Modern Irrigation Networks of Iran: Problems & Challenges

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Agricultural Development

- Due to increasing population and growing cities and increasing demand for food, planning, design and construction of the modern irrigation networks in Iran started in 1950's.
- The first modern irrigation network, Dez, was constructed in early 1960.
- So far more than 100 modern irrigation networks have been constructed covering an area of 1.6 mha.

An overview on Iran
Land & Water Resources

a. Land

Total Area	Total Arable Land	Total Land Annually Under Cultivation	Forest Area	Irrigated Agriculture	Rain fed Agriculture	Area under Modern Irrigation Networks
165 mha	51 mha	18.5 mha	12.4 mha	8.5 mha	10 mha	1.6 mha

b. Water

Total Annual Precipitation	Annual Renewable Water	Surface Runoff	Agricultural Water
430 bcm	130 bcm	95 bcm	85 bcm

Based on the report published by Ministry of Energy, modern irrigation structures have been suffering different rates of damages:

- **High to moderate 30%**
- **Medium to low 36%**
- **Low to zero 34%**

The nature of the problems in irrigation networks:

- **Geographical and topographical conditions**
  - Harsh topography, more than 2/3 of the country is covered by mountains , hilly areas and deserts.
- **Geological conditions**
  - Locating in a highly seismic active zone, presence of 100's active faults which face the structures with seismic hazards.
  - Presence of weak sedimentary formation, such as gypsum, marl, shale and saline soil.
- **Climatic conditions**
  - Very high and very low temperatures, long freezing periods, long hot summer periods. 1/3 of country has less than 50mm annual precipitation (deserts).
- **Political, social and cultural issues**

Main causes of damages to the irrigation structures

-Technical and design related problems

-Poor construction practices

-Poor operation

-Poor maintenance

-Cultural and social issues

Design Related Problems

- Insufficient discharge capacity of canals
  - -Insufficient freeboard
  - -Improper friction coefficient
- Improper flow velocity
  - -Sedimentation
  - -Erosion
- Lack of safety structures

Lack of Under Drainage Structures

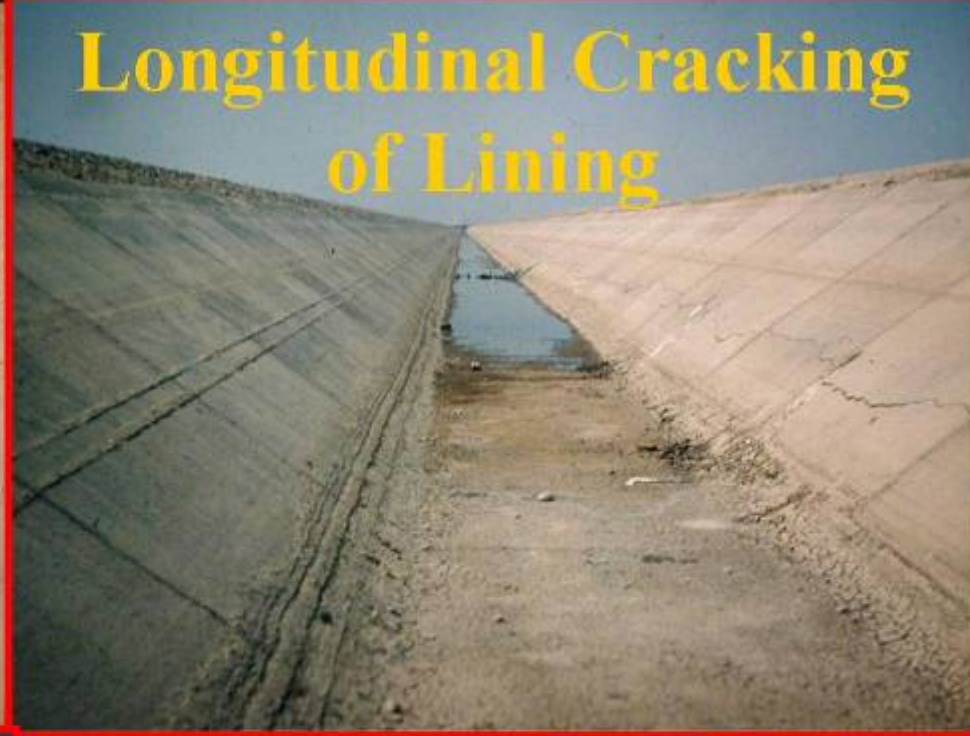
Problems Related to Presence of Problematic or Difficult Soils:

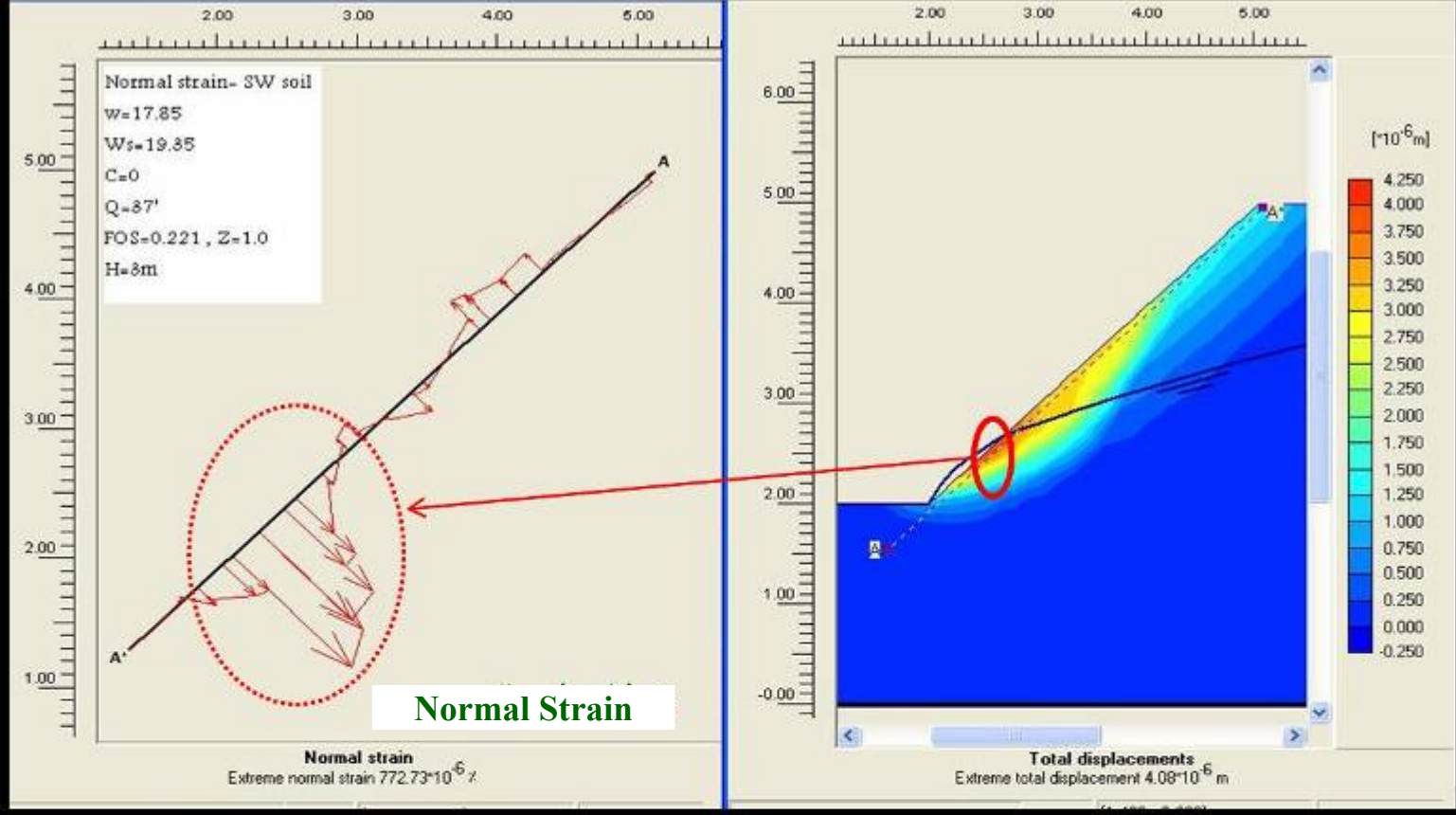
Soils which cause damage to the upper structure when in contact with water

- Swelling Soils
- Dispersive Soils
- Soluble Soils
- Collapsible Soils
- Liquefiable Soils – Fine Sandy soils
- Weak Organic Soils – Saturated Clays

Problems Related to Expansive Soils

(The soils which suffer high volume change due to change in water content)


