CLAY MINERALS EFFECTS ON ER – RASHYIDA SLIDE (STATION 39 +200 KM)ALONG IRBID – JERASH- AMMAN HIGHWAY[+]

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Abstract

The failure in the studied area (station 39+200km) took take place in varicolored sandstone which is called kurnub sandstone of lower cretaceous. The common characteristics between these sediments are the presence of clay lenses which consist mainly of smectite. This indicatines that the sliding area is mainly related to swelling processes. The presences of smectite clay is the most important factor that brooked sliding. It imbibes water, infiltrated through the overlying friable and high permeable sandstone, to give the greatest expansion. The high swelling pressures of clay has resulted in the reduction of shear strength and disturbance the equilibrium in the slope forming cracks and finally leads to rupture. As a result and during the winter of 1993 the whole mass overlying the clayey layers was downslided.

المستخلص

دلت الدراسة اليثولوجية على أن منطقة الانزلاق عند محطة ٣٩+٢٠٠ كم تقع ضمن الصخور الرملية المتعددة الألوان والتي تدعى صخور الكرنب ويرجع عمر هذه الصخور إلى الطباشيري الأسفل. تتخلل هذه الترسبات طبقات طينية هي في الغالب مكونة من السمكتايت وهذا دليل على ان الانزلاق في منطقة الدراسة مرتبطة بعمليات الانتفاخات المميزة لهذا النوع من المعادن الطينية . ان وجود السميكتايت يعد من العوامل المهمة في حدوث الانزلاق إذ تعمل هذه الطبقات كمصائد لمياه المطر الداخلة أليها عن طريق الطبقات الرملية الهشة التي تعلوها فتصبح اكثر نعومة ويؤدي ذلك إلى تقليل قوى القص وزعزعة استقرارية الكتل الصخرية وبالتالي تشكل تكسرات وشقوق وفي النهاية يحدث الانزلاق. ونتيجة لذلك وخلال شتاء ١٩٩٣ انزلقت الكتل الصخرية الموجودة فوق الطبقات الطينية باتجاه الشارع ساعدها في ذلك قص الشارع.

Introduction

The Amman –Jerash- Irbid Highway is transport route of national importance linking the north Jordan and Syrian frontier with the Jordanian capital city of Amman. The Jordanian government has undertaken to construct a dual carriageway along essentially the same corridor as the existing road, although now by passing Jerash city to the east. During the construction of new road between Irbid –Amman, seven major landslides have occurred because of the nature of the earth material in this area which is considered as a suitable place for slide. They have taken place after the very wet 1991, 1992 winters. One of them was chosen for the present study, which is located to the eastern side of the highway near Er- Rashayida village about 6 km south of Jerash city (Fig .1). The main objectives of this study are estimation of engineering properties of the soil in the area and determination of the clay minerals and their effects on the stability.

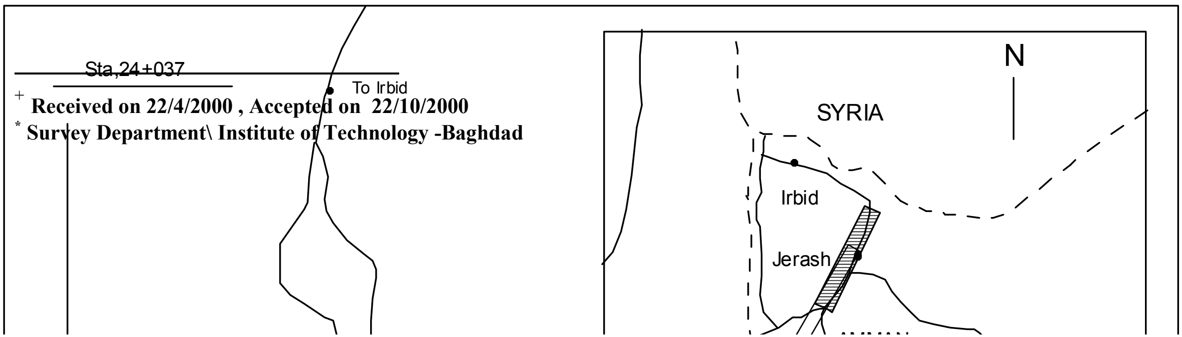

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Fig.1: Location map of Irbid – Jerash- Amman highway shows the sites of the various landslides and studied slide (After [1])

Stratigraphy

The outcropping rocks in the studied area belong to Lower Cretaceous (Kurnub sandstone Formation). The name of Kurnub sandstone was introduced for the exposed sandstone at wadi Hathira kurnub near Berr Sheba east of the Jordan Rift. It was referred to as kurnub sandstone by [2], [3] and [4] (table .1).

