SSC JE EXAM-2018
Paper

(Conducted on General Engineering Paper II 29.12.2019)

General Engineering Paper II
Civil and Structural

1. (*a*) For a town with population of 22 lakhs a water supply scheme is to be designed. The maximum daily demand may be assumed as 200 litre/capita/day. The storage reservoir is situated 5 km away from the town. Assuming loss of head from source to town as 10 m and coefficient of friction for the pipe material as 0.012, recommend the size of supply main. 50% of the daily demand has to be pumped in 8 hours for the proposed scheme. **(15)**

(*b*) A certain clay layer has a thickness of 5 m. After 1 year, when the clay was 50% Consolidated, 8 cm of settlement had occurred. For a similar clay and loading conditions, how much settlement would occur at the end of 1 year and 4 years respectively, if the thickness of new layer is 25 m ? **(15)**

(*c*) What is efficiency and explain different kinds of irrigation efficiencies ? **(15)**

(*d*) The speed of overtaking and overtaken vehicles are 70 and 40 kmph, respectively on a two way traffic road. The average acceleration during overtaking may be assumed as 0.99 m/s^2.

(i) Calculate safe overtaking sight distance.

(ii) What is the minimum length of overtaking zone and draw a neat sketch of the Overtaking zone and show the position of sign post. **(15)**

2. (*a*) What are the requirements of an ideal permanent way? Draw a dimensional cross section of a BG track in embankment on a straight track and mark the details. **(15)**

(*b*) The following are bearings taken on a closed compass traverse :

LINE	F.B.	B.B.
AB	80°10′	259°0′
BC	120°20′	301°50′
CD	170°50′	350°50′
DE	230°10′	49°30′
EA	310°20′	130°15′

Compute the interior angles and correct them for observational errors.

Assuming the Observed bearing of the line CD to be correct, adjust the bearing of remaining sides. **(10)**

(*c*) Mention the factors governing selection of dam site. **(15)**

(*d*) Design a regime channel for a discharge of 35 m^3/s with silt factor of 0.9 by Lacey's theory taking side slopes as 1H : 2V. **(15)**

3. (*a*) Describe Direct shear test with the help of neat diagram and mention its advantages **(20)**

(*b*) Design a simply supported roof slab for a room 8 m × 3.5 m clear in size if the Superimposed load is 5 kN/m². Use M15 mix and Fe 415 grade steel. Use limit state method of design.

100 As/bd	0.15	0.25	0.50	0.75	1.0
τ_c **(N/mm²)**	0.19	0.36	0.49	0.57	0.64

(25)

(*c*) Design a rectangular beam to resist a bending moment of working load equal to 45 kNm using M15 and mild steel ? **(15)**

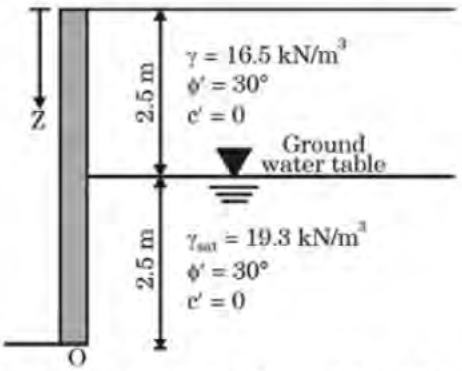
4. (*a*) What is workability of concrete? Explain slump test and compacting factor test. Discuss the factors affecting workability. **(20)**

(*b*) A trapezoidal channel has a bottom width of 3 m and side slopes of 1.5 horizontal : 1 vertical. The longitudinal slope of channel is 0.0004. (a) Calculate the average Shear stress on the channel boundary when the flow takes place at a uniform depth of 1.25 m, if the Manning's roughness coefficient of the channel boundary is 0.012 ? **(15)**

(*c*) A pelton wheel has a mean bucket speed of 10 m/s with a jet of water flowing at the rate of 700 litres/s under a head of 30 m. The buckets deflect the jet through an angle of 160°. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume coefficient to velocity as 0.98. **(15)**

(*d*) What are the characteristics of good quality of timber ? **(10)**

5. (*a*) For the retaining wall shown in the figure, determine the lateral earth force at rest per unit length of wall. Also determine the location of resultant force and also draw the pressure distribution diagram. **(20)**



(*b*) 500g of dry soil was subjected to sieve analysis. The weight of soil retained on the Sieve is as follows :

IS sieve size	Wt. of soil, g	IS sieve size	Wt. of soil, g
4.75 mm	10	425μ	85
2.00 mm	165	212μ	40
1.00 mm	100	150μ	30
		75μ	50

Plot the grain size distribution curve and determine the following :

(i) Percentages of gravel, coarse sand, medium sand, fine sand and slit-clay fraction in the soil.

