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Research Article

Investigating the ways of using sand materials in compacted layers in the irrigation and drainage network (case study fiber glass pipe)

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Abstract

The discussion of earthworks and irrigation and drainage projects is very important from a technical and economic point of view. In the Southwest Khuzestan pipeline project with 230 kilometers of G.R.P. pipes, it is effective to provide the volume of earth materials for earthling around the pipe and also earthling to ensure the depth of the trench before trenching. Due to the presence of sand materials in the region, in this research, these materials were used in earthworks around the pipe in different ways, including compaction by compactor and also compaction by flooding method, and the results showed that it is possible to use sand materials with fine grains less than He compacted 12% in the form of flooding and up to a density of 85%. Also, in order to provide the depth of the trench, you can mix sand materials with different percentages of clay so that the percentage of different salts such as gypsum, sulfate, and chlorine is reduced and the specific weight of the clay is increased. Different methods of moistening soil materials were compared in order to provide optimal moisture, including moistening at the borrow site and on the road. The effect of humidity on the density of soils with different grain sizes was also compared. The results showed that in clay materials, if the moisture content is more than 3% less than the optimum moisture content, it is difficult to compensate it by tamping. In the earthen layers made with fine-grained materials, traffic has a more negative effect on the density of the layer. The coarser the materials, the less impact traffic and passage of time will have. Also, the study of cross-sections showed that in sandy fields, the best way to protect the roads from the influx of quicksand is to follow the natural slope of the land as much as possible and to avoid earthmoving or earthmoving at a high height as much as possible.

Keywords:

G.R.P pipe, suitable gravel around the pipe, wind sand

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1- Introduction

The use of soil materials in the implementation of irrigation and drainage networks and soil compaction is very important, and this is one of the most important issues, especially in the implementation of soil layers around G.R.P. pipes, which require a lot of control and precision. Earthling around these pipes should be done in 15 cm layers and until the density percentage is at least 85%.In addition, suitale gravel should be done from the bed up to 30 cm on the crown of the pipe with the aforementioned specifications. In order to make a project economical, it is necessary to research the density characteristics of different soils and to use the materials available in the area as much as possible. In order to successfully implement a project, it is necessary to know the compaction characteristics of different soils and the factors affecting them, and even if possible to make the projects economical by using ways (observing the technical principles of course) of the soils in the region with a short transportation distance.

Among the factors influencing the relative compaction, we can mention the thickness of the embankment layers, soil granularity, the maximum specific weight of the soil, the amount of moisture during compaction, etc. Musian is studied in Dehlran city and in the southern tip of Ilam province. This area is one of the lands covered by the Karkheh River, and G.R.P. pipelines are used to transfer water to the lands. The problems related to the embankment around the pipes and the factors affecting the density of the embankment layer are studied in this research. The main irrigation and drainage network of Ain Khosh and Feke plains, which is located in the southwest of Ilam province, in order to develop the cultivated area, increase the income of farmers, increase the level of employment, create residential settlements in the border strip and increase national security, feed the aquifer. and relative improvement of underground water quality and stabilization of water level, control of floods entering the plain., economic self-reliance by increasing basic and strategic products and helping to save and extract foreign exchange income in the areas of Ain Khosh and Feke, is designed and is being implemented. Figure (1) shows the general view of the irrigation and drainage network of Karkheh Dam and the view of the Fakeh pipeline network in Figure (1).

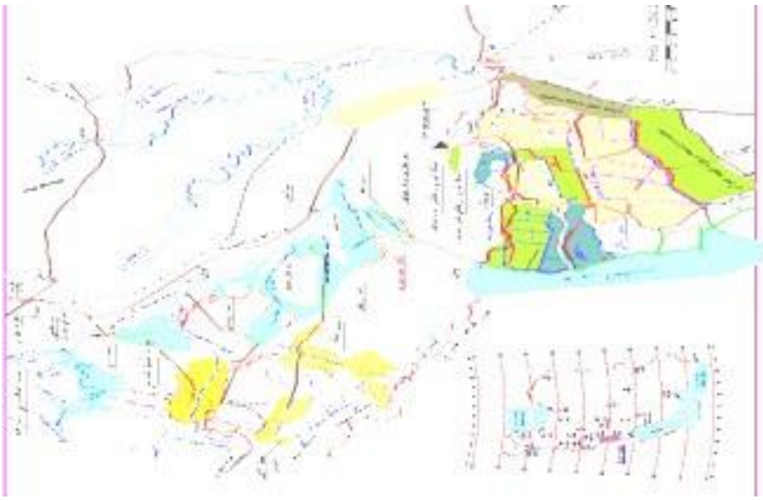

Figure (1) The general view of the area of the main pipelines of the irrigation network

