikan tiang C/3 samada tiang pendek atau langsing.

(14 markah)

(b) Tentukan momen rekabentuk muktamad tiang, M_c.

(11 markah)

(c) Diberi $100A_{sc}/bh = 0.6$ (selepas K adalah hampir malar), rekabentukkan tetulang utama dan tetulang pengikat bagi tiang C/3 di aras 0-1. Sediakan perincian rekabentuk bagi tiang tersebut. Gunakan saiz tetulang utama 16mm.

(7 markah)

(d) Pada pendapat anda, apakah faktor yang mempengaruhi di dalam rekabentuk tiang?

(3 markah)

S5 (a) Lukiskan dan terangkan kegunaan jenis-jenis asas seperti yang diberikan di bawah:

(i) Asas cerucuk
(ii) Asas gabungan
(iii) Asas rakit
(iv) Asas pad

(6 markah)

(b) Satu asas pad seperti yang ditunjukkan di dalam Rajah **Q5** diperlukan untuk menyokong satu tiang yang memindahkan beban tumpu yang mengandungi beban mati, G_k = 600 kN dan beban hidup, Q_k = 450 kN. Dengan menggunakan data yang disediakan,

Kekuatan sifat konkrit, f_{cu}	=	25 N/mm^2
Kekuatan sifat keluli, f_y	=	460 N/mm^2
Penutup konkrit	=	35 mm
Diameter tetulang utama	=	16 mm
Kemasan dan beban khidmat	=	1.5 kN/m^2
Saiz tiang	=	300 x 300 mm
Tegasan galas izin tanah	=	200 N/mm^2

(i) Kirakan saiz asas pad yang sesuai dengan ukur dalam keseluruhan, h = 450 mm dan lukiskan gambarajah asas tersebut.

(4 markah)

(ii) Rekabentuk tetulang yang diperlukan.

(8 markah)

(iii) Semak rintangan ricih pada asas pad tersebut.

(10 markah)

(iv) Lukiskan perincian bagi asas ini.

(3 markah)

(c) Di dalam process melantak cerucuk, di dapati sebatang cerucuk daripada kumpulan cerucuk telah terpesong daripada kedudukan asalnya sebanyak 150 mm. Sebagai seorang jurutera struktur, cadangkan alternatif untuk menyelesaikan masalah ini.

(4 markah)

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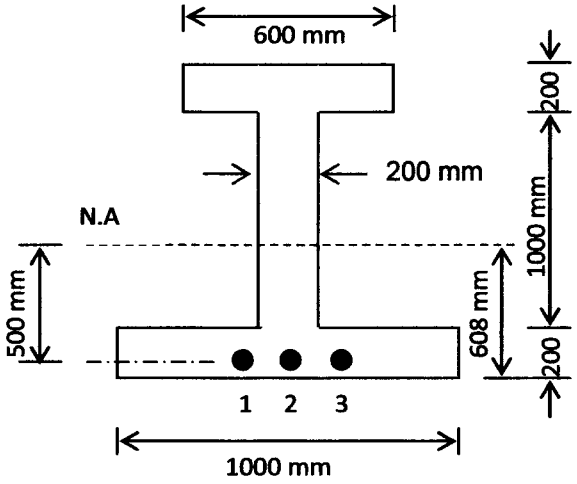