(ii) Effective size

(iii) Uniformity coefficient

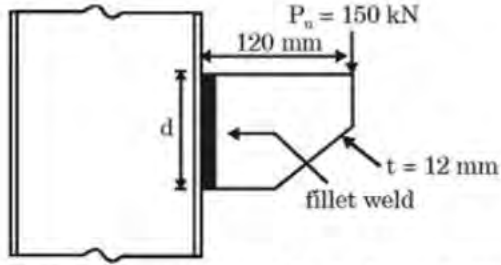
(iv) Coefficient of curvature **(25)**

(c) A 30 cm diameter well penetrates 25 m below the static water table. After 24 hours of pumping @5400 litres/minute, the water level in a test well at 90 m is lowered by 0.53 m, and in a well 30 m away the drawdown is 1.1 m.

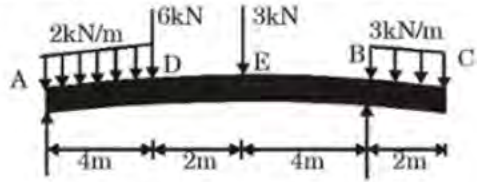
(i) What is transmissibility of the aquifer?

(ii) Also determine the drawdown in the main well. **(15)**

6. (*a*) A welded bracket connection is shown in figure. It supports a factored load of 150 kN at a distance of 120 mm from the face of column. Design the fillet weld on two sides. Grade of steel = Fe 410 $f_y = 250$ MPa. **(25)**



(*b*) Draw the Shear Force and Bending Moment diagram for the beam shown **(20)**



(*c*) Define the following terms:

Depreciation, Sinking fund, Salvage value, methods of valuation. **(15)**

Tabel 1 : Permissible Stresses in Concrete

(Clauses B-1.3, B-2.1, B-2.1.2, B-2.3 and B-4.2)

All values in N/mm²

Grade of Concrete	Permissible Stress in Compression		Permissible Stress in Bond (Average) for Plain Bars in Tension
	Bending	Direct	
(1)	(2)	(3)	(4)
	σ_{cbc}	σ_{cc}	τ_{bd}
M 10	3.0	2.5	–
M 15	5.0	4.0	0.6
M 20	7.0	5.0	0.8
M 25	8.5	6.0	0.9
M 30	10.0	8.0	1.0
M 35	11.5	9.0	1.1
M 40	13.0	10.0	1.2
M 45	14.5	11.0	1.3
M 50	16.0	12.0	1.4

Notes :

1. The values of permissible shear stress in concrete are given in Table 23.
2. The bond stress given in column 4 shall be increased by 25 percent for bars in compression.

Tabel 23 : Permissible Shear Stress in Concrete

(Clauses B-2.1, B-2.3, B-4.2, B-5.2.1 B-5.2.2, B-5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B-6.4.3 and Table 21)

$100\ A_s$ / bd	Permissible Shear Stress in Concrete, τ_c N/mm² Grade of Concrete					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤0.15	0.18	0.18	0.19	0.20	0.20	0.20
0.25	0.22	0.22	0.23	0.23	0.23	0.23
0.50	0.29	0.30	0.31	0.31	0.31	0.32
0.75	0.34	0.35	0.36	0.37	0.37	0.38
1.00	0.37	0.39	0.40	0.41	0.42	0.42
1.25	0.40	0.42	0.44	0.45	0.45	0.46
1.50	0.42	0.45	0.46	0.48	0.49	0.49
1.75	0.44	0.47	0.49	0.50	0.52	0.52
2.00	0.44	0.49	0.51	0.53	0.54	0.55
2.25	0.44	0.51	0.53	0.55	0.56	0.57
2.50	0.44	0.51	0.55	0.57	0.58	0.60
2.75	0.44	0.51	0.56	0.58	0.60	0.62
3.00 and above	0.44	0.51	0.57	0.60	0.62	0.63

Note : A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyound the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Tabel 24 : Maximum Shear Stress, $\tau_{c\ max}$, N/mm²