2- Embankment to ensure the depth of the trench before trenching

The cross-sections used for the implementation of G.R.P pipelines prepared by the consultant are as follows. Figure 2).

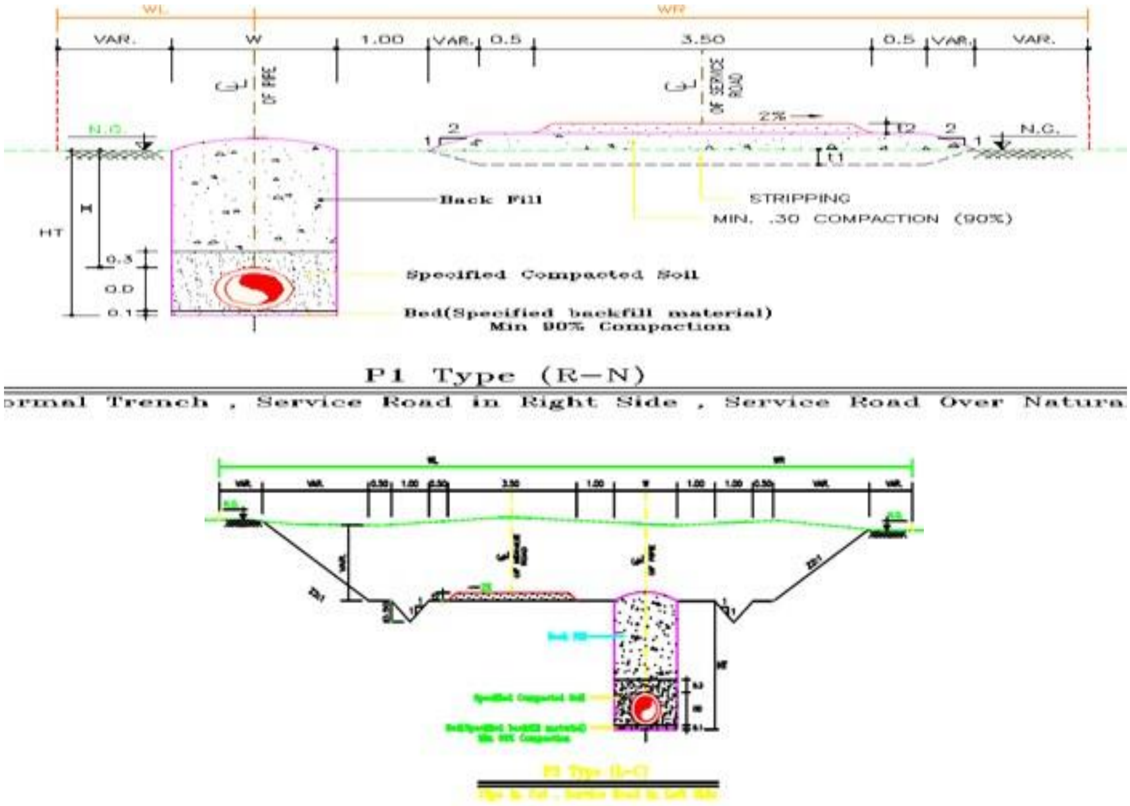

Figure (2) cross-sections for the implementation of pipelines

These sections are designed in such a way that the minimum required soil on the pipe that is specified in the maps and according to table (1) is provided.

