H.W 501

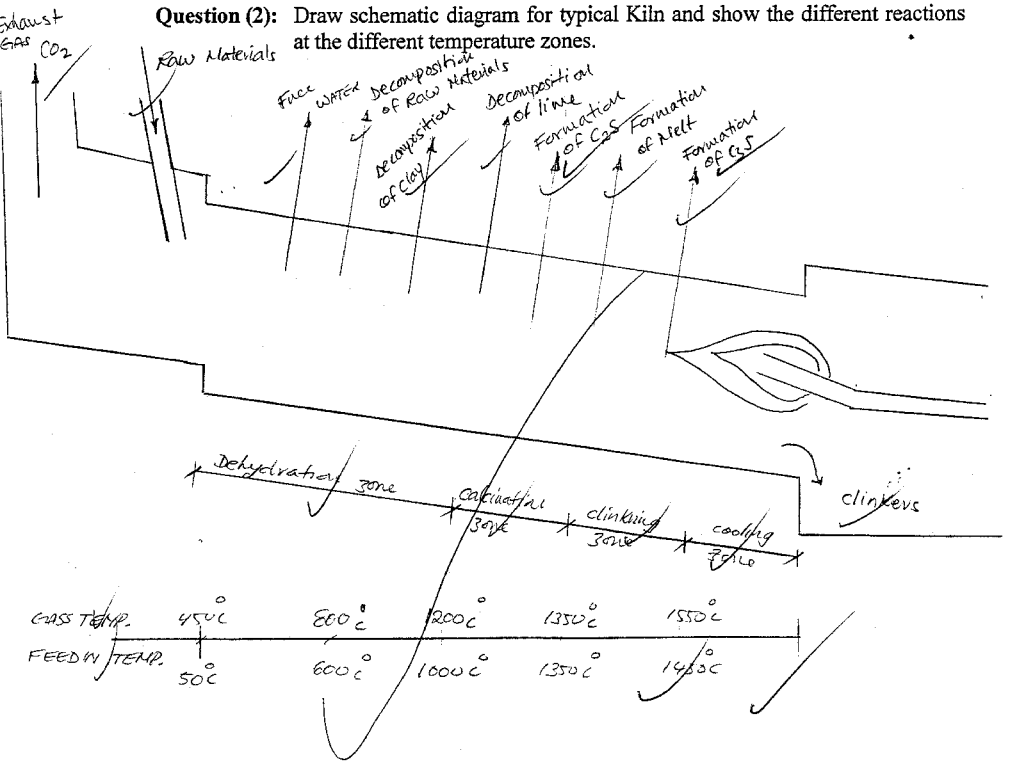
Question (1): Manufacturing of cement required the availability of raw materials containing the necessary oxides for the formation cement compounds. List these oxides and their relative percentages.

Oxide	Name	Abbreviation	Limits	
CaO	Calcium Oxide "limestone"	C	(60 - 67) %	Primary oxides ≃ 75%
SiO_2	Silicon Oxide "clay, shale, ..."	S	(16 - 25) %	
Al_2O_3	Aluminium oxide	A	(3 - 8) %	Secondary oxides ≃ 15%
Fe_2O_3	Ferric oxide	F	(0.3 - 6) %	
$(Na_2O - K_2O)$	Alkalies	N, K	0.1 %	
TiO_2	Titania oxides	T		
MgO	Magnesia oxide	M		
P_2O_5	Phosphoric oxide	P		
SO_3	Sulfate oxide	S		

(1) Major oxide ≃ 90%

(2) minor oxide ≃ 10%

Question (2): Draw schematic diagram for typical Kiln and show the different reactions at the different temperature zones.



Question (3): Lime content (CaO) in the raw materials must be within certain limits. Explain the problems associated with high or low content.

* High (CaO) content :-

The problems associated with high content of CaO ie CaO > (CaO)max) are :-

(1) Unsoundness of cement due to uncombined lime causing increase in volume of cement and cracking.

(2) Burnability problems 'cause the CaO needs high degree of temperature to be set in reaction with other oxides

* Low (CaO) content :-

(1) slow rate of development of strength in cement.

(2) clusting of the klin because of the conversing of βC_2S to γC_2S.

Question (4): Hydration of portland cement goes through different stages, explain.

Stage I :- Pre-dormant period.

- It takes from (6 - 15) minutes after adding water to the cement.
- Instantenous formation of primary ettringite due to hydration of C_3A.
  Liberation of (C-S-H) and $Ca(OH)_2$ due to hydration of C_3S
- The primary ettringite and the (C-S-H) cover the C_3S and C_3A phases of cement slow down their rate of hydration.
- A huge amount of heat liberate in this stage.

Stage II :- Dormant period

- It takes about (1 - 2) hr from the termination of the pre-dormant period.
- The hydration of C_3S and C_3A slow down.
- The (C-S-H) and primary ettringite covering C_3S and C_3A broke down at the end of this period and the hydration of C_3A and C_3S continue.