(Clauses B-5.2.3, B-5.2.3.1, B-5.5.1 and B-6.3.1)

Concrete Grade	M 15	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\ max}$, N/mm²	1.6	1.8	1.9	2.2	2.3	2.5

Question Paper 2017

Civil Engineering

(Paper II)

1. (*a*) Determine the dissolved oxygen at the end of 2 days for the following data: (15)

Characteristics	Stream water	Waste water
Flow (m^3/sec)	22	3
DO (mg/litre)	10	0
BOD (mg/litre)	3	190

Assume :

Deoxygenation constant K = 0.11 per day

Reoxygenation constant R = 0.33 per day

(*b*) A clay stratum has 2.5 m thickness and has initial overburden pressure of 45 kN/m^2. The clay is over consolidated with a preconsolidation pressure of 65 kN/m^2.Find the final settlement due to increment of pressure of 55 kN/m^2 at the middle of clay layer. Use the following data:

Initial void ratio = 1.2

Compression index = 0.27

Swelling index = 0.06 (15)

(*c*) Discuss the factors affecting duty of water (15)

(*d*) Calculate the safe overtaking sight distance. For a design speed of 100 km/hr. Assume maximum overtaking acceleration as 1.92 km/hr/sec. (15)

2. (*a*) What are the requirements of a good ballast in railway engineering? Explain how the minimum depth of ballast cushion is estimated. (15)

(*b*) Determine the correct bearings of the lines of a closed traverse PQRSTP. The readings are as follows:

Line	Fore bearing	Back bearing
PQ	195°30′	17°0′
QR	73°30′	250°30′
RS	36°15′	214°30′
ST	266°45′	84°45′
TP	234°15′	57°0′

Identify the stations affected by local attraction. (20)

(*c*) What are the factors affecting selection of contour interval? (10)

(*d*) A trapezoidal dam with a vertical water face is 2.5 m wide at the top and 14 m wide at the base. The height of the dam is 27 m. Find the maximum depth of water so that the dam section is free from tension. Assume unit weight of dam material as 21 kN/m^3 and that of water as 9.81 kN/m^3. (15)

3. (*a*) Describe plate load test as per IS 1888. Discuss the limitations. What are the effects of size of plate on bearing capacity and settlement? (20)

(*b*) A classroom is of the size 8.5 m × 3.6 m. Design a simply supported roof slab for this room. The superimposed load is 5 kN/m. Use M 20 grade concrete and HYSD Fe 415 steel. Use limit state method for the design. (25)

$100A_s / b_d$	0.15	0.25	0.50	0.75	1.0
$\tau_c N/mm^2$	0.19	0.36	0.49	0.57	0.64

(*c*) Explain the steps for the design of column with helical reinforcement in limit state method. (15)

4. (*a*) What are the characteristics of a good quality timber? (10)

(*b*) Derive the condition for the trapezoidal channel of best section. Prove that the hydraulic mean depth for such a channel is one-half the depth of flow. (15)

(*c*) The discharge of a Pelton wheel turbine is 5 m^3/sec at a head of 300 m at the nozzle. There are two runners and each runner has two jets. The length of the pipeline is 1900 m. The efficiency of the transmission for the pipe is 90%. Assume friction factor f as 0.008. Determine jet diameter, pipe diameter and output of the turbine. The overall efficiency of turbine is 85%. (15)

(*d*) What is workability of concrete? Explain slump test and compacting factor test. Discuss the factors affecting workability. (20)

5. (*a*) A 6 m high vertical wall supports a saturated cohesive soil with horizontal surface. The top 3.5 m of the backfill has bulk density 18 kN/m^3 and apparent cohesion of 16 kN/m^2. The bulk density and apparent cohesion of the bottom 2.5 m is 19.5 kN/m^3 and 18 kN/m^2 respectively. What will be total active earth pressure on the wall? Draw the pressure distribution diagram. Assume that tension cracks will develop. Locate the point of application of the resultant pressure. (20)

(*b*) A direct shear test was conducted on a silty sand. At failure the normal and shear stresses were found to be 66 kPa and 40kPa respectively. Draw Mohr's circle and determine:

(*i*) Angle of shearing resistance

(*ii*) Principal stresses at failure

(*iii*) Locate the pole and find orientation of failure plane. (20)