Longitudinal Cracking
of Lining


Normal strain- SW soil
w=17.85
Ws=19.85
C=0
Q=37'
FOS=0.221 , Z=1.0
H=8m
A
A'
Normal Strain
Normal strain
Extreme normal strain 772.73*10^-6 /
Total displacements
Extreme total displacement 4.08*10^-6 m
[*10^-6m]
4.250
4.000
3.750
3.500
3.250
3.000
2.750
2.500
2.250
2.000
1.750
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1.250
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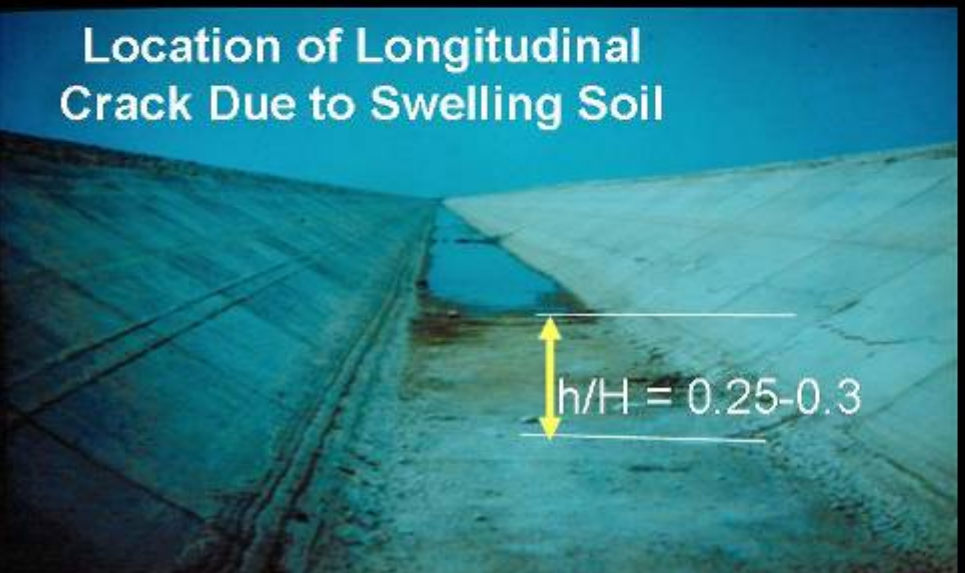
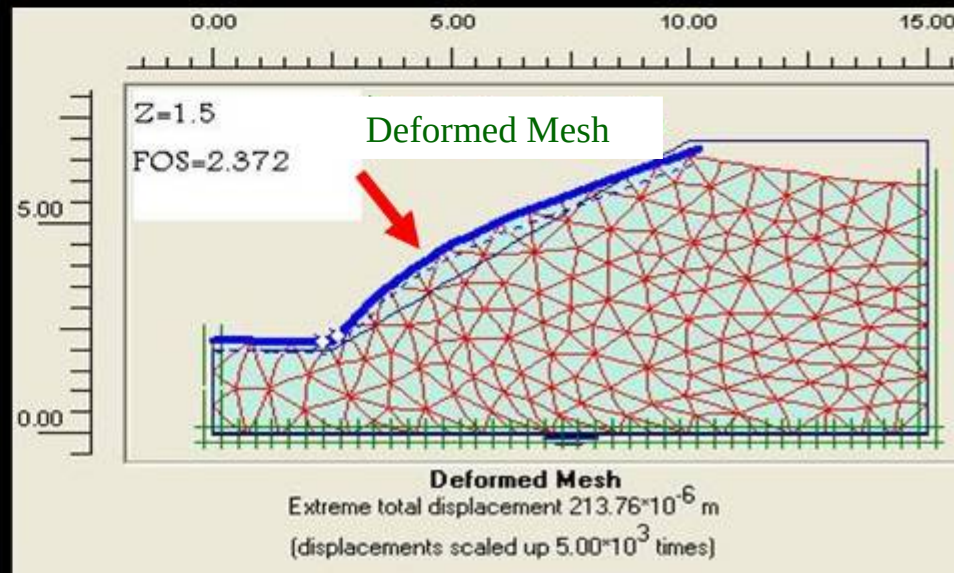
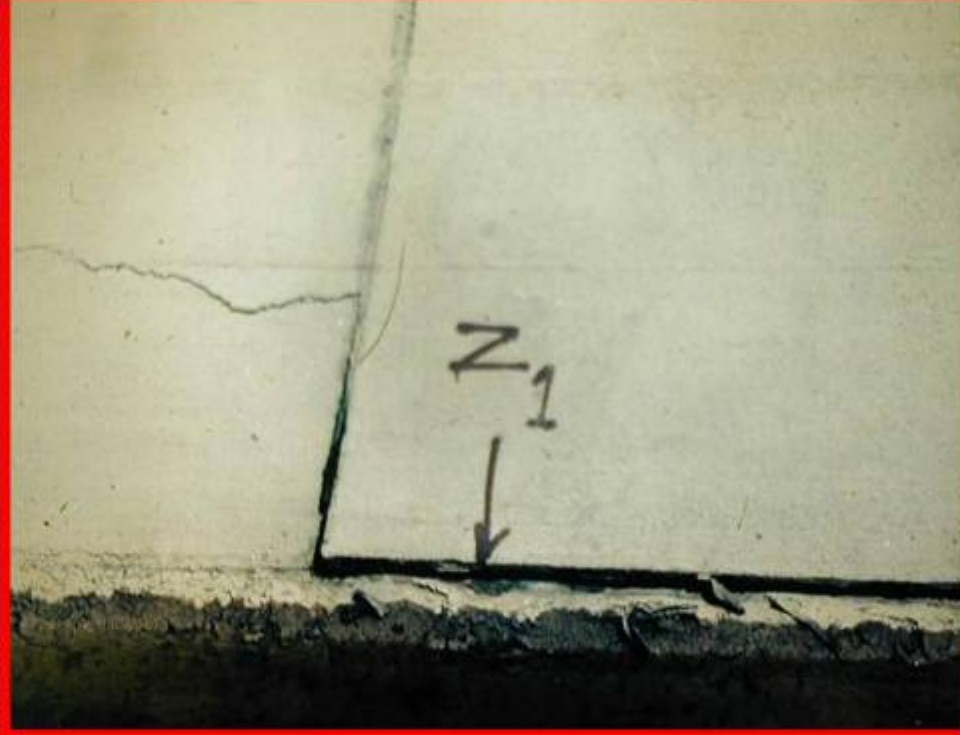
0.000
-0.250


Location of Longitudinal
Crack Due to Swelling Soil
h/H = 0.25-0.3


Z=1.5
FOS=2.372
Deformed Mesh
Deformed Mesh
Extreme total displacement 213.76*10^-6 m
(displacements scaled up 5.00*10^3 times)


Embankment Cracking


z_1


Uplifting of Concrete Slabs

Problems Related to Dispersive Soils

(The soils which are easily eroded in contact with water)

