Appendix (A)

Laboratory test

Expansive soil supply:

The expansive soil used in this investigation was collected from wad Medani in Gezira university (Nishaishiba)

Physical examination:

Physical examination such as Atterberg limits.

Atterberg limits:

Purpose:

Determine the plastic, liquid limits and Plasticity Index of Soils.

Equipment:

- Liquid limit device.
- Spatula.
- Moisture cans.
- Glass plate.
- Drying oven set at 105°C.
- Balance.
- Wash bottle filled with distilled water.
- Sieve No (40)

Test Procedure:

Liquid Limit:

1. Take roughly 3/4 of the soil and place it into the porcelain dish. The soil was previously passed through a No. 40 sieve, thoroughly mix the soil with a small amount of distilled water until it appears as a smooth uniform paste. Cover the dish with cellophane to prevent moisture from escaping.
2. Weigh four of the empty moisture cans with their lids, and record the respective weights.

3. Adjust the liquid limit apparatus by checking the height of drop of the cup. The point on the cup that comes in contact with the base should rise to a height of 10 mm. The block on the end of the grooving tool is 10 mm high and should be used as a gage. Practice using the cup and determine the correct rate to rotate the crank so that the cup drops approximately two times per second.
4. Place a portion of the previously mixed soil into the cup of the liquid limit apparatus at the point where the cup rests on the base.
5. Use the grooving tool carefully cut a clean straight groove down the center of the cup.
6. Turn the crank of the apparatus at a rate of approximately two drops per second and count the number of drops, N, it takes to make the two halves of the soil pat come into contact at the bottom of the groove along a distance of 13 mm (1/2 in.)
7. Take a sample, using the spatula, from edge to edge of the soil pat. Place the soil into a moisture can cover it. Immediately weigh the moisture can containing the soil, record it's mass, remove the lid, and place the can into the oven. Leave the moisture can in the oven for at least 16 hours.
8. Remix the entire soil specimen in the porcelain dish. Add a small amount of distilled water to increase the water content so that the number of drops required to close the groove decrease.
9. Repeat steps six, seven, and eight for at least two additional trials producing successively lower numbers of drops to close the groove.

Determine the water content from each trial by using the same method used in the first laboratory.

Plastic Limit:

1. Weigh the remaining empty moisture cans with their lids, and record the respective weights and can numbers on the data sheet.
2. Take the remaining 1/4 of the original soil sample and add distilled water until the soil is at a consistency where it can be rolled without sticking to the hands.
3. The thread shall be deformed so that its diameter reaches 3.2 mm (1/8 in.), taking no more than two minutes.
4. When the diameter of the thread reaches the correct diameter, break the thread into several pieces. Knead and reform the pieces into ellipsoidal masses and re-roll them. Continue this alternate rolling, gathering together, kneading and re-rolling until the thread crumbles under the pressure required for rolling and can no longer be rolled into a 3.2 mm diameter thread (See Photo A.3).
5. Gather the portions of the crumbled thread together and place the soil into a moisture can, then cover it. If the can does not contain at least 6 grams of soil, add soil to the can from the next trial (See Step 6).

Immediately weigh the moisture can containing the soil, record it's mass, remove the lid, and place the can into the oven. Leave the moisture can in the oven for at least 16 hours.

6. Repeat steps three, four, and five at least two more times. Determine the water content from each trial by using the same method used in the first laboratory. Remember to use the same balance for all weighing Analysis.

Liquid Limit:

1. Calculate the water content of each of the liquid limit moisture cans after they have been in the oven for at least 16 hours.
2. Plot the number of drops, N, (on the log scale) versus the water content (w). Draw the best-fit straight line through the plotted points and determine the liquid limit (LL) as the water content at 25 drops

Atterberge limits data:

Liquid Limit Determination

Table (A.1) Liquid Limit

Sample no.	1	2	3	4
Mass of empty, clean can + lid (grams)	24	24	24	24
Mass of can, lid, and moist soil (grams)	39.5	37	40	39
Mass of can, lid, and dry soil (grams)	35	32	33.5	33
Mass of pore water (grams)	4.5	5	6.5	6
Mass of soil solids (grams)	11	8	9.5	9
Water content, w%	40.9	62.5	68.42	66.67
No. of drops (N)	20	30	16	27

Plastic Limit:

1. Calculate the water content of each of the plastic limit moisture cans after they have been in the oven for at least 16 hours.
2. Compute the average of the water contents to determine the plastic limit, PL. Check to see if the difference between the water contents is greater than the acceptable range of two results (2.6 %).
3. Calculate the plasticity index, PI=LL-PL.