Table (1), the minimum required soil on the pipe according to the diameter of the pipe

Pipe diameter D (mm)	Pipe material	Minimum soil on the pipe Hmin (cm)	Description
2200	GRP	145	**GRP: Glass Reinforced Polyster D(mm): Nominal Diameter of pipe in Millimetre W(mm): Trench Width in Centimetre Hmin : Minimum Height of Embankment over the pipe**
2000	GRP	140	
1800	GRP	135	
1600	GRP	130	
1400	GRP	125	
1200	GRP	145	
1000	GRP	140	
900	GRP	150	
800	GRP	135	
700	GRP	145	

Paying attention to the prepared profiles, in some sections, the minimum soil on the pipe is not provided, and in order to implement the pipelines, in order to ensure the depth of the trench before trenching, it is necessary to implement embankment layer by layer with a density of 95% and with a thickness of 15 cm according to the cross section. . Figure (3).

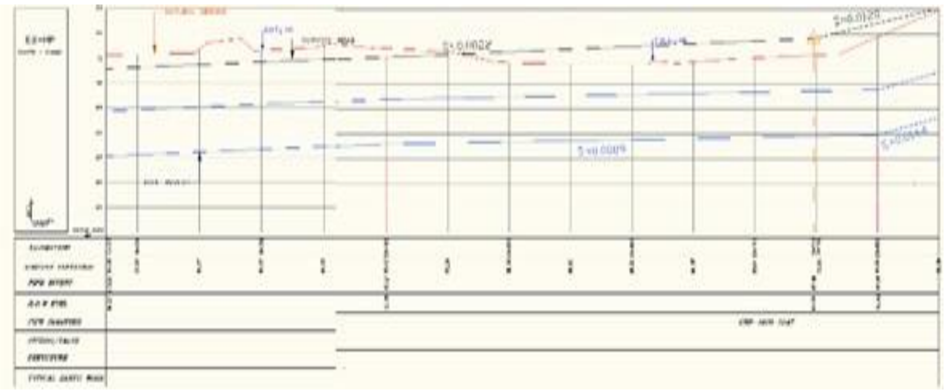

Figure (3) - An example of the longitudinal profiles of the pipe route

It can be seen that in some sections marked as FILL section, the depth of the trench is low, so in order to provide the depth of the trench, embankment with a density of 95% is done. Windy sand in the region, efforts are being made to find ways to use these materials by mixing these materials with adhesive materials.

3- Suitable materials around the pipe

According to the previous explanations, in addition to the embankment to ensure the depth of the trench, which is related to before trenching, after trenching and installing the pipes, it is necessary to do the embankment around the pipes. Recommended materials for the earthworks around and on the pipe. G.R.P are divided into five groups according to the flow tite standard:

Group A: including crushed stone with fine-grained materials less than 12%. Group B: sand, with fine-grained material less than 12%. Group C: silty sand, 12-35% fine-grained, 40% > LL. Group D: sand layer or clay, 50-35% fine grain, 40% > LL. Group E: clay or sand layer, 50-70% fine grain, 40% > LL. Group F: fine-grained soil with little plasticity, > 40% LL. According to the standard, group A materials are the best materials for soiling around the pipe. Then there are groups B, C, D, E and F. Group A and B materials are easy to use and are very reliable as pipe burial materials. These soils have very little sensitivity to moisture. This type of substitute soil can be easily compacted in layers of 20 cm to 30 cm. Substitute soils of type C are acceptable and usually available for burying the pipe.Many of the local soils in which the pipe is installed are of type C, so the same soil excavated from the trench can be directly used for replacement. When using this type of soil, you must be completely careful, because these soils are sensitive to moisture. The behavior of C soils is often influenced by the behavior of fine grains in it. It may be necessary to control humidity during soil compaction to reach the required density with reasonable compaction energy and compaction devices.

4- Investigating the method of using sand materials in earthworks around G.R.P pipes

According to the presented materials, in order to evaluate sandblasted materials, it is necessary to perform a grading test on these materials first. Sampling was done from windy sand materials located in the vicinity of F2-MP road, about 1+000 km. Figure (4).

Figure (4) - Abundance of wind sand materials in the project site

Then, on these materials with the selected sample weight of 508.6 grams, a granulation test was conducted, the results of which are as follows. The grading curve is as follows (red diagram). Figure (5).

