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STUDY AND EVALUATION OF SOIL SLOPE STABILITY OF AL- MASAB AL-AAM CHANNEL (MIDDLE SECTOR) OF IRAQ

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ABSTRACT
This study is concerned with channel banks stability in the middle sector of Al-Massab Al-Aam channel in the middle and south of Iraq, four stations where the factors controlling and affecting their stability, are determined. Field observations showed instability in many parts of the channel banks including soil falls that represent the major type of soil failures in steep bank slopes close to water surface .It forms 50% of the soil failures in the study area; toppling represents smaller percentage of soil failures forming 40% of the soil failures in the study area, and the other types sliding bounded by tension cracks from behind and rolling are very little and forming only 10% of the soil failures and concentrated in the upper part of channel banks; erosion including undercutting of the toe of vertical channel banks close to water surface which leads to overhanging slope is also present. Some treatment measures are proposed to stabilize the slopes in the area.

KEYWORDS: Soil slope stability, types of failure, Soil stabilization.

INTRODUCTION

Location of the Study Area

The study area occupies some of the central and southern parts of the Mesopotamian plain, along 199km, it is located within Babylon , Al-Qadissiya, Wasit and Thi-Qar Governorates and bounded by Al-Shomaly district(Hilla-Waist road) from east and Al-Nasriya city from west ,the study area extends between longitudes (45° 06' - 46° 17') E and latitudes (31° 04' - 32°26') N as in Fig.(1)

Aims of the Study:

The aims of this study are to

- Make slope stability evaluation at four sites in the channel bank and determine the mode of failures and the unstable hazardous sites.
- Propse some treatment measures to stabilize the soil slopes in the area.

METHODOLOGY

Stages of research involved

1 The Data Collection Stage in which maps and references about the study area have been collected.
2 Field work stage where the slopes and gullies were surveyed and soil samples were collected
3 Laboratory work stage in which the physical and engineering tests of the soil samples at failure sites was found.**,** Sedimentology,

Previous studies

previous studies are almost focused on Geomorphology.

Hydrogeology and an environmental study

(Abdul Ameer, 2012 , Imran et al., 1996 , Al-Husseini 1998 , Al-Ezerajawi, 2012 respectively) .There is only one Ph.D. Thesis on slope stability of outfall drain (Middle sector) of Iraq by Al-Amar(2014),from which the basic data of this paper are derived.

Geology of the study area

The study area is located within the Mesopotamian plain in the area of Unstable Zone relative to the tectonic divisions of Iraq (Buday, 1980) within the geosyncline basin, between the Zagros Mountains in the north east and the Western Stable Arabian Plateau) in south west . The Mesopotamian plain is a broad syncline formed since the Pliocene period, the delta Plain province is a vast alluvial plain with a slight southeast gradient. It is filled with an accumulation of flood plain, deltaic and lacustrine deposits, and due to human activities for several thousand years many artificial irrigation canals have behaved as rivers, eroding the original sedimentary cover of the plain.

From geological point of view the study area is covered by Quaternary deposits particularly of Holocene, these deposits were accumulated in thick sequence that consist of clastic deposit composed mainly of sand , silt , and clay which are represented by depression fill deposits, flood plain deposits, and Aeolian deposits in (Barwary1992)