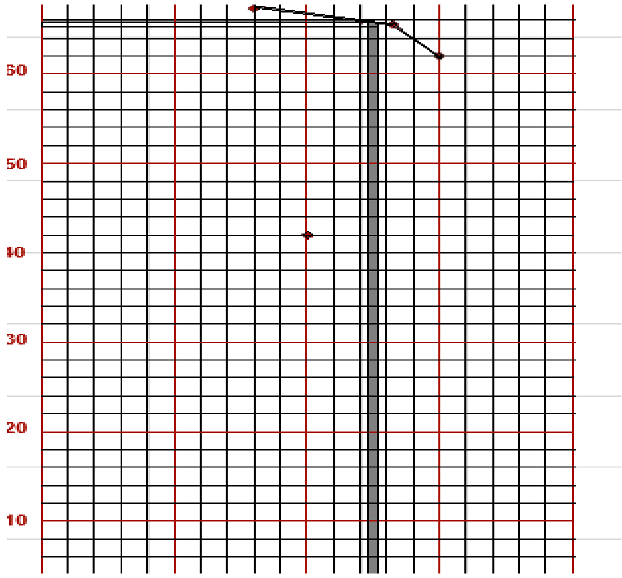
Report the liquid limit, plastic limit, and plasticity index to the nearest whole number, omitting the percent designation.

Plastic Limit Determination

Table (A.2) Liquid Limit

Sample no.	1	2	3
Mass of empty, clean can + lid (grams)	24	24	24
Mass of can, lid, and moist soil (grams)	40	40	40
Mass of can, lid, and dry soil (grams)	34	32	35
Mass of pore water (grams)	6	8	6
Mass of soil solids (grams)	10	8	5
Water content, w%	28	32.7	29
No. of drops (N)	35.7	24.46	17.24

Plastic Limit (PL) = Average w %= $\frac{35.7+24.46+17.24}{3}$ = = 25.8%



Liquid limit chart:

Fig: A.1 Sample of the soil

Fig: A.2 Dry sample

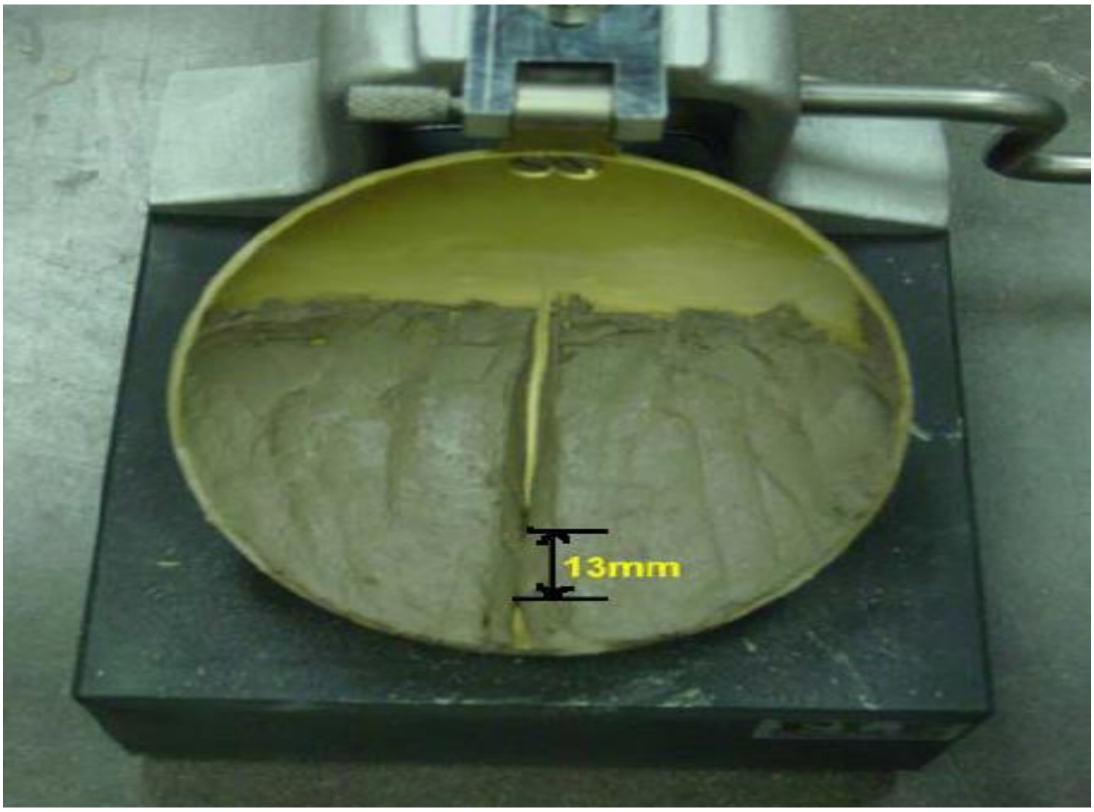


Fig: A.3 Drop the sample

Fig: A.4 Rolling sample

Appendix (B)

Table B.1 ultimate anchorage bound lengths and lap lengths multiples of bar size

Reinforcement types	Grade 250 plain	Grade 460			
		Plain	Deformed type 1	Deformed type 2	Fabric
	Concrete cube strength 25				
Tension anchorage and lap length	43	79	55	44	34
1.4 × tension lap	60	110	77	62	48
2.0 × tension lap	85	157	110	88	68
Compression anchorage length	34	63	44	35	28
Compression lap length	43	79	55	44	84
	Concrete cube strength 30				
Tension anchorage and lap length	39	72	50	40	31
1.4 × tension lap	55	100	70	56	44
2.0 × tension lap	78	143	100	80	62
Compression anchorage length	32	58	40	32	25
Compression lap length	39	72	50	40	31
	Concrete cube strength 35				
Tension anchorage and lap length	36	67	47	38	29
1.4 × tension lap	51	93	65	52	40
2.0 × tension lap	72	133	93	75	57
Compression anchorage length	29	53	38	30	23
Compression lap length	36	67	47	38	29
	Concrete cube strength 40				
Tension anchorage and lap length	34	62	44	35	27
1.4 × tension lap	48	87	61	49	38
2.0 × tension lap	68	124	81	70	54
Compression anchorage length	27	50	35	28	22
Compression lap length	34	62	44	35	27
NOTE The values are rounded up to the nearest whole number and the length derived from these values may differ slightly from those calculated directly for each bar or wire size.					