(*c*) The pump-out test was performed to determine the field permeability of an unconfined aquifer and the following observations were made:

RL of original water table before pumping = 250.5 m

RL of water in the well at constant pumping = 245.6 m

RL of the rock of impervious layer = 220.0 m

The distance of observation well from tubewell = 48 m (20)

Determine

(*i*) Coefficient of permeability of the aquifer (k)

(*ii*) Error in k if observations are not taken in the observation well and radius of influence is assumed to be 298 m

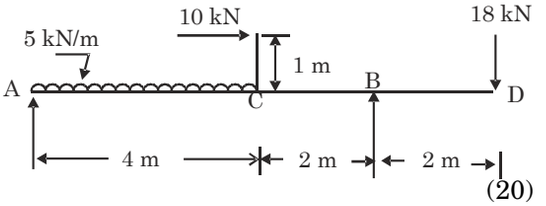
(*iii*) Actual radius of influence based on the observations of observation well

(*iv*) Radius of influence using sichart equation

The diameter of the well is 20 cm and discharge is 250 m^3/hr.

6. (*a*) In a roof truss, the member consists of 2 ISA 100 × 75 × 8 mm. The angles are connected to either side of a 10 mm gusset plate and member is subjected to a working pull of 280 kN. Design the welded connection assuming they are made in the workshop. The centre of gravity of the section from the top may be considered 31 mm. (20)

(*b*) Draw the shear force and bending moment diagram for the beam as shown below:



(20)

(*c*) Define the following terms:

Scarp value, Salvage value, Sinking fund and Depreciation (20)

Question Paper 2016

Civil Engineering

(Paper II)

1. (*a*) A town on the bank of river Ganga discharges 18000 m^3/day of treated wastewater into the river. The treated wastewater has a BOD_5 of 20 mg/L, and a BOD decay constant of 0.12 day^{-1} at 20°C. The river has a flow rate of 0.43 m^3/sec and an ultimate BOD of 5.0 mg/L. The DO of the river is 6.0 mg/L and the DO of the wastewater is 0.4 mg/L. Compute the DO and initial ultimate BOD in the river, immediately after mixing. (15)

(*b*) A sample of normally consolidated clay was subjected to a consolidated undrained triaxial compression test that was carried out until the specimen failed at a deviator stress of 50 kN/m^2. The pore water pressure at failure was recorded to be 20 kN/m^2 and confining pressure of 50 kN/m^2 was used in the test. Determine the consolidated undrained friction angle. (15)

(*c*) Using Lacey's theory, design an irrigation channel carrying 30 m^3/sec. Take silt factor as 1.0. (15)

(*d*) Discuss the various causes of disintegration and the major faults occurring in WBM and surface treated (asphalt roads) in India. (15)

2. (*a*) Differentiate between the following with reference to bituminous construction: (15)

(*i*) Prime coat and Tack coat

(*ii*) Bituminous concrete and Bituminous macadam.

(*b*) A road is to be constructed with a uniform rising gradient of 1 in 100. Determine the staff readings required for setting the tops of the two pegs on the given gradient at 30 meters interval from the last position of the instrument. The RL of the first peg is 384.500 m. A fly levelling was carried out from a BM of RL 387.000 m. The following observations (in m) were recorded: (15)

Backsight :	1.625	2.345	2.045	2.955
Foresight :	1.315	3.560	2.355	

(*c*) What are the errors induced in theodolite survey? (15)

(*d*) A solid shaft transmits 250 kW at 100 r.p.m. If the shear stress is not to exceed 75 N/mm^2, what should be the diameter of the shaft ?

If this shaft is to be replaced by a hollow shaft whose internal diameter shall be 0.6 times the outer diameter, determine the size and percentage saving in weight maximum stresses being the same. (15)

3. (*a*) Design a circular column with helical reinforcement subjected to a working load of 1500 kN. Diameter of the column is 450 mm. The column has unsupported length of 3.5 m and is effectively held is position at both ends but not restrained against rotation. Use limit state design method. Use M-25 concrete and HYSD Fe-415 steel. (25)

(*b*) Design a constant thickness footing for a reinforced concrete column of 300 mm × 300 mm. The column is carrying an axial working load of 600 kN. The bearing capacity of soil is 200 kN/m^2. Use M-25 concrete and HYSD Fe-415 bars. Use limit state design method. (15)

