(The *University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

UNIVERSITY EXAMINATIONS 2012/2013 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CVS 516E

COURSE TITLE: DESIGN OF SPECIAL STRUCTURES

DATE: Thursday, 2nd May 2013 **TIME:** 2.00 pm - 5.00 pm

INSTRUCTIONS TO CANDIDATES

- This paper contains FIVE questions
- Answer all questions
- No unauthorized materials are allowed in the examination room

Question One

a) Determine the structural Period *(T)* and Base shear force *(V)* for the following building data:

Building:	Height	150 m
	Length	40 m
	Width	40 m
	W	560,600 kN
Concrete Moment Resistance Frame system: Ordinary moment resisting frame		
Category U occupancy		
Soil profile type		Sc
Seismic Zone Factor		Z = 0.28
Wind pressure		$P = 0.60$ kN/m^2

Check that the building structure is stable. (6 marks)

b) List four techniques of assessing defects in building structures. (4 marks)

Question Two

Calculate the N-S wind direction total wind load on the building on figure 1, taking:

1. Basic wind speed as 25m/s
2. The building is 50 km from the sea
3. Attitude Factor $S_a = 1$
4. Direction factor $S_d = 1$
5. Seasonal factor $S_s = 1$
6. Probability factor $S_p = 1$

(10 marks)

Question Three

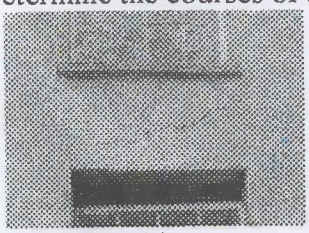
Design the internal column for Figure 1 at ground level from the sub-frame analysis ultimate design data given on Table 1, with 40 mm nominal cover and 400 x 400 mm column size, f_{cu} = 40 N/m^2, f_y = 460 N/mm^2 (main bars) 250 N/mm^2 (links) with d = 347 mm, $\beta = 0.9$ (N-S direction) and $\beta = 0.95$ (E-W direction), (10 marks)

Question Four

Design the pad foundation for the internal column in **question three**. Using the allowable ground bearing pressure of 300 kN/m^2, allow 10 kN/m^2 extra over soil displaced by concrete, with 40 mm nominal cover and f_{cu} = 40 N/m^2 concrete strength, taking d = 535 mm (10 marks)

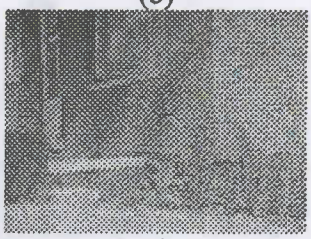
Question Five

Determine the courses of the following Structural defects. (10 marks)



(a)

(b)



(c)