A View of Dispersive Soils

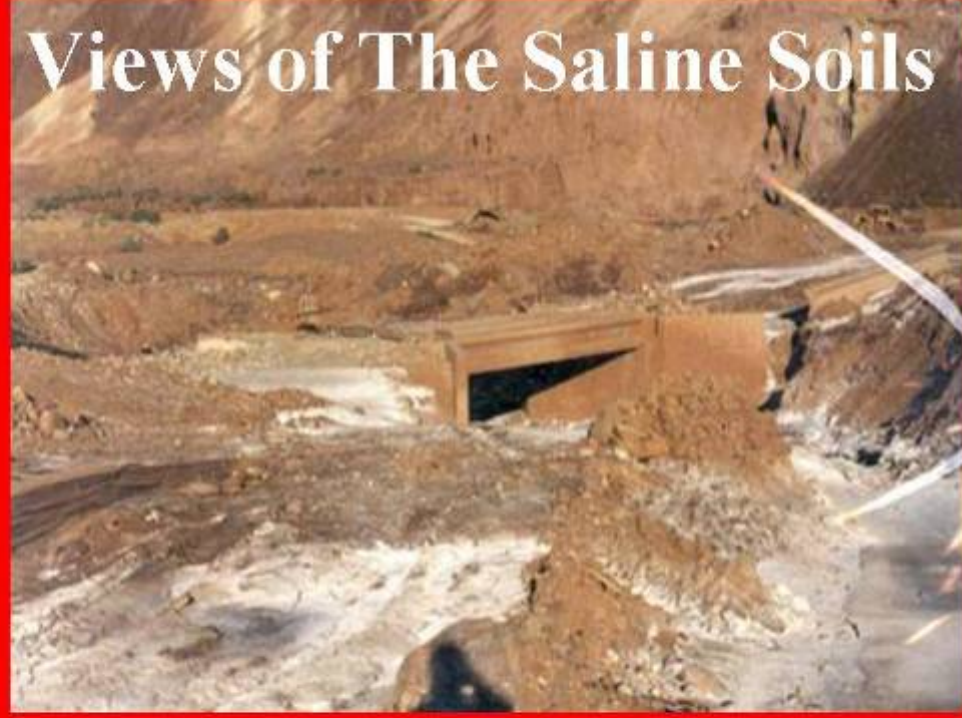
Canal Lining Destruction Due to Piping of Dispersive Soils

Erosion of Subgrade Soil Due to Presence of Dispersive Soil

Problems Related to Soluble Soils

(The soils which are easily leached in contact with running water, including gypsiferous and saline soils)

Views of The Saline Soils



Views of The Gypsiferous Soils


Cavities Under Concrete Lining
Due to Solution of Gypsum

Problems Due to Liquefiable Soils

(The soils which lose their shearing strength when subjected to dynamic forces in loose, submerged conditions)

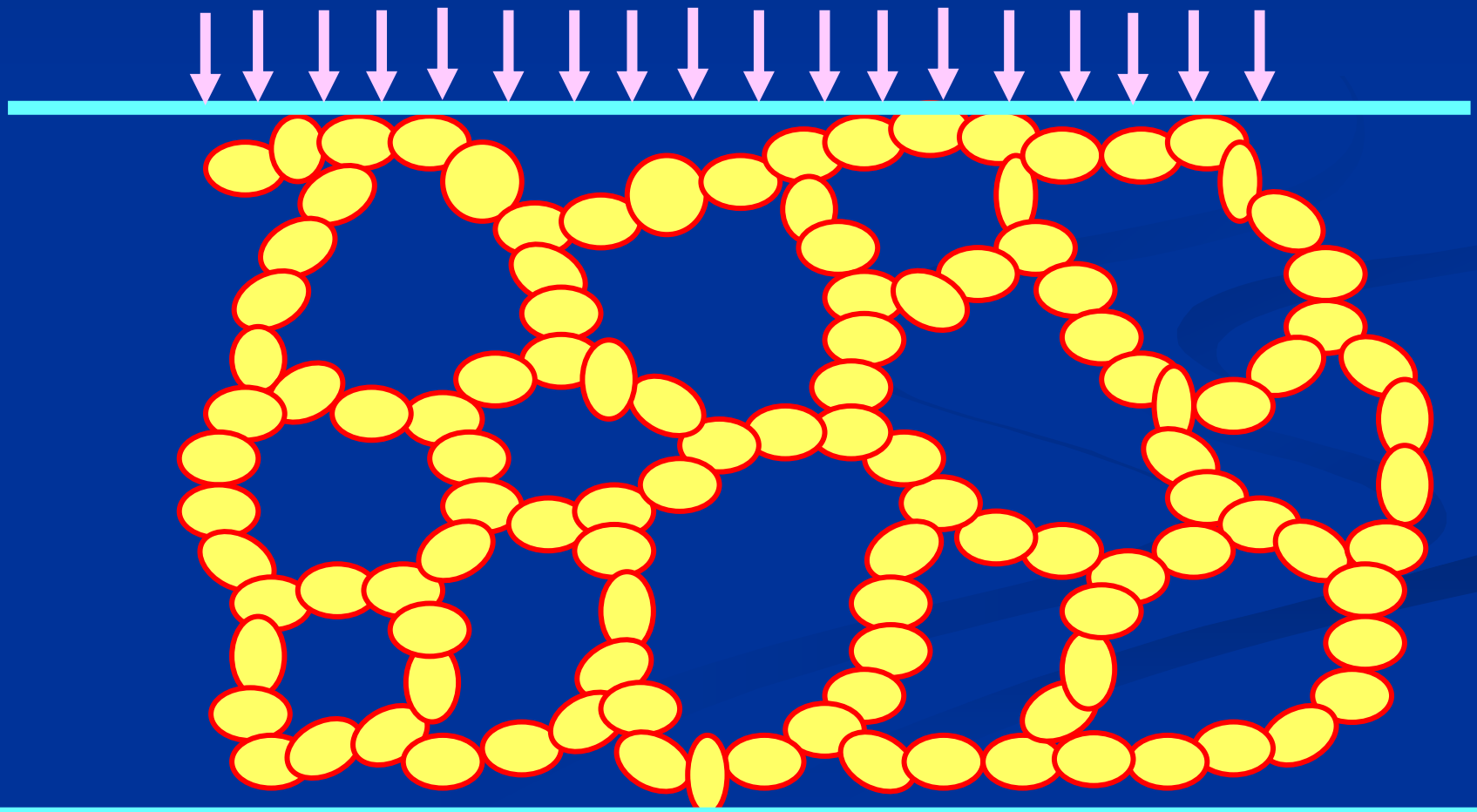
Effects of Soil Liquefaction on the Ground Surface

Problems Related to Collapsible Soils

(The soils which their structure will collapse when in contact with water)