Table.1: Stratigraphic position of the Kurnub Sandstone Formation.

Period	Epoch	Age	GROUP	Members [5]	Formations [6]	Symbol [7]
TARTRAY		Paleocene	BELQA	Chalk_mar1	Muwaqqar	B3
CRETACEOUS	LATE	Maastrichtian		phosphorite	Amman	B2
		Campanian		Silicified limestone		
		Santonian Coniacian		Massive Limestone	Ghudran	B1
		Turonian	AJLUN		Wadi Es Sir	A7
		Cenomanian		Echinoidal Limestone	Shueib	A5- 6
					Hummer	A4
				Nodular Limestone	Fuhais	A3
					Naur	A1-2
	Early	**Kurnub Sandstone**				

[5] introduced the name varicolored sandstone unit for the Lower Cretaceous sediments. These sediments consist of friable sandstone which are varicolored and are of fine size intercalated with siltstones and claystones. The claystone intercalations are found at the upper part and are lenticular in shape with limited extensions (Fig. 2). It is clear that the whole failure has occurred within the kurnub sandstone formation. The slope of the bed rock at this site is about 8 or 9 NNW (i.e. towards the valley of Jerash). Fig. 3 represents the geological cross section for failure area at this site.

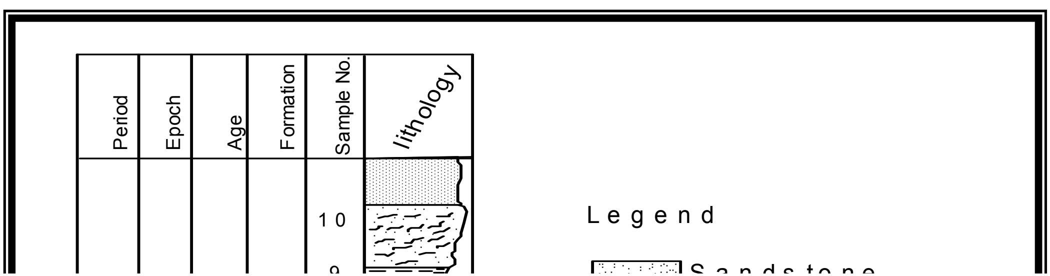

Fig. 2: Columnar section of the landslide area

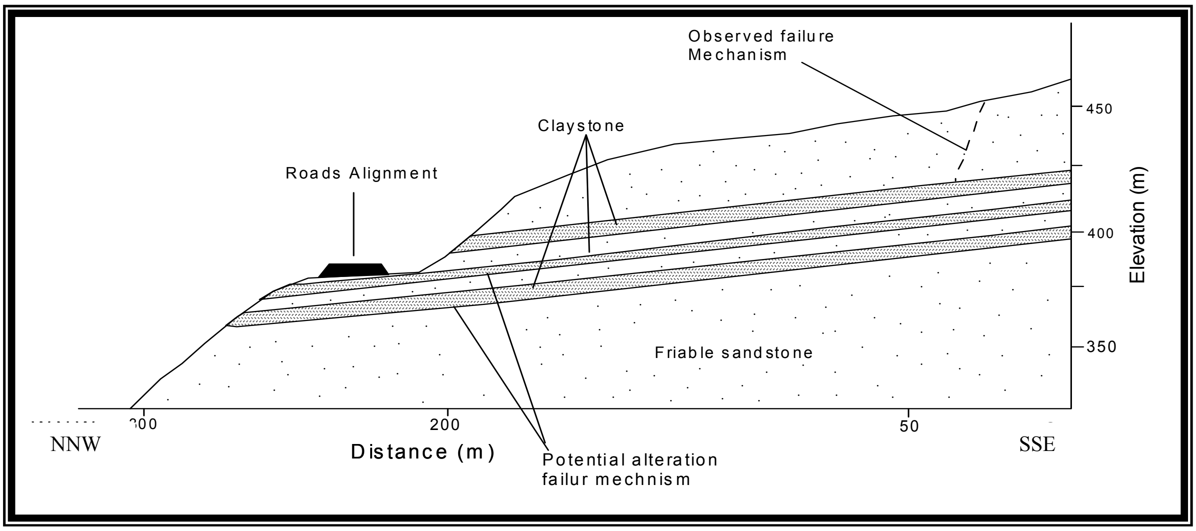

Fig. 3: A geological cross section at slide area (After [8])

Climate

The relationship between annual precipitation and sliding is very important, and it is clear from the historical review that landslides were contemporaneous with the highest recorded annual precipitation. The study area is characterized by pleasant climate, it has cool dry summer and cold wet winter. The lowest temperature recorded is less than 5 °C in January. August is the hottest month of the year, the temperature recorded exceeds 40 °C. The annual precipitate is concentrated between September and May (Fig. 4).

