Department of Civil Engineering
Institute of Technical Education & Research, SOA University

End-Semester Examination Solutions, December-2016
Civil Engineering Materials (CVL3211)

Semester: 5^{th} Branch: Civil Engineering
Full mark: 60 Time: 3 Hours

All questions carry equal marks. All bits of each question carry equal marks.

Q.1 Solutions

a Modulus of Resilience = $0.5 \times 2MPa \times 0.002 = 2000Pa$.

b Offset method : draw line with slope E from $\epsilon = 0.2\%$ to cut stress-strain curve at yield point.
Equation of line 1 is $y = mx + c$, where
m = slope of elastoplastic part of curve = (2.5-2)MPa / (0.003-0.002) = 500MPa
$c = y - mx$ with $(x, y) \equiv (2, 0.002)$ so c = $2MPa - 0.002 \times 500MPa = 1MPa$
Equation of line 2 is $y = mx + c$, where
m=slope of elastic part of curve = $(0 - 2)MPa/(0 - 0.002)$ =1GPa
$c = y - mx$ with $(x, y) \equiv (0, 0.002)$ so c = $0 - 0.002 \times 1GPa = -2MPa$
From line 1 and 2, we get Yield stress, $\sigma_y = 4MPa$

c Toughness = Area under stress-strain curve till yield stress
Toughness = $0.5 \times 2MPa \times 0.002 + 0.5 \times 2MPa \times 0.004 + 2MPa \times 0.004$ = 14kPa

Q.2 Solutions

a Volume of concrete= $0.25m^3$.
Air content of concrete mix = $(3 \times 0.25)/100 = 0.0075m^3$
Volume of concrete minus air in test cube = $0.25 - 0.0075 = 0.2425m^3$

b Let us assume weight of cement be x, for M25 (1:1:2)

	Cement	**Sand**	**Coarse aggregates**
Weight (Kg)	x	x	$2x$
Density (gm/cc)	3	2.6	2.7
Volume ($m^3 \times 10^{-3}$)	$x/3$	$x/2.6$	$2x/2.7$

Volume or Weight of water = $0.5x$
Volume balance equation, $V_c + V_w + V_s + V_a = 0.2425m^3$
$(x/3 + 0.5x + x/2.6 + 2x/2.7) \times 1/1000m^3 = 0.2425m^3$
From above equation x = weight of cement = 123.8Kg

c Weight of sand = $123.8Kg$
weight of coarse aggregates = $247.6Kg$
weight of water = $61.9Kg$

Q.3 Solutions

a Chemicals that are responsible for initial setting and false setting of cement are C_3S and C_3A respectively.

b Fly ash cement will have greater workability as fly ash as a constituent/admixture imparts less friction between cement particles due to its inertness.

c Graph shown in Figure 1 is appropriate answer.

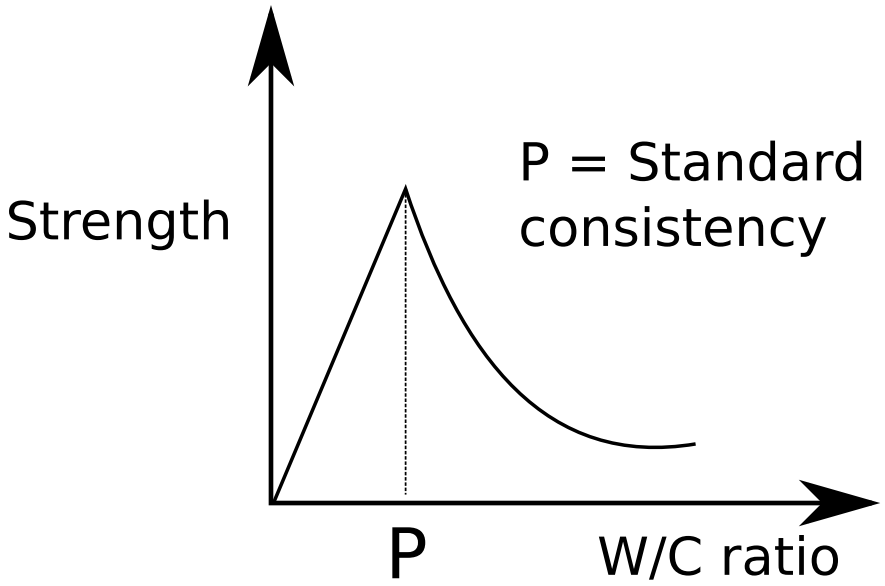

Figure 1: W/C ratio v/s strength

Q.4 **Solutions**

a Two concretes A and B with proportions M20 and M30 are given. Assuming if straight is less, it contains lesser cementing material or more voids. In any case weaker cube will contain lesser cement so lesser curing time will be needed. Opposite is true for stronger cube. Increasing order of curing will be $M20 < M30$

b If size of aggregates is increased keeping their proportion constant then void ratio will increase so does the air content and workability but strength will decrease.

c Cement A passes 6% and Cement B passes 15% from $IS90\mu$ sieve. Cement B having more finer will have higher surface area hence faster hydration.