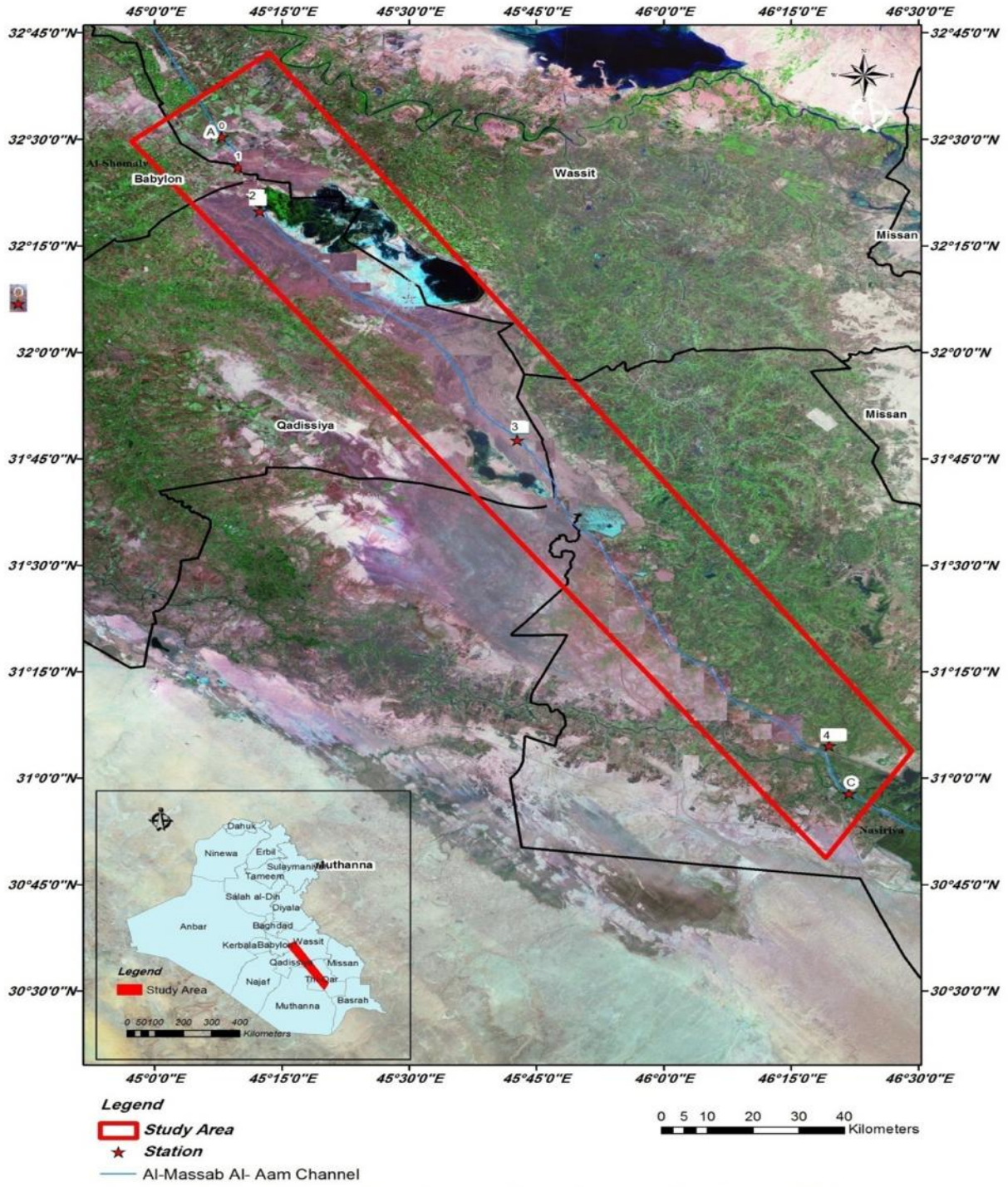


Figure (1) Location map of the study area in the southern part of Iraq from satellite image.

SOIL SLOPE STABILITY EVALUATION IN THE STUDY AREA

Four sites (stations) have been chosen in this study where different types of slope failure exit, to evaluate slope stability in the area.

Station No. (1)2-1

This station lies 23 km (SE) of Al-Shomaly town , and 9 km (NW) of station (A),on the left bank, at latitude (32º 26' 02")N and longitude (45º 09' 51")E, within Babylon Governorate .It represents the beginning of the study area and it is called station (365+00)area , (Fig.1 and plate1).The bank slope inclination is (220º/88º-OH) and slope height is (2.5)m.(Fig. 2) shows vertical profile perpendicular to the bank slope trend at station No(1).It shows from bottom upward the following parts:(1)the main vertical bank slope partially overhanging which is 2.5m high (2)the horizontal berm which is 3m wide (3)soil slope inclined 45º SW, which is 2.8m high, and (4)horizontal service road. The soil at this site is composed

of sandy silty clay,(CL), it was collected from the lower part of the slope which is close to the water surface .The soil has brown color, medium hardness , low plasticity and moisture content of (19.6%).