$100\ (A_{st}/bd)$	0.15	0.25	0.50	0.75	1.0
τ_c (N/mm^2)	0.19	0.36	0.49	0.57	0.64

(*c*) State and discuss different factors influencing compaction of soil in the field. (20)

4. (*a*) Classify the solid wastes, giving suitable example for each of them. Also explain the different methods of disposal of solid wastes. (15)

(*b*) Estimate for 1 : 20 model of a spillway (*i*) prototype velocity corresponding to a model velocity of 2 m/sec, (*ii*) prototype discharge

per unit width corresponding to a model discharge per unit width of 0.3 m^3/sec/m, (*iii*) pressure head in the prototype corresponding to a model head of 5 cm of mercury at a point, and (*iv*) the energy dissipated per second in the model corresponding to a prototype value of 1.5 kW. (15)

(*c*) A centrifugal pump having an impeller of 35 cm outside diameter rotates at 1050 r.p.m. The vanes are radial at exit and are 7.0 cm wide. The velocity of radial flow through the impeller is 3 m/sec. The velocity in the suction and delivery pipes are 2.5 m/sec and 1.5 m/sec respectively. Neglecting frictional losses, determine the height through which the pump lifts and the horse-power of the pump. (15)

(*d*) Name the four important constituents of cement and also state the role of each in achieving its properties. (15)

5. (*a*) A retaining wall with a smooth vertical back is 9 m high and retains a two-layer sand backfill with the following properties:

0 – 3 m depth : $c' = 0.0$, $\varphi = 30°$, $\gamma = 18$ kN/m^3

3 – 9 m depth : $c' = 0.0$ $\varphi = 35°$, $\gamma = 20$ kN/m^3.

Show the active earth pressure distribution and determine the total active thrust on the wall. Assume that the water table is well below the base of the wall. (20)

(*b*) A layer of sand 6.0 m thick lies above a layer of clay soil. The water table is at a depth of 2.0 m below the ground surface. The void ratio of the sand layer is 0.6 and the degree of saturation of the sand layer above the water table is 40%. The void ratio of the clay layer is 0.7. Determine the total stress, neutral stress and effective stress at a point 10 m below the ground surface. Assume specific gravity of the sand and clay soil respectively as 2.65 and 2.7. (20)

(*c*) What is grit? Why should grit be removed from wastewater? What is the basic principle behind the design of grit chambers? What is the reason to have constant velocity of flow in a grit chamber (conventional horizontal flow) and how is it achieved? (20)

6. (*a*) Design riveted splices for a tie of a steel bridge, 20 cm wide, 20 mm thick, carrying an axial tensile force of 50,000 kg. Use 12 mm thick cover plates and 22 mm diameter rivets.

Permissible stresses :

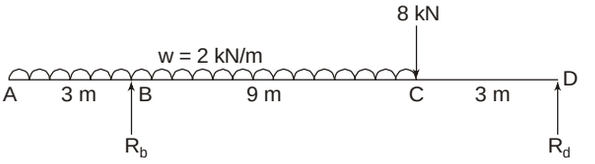
Tension in plates = 1500 kg/cm^2

Shear in rivets = 1000 kg/cm^2

Bearing in rivets = 3000 kg/cm^2

Give a neat sketch of the arrangement. (25)

(*b*) Draw BMD and SFD for the beam shown below: (25)



6. (*c*) Enumerate the situation in which doubly reinforced concrete beams become necessary. What is the role of compression steel? (10)

Essential Table of IS 456 : 2000 Code of Practice **IS 456 : 2000**

25. 2. 1.1 Design bond stress in limit state method for plain bars in tension shall be as below

Grade of concrete	M 20	M 25	M 30	M 35	M 40 and above
Design bond stress, τ_{bd}, N/mm^2	1.2	1.4	1.5	1.7	1.9

Table 16. Nominal Cover to Meet Durability Requirements (*Clause 26.4.2*)

Exposure	*Nominal Concrete Cover in mm Not Less Than*
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

Notes :

1. For main reinforement up to 12 mm diameter bar for mild exposure, the nominal cover may be reduced by 5 mm.
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by $^{+10}_{0}$ mm.
3. For exposure condition 'severe' and 'very severe', reduction of 5 mm may be made, where concrete grade is *M* 35 and above

Table 19 : Design Shear Strength of Concrete, τ_c, N/mm²

(Clauses 40.2.1, 40.2.2, 40.4, 40.5.3, 41.3.2, 41.3.3 and 41.4.3)