Q.5 **Solutions**

a Elastic - Steel, Rubber band
Viscoelastic - Bitumen, Chewing gum (Other examples will also be marked)

b Endurance limit - Maximum cyclic load which can be applied to a material infinite time without causing failure. Typical graph of number of load cycles versus σ_a/σ_y is given in Figure 2.

c Necking and rupture (failure) point on a typical $\sigma - \epsilon$ curve for steel are given in Figure 3.

Q.6 **Solutions**

a Given two asphalts A_1 and A_2 having penetration grades 70-80 and 40-50 respectively. Penetration grade is inversely proportional to viscosity. So A_2 will have higher viscosity.

b A_1 can be used as a better sealant. It requires less viscosity to work as an asphalt seal as load carrying is not considered.

c Weight of unabsorbed asphalt binder = Weight of Total asphalt - Weight of absorbed asphalt
1 - 1/5 = 0.8Kg.

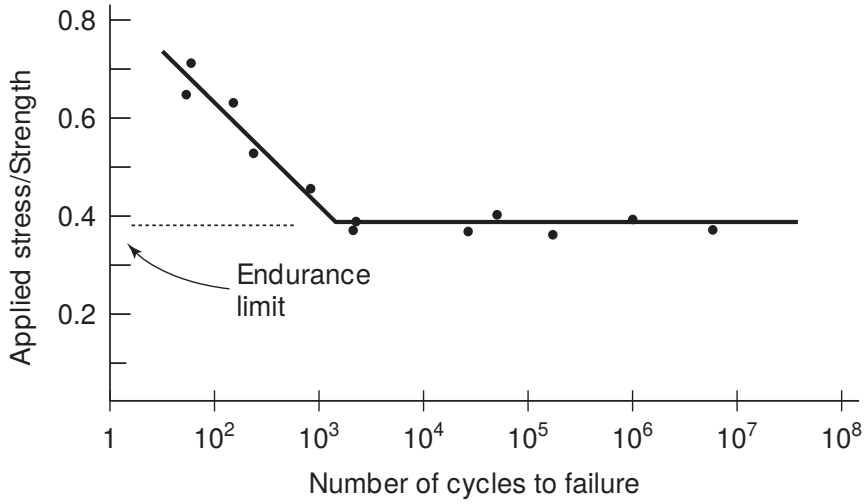

Figure 2: Endurance limit

Q.7 **Solutions**

a Relative $\sigma - \epsilon$ curves of S_1 and S_2 are given in Figure 4.

b Based on above data,S_1 will require more heat to reach pure Austenite line. It can be inferred from Iron-Carbon phase diagram.

c Given S_1 is alloyed with 15% Nickel and S_2 is alloyed with 5% Chromium. On calculation carbon equivalent of S_1 and S_2 comes out to be 2.5 and 2. Carbon equivalent is inversely proportional to weldability. So S_2 will have better weldability.

Q.8 **Solutions**

a Fly ash bricks are lightweight, uniform, water/fire resistant and strong as compared to clay bricks.

b

Factor	**Clamp burning**	**Kiln burning**
Capacity	20000-100000	25000
Fuel cost	Low i.e. grass, cow dung etc.	High i.e. coal, electricity etc.
Infrastructure	Low (temporary structures)	High (permanent kilns)
Quality	60% of batch is good	90% of batch is good
Fire regulation	Unregulated (no control system)	Regulated by fuel insertion and removal
Conduction Time	2-6 months for one clamp	Works 24×7 and 12 days for brick cooling

c Brick soundness and water absorption are inversely proportional. If a brick absorbs more water that means it contains more voids and hence on banging two brick to each other a metallic sound won't be produced. Vice versa is also correct.

Q.9 **Solutions**

a Heating steel 50^0C above austenite line and rapid cooling by quenching in water is called hardening/quenching.