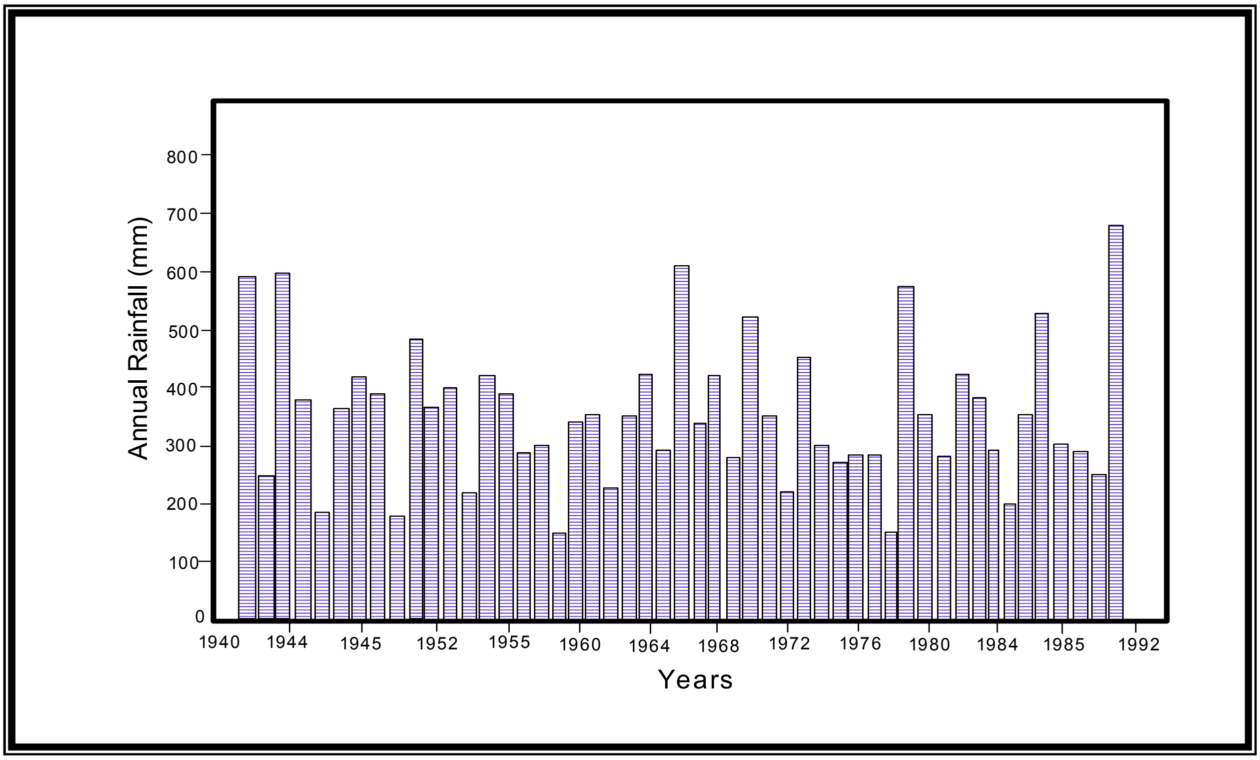

Fig. 4: Average rainfall for the last 50 years in the landslide area

Clay minerals

Ten samples of clay and surface soil were collected from landslide area and analyzed using x-ray diffraction method. Each sample has been subdivided into three subsamples, one subsample was left without any treatment (i.e. Normal), and the second one was treated by using Ethyl- glycol while the third subsample was heated on 550 °C (Fig.5).

The mineralogical analyzed indicated that kaolinite and smectite are the main constituents. Kaolinite and smectite are recorded in most studied sample whereas the Illite is recorded in only one sample. Swelling, shrinkage and break down of clays are important process in studying of slop stability specially when water is introduced into the medium and trapped by the clayey material.