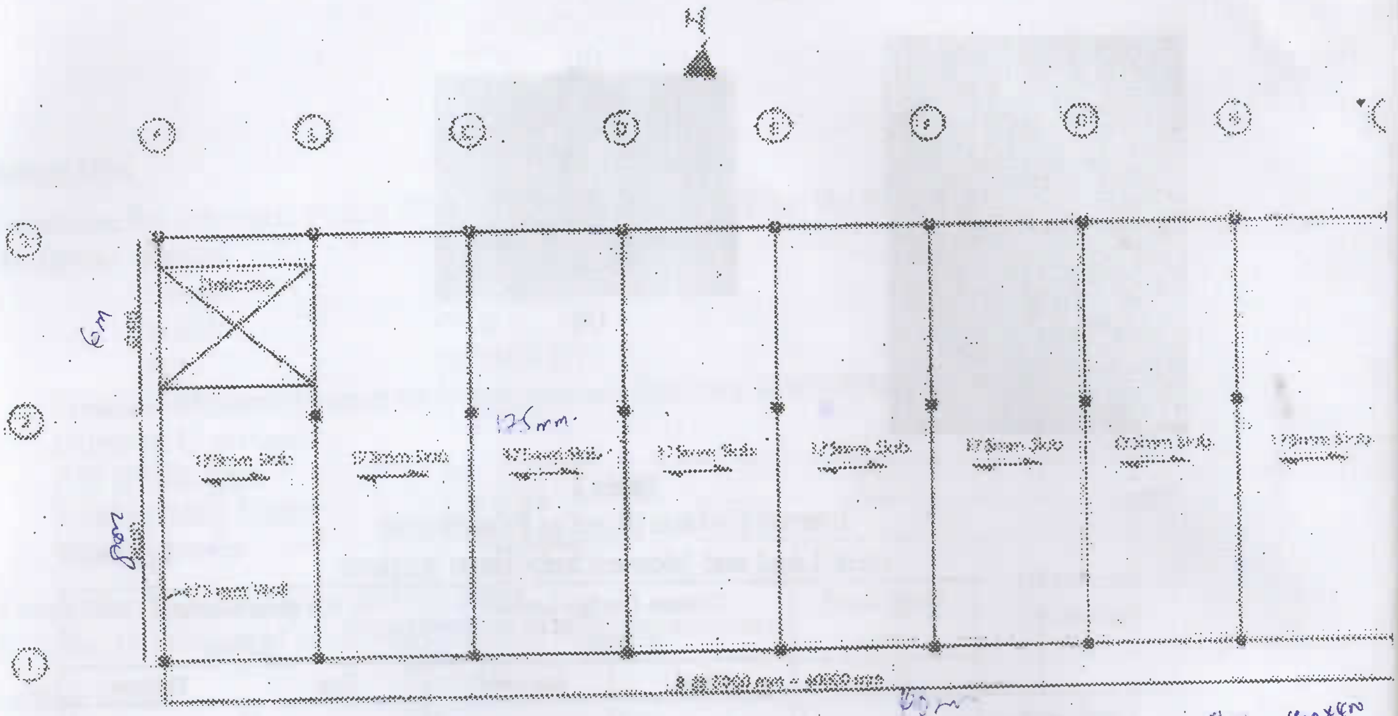
Table 1

Internal Column (Roof to Foundation)

Axial Load and Moment Sub-frame Analysis

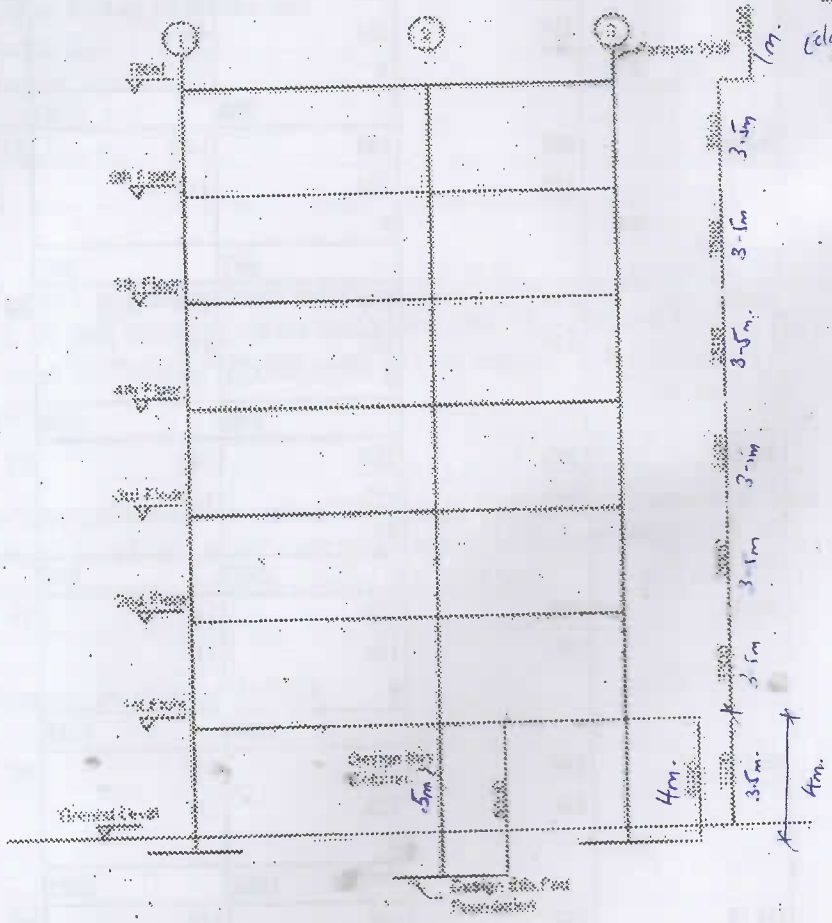
		Beam Load	Column Design Loads		Column Moment	
		(kN)	(kN)		(kNm)	
		Total	Dead	Imposed	Top	Botom
Load Case		1	1	1	1	1
Level						
Roof		249	195	54	34	
		210	164	46		32
	sw		9			
			368	100		
6th Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			667	357		
5th Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			966	614		
4th Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			1265	871		
3rd Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			1564	1128		
2nd Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			1863	1385		
1st Fl		298	158	140	32	
		249	132	117		32
	sw		9			
			2162	1642		
Grd Fl		300	159	141	19	
		252	132	118		-
	sw		14			

H



Typical Floor Plan

Notes:
1. All Columns 400...
2. Main Beams 300...
3. Edge Beams 300...