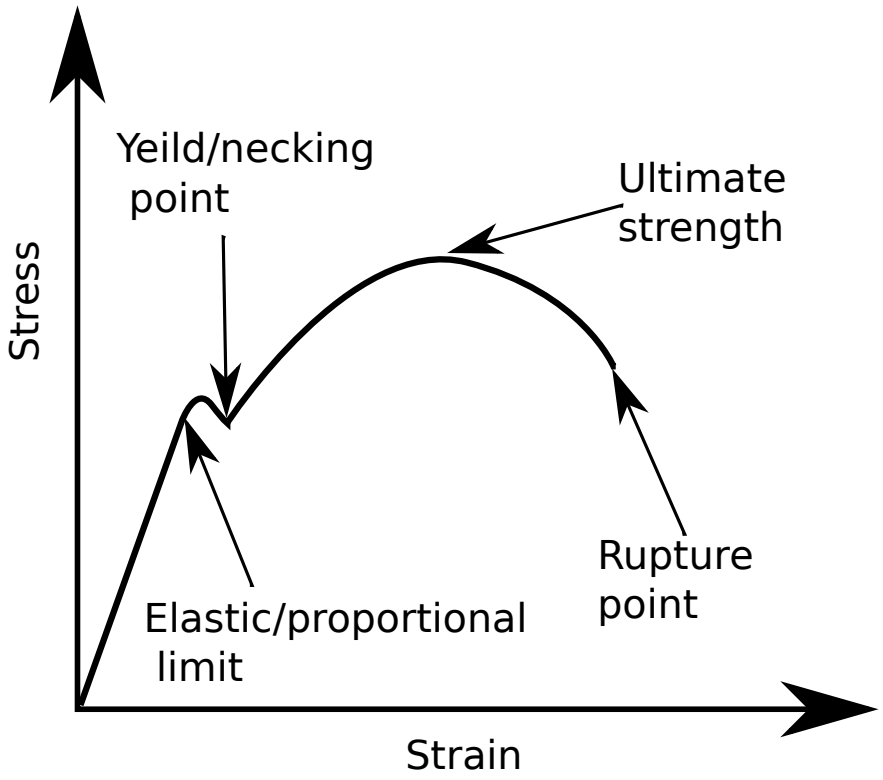

Figure 3: $\sigma - \epsilon$ curve for steel

b Due to quick cooling in hardening thermal stress accumulates in steel grains to release this stress reheating is required to counter brittleness and tempering does the job.

c Frog is engraving on top face of brick required for cement joint connection in masonry and further engraving the brand name of manufacturer.

Q.10 **Solutions**

a Asphalt emulsions: Mixture of asphalt and water, results in asphalt particles remaining dispersed/suspended in water.
Asphalt solutions: Mixture of asphalt with hydrocarbon or other petroleum liquids, results in a solution.

b Coat: Used to repair pavements and flexible pavements. It is designed to carry load.
Seal: Used for renovation and resurfacing. Seals off pavement from attack of water. It is not designed to carry loads.

c FRC can be used as admixture in concrete to provide structural strength. (Other examples will also be marked)

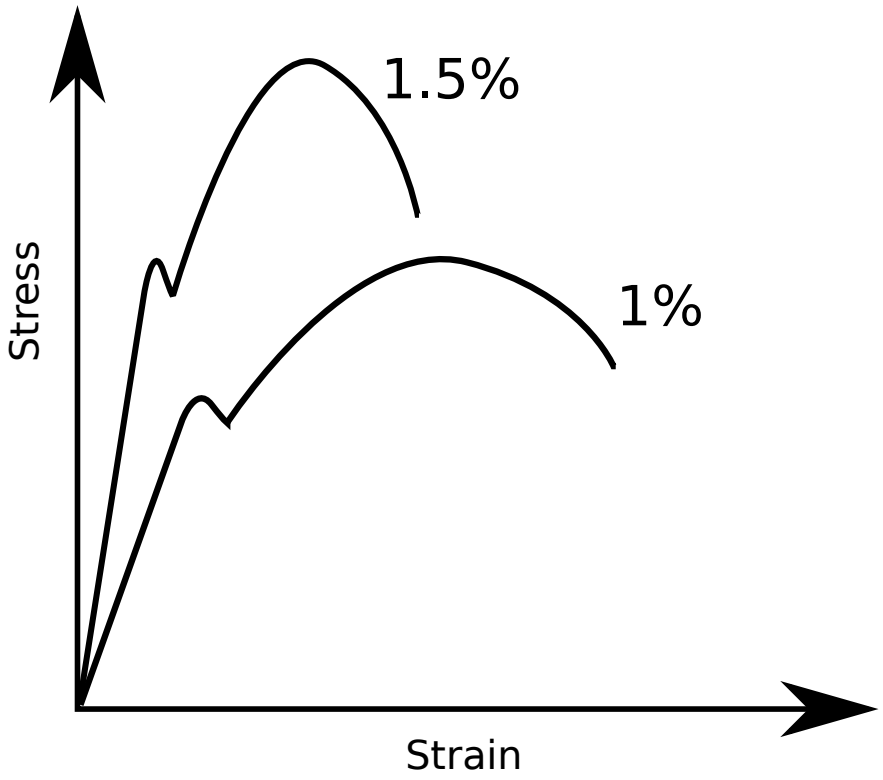

Figure 4: $\sigma - \epsilon$ curves of S_1 and S_2