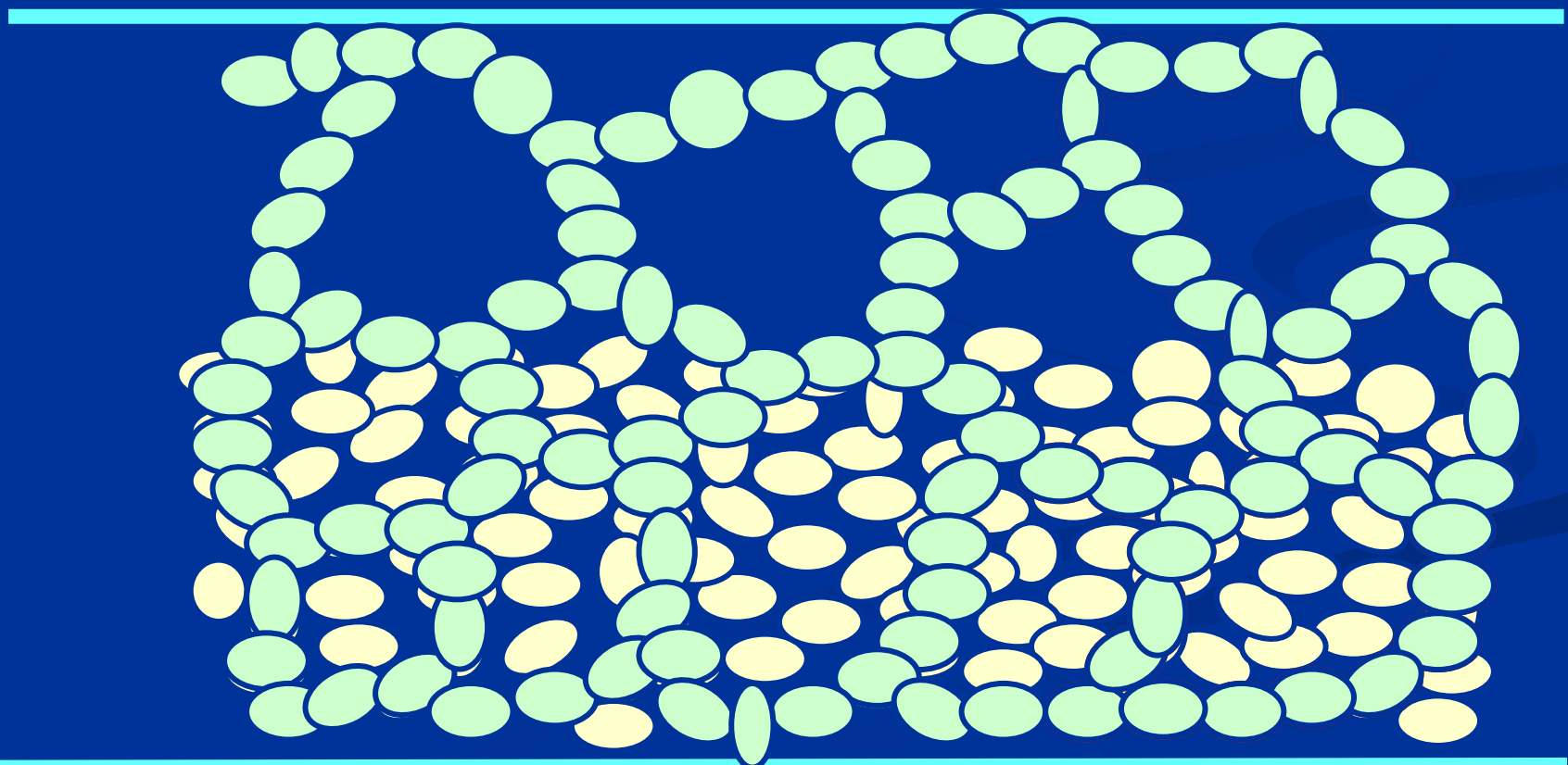
Structure of Collapsible Soil

Fine Sand & Coarse Silt



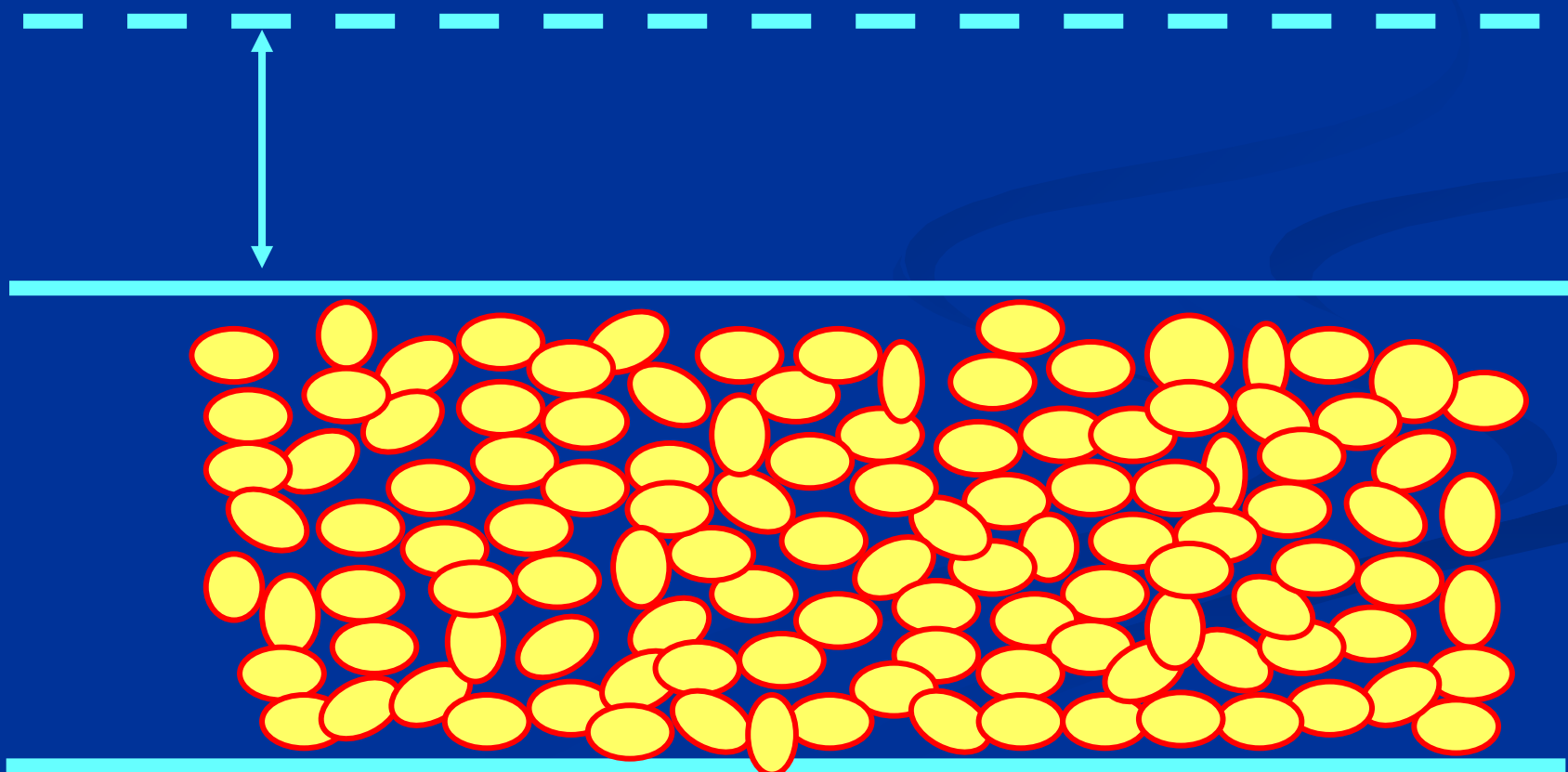
Structure of Collapsible Soil

Fine Sand & Coarse Silt



Structure of Collapsible Soil