This station is one of the unstable sites, where(1)salt layers are observed in the lower part of bank close to the water surface (2)there are many soil slabs with observed failure of soil masses (probably sliding and fall)close to the bank slope toe indicating soil detachment as in plate(1).

Plate(1) Showing (a) General front view of the bank slope at station No.(1) in the Al-Massab Al-Aam channel (middle sector).Photo direction is NE. (b)Close side view of the salt layers, and soil slabs failure sliding and fall in the lower part of the bank slope at station No.(1)

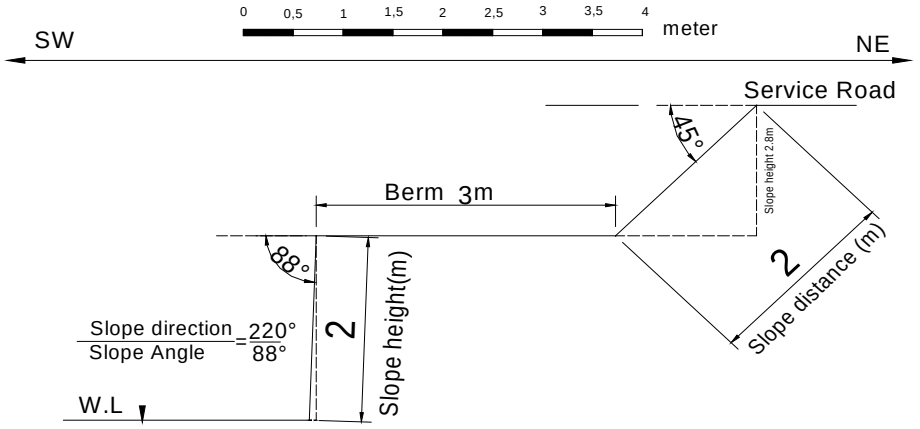


Figure (2) Vertical profile perpendicular to the bank slope trend at station No(1) in the Al-Massab Al-Aam channel (middle sector).

Station No(2) -2

This station lies 100km (SE) of station No1,on the right bank at latitude (32º 19' 25") N and longitude (45º 12' 25")E, within Qadisiya Governorate sector . It is called station (351+00)area , (Fig.1 and plate 2).The bank slope inclination is(040º/88º)and slope height is(1.7)m. (Fig. 3) shows vertical profile perpendicular to the bank slope trend at station No(2).It shows from bottom upward the following parts:(1)the main vertical bank slope(2)the horizontal berm which is 4m wide. The soil at this site is composed of silty sandy clay ,(CL)it was collected from the upper part of the slope which is far from the water surface .The soil has brown color, medium hardness , low plasticity and moisture content (23.6%).

This station is one of the unstable sites, where observed failures include tension crack ,toppling and soil fall of soil masses close to the bank slope toe as in plate(2).

plate(2) Showing views of the bank slope at station No.(2)in the Al-Massab Al-Aam channel(middle sector). (a) General side view of the bank slope. Photo direction is SE. (b)Close side view of the failed bank slope showing detached soil blocks. Photo direction is NW.

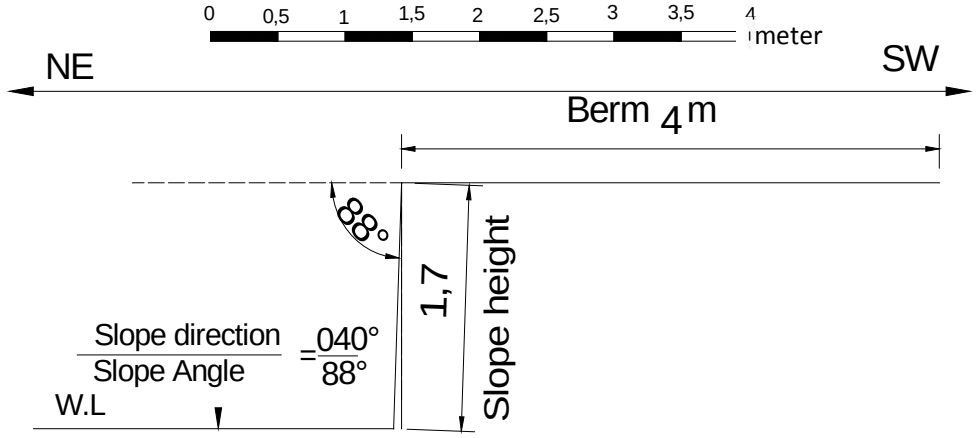


Figure (3) Vertical profile perpendicular to the bank slope trend at station No(2) in the Al-Massab Al-Aam channel (middle sector).