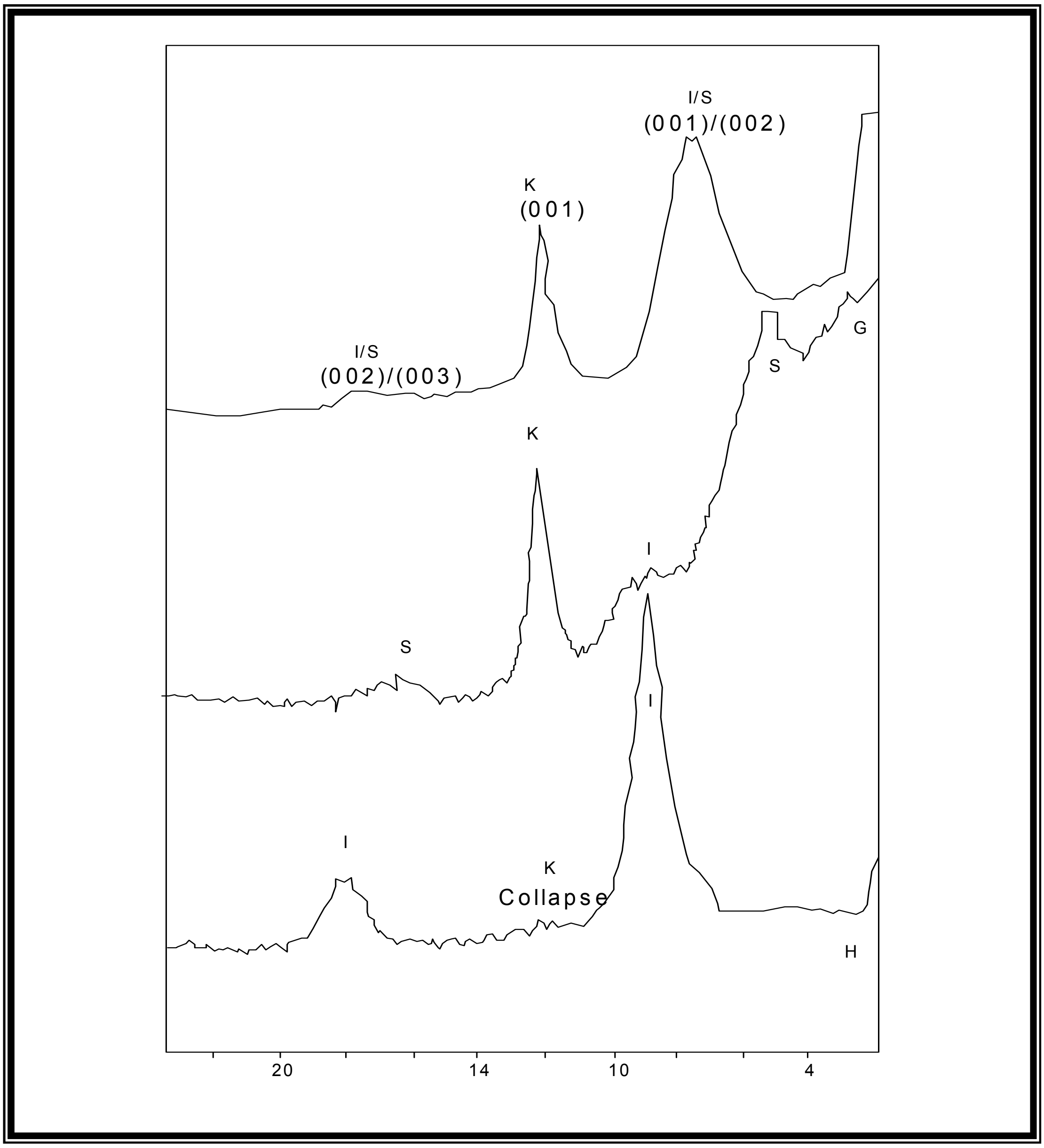

Fig.5: Oriented X-ray Diffroctograms for representative sample
(N: Normal, G: Glycolated H: Heated to 550 °C)

Geotechnical Analysis of Soil

Geotechnical properties of every type of engineering soil are shown in table (2). Most samples consist mainly of silt and clay and can be classified as silty loam.

Atterbergs Limits

The clay mineral content could greatly influence the Atterberg Limits. There is a positive correlation between the Atterberg limits and the clay minerals content. Types and the amount of every type of clay minerals affect the liquid limit and plasticity limit. The maximum liquid limit (L.L) and plasticity index (P.L) values are 99, 52 respectively. The grain size analysis for the same sample indicated that it has the highest clay size content. The comparison among clay minerals in the studied samples with Atterberg Limits indicate that the samples with highest smectite tend to have the highest Atterberg Limits.