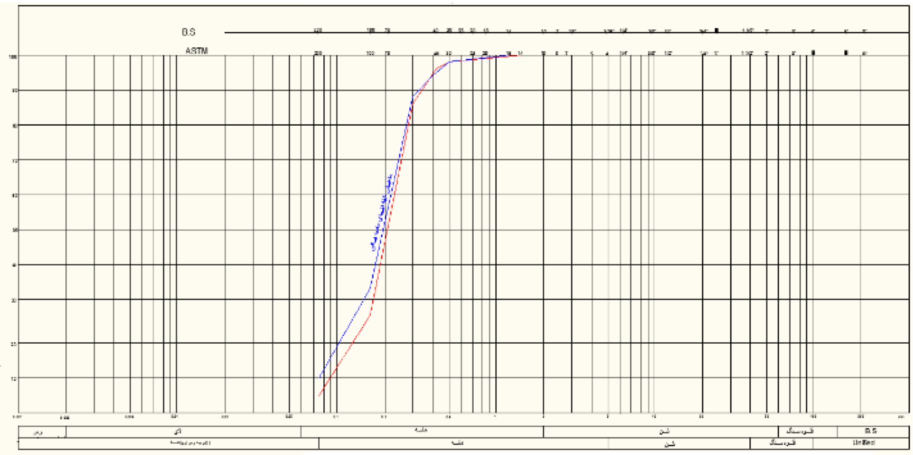

Figure (5) - Granulation curve of windy sand

In most cases, the granulation curve of windy sand is one of the states shown above. As it can be seen and according to the content of these materials, they are mostly in B and C groups, that is, with fine grain of at least 12% or between 12 and 35% of fine grain. After the granulation test, the sand material was used in the earthworks around the G.R.P pipe.In order to use this material in a 15 cm layer, it was spread and adjusted by the worker, then water was sprinkled on the layer using a sprinkler tanker. Using a manual compactor, the applied layer was compacted four times. The test was conducted in several other cases and almost similar results were obtained. According to the obtained compaction percentages, it can be seen that the desired result has been obtained, but in the method of compaction by manual compactors, there is a possibility of damaging the pipe.Also, due to the need for time to determine the density percentage and its time-consuming nature, work efficiency decreases. Therefore, it was decided to test the layer flooding method to achieve density. In this method, a windblown sand sample was used with the passing percentage of sieve 200 at about 25%. The materials were applied in a 15 cm layer and in order to facilitate the humidification and to ensure that all the materials were submerged, plots were created by the worker at distances of about 8 meters. Then the layer was moistened with a sprinkler tank until the applied layer was completely submerged. After flooding, a compaction test was carried out, the results of which are as described in table (2).

Table (2) - Compaction by flooding method for materials with 25% fine grain

Density percentage	Laboratory density		Density of place		No
	Optimum humidity percentage	Maximum dry density)g/ cm^3 (	Moisture percentage	dry density)g/ cm^3 (	
۸۱	۱۱/۳	۱/۸۶	۶/۳	۱/۵۱	۱
۷۸	۱۱/۳	۱/۸۶	۷/۶	۱/۴۵	۲
۸۵	۱۱/۳	۱/۸۶	۹/۴	۱/۵۹	۳
۷۹	۱۱/۳	۱/۸۶	۷/۹	۱/۴۷	۴
۸۴	۱۱/۳	۱/۸۶	۷	۱/۵۶	۵
۷۵	۱۱/۳	۱/۸۶	۱۰	۱/۴۰	۶

According to the resulting density percentages, as can be seen, the result is less than 85% in most cases, and therefore the desired result was not achieved. According to the recommendations of flutite and the percentage of fine grains of 25%, it was possible that the reason for not achieving compaction is related to the high percentage of fine grains. Therefore, in another experiment, sand materials with a fine grain percentage of about 7% were used. These materials were only submerged in a 15 cm layer and no compactor was used. Figure (6).