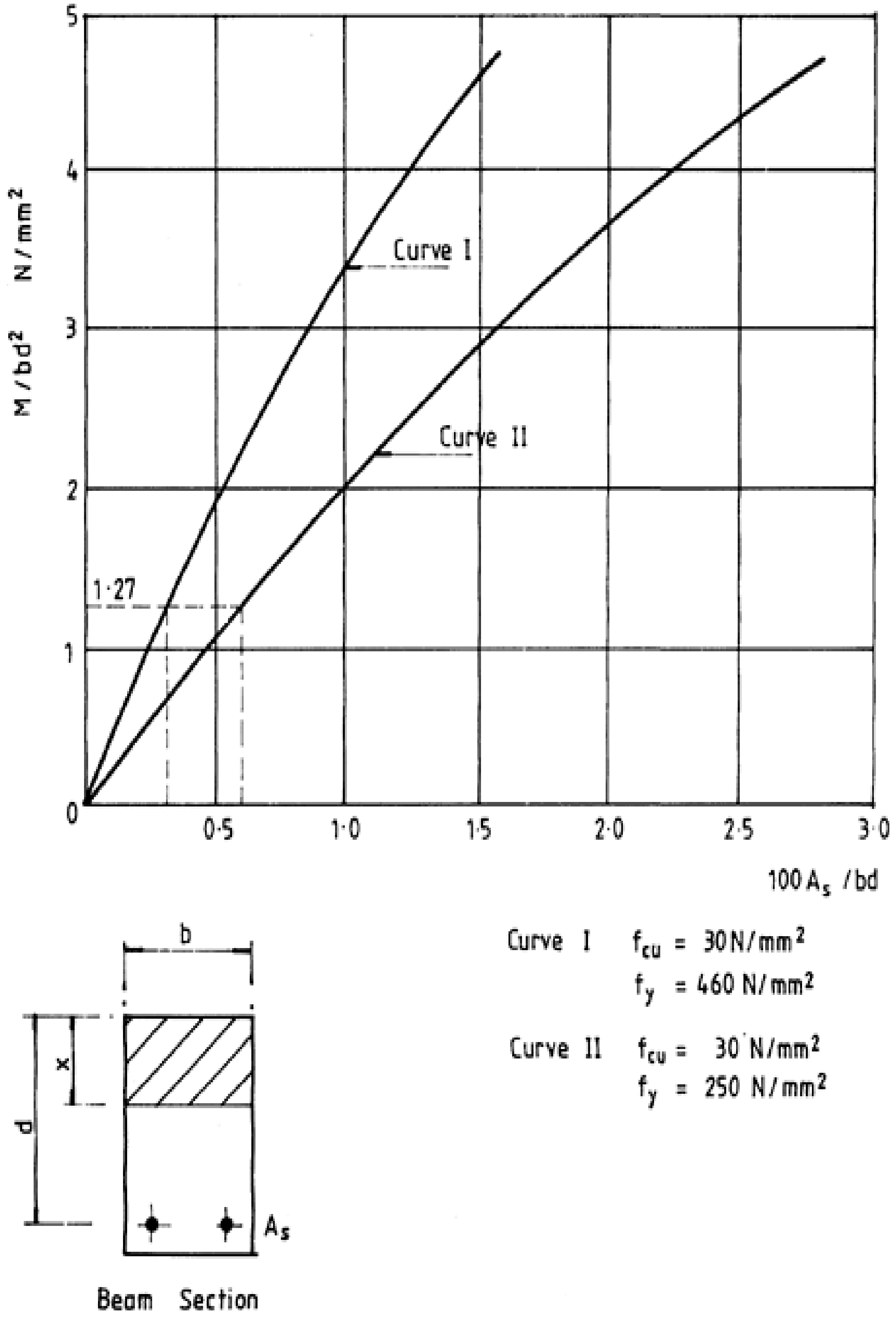


Fig: B.1 Design chart

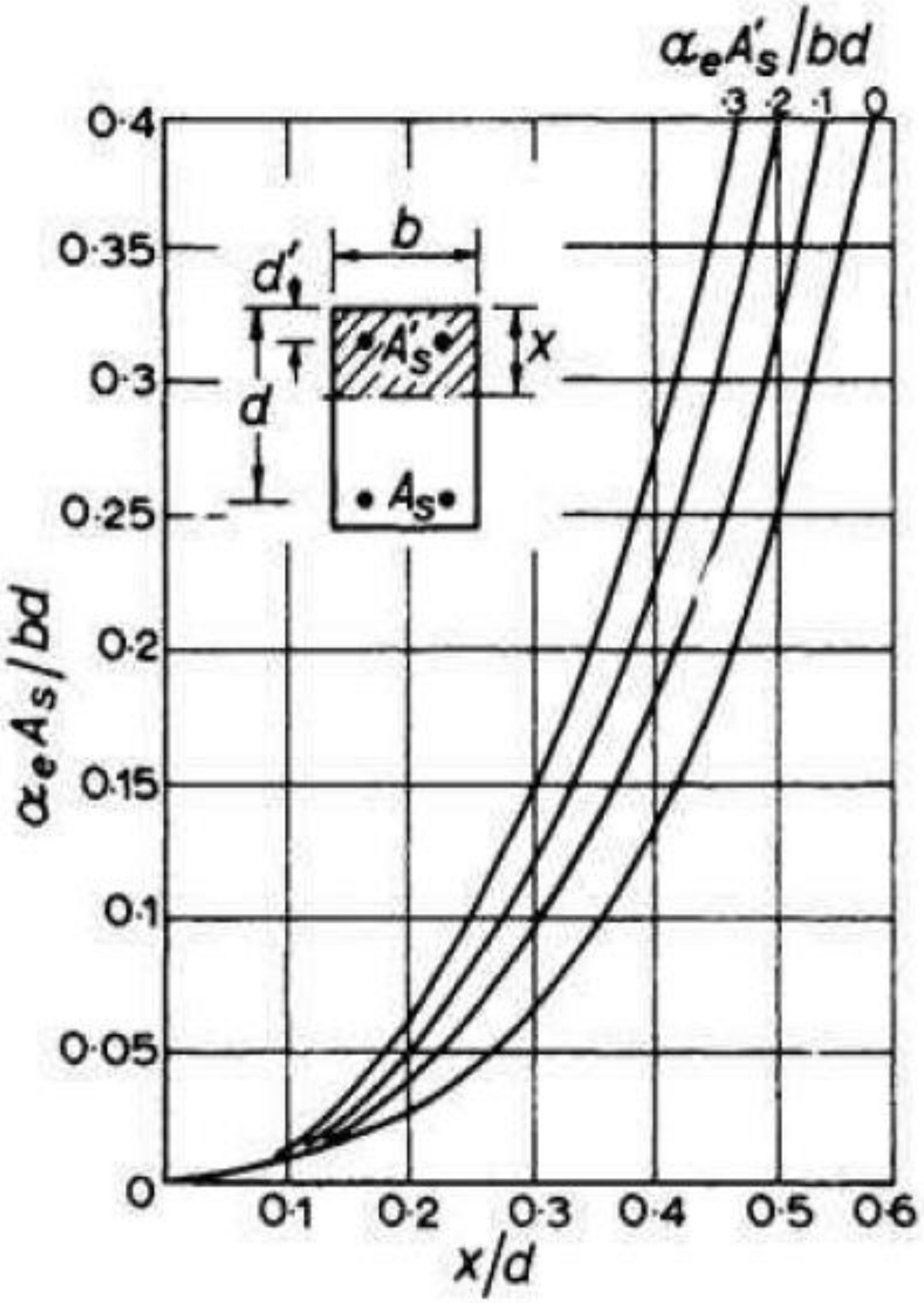