FIGURE Q1

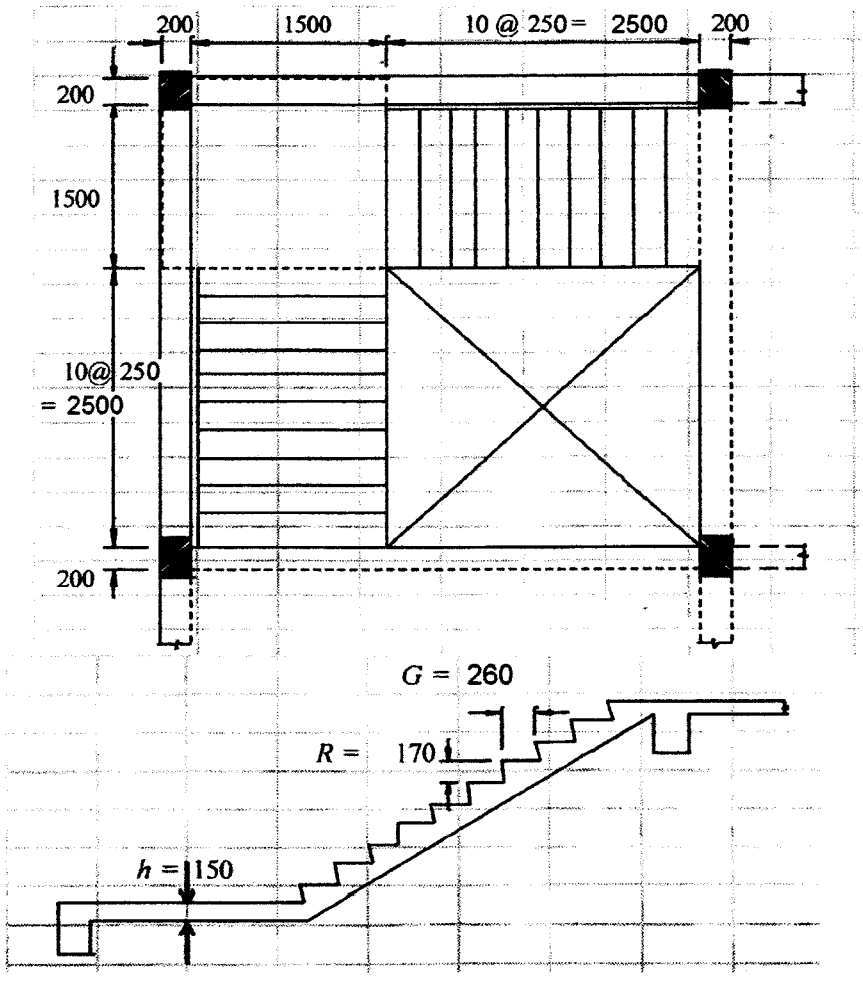

FIGURE Q2

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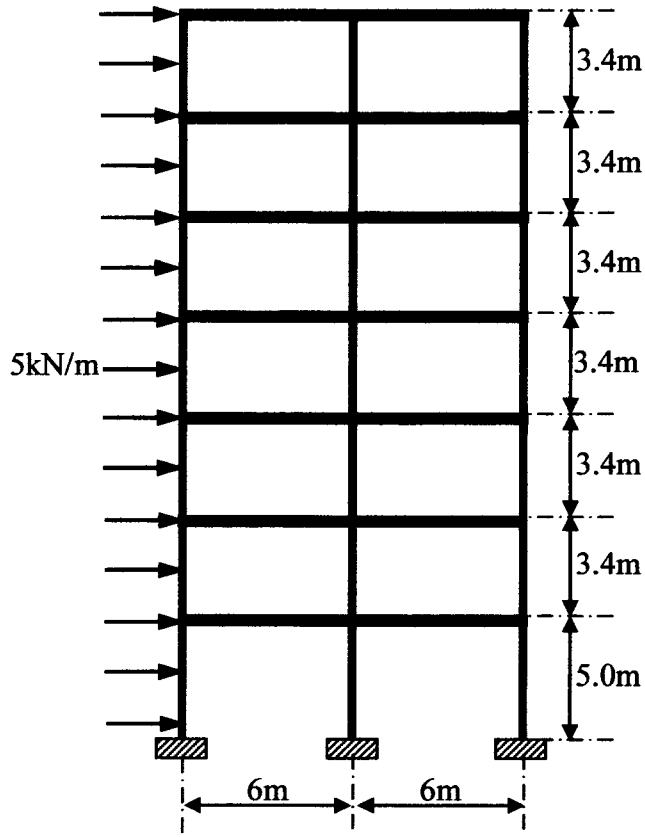