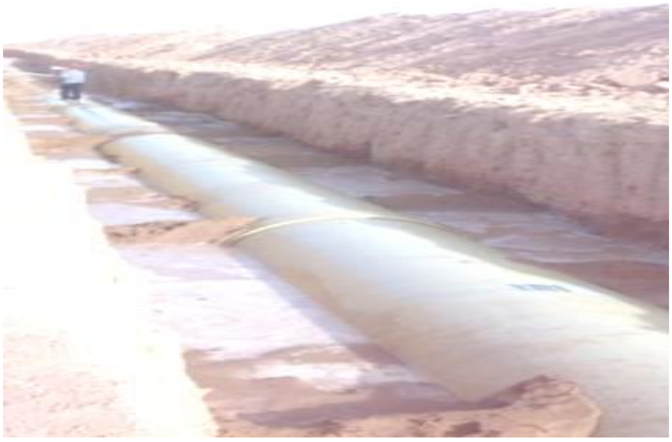

Figure (6) - Flooding of the earthen layer around the pipe

Then the compression test was done. The results of this test are as described in Table (3). It can be seen that the materials used (minimum 12% fine grain) by flooding method achieve the desired result.

Table (3) - The results of the compaction test for the flooding method

Density percentage	Laboratory density		Density of place		Test number
	Optimum humidity percentage	Maximum dry density	Moisture percentage	dry density)g/ cm3 (	
۸۸	۱۰/۸	۱/۷۹	۹	۱/۵۸	۱
۹۴	۱۰/۸	۱/۷۹	۸/۵	۱/۶۸	۲
۹۸	۱۰/۸	۱/۷۹	۹/۵	۱/۷۵	۳
۹۱	۱۰/۸	۱/۷۹	۹/۴	۱/۶۲	۴
۹۴	۱۰/۸	۱/۷۹	۹/۵	۱/۶۸	۵

5- Excavation to ensure the depth of the trench before trenching

In many routes, due to the longitudinal profile of the pipeline, the depth of the trench is low, and in order to ensure the depth of the trench before trenching, it is necessary to excavate in layers of 15 cm and with a density of 95% according to the cross section. Figure (7).

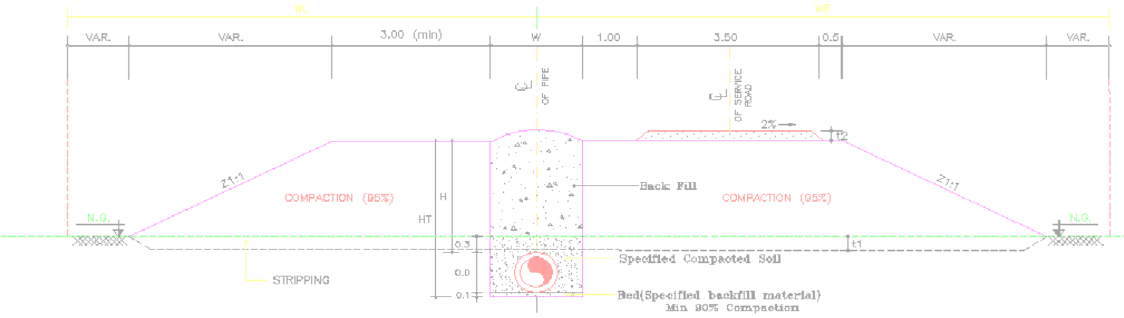

Figure (7) - Transverse section to ensure the depth of the trench

After being transported to the site, the materials are spread and mixed by a grader and sprinkler tanker, and after uniform moistening, they are crushed by a roller. The type of roller depends on the soil used. After the above cross-section, trenching and subsequent installation of the pipe will be done. Due to the high volume of earthworks, in order to reduce the distance of the earthworks and make the project economical, the available materials within the scope of the project should be used as much as possible. Due to the abundance of windy sand materials in the region, it is necessary to find a way to use these materials through mixing. Airy sand materials are not sticky, so they should be mixed with sticky materials, i.e. clay, even if possible. Also, due to the fact that fine-grained clay sediments are formed by Aghajari formation and its Lehbari unit, and due to the presence of gypsum veins in these materials and its swelling properties, materials with sand materials or coarse-grained materials such as GW or GP It is mixed to reduce the percentage of plaster and the possibility of swelling. Sampling of sand and clay materials was done in a range (Figure 8).