Station No. (3)2-3

This station lies 30 km (SE) of station No2 , on the left bank, at latitude (31º 47' 34") N and longitude (45º 37' 07")E, within Nasiriya Governorate sector, (Fig.1and plate 3).The bank slope consists of two part ,the lower part is inclined 250/50 º and it is 2m high ,while the upper slope of hard soil is inclined(250/88 –OH) and it is 1m high . (Fig 4) shows vertical profile perpendicular to the bank slope trend at station No(3).It shows from bottom upward the following parts:(1)the main bank slopes as explained above(2)the horizontal berm which is 3m wide(3) soil slope inclined 45º SW, which is 2.1m high, and (4)horizontal service road. The soil at this site is composed of silty clay,(CH) it was collected from the lower part of the slope which is close to the water surface .The soil has brown color, medium hardness , high plasticity and moisture content of(21.2%). This station is one of the unstable sites, where the observed failures include tension crack ,detached soil blocks from the upper hard soil layer as seen in Plate(3).

plate(3) Showing views of the bank slope at station No.(3) in the Al-Massab Al-Aam channel (middle sector). Photo directions are NW.(a)General side view of the bank slopes showing the lower inclined slope (2m high)and the upper vertical slope of salty layer gypsam)(b)Close side view showing the lower inclined and the upper vertical slopes with fallen detached blocks from the upper hard soil.

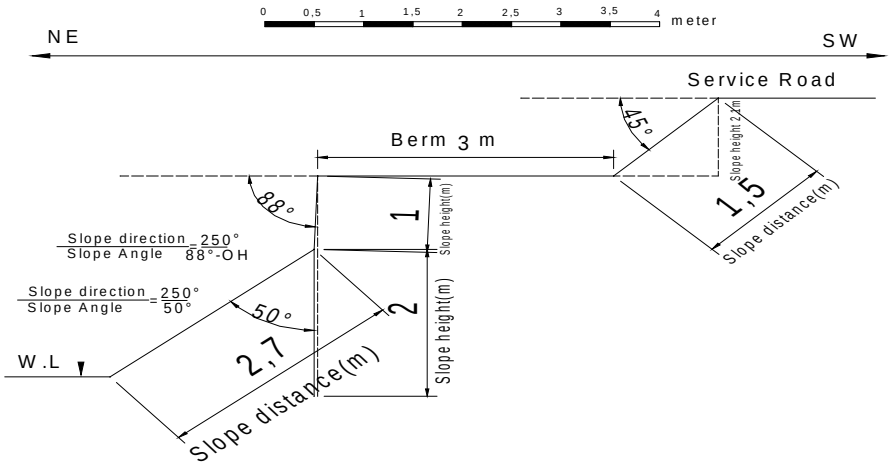
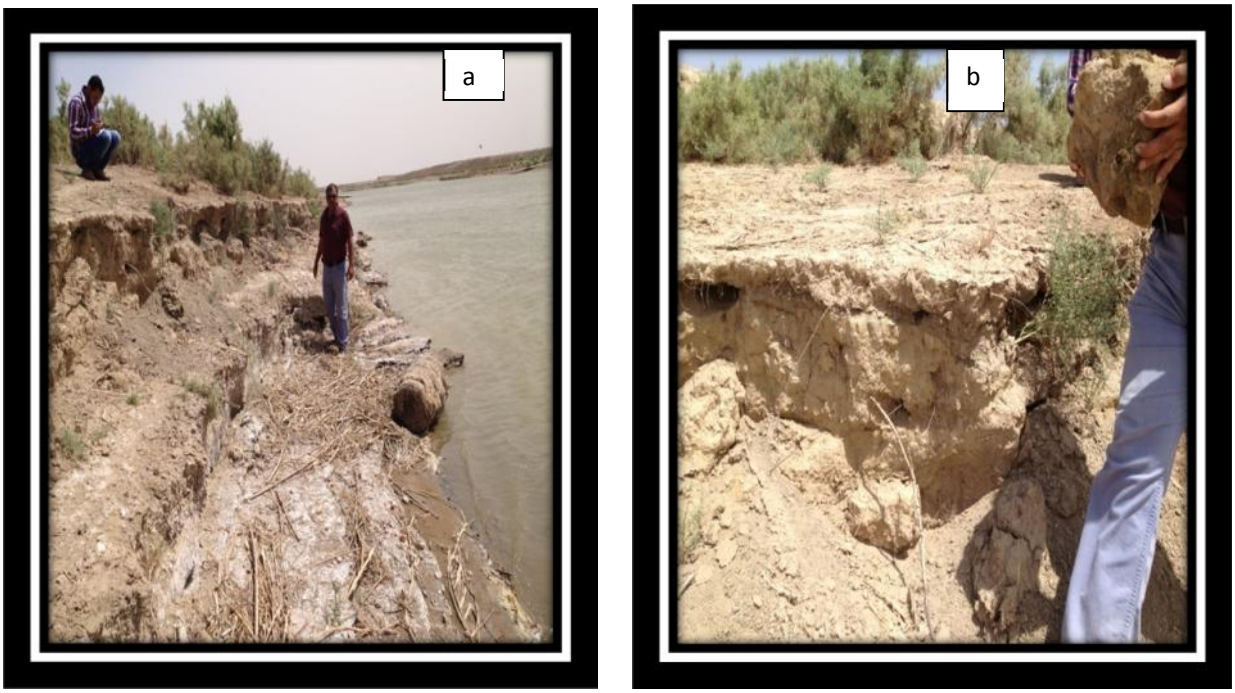