Typical Cross Section

Figure Y

Table 2 *OCCUPANCY CATEGORY*

OCCUPANCY CATEGORY	OCCUPANCY OR FUNCTIONS OF STRUCTURE	SEISMIC IMPORTANCE FACTOR, I	SEISMIC IMPORTANCE[1] FACTOR, I_p	WIND IMPORTANCE FACTOR, I_w
1. Essential facilities[2]	Group I, Division 1 Occupancies having surgery and emergency treatment areas Fire and police stations Garages and shelters for emergency vehicles and emergency aircraft Structures and shelters in emergency-preparedness centers Aviation control towers Structures and equipment in government communication centers and other facilities required for emergency response Standby power-generating equipment for Category 1 facilities Tanks or other structures containing housing or supporting water or other fire-suppression material or equipment required for the protection of Category 1, 2 or 3 structures	1.25	1.50	1.15
2. Hazardous facilities	Group H, Divisions 1, 2, 6 and 7 Occupancies and structures therein housing or supporting toxic or explosive chemicals or substances Nonbuilding structures housing, supporting or containing quantities of toxic or explosive substances that, if contained within a building, would cause that building to be classified as a Group H, Division 1, 2 or 7 Occupancy	1.25	1.50	1.15
3. Special occupancy structures[3]	Group A, Divisions 1, 2 and 2.1 Occupancies Buildings housing Group E, Divisions 1 and 3 Occupancies with a capacity greater than 300 students Buildings housing Group B Occupancies used for college or adult education with a capacity greater than 500 students Group I, Divisions 1 and 2 Occupancies with 50 or more resident incapacitated patients, but not included in Category 1 Group I, Division 3 Occupancies All structures with an occupancy greater than 5,000 persons Structures and equipment in power-generating stations, and other public utility facilities not included in Category 1 or Category 2 above, and required for continued operation	1.00	1.00	1.00
4. Standard occupancy structures[3]	All structures housing occupancies or having functions not listed in Category 1, 2 or 3 and Group U Occupancy towers	1.00	1.00	1.00
5. Miscellaneous structures	Group U Occupancies except for towers	1.00	1.00	1.00

Table 3 STRUCTURAL SYSTEMS

BASIC STRUCTURAL SYSTEM[2]	LATERAL-FORCE-RESISTING SYSTEM DESCRIPTION	R	Ω_0	HEIGHT LIMIT FO SEISMIC ZONES AND 4 (feet) × 304.8 for mm
1. Bearing wall system	1. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	5.5	2.8	65
	b. All other light-framed walls	4.5	2.8	65
	2. Shear walls			
	a. Concrete	4.5	2.8	160
	b. Masonry	4.5	2.8	160
	3. Light steel-framed bearing walls with tension-only bracing	2.8	2.2	65
	4. Braced frames where bracing carries gravity load			
	a. Steel	4.4	2.2	160
	b. Concrete[3]	2.8	2.2	—
	c. Heavy timber	2.8	2.2	65
2. Building frame system	1. Steel eccentrically braced frame (EBF)	7.0	2.8	240
	2. Light-framed walls with shear panels			
	a. Wood structural panel walls for structures three stories or less	6.5	2.8	65
	b. All other light-framed walls	5.0	2.8	65
	3. Shear walls			
	a. Concrete	5.5	2.8	240
	b. Masonry	5.5	2.8	160
	4. Ordinary braced frames			
	a. Steel	5.6	2.2	160
	b. Concrete[3]	5.6	2.2	—
	c. Heavy timber	5.6	2.2	65
	5. Special concentrically braced frames			
	a. Steel	6.4	2.2	240
3. Moment-resisting frame system	1. Special moment-resisting frame (SMRF)			
	a. Steel	8.5	2.8	N.L.
	b. Concrete[4]	8.5	2.8	N.L.
	2. Masonry moment-resisting wall frame (MMRWF)	6.5	2.8	160
	3. Concrete intermediate moment-resisting frame (IMRF)[5]	5.5	2.8	—
	4. Ordinary moment-resisting frame (OMRF)			
	a. Steel[6]	4.5	2.8	160
	b. Concrete[7]	3.5	2.8	—
	5. Special truss moment frames of steel (STMF)	6.5	2.8	240
4. Dual systems	1. Shear walls			
	a. Concrete with SMRF	8.5	2.8	N.L.
	b. Concrete with steel OMRF	4.2	2.8	160
	c. Concrete with concrete IMRF[5]	6.5	2.8	160
	d. Masonry with SMRF	5.5	2.8	160
	e. Masonry with steel OMRF	4.2	2.8	160
	f. Masonry with concrete IMRF[3]	4.2	2.8	—
	g. Masonry with masonry MMRWF	6.0	2.8	160
	2. Steel EBF			
	a. With steel SMRF	8.5	2.8	N.L.
	b. With steel OMRF	4.2	2.8	160
	3. Ordinary braced frames			
	a. Steel with steel SMRF	6.5	2.8	N.L.
	b. Steel with steel OMRF	4.2	2.8	160
	c. Concrete with concrete SMRF[3]	6.5	2.8	—
	d. Concrete with concrete IMRF[3]	4.2	2.8	—
	4. Special concentrically braced frames			
	a. Steel with steel SMRF	7.5	2.8	N.L.
	b. Steel with steel OMRF	4.2	2.8	160
5. Cantilevered column building systems	1. Cantilevered column elements	2.2	2.0	35[6]
6. Shear wall-frame interaction systems	1. Concrete[8]	5.5	2.8	160
7. Undefined systems	See Sections 1629.6.7 and 1629.9.2	—	—	—