Figure (8) - Operation of pounding embankment layers for implementation

Etterberg's grading and grading test was performed on clay materials and the PI and percentage passing through the 200 grade sieve were obtained as 22 and 97%, respectively. Then these materials were mixed together in different percentages by weight as follows: 70% windblown sand + 30% clay materials. 60% windblown sand + 40% clay material. 50% windblown sand + 50% clay material. 40% windblown sand + 60% clay material. 30% windblown sand + 70% clay material. 20% windblown sand + 80% clay material. After mixing, granulation tests and Etterberg parameters were performed on these materials, and the results are as follows. Figure (9).

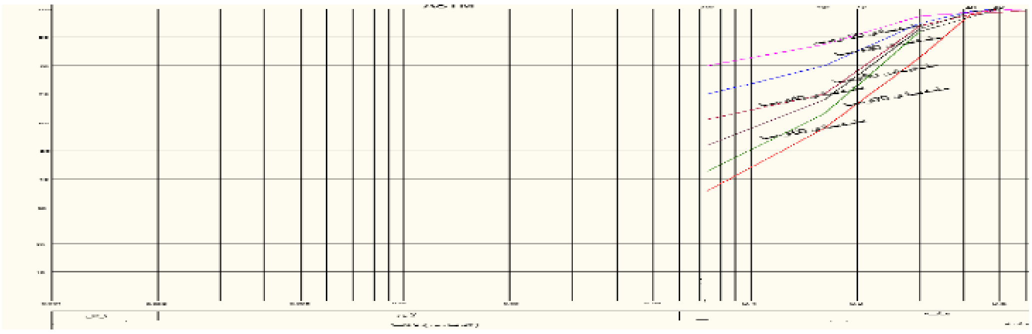

Figure (9) - The results of granulation tests and Aetterberg limits on different percentages of mixing

The results of the PI and LL test for the mentioned mixtures are as follows: Table (4)

Table (4) - The results of the Etterberg limit test after mixing with windblown sand

		Laboratory density		Density of place	
Test number	Density percentage	Optimum humidity percentage	Maximum dry density	Moisture percentage	dry density)g/ cm3 (
	٨٨	١٠/٨	١/٧٩	٩	١/٥٨
١	٩۴	١٠/٨	١/٧٩	٨/٥	١/۶٨
٢	٩٨	١٠/٨	١/٧٩	٩/٥	١/٧٥
٣	٩١	١٠/٨	١/٧٩	٩/۴	١/۶٢
۴	٩۴	١٠/٨	١/٧٩	٩/٥	١/۶٨

It seems that the mixtures of (50% clay + 50% windblown sand), (60% clay + 40% windblown sand) and (70% clay + 30% windblown sand), considering that they have a suitable PI for earthworks and the possibility Their density is up to 95% by elephant foot rollers, they are more suitable than other mixes. Due to the lack of PI in the mixture, the percentages of windy sand more than 60% have a problem in terms of density and they fall apart when pounded, and it is not possible to use them. Different clays with specifications according to table (5) were tested for combination with sandblasted materials. The results of the compaction test of mixing different soils with windy sand materials are given in table (6). Shrinkage limit testing was done on all the above materials and the obtained shrinkage limit indicates low swelling property.

Table (5) - Characteristics of different soils

Shrinkage limit	Sulfate percenta) geSo3 (	The percentage of chlorine CL	Caso4 percentage plaster 2H2o	W_{opt}	$\gamma_{d(MAX)}$ gr/cm^3	P.I	LL	percentage of clay	percentage of sand	The percentage of sand	The percentage passing through the sieve is ۲۰۰	Soil type	Test number
۲۰/۲	3.2	0.097	7.15	17.2	1.67	16	40	16	0	20	80	CL-a	۱
۲۳/۶	0.89	0.022	1.94	19.8	1.61	20	45	20	0	24	76	CL-b	۲
۲۱	0.55	0.027	1.69	20	1.64	15	38	24	0	27	73	CL-c	۳
-	0	0.76	1.78	19	1.697	14	39	24	0	5	95	CL-d	۴
-	2.06	0.87	4.47	19.7	1.67	12	38	16	0	18	82	ML	۵

Since the materials did not have a swelling problem before mixing, swelling was not measured after mixing. Figure (10) shows the effect of mixing fine-grained materials with sand on different parameters of fine-grained soil.