Fig: B.2 Neutral axis depth cracked section

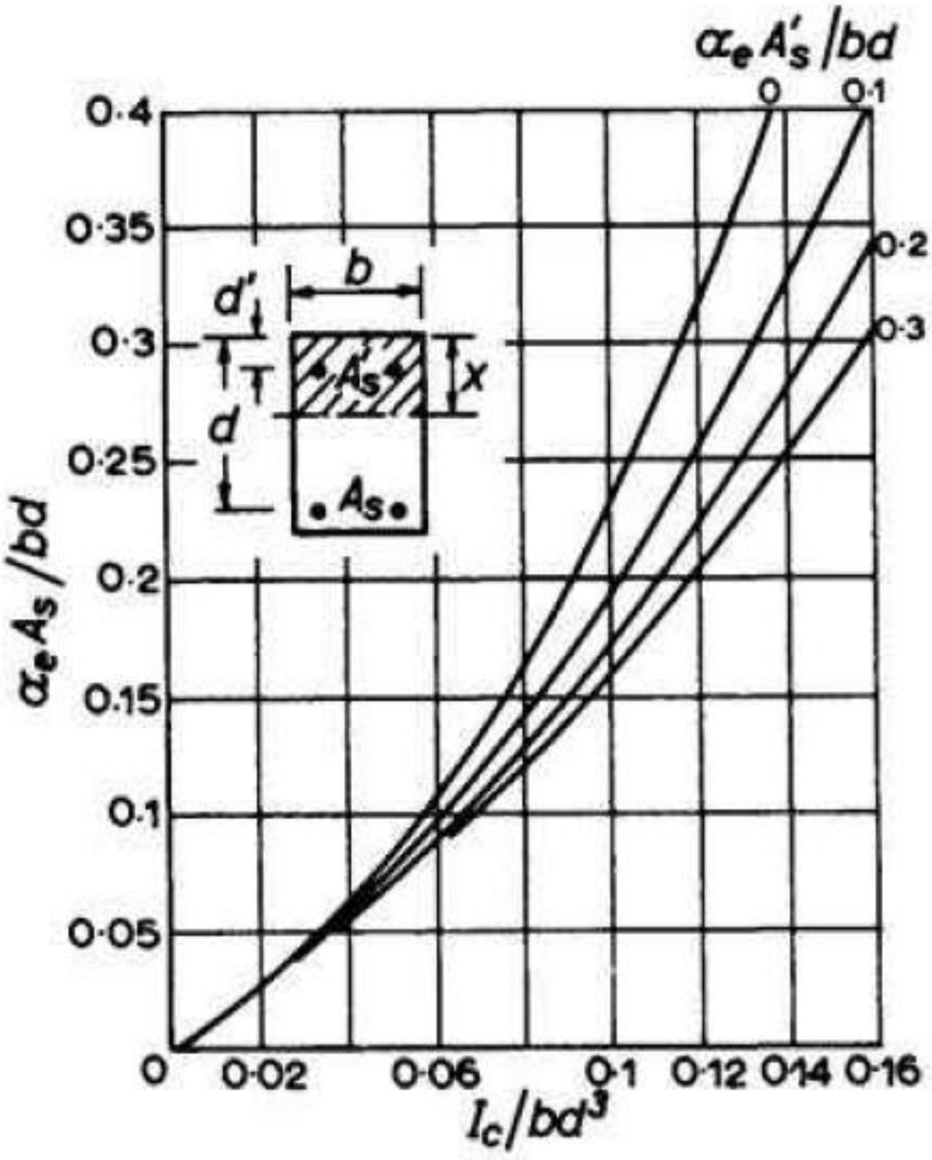


Fig: B.3 Second moment of area of cracked section

Appendix (C)

