Ex1 : Chemical analysis for type of cement as shown in table:

1- What is the type of cement?

2- Is the cement accepted with limitation of portland cement? And where used?

Oxide	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Na_2O	K_2O
%	64	21	5	3	3	2.8	0.6	0.6

Sum of oxide = 100 %

$C_3S = 4.07(CaO) – 7.60(SiO_2) – 6.72(Al_2O_3) – 1.43(Fe_2O_3) – 2.85(SO_3)$

$C_3S = 4.07(64) – 7.60(21) – 6.72(5) – 1.43(3) – 2.85(2.8) = 55\%$

$C_2S = 2.87(SiO_2) – 0.754(C_3S)$

$C_2S = 2.87(21) – 0.754(55) = 18.8\%$

$C_3A = 2.65(Al_2O_3) – 1.69(Fe_2O_3)$

$C_3A = 2.65(5) – 1.69(3) = 8.2\%$

$C_4AF = 3.04(Fe_2O_3)$

$C_4AF = 3.04(3) = 9.1\%$

$$\textbf{L.S.F} = \frac{CaO - 0.7(SO_3)}{2.8(SiO_2) + 1.2\,(Al_2O_3) + 0.65\,(Fe_2O_3)} \quad \textbf{.....} \quad \textbf{(0.66-}1.02)$$

$$\text{L.S.F} = \frac{64 - (0.7 * 2.8)}{2.8(21) + 1.2\,(5) + 0.65\,(3)} = 0.9 \ \text{(o.k)}$$

1- This type of cement is O.P.C because the percentage of the four major compounds is identical with the percentage of major compounds for O.P.C. also, the L.S.F value is also identical to that L.S.F of Ordinary Portland Cement.

2- This type of cement use in constructions when there is no exposure to sulfates in the soil or groundwater.

Ex2: **Chemical analysis for type of cement as shown in table:**

1- What is the type of cement?

2- Is the cement accepted with limitation of portland cement?

Oxide	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Na_2O	K_2O
%	36.2	12.6	3	1.56	2	1.45	1.53	0.43

Sum of oxide = 58.8 %

L.O.I = 100 -$\sum Oxide$

L.O.I = 100 – 58.8 = 41.2 %

New Oxide Value = $\frac{old\ Oxide\ value}{sum\ of\ oxide} * 100\%$

$[CaO]_{new} = \frac{36.2}{58.8} * 100\% = 61.2\%$

Oxide	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Na_2O	K_2O
%	61.6	21.4	5.1	2.7	3.4	2.5	2.6	0.7

Sum of oxide = 100 %

$C_3S = 4.07(CaO) – 7.60(SiO_2) – 6.72(Al_2O_3) – 1.43(Fe_2O_3) – 2.85(SO_3)$

$C_3S = 4.07(61.6) – 7.60(21.4) – 6.72(5.1) – 1.43(2.7) – 2.85(2.5) = 42.8\%$

$C_2S = 2.87(SiO_2) – 0.754(C_3S)$

$C_2S = 2.87(21.4) – 0.754(42.8) = 29.1\%$

$C_3A = 2.65(Al_2O_3) – 1.69(Fe_2O_3)$

$C_3A = 2.65(5.1) – 1.69(2.7) = 9\%$

$C_4AF = 3.04(Fe_2O_3)$

$C_4AF = 3.04(2.7) = 8.2\%$

$$\textbf{L.S.F} = \frac{\boldsymbol{CaO - 0.7(SO_3)}}{\boldsymbol{2.8(SiO_2)+1.2\ (Al_2O_3)+0.65\ (\ Fe_2O_3)}} \text{ ..... } \textbf{(0.66-1.02)}$$

$$\text{L.S.F} = \frac{61.6-(0.7*2.5)}{2.8(21.4)+1.2\ (5.1)+0.65\ (\ 2.7)} = 0.9 \text{ (o.k)}$$

- (Al_2O_3/ Fe_2O_3) = 1.889 > 0.66 (o.k)
- Percentage of Mgo = 3.4% < 5% (o.k)

1- This type of cement is O.P.C because the percentage of the four major compounds is identical with the percentage of major compounds for O.P.C. also, the L.S.F value is also identical to that L.S.F of Ordinary Portland Cement.

2- This type of cement use in constructions when there is no exposure to sulfates in the soil or groundwater.

Ex3: A type of cement it contains (2/3 limestone and 1/3 clay) and the percentage of oxides in each material as in the table below

1- What is the type of cement?

2- Is the cement accepted with limitation of portland cement?

Oxide %	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Na_2O	K_2O
Lime Stone	50	2	2	1	3	1	0.5	0.5
Clay	15	45	6	2	4	1	0.5	0.5

Sol:

Sum of lime stone oxide = 60 %

Sum of clay oxide = 74 %

L.O.I $[lime\ stone]$= 100 - $\sum Oxide[lime\ stone]$ = 100 – 60 = 40 %

L.O.I $[clay]$= 100 - $\sum Oxide[clay]$ = 100 – 74 = 26 %

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ $* \frac{^2/_3}{1- L.O.I\ _{Lime\ stone}}$

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ $*\frac{2/3}{1-0.4}$

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ * 1.11

New Oxide $[clay]$ = Old Oxide $[clay]$ $*\frac{1/3}{1-L.O.I\ _{clay}}$

New Oxide $[clay]$ = Old Oxide $[clay]$ $*\frac{1/3}{1-0.26}$

New Oxide $[clay]$ = Old Oxide $[clay]$ * 0.45

Oxide %	Lime Stone	Clay	New. Oxide) Lime	New. Oxide) Clay	Sum. Oxide %
CaO	**50**	**15**	55.56	6.76	**62.32**
SiO_2	**2**	**45**	2.22	20.27	**22.49**
Al_2O_3	**2**	**6**	2.22	2.7	**4.92**
Fe_2O_3	**1**	**2**	1.11	0.9	**2.01**
MgO	**3**	**4**	3.33	1.8	**5.13**
SO_3	**1**	**1**	1.11	0.45	**1.56**
Na_2O	**0.5**	**0.5**	0.56	0.23	**0.79**
K_2O	**0.5**	**0.5**	0.56	0.23	**0.79**