Figure (4) vertical profile perpendicular to the bank slope trend at station No(3) in the Al-Massab Al-Aam channel (middle sector).

Station No. (4)2-4

This station lies70 km (SE) of station No 3 , on the left bank at latitude (31º 04' 30")N and longitude (46º 19' 27")E, within Nasiriya Governorate sector, (Fig.1 and plate 4).The bank slope inclination is(280º/40º)and slope height is (2)m. The slope is stepped with many hard horizontal soil layers indicating many stages of wave erosion. (Fig. 5) shows vertical profile perpendicular to the bank slope trend at station No(4).It shows from bottom upward the following parts:(1)the main bank slope is inclined 40º NW ,which is 2m high the horizontal berm which is 3m wide. The soil at this site is composed of silty clay,(CL) it was collected from the upper part of the slope which is far from the water surface .The soil has brown color, low hardness , low plasticity and moisture content of (29.4%).

This station is one of the unstable sites, where(1) salt layers are observed in the lower part of the bank close to the water surface (2) slope failure includes local disintegration of different layers with detached soil blocks by fall or toppling as in Plate(4).



plate(4) Showing general views of the bank slope at station No.(4) in the Al-Massab Al-Aam channel (middle sector), (a)side view showing the stepped bank slope like stream terraces in form but with different origin (wave erosion). Photo direction is SW.(b)Front view of one step (layer)in the upper part of the slope showing detached soil blocks .