Fine Sand & Coarse Silt

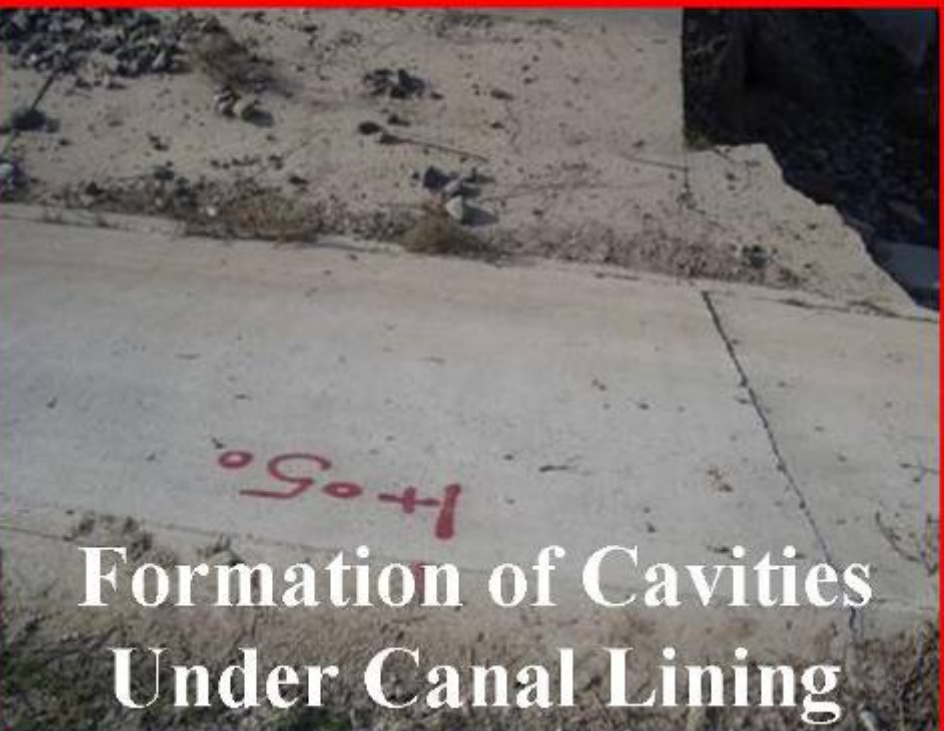


A view of the collapsed ground surface

Canal Embankment Cracking
Due to Collapse of the Soil

Problems in Unstable Fine Sandy Soils (Physical Dispersivity)