FIGURE Q3

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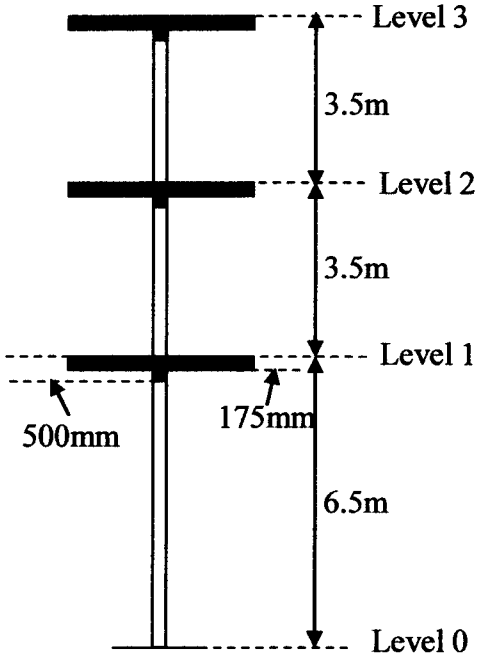
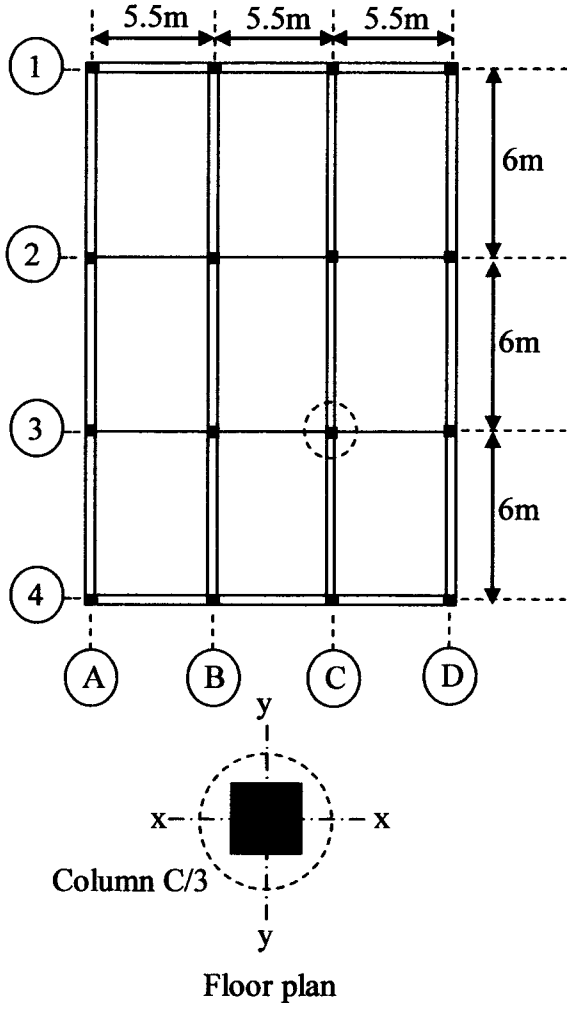


Front elevation of column C/3



Floor plan

FIGURE Q4

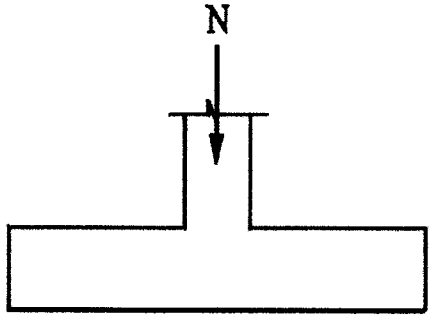


FIGURE Q5

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