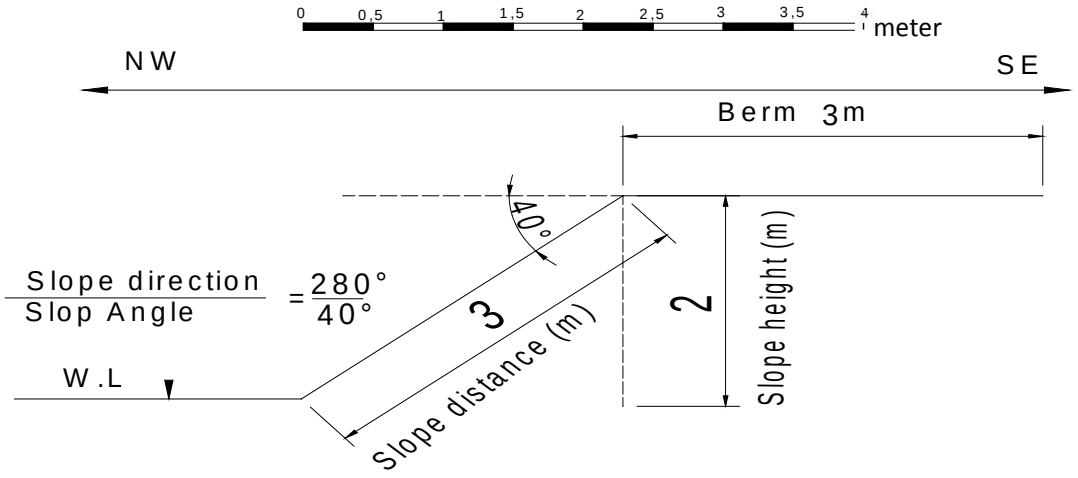


Figure (5) Vertical profile perpendicular to the bank slope trend at station No(25) in the Al-Massab Al-Aam channel (middle sector).

SLOPE STABILITY EVALUATION IN STUDY AREA STATIONS

The soil failures have happened in most parts of the study area, thus soil failure for each station is explained as follows

Station No.1

This station is one of the unstable sites, where(1)salt layers are observed in the lower part of bank close to the water surface (2)there are many soil slabs with observed failure of soil masses (probably sliding and fall)close to the bank slope toe indicating soil detachment.

Station No.2

This station is one of the unstable sites, where observed failures include tension crack

,toppling and soil fall of soil masses close to the bank slope toe is 0.5m thick.

Station No.3

This station is one of the unstable sites, where the observed failures include tension crack, detached soil blocks from the upper hard soil layer.

Station No.4

This station is one of the unstable sites, where(1) salt layers are observed in the lower part of the bank close to

the water surface (2) slope failure includes local disintegration of different layers with detached soil blocks by fall or toppling.

SOIL STABILIZATION METHODS

There are many different methods which can treat the problem of soil failures including the following treatments

1. The soil cement mixture can using for casing the drainage and irrigation channels in Al-Massab Al-Aam channel where most drainage which is flow in the Al-Massab Al-Aam channel causes water erosion and bank slopes failures therefore must be stabilizing it especially in station.
2. Lime stabilizations technology can be using in some station of Al-Massab Al-Aam channel especially station
3. The riprap methods generally used for casing the bank slopes which had highly erosions such as the meanderings rivers and the locations of meeting the Al-Massab Al-Aam channel (middle sector) with its branches, therefore this method can be used in some stations especially stations(2,4).

CONCLUSIONS

1. Large parts of the bank slopes (72%)are in unstable conditions; these represent different soil failures that result from the weight of soil mass, and bank slopes erosion because of the undercutting erosion in slopes toes or by gulley erosions caused by the rainfall waters on the bank slopes that led to decrease of its slope angle and to transport large part of the bank soils to the bottom of the channel.

2. The upper parts of the bank slopes are more liable to gulley erosion ,while the lower parts (which are close to water surface) were more liable to undercutting that leads to failures such as :toppling ,soil fall sliding and rolling. The tension cracks exist in the berms surfaces extending in parallel direction to them .They reflect the start of mass movement to the lower slope

3. There are many types of soil failures in the bank slopes of Al-Massab Al-Aam channel including soil falls that represent the major type of soil failures, forming 50% of the soil failures in the study area, toppling represents smaller percentage ,forming40% of the soil failures in the study area, and the other types (sliding and rolls) are very little forming just(10%) of the soil failures in the study area.

RECOMMENDATIONS

After studying all field observations of Al-Massab Al-Aam channel soil(middle sector),the following points are recommended :

1. Using some types of plants that have resistance to the high concentration of salts along Al-Massab Al-Aam channel (middle sector) in order to stabilize and protect the soil of bank slopes from failures.
2. Flattening the steep bank slopes by reducing their slope angle or by grading the slope into steps.This will increase slope stability.
3. Using field compaction for the upper layers of the bank slopes in order to increase the soil strength.
4. Supporting the bank slope toes and the gullies by gravels in order to protect them from water erosions and allowing water movement between the bank soil and the channel.
5. Using riprap in the banks slopes that are more liable to failures or erosions in order to protect them from such hazards in the future.

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