Fig: C.1 Concrete work in water tanks

Fig: C.2 Formwork in water tanks

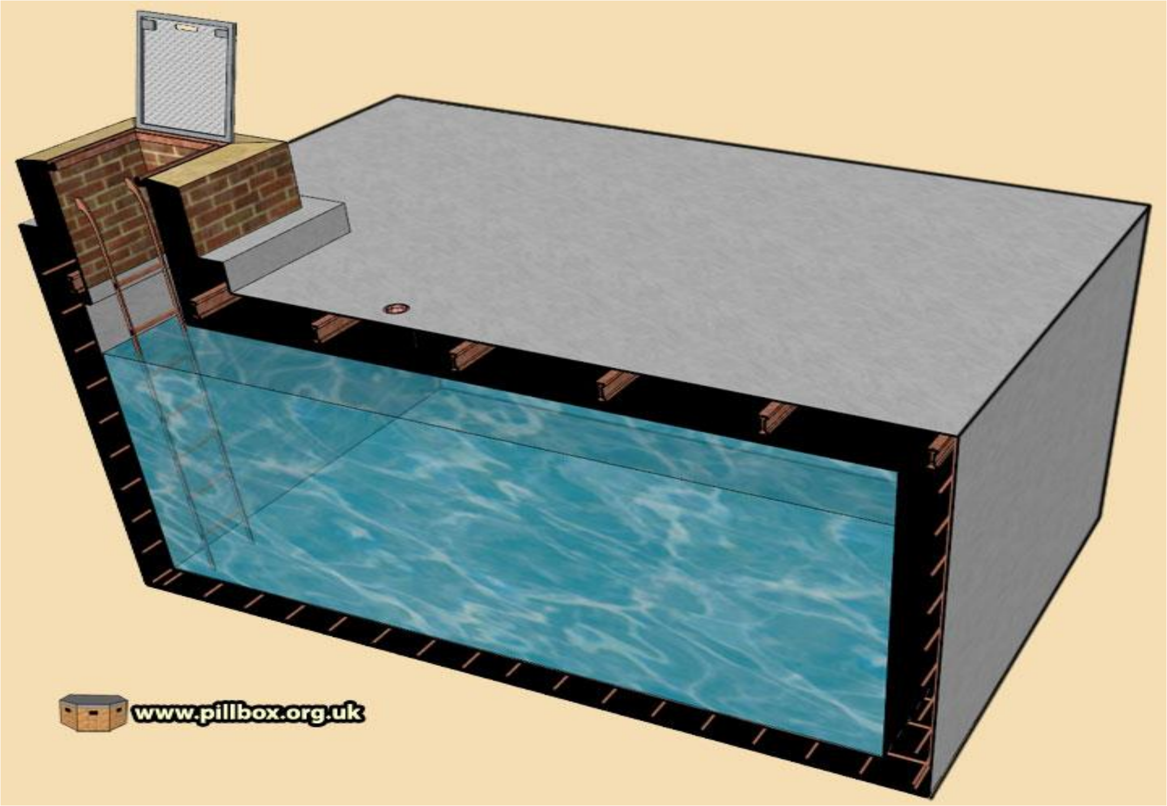


Fig: C.3 During maintenance

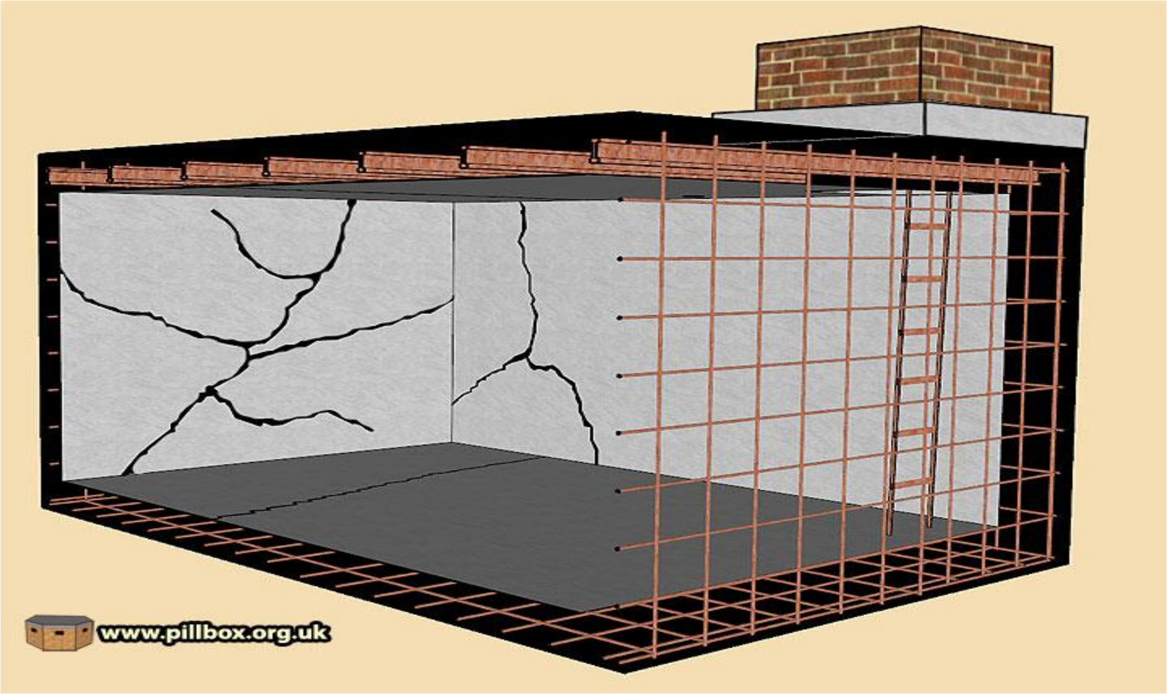


Fig: C.4 Explain crack in tanks