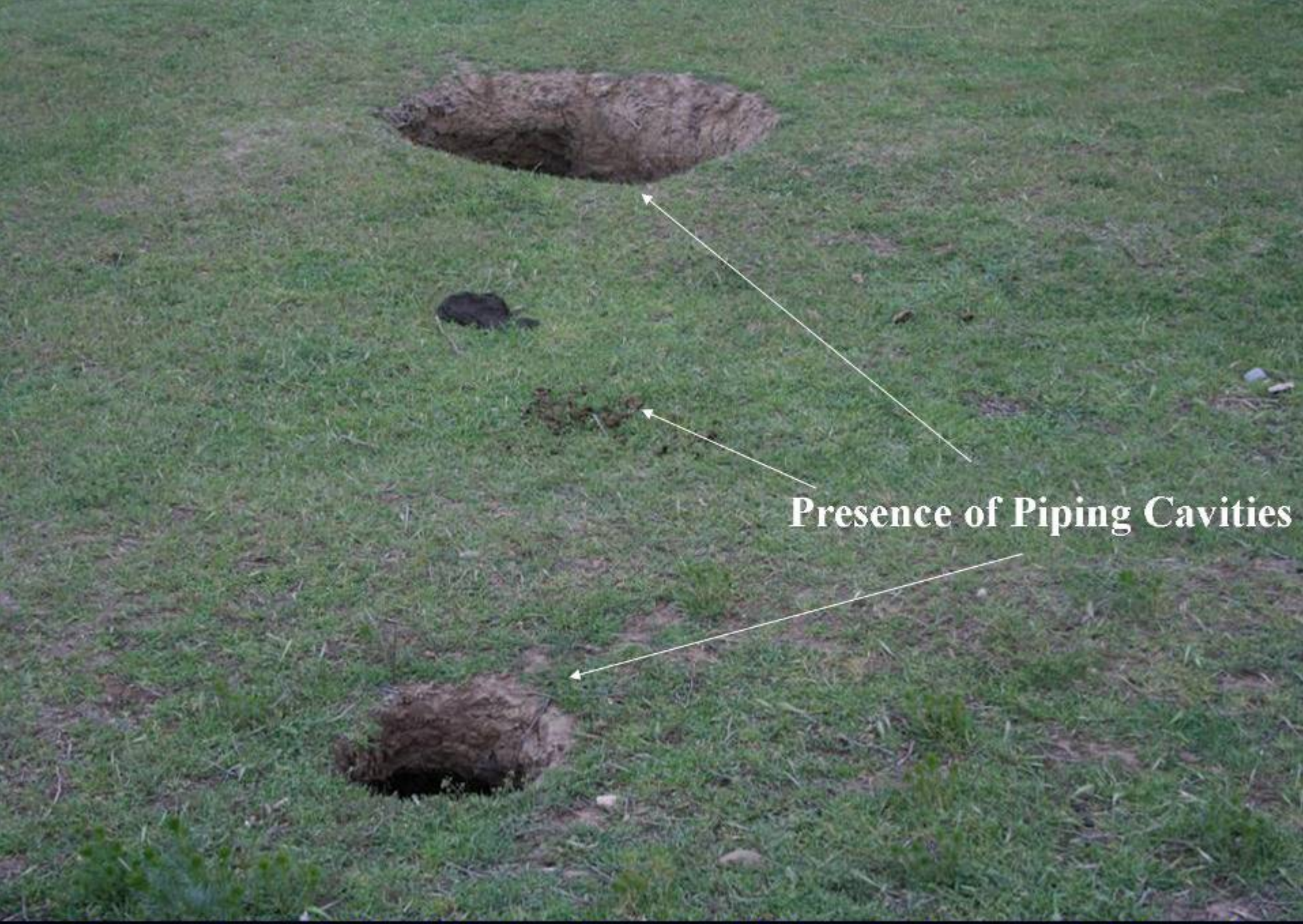
(These type of soils are mostly made of uniform, fine sand, which are easily eroded by flowing water)



Formation of Cavities Under Canal Lining

Presence of Aeolian Soils

Presence of Sand Dunes

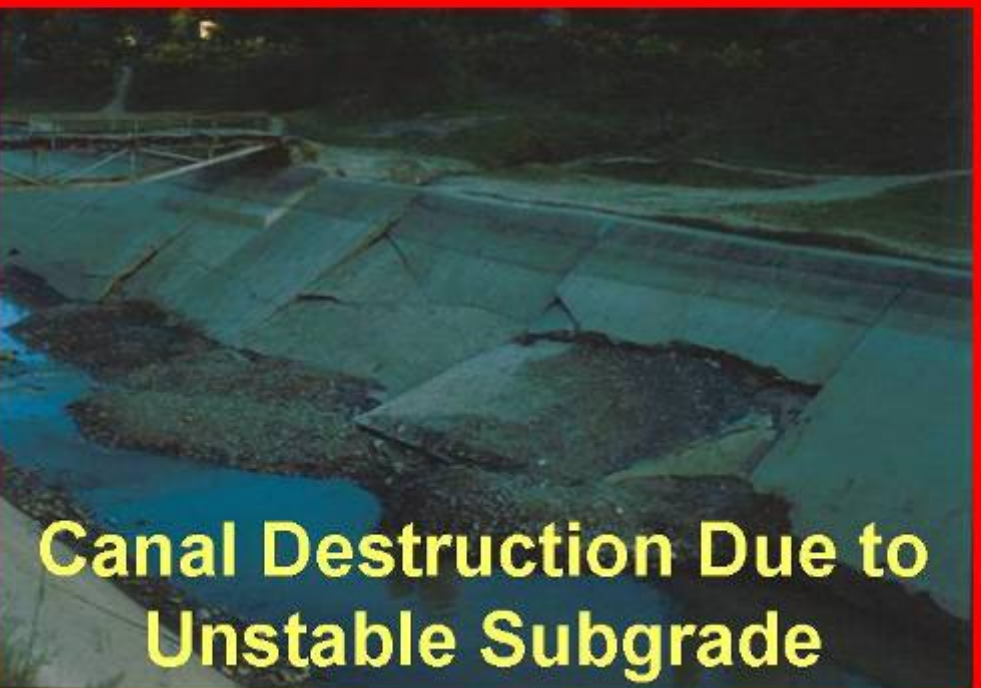


Formation of Sink Holes Due to Piping Adjacent to Canal

Piping Cavities Under the Old Concrete Lining

Problems Due to Weak , Organic Soils

(The soils which have high moisture and organic contents)