Table (2): Engineering properties of the studied samples

S.NO	***Clay***	***Silt***	***Sand***	***Water continent***	***Atterberg limite***			***θ***
					*L.L**	*P.L**	*PI**	
J1	10.5	75.5	14.0	20	39.0	29.5	9.5	14.2
J2	35.0	50.6	16	16	66	25	41	15.5
J3	39.1	52.9	8.0	19	45	20.0	25.0	15
J4	25.0	70.8	4.2	26.3	54	38	16	12.5
J5	34.0	60.4	5.6	23.75	51	28	23	13.0
J6	50.8	48.2	1	33	99	47	52	9.8

***L.L: Liquid limit, P.L: Plastic limit, PI: Plasticity index, θ: internal friction angle**

Shear strength

The maximum internal friction angle (θ) was 15.5 and the minimum one was 9.8 for samples 1 and 6 respectively for the peak at the first time shearing. The clay content for the sample 4 is very minor whereas the sample 9 is about 53% and 80% of the samples is smectite. It has been observed that there is negative relationship between internal friction and clay content (smectite). The higher smectite content and the lower values of shear strength make the sliding so easy with the presence of water.

Swell

Swellings of clays are important processes in studying of slope stability [9]. The initial water content plays an important role in the swelling so in rainy seasons the moisture –saturated soil absorbs large quantity of water and swells substantially. The potential swell is found to decrease with the increase of initial water content and to increase with the increase of the liquid limit. It clears that with higher liquid limit and plasticity limit value tend to have the highest values of swell percentages.

It is noticeable that there is a positive relationship between the clay content and plasticity limit values and the swell percentages. The effect of the mineral type and content is illustrated in (Fig 6 and Fig 7). It can be observed from the figures that the smectite clay content influences the swell more than the kaolinite.

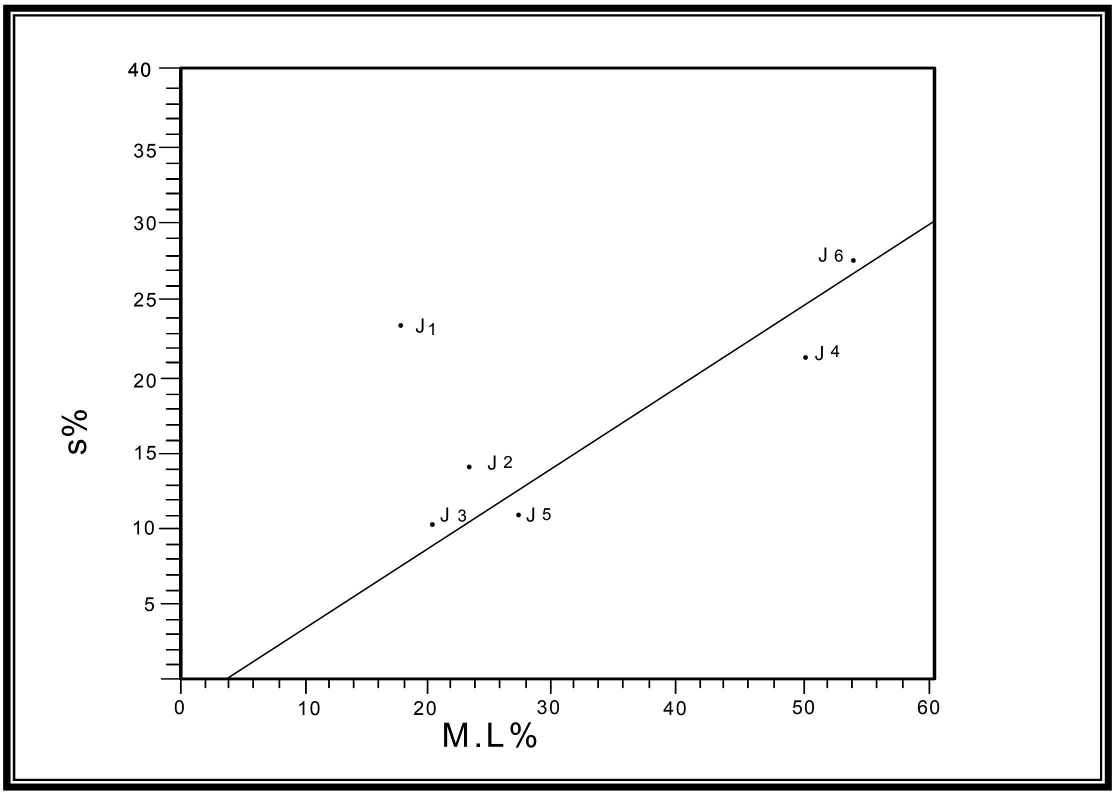

Fig. 6: The relationship between the swell (S %) and the Semctite% of the studied samples