Table 4 R AND Ω_o FACTORS FOR NONBUILING STRUCTURES

STRUCTURE TYPE	R	Ω_o
1. Vessels, including tanks and pressurized spheres, on braced or unbraced legs.	2.2	2.0
2. Cast-in-place concrete silos and chimneys having walls continuous to the foundations.	3.6	2.0
3. Distributed mass cantilever structures such as stacks, chimneys, silos and skirt-supported vertical vessels.	2.9	2.0
4. Trussed towers (freestanding or guyed), guyed stacks and chimneys.	2.9	2.0
5. Cantilevered column-type structures.	2.2	2.0
6. Cooling towers.	3.6	2.0
7. Bins and hoppers on braced or unbraced legs.	2.9	2.0
8. Storage racks.	3.6	2.0
9. Signs and billboards.	3.6	2.0
10. Amusement structures and monuments.	2.2	2.0
11. All other self-supporting structures not otherwise covered.	2.9	2.0

Table 5 SEISMIC COEFFICIENT C_a

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	Z = 0.075	Z = 0.15	Z = 0.2	Z = 0.3	Z = 0.4
S_A	0.06	0.12	0.16	0.24	$0.32N_a$
S_B	0.08	0.15	0.20	0.30	$0.40N_a$
S_C	0.09	0.18	0.24	0.33	$0.40N_a$
S_D	0.12	0.22	0.28	0.36	$0.44N_a$
S_E	0.19	0.30	0.34	0.36	$0.36N_a$
S_F	See Footnote 1				

Table 6 SEISMIC COEFFICIENT C_v

SOIL PROFILE TYPE	SEISMIC ZONE FACTOR, Z				
	Z = 0.075	Z = 0.15	Z = 0.2	Z = 0.3	Z = 0.4
S_A	0.06	0.12	0.16	0.24	$0.32N_v$
S_B	0.08	0.15	0.20	0.30	$0.40N_v$
S_C	0.13	0.25	0.32	0.45	$0.56N_v$
S_D	0.18	0.32	0.40	0.54	$0.64N_v$
S_E	0.26	0.50	0.64	0.84	$0.96N_v$
S_F	See Footnote 1				

Table 7 Building Type Factor K_b

Type of Building	K_b
Weld steel unclad frames	*8*
Bolted steel and reinforced concrete unclad frame	*4*
Portal sheds and similar light structures with few internal walls	*2*
Framed buildings with structural wall around lifts and stairs only (e.g. office building of open plan or with partitioning)	*1*
Framed buildings with structural wall around lifts and stairs with additional masonry subdivision walls (e.g. apartment buildings), buildings of masonry construction and timber-framed housing	*0.5*