Sum. of Oxide = 100 %

$C_3S = 4.07(CaO) – 7.60(SiO_2) – 6.72(Al_2O_3) – 1.43(Fe_2O_3) – 2.85(SO_3)$

$C_3S = 4.07(62.32) – 7.60(22.49) – 6.72(4.92) – 1.43(2.01) – 2.85(1.56) = 42.3$ %

$C_2S = 2.87(SiO_2) – 0.754(C_3S)$

$C_2S = 2.87(22.49) – 0.754(42.3) = 32.6$ %

$C_3A = 2.65(Al_2O_3) – 1.69(Fe_2O_3)$

$C_3A = 2.65(4.92) – 1.69(2.01) = 9.6$ %

$C_4AF = 3.04(Fe_2O_3)$

$C_4AF = 3.04(2.01) = 6.1\ \%$

$$\textbf{L.S.F} = \frac{CaO - 0.7(SO_3)}{2.8(SiO_2) + 1.2\ (Al_2O_3) + 0.65\ (Fe_2O_3)} \quad \textbf{.....} \quad \textbf{(0.66-}1.02)$$

$$\text{L.S.F} = \frac{62.32 - (0.7 * 1.56)}{2.8(22.49) + 1.2\ (4.92) + 0.65\ (2.01)} = 0.872 \ \text{(o.k)}$$

Type of cement is O.P.C

Ex4: After conducting a chemical analysis for a type of cement, it was found that the percentages of oxides in the raw materials used in the cement manufacture, as shown in the table below.

1- What is the type of cement?
2- Is the cement accepted with limitation of portland cement?

Oxide %	$CaCO_3$	SiO_2	Al_2O_3	Fe_2O_3	$MgCO_3$	SO_3	Alkali	H_2O
Lime Stone	82	2	2	3	8	1.5	1	1.6
Clay	26	44.5	4	4	8	1.5	1	6

$CaCO_3 \longrightarrow CaO + CO_2$

molecular weight $_{(CaO)}$ = (16*1)+(40*1) = 56

Weight of CaO $_{(Lime)}$ = $\frac{56*82}{100}$ = 45.92 %

Weight of CaO $_{(Clay)}$ = $\frac{56*26}{100}$ = 14.56 %

$MgCO_3 \longrightarrow MgO + CO_2$

molecular weight $_{(CaO)}$ = (16*1)+(24*1) = 40

Weight of MgO $_{(Lime)}$ = $\frac{40*8}{100}$ = 3.2 %

Weight of MgO $_{(Clay)}$ = $\frac{40*8}{100}$ = 3.2 %

Oxide %	CaO	SiO_2	Al_2O_3	Fe_2O_3	MgO	SO_3	Alkali	H_2O
Lime Stone	45.92	2	2	3	3.2	1.5	1	1.6
Clay	14.56	44.5	4	4	3.2	1.5	1	6

Sum. of lime stone oxide = 60.22 %

Sum. of clay oxide = 78.76 %

L.O.I $[lime\ stone]$= 100 - $\sum Oxide[lime\ stone]$ = 100 – 60.22 = 39.78 %

L.O.I $[clay]$= 100 - $\sum Oxide[clay]$ = 100 – 78.76 = 21.24 %

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ $*\frac{2/3}{1-L.O.I_{\ Lime\ stone}}$

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ $*\frac{2/3}{1-0.3978}$

New Oxide $[lime\ stone]$ = Old Oxide $[lime\ stone]$ * 1.107

New Oxide $[clay]$ = Old Oxide $[clay]$ $*\frac{1/3}{1-L.O.I_{\ clay}}$

New Oxide $[clay]$ = Old Oxide $[clay]$ $*\frac{1/3}{1-0.2124}$

New Oxide $[clay]$ = Old Oxide $[clay]$ * 0.423

Oxide %	Lime Stone	Clay	New. Oxide) Lime	New. Oxide) Clay	Sum. Oxide %
CaO	45.92	14.56	50.84	6.16	**57**
SiO_2	2	44.5	2.21	18.83	**21.04**
Al_2O_3	2	4	2.21	1.69	**3.9**
Fe_2O_3	3	4	3.32	1.69	**5.01**
MgO	3.2	3.2	3.54	1.35	**4.89**
SO_3	1.5	1.5	1.66	0.63	**2.29**
Alkali	1	1	1.11	0.42	**1.53**
H_2O	1.6	6	1.77	2.54	**4.31**

Sum. of Oxide = 99.97 % (O.K)

$C_3S = 4.07(CaO) – 7.60(SiO_2) – 6.72(Al_2O_3) – 1.43(Fe_2O_3) – 2.85(SO_3)$

C_3S = 32.2 %

$C_2S = 2.87(SiO_2) – 0.754(C_3S)$

C_2S = 36.1

$C_3A = 2.65(Al_2O_3) – 1.69(Fe_2O_3)$

C_3A = 1.9 %

$C_4AF = 3.04(Fe_2O_3)$

C_4AF = 15.2 %

L.S.F = $\frac{CaO - 0.7(SO_3)}{2.8(SiO_2)+1.2\ (Al_2O_3)+0.65\ (\ Fe_2O_3)}$ ..... **(0.66-**1.02)

L.S.F = 0.829 (o.k)