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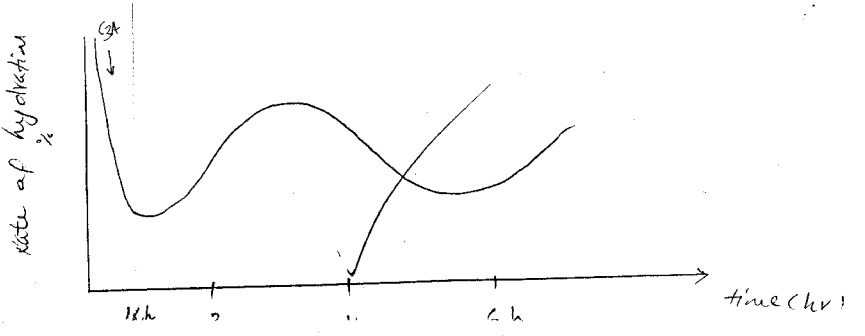
Stage III :- Acceleration period :-

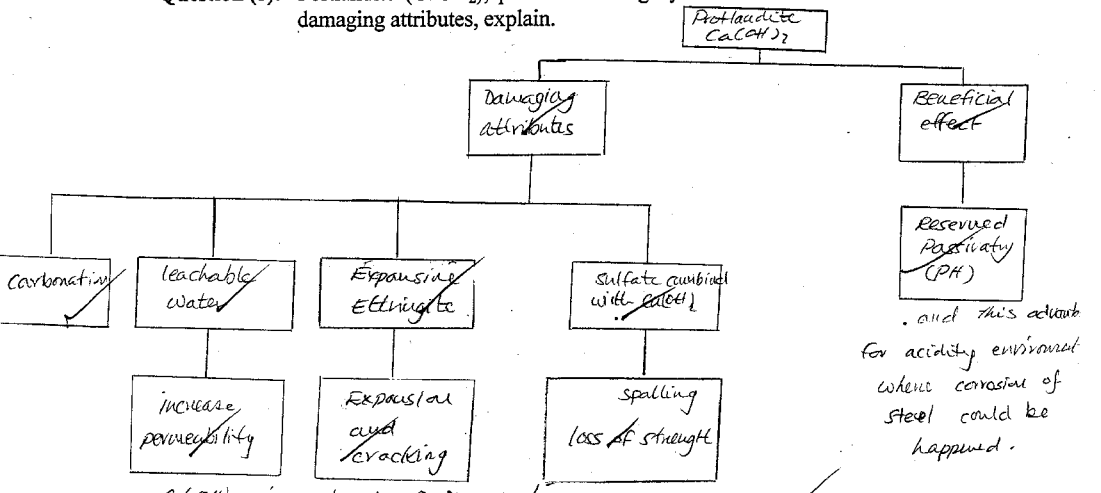
- it takes (4-6) hr from the termination of the dormant period.
- The hydration of C_3S continue, vigorously.
- The amount of water reduced because of chemical reactions and adsorption.
- The initial setting time take place and the beginning of this period.
- The porosity and impermeability increased in this period due the formation of (C-S-H) and (CH)
- The final setting time begin at the end of this period.

Stage IV :- Declaration and steady period :-

- The hydration of C_3S continue and the hydration of C_2S starts in this period and due the diffusion water rather than chemical reactions.
- The hydration of C_3A increase
- The formation of primary ettringite comes to end after 18 to 24 hrs.
- The impreambility continue to increase.



Question (5): Portlandite ($CaOH_2$), produced during hydration has both beneficial and damaging attributes, explain.



- $Cd(OH)_2$ is about 20% of hcp
- it could be controled by C_3S/C_2S ration.
- The damaging attributes could be less when adding Pozzolanic Materials.

Question (6): Explain the features of the pozzolanic reactions.

There are three fractures of the pozzolanic reactions: -

(1) The pozzolanic reaction is slow, thats why the rate of strength in the first period is very low and the concrete need a long period of curing.

(2) The reaction is lime consuming rather lime producing.

(3) The replacing of $Ca(OH)_2$ by secondary (C-S-H) enhanced the physical properties of the cement paste in two ways:

(a) pore size refinement

(b) Grain size refinement

both of them improve the strength and the durability of the concrete

Question (7): Explain the effect of addition of mineral admixtures on early gain of strength, shrinkage and bleeding.

* Bleeding :-

Due to fineness of mineral admixtures it works as filler to the capillary voids and increased the transtity flow channel (tortuosity) so it decrease the bleeding.

* Drying Shrinkage :- due the decreasing in bleeding when adding mineral admixture, the surface of the concrete dry quickly making tensile stress at concrete surface and easing increase in craking due to shrinkage.

* Early gain strength :-

due the dilution of active materials (C_3A and C_2S) with less active mineral admixture the rate of hydration and the early strength are very slow. So the mineral admixture decrease the early gain of strength.

Fig (1) →

Question (8): Addition of microsilica improve significantly the compression strength, explain.

The microsilica improve significantly the compression strength due to :-

(1) Fineness of the grain, and it role as a filler and increase the density of the mix.

(2) the production of secondary (C-S-H) and the replacing of $Ca(OH)_2$ decrease the thin layer of Transition zone which is the weakest part of the concrete.

The improving of the compression strength influened by many factors :-

(1) microsilica content
(2) water / c content
(3) rate of hydration
(4) Curing period.
(5) temperature
(6) The fineness of P.C particles and SF particle

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Question (9): The reaction of Fly Ash with portland cement depends on many factors, explain these factors.

There are many factors that Fly Ash reactivity depends on:-

(1) Morophology of the Fly Ash ✓

(2) Fineness of the particles of Fly Ash and PC ✓.

(3) The chemical compound of Fly Ash and PC ✓

(4) The Alkali-hydroxide concentrating in paste of Fly Ash and PC ✓.

(5) The development of heat generating in the stages of reaction between FA and PC

(6) The amount of water reduced in the mix of FA and PC ✓.

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Question (10): Explain the reaction of C_3A compound with sulfate during early hydration time in case there is more of C_3A (or less) compare to the sulfate quantity.

C_3A	Sulfate	case (which are these cases?)	setting time
low	low	I	Prolonged set
High	High	II ✓	normal setting time
High	low	III	set quickly ✓
High	very low OR (Nil)	IV	Flash setting time ✓
low	High	V	False setting time ✓

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