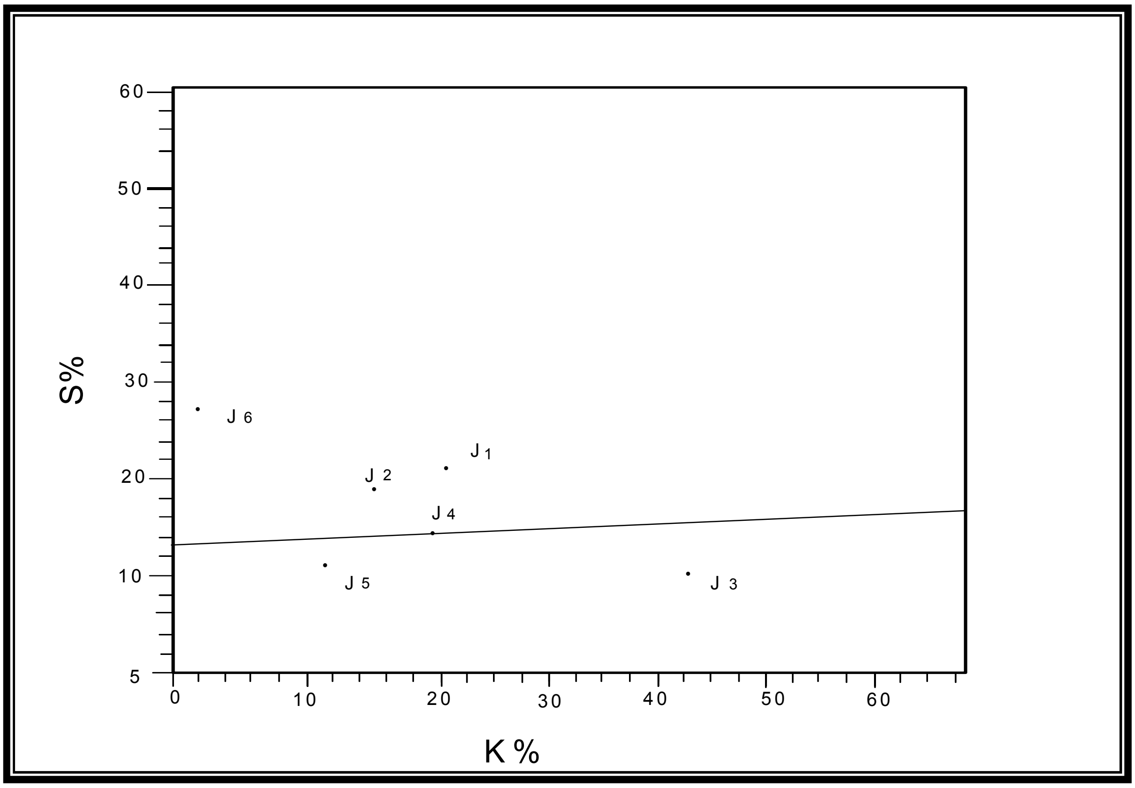

Fig. 7: The relationship between the swell (S %) and the kaolinte % of the studied samples

Conclusions

The clay beds of the Upper Kurnub Sandstone were subjected for mineralogical and enginerring properties to explain the effect of clay minerals on Er Rashayda landslide along Irbid- Jerash- Amman Higyway. The representative sample shows relatively high amount of smectite which indicates that the sliding area is mainly related to swelling processes.

The high ability of smectite clays to expand with the presence of water has resulted in the reduction of shear strength parameters which activated the sliding processes. As a result, and during the winter of 1993 enhanced by slope of the bed rock and cut of the road the whole mass overlying the clayey layers slides.

Recommendations

1. The study area has previously suffered from ancient landslides, the shear or sliding surfaces are to be considered during the construction of the highway.
2. The exposed clayey beds are to be covered by concrete or plant blankets to prevent water perculation
3. To avoid water perculation at the locations of the exposed clayey beds construction of a surface water channel draining system is a necessity.
4. The dip and the dip direction of the in situ beds must be taken into consideration during the construction of the highway.
5. It is recommended to shift the alignment to a more stable location around the highway.

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