Table 8 Factor S_b for standard method

Site in country					Site in tow, extending 2 km upwind from the site			
Effective height H_r m	Closest distance to sea km				Effective Height H_r m	Closest distance to sea km		
	≤ 0.1	2	10	≥ 100		2	10	≥ 100
≤2	1.48	1.40	1.35	1.26	≤2	1.18	1.15	1.07
5	1.65	1.62	1.57	1.45	5	1.50	1.45	1.36
10	1.78	1.78	1.73	1.62	10	1.73	1.69	1.58
15	1.85	1.85	1.82	1.71	15	1.85	1.82	1.71
20	1.90	1.90	1.89	1.77	20	1.90	1.89	1.77
30	1.96	1.96	1.96	1.85	30	1.96	1.96	1.85
50	2.04	2.04	2.04	1.95	50	2.04	2.04	1.95
100	2.12	2.12	2.12	2.07	100	2.12	2.12	2.07
NOTE 1. Interpolation may be used within each table								

Table 9 External pressure coefficients C_{pe} for vertical walls

Vertical wall face	Span ration building		Vertical wall face		Exposure case	
	D/H ≤ 1	D/H ≥ 4			Isolated	Funneling
Windward (front) face	+ 0.85	+ 0.6	Side	Zone A	− 0.5	− 0.5
Leeward (rear) face	− 0.5	− 0.5		Zone B	− 0.5	− 0.5
				Zone C	− 0.5	− 0.5
Note: Interpolation may be used in the range 1 < D/H < 4						

Table 10 Reduction in total distributed impose floor loads with number of storeys

Number of floors with loads qualifying for reduction carried by member under consideration	Reduction in total distributed impose load on all floors carried by the member under consideration (%)
1	0
2	10
3	20
4	30
5 to 10	40
Over 10	50 max