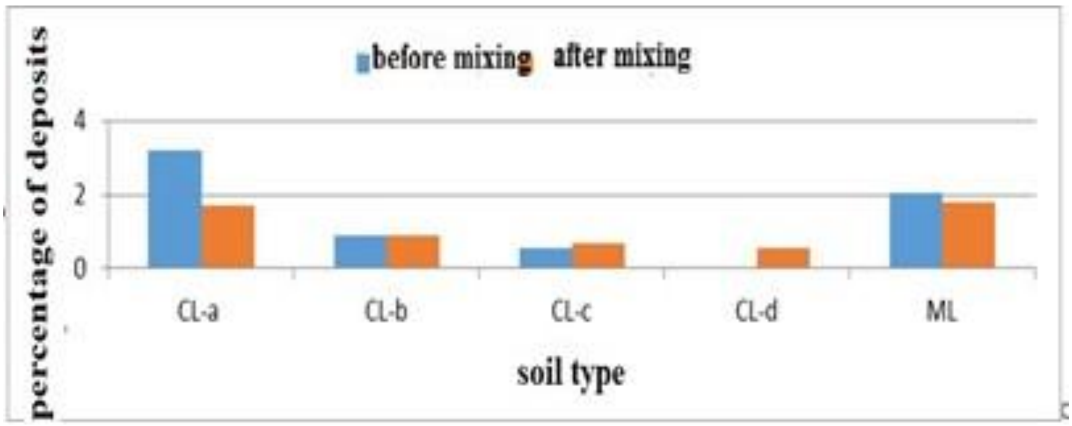

Diagram (10)- The effect of mixing fine-grained materials with sand on different soil parameters

It can be seen that the addition of airy sand materials to clay materials reduces the percentage of gypsum and sulphate, while the specific weight also increases. Based on the obtained results, the resulting mixtures are suitable in terms of the percentage of gypsum, sulfate and chlorine. Also, according to PI and density, the quality of these mixtures is suitable for earthworks. According to the results of compression and PI tests, it seems that mixing 50% of clay and 50% of sand will have a more suitable result because it has both PI and a higher density. The percentage of blown sand is more than 50 percent, although it will result in a higher density, but since it reduces the PI, it cannot be used from an operational point of view.

6- Discussion & Conclusion

Sand materials, if their percentage of fine grains is less than 12%, can be compacted by flooding method without using a compactor. In addition to increasing the efficiency of the executive operation, this method also prevents possible damage caused by the use of manual compactors. Since the ground material in most of the pipeline routes is sandy, therefore, the use of sand materials is also very important from an economic point of view due to the reduction of site distances from the transfer of particles from around the pipe to the surrounding soils or vice versa due to the existence It prevents the flow of underground water because the soil texture is the same in the soil around the pipe and in the adjacent ground. Sand materials that have more than 12% of fine grains do not achieve the desired result by flooding method due to the presence of many fine grains and mechanical compactors should be used. It is possible to mix sand and clay materials. Mixing windblown sand with clay has advantages:

a) Due to the stickiness of clay, the stickiness of mixing also increases and prevents the erosion of sand materials.

b) It is easier to reach a density of 95 with the help of graders and rollers.

c) The presence of windy sand causes the negative properties that are probably present in clay, such as swelling or the percentage of gypsum and sulfate, to decrease.

d) Mixing of windy sand increases the density. When performing the compaction test of embankment layers that have been implemented for a long time, it should be noted that the selection of the sample to determine the percentage of moisture should represent the entire thickness of the layer, not just the upper part or Bottom of it. In the areas where the pipelines pass through sandy lands, excessive excavation should be avoided as much as possible because the route will be filled again due to the sandstorm, it is better if the pipeline route follows the natural slope of the land as much as possible. It is better to use sand materials with a PI of about 5 to 7 to implement the service road sand in the irrigation and drainage network.

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