$100\frac{A_s}{bd}$	Concrete Grade					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0.15	0.28	0.28	0.29	0.29	0.29	0.30
0.25	0.35	0.36	0.36	0.37	0.37	0.38
0.50	0.46	0.48	0.49	0.50	0.50	0.51
0.75	0.54	0.56	0.57	0.59	0.59	0.60
1.00	0.60	0.62	0.64	0.66	0.67	0.68
1.25	0.64	0.67	0.70	0.71	0.73	0.74
1.50	0.680.71	0.72	0.74	0.76	0.78	0.79
1.75	0.71	0.75	0.78	0.80	0.82	0.84
2.00	0.71	0.79	0.82	0.84	0.86	0.88
2.25	0.71	0.81	0.85	0.88	0.90	0.92
2.50	0.71	0.82	0.88	0.91	0.93	0.95
2.75	0.71	0.82	0.90	0.94	0.96	0.98
3.00 and above	0.71	0.82	0.92	0.96	0.99	1.01

Note : The term A_s is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered except at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 20 : Maximum Shear Stress, $\tau_{c\ max}$, N/mm²

(Clauses 40.2.3, 40.2.3.1, 40.5.1 and 41.3.1)

Concrete Grade	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\ max}$, N/mm²	2.8	3.1	3.5	3.7	4.0

Table 21 : Permissible Stresses in Concrete

(Clauses B.1.3, B.2.1, B.2.1.2, B. 2. 3 and B-4.2)

All values in N/mm²

Grade of Concrete	Permissible Stress in Compression		Permissible Stress in Bond (Average) for plain Bars in Tension
	Bending	Direct	
(1)	(2)	(3)	(4)
	σ_{cbc}	σ_{cc}	τ_{bd}
M 10	3.0	2.5	–
M 15	5.0	4.0	0.6
M 20	7.0	5.0	0.8
M 25	8.5	6.0	0.9
M 30	10.0	8.0	1.0
M 35	11.5	9.0	1.1
M 40	13.0	10.0	1.2
M 45	14.5	11.0	1.3
M 50	16.0	12.0	1.4

Notes:

1. The values of permissible shear stress in concrete are given in Table 23.
2. The bond stress given in column 4 shall be increased by 25 percent for bars in compression.

Table 23 : Permissible Shear Stress in Concrete

(Clauses B.2.1, B.2.3, B-4.2, B-5.2.1, B.5.2.2, B.5.3, B-5.4, B-5.5.1, B-5.5.3, B-6.3.2, B-6.3.3 and B.6.4.3 and Table 21)

$100\frac{A_s}{bd}$	Permissible Shear Stress in Concrete, τ_c, N/mm² Grade of Concrete					
	M 15	M 20	M 25	M 30	M 35	M 40 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)
≤ 0.15	0.18	0.18	0.19	0.20	0.20	0.20
0.25	0.22	0.22	0.23	0.23	0.23	0.23
0.50	0.29	0.30	0.31	0.31	0.31	0.32
0.75	0.34	0.35	0.36	0.37	0.37	0.38
1.00	0.37	0.39	0.40	0.41	0.42	0.42
1.25	0.40	0.42	0.44	0.45	0.45	0.46
1.50	0.42	0.45	0.46	0.48	0.49	0.49
1.75	0.44	0.47	0.49	0.50	0.52	0.52
2.00	0.44	0.49	0.51	0.53	0.54	0.55
2.25	0.44	0.51	0.53	0.55	0.56	0.57
2.50	0.44	0.51	0.55	0.57	0.58	0.60
2.75	0.44	0.51	0.56	0.58	0.60	0.62
3.00 and above	0.44	0.51	0.57	0.60	0.62	0.63

Note: A_S is the area of longitudinal tension reinforcement which continues at least one effective depth beyond the section being considered excepts at support where the full area of tension reinforcement may be used provided the detailing conforms to 26.2.2 and 26.2.3.

Table 24: Maximum Shear Stress, $\tau_{c\ max}$, N/mm²

(Clauses B.5.2.3, B.5.2. 3.1, B.5.5.1 and B.6.3.1)

Concrete Grade	M 15	M 20	M 25	M 30	M 35	M 40 and above
$\tau_{c\ max}$, N/mm²	1.6	1.8	1.9	2.2	2.3	2.5