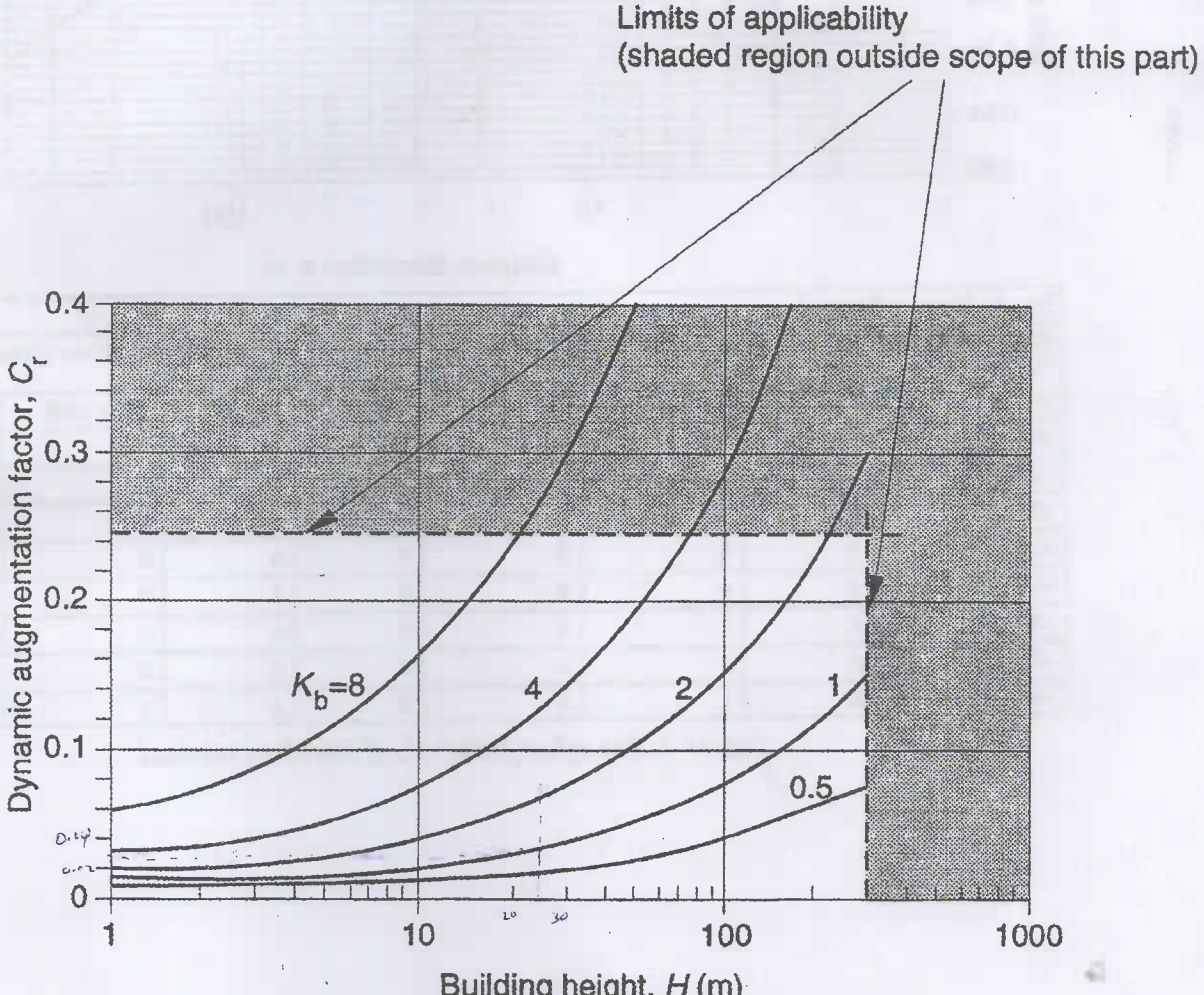
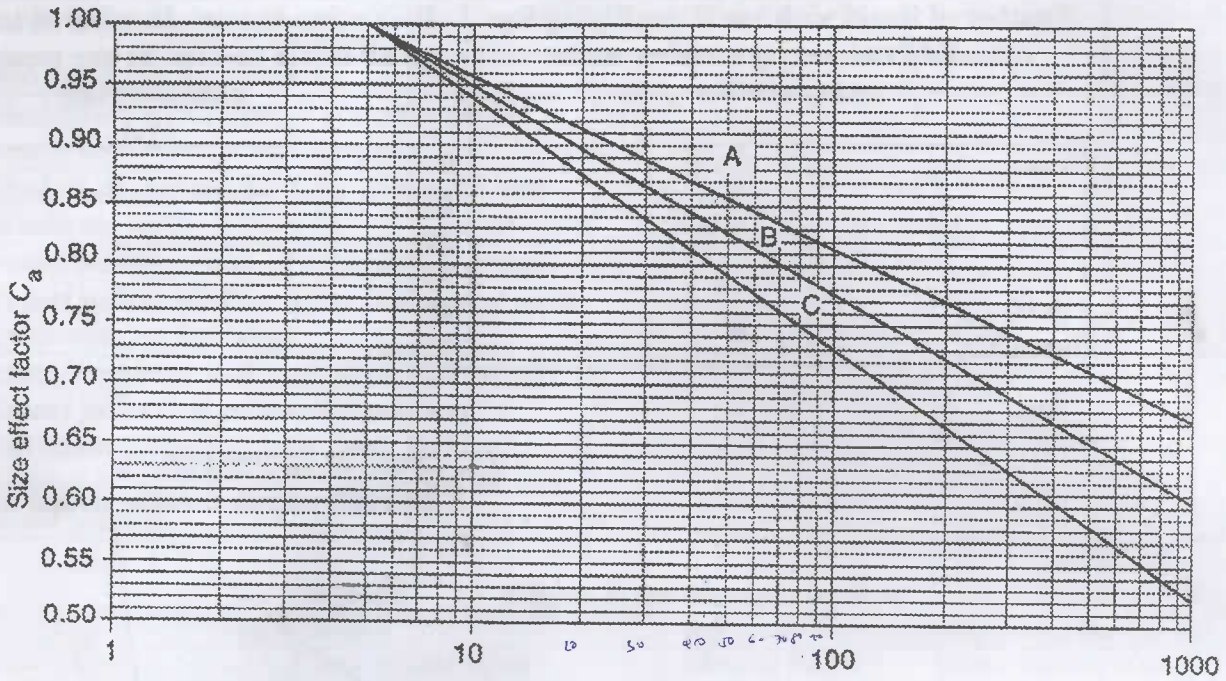


Figure 2.Dunamic augmentation factor C_r



Key to lines on figure 4							
Effective height H_e	Site in country: closest distance to sea (km)				Site in town: closest distance to sea (km)		
m	0 to <2	2 to <10	10 to <100	≥100	2 to <10	10 to <100	≥100
≤2	A	B	B	B	C	C	C
>2 to 5	A	B	B	B	C	C	C
>5 to 10	A	A	B	B	A	C	C
>10 to 15	A	A	B	B	A	B	B
>15 to 20	A	A	B	B	A	B	B
>20 to 30	A	A	A	B	A	A	B
>30 to 50	A	A	A	B	A	A	B
>50	A	A	A	B	A	A	B

Figure 3.Size effect factor C_a of standard method