Canal Destruction Due to Unstable Subgrade

Problems Due to Low Quality Construction Materials

Low Quality Construction Materials

-Improper mix design of concrete

-Chemical attacks

  -(sulfate attack, alkali - silica reaction)

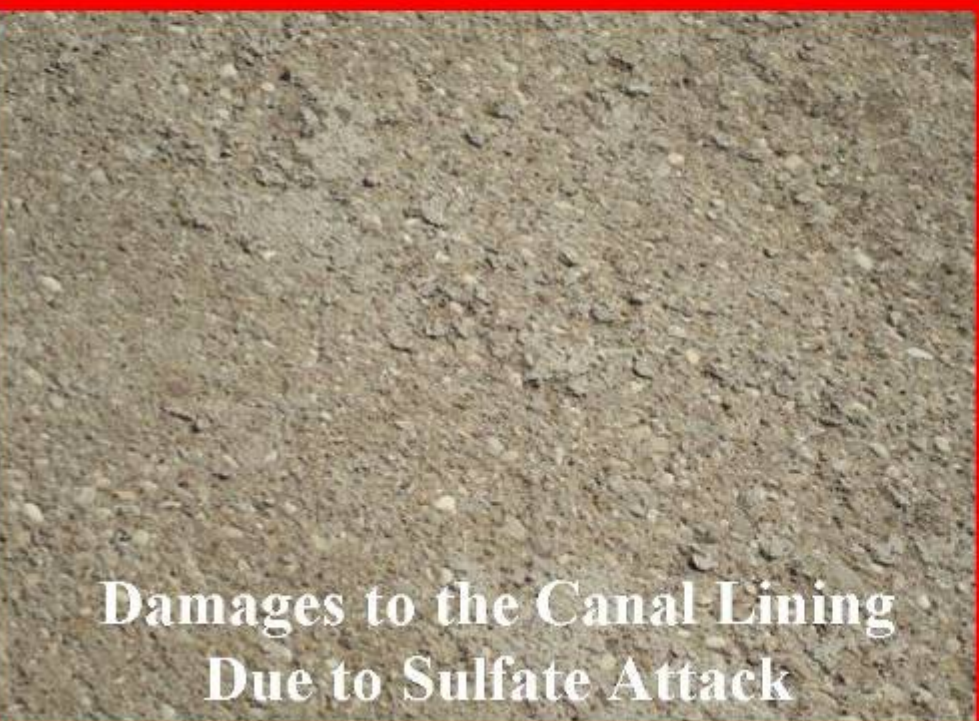
-Climatic attacks

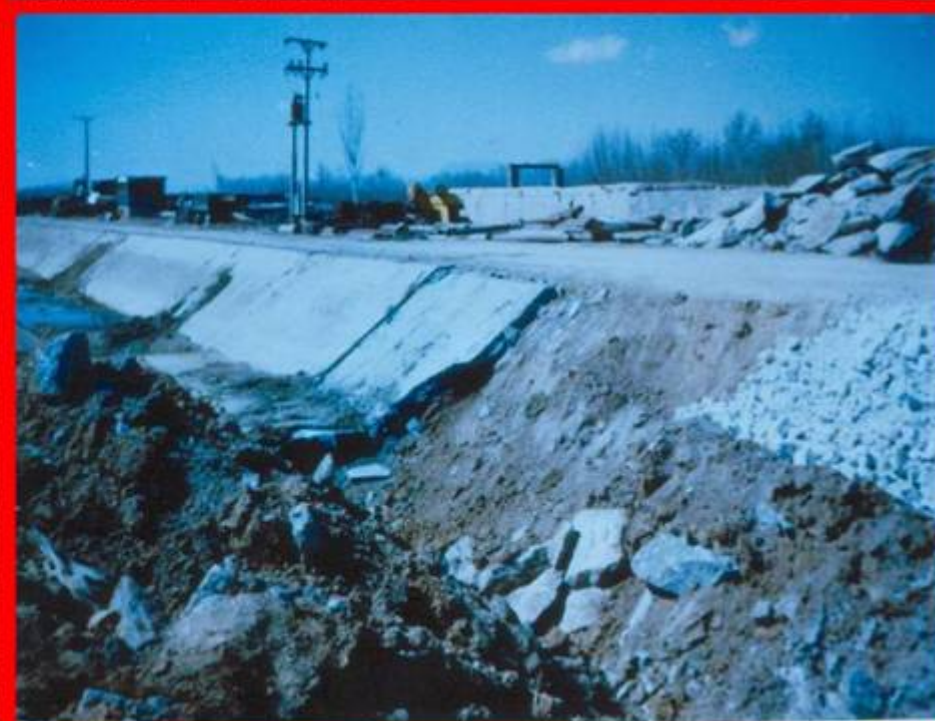
  -(hot & cold weather, freezing, etc.)

-Low quality ingredients

  -(Portland cement, aggregate, mixing water, etc.)


Damages to the Canal Lining
Due to Low Quality Concrete


Damages to the Canal Lining
Due to Sulfate Attack



Poor Construction Practice

- Improper consolidation of concrete lining
- Improper compaction of subgarde soil
- Improper finishing of concrete surface
- Improper joint system
  -(contraction - expansion, construction)

Poor Operation and Maintenance

- Lack of dredging operation
- Using improper dredging equipments
- Uncontrolled weeds
- Lack of annual repairs
- Improper service of hydro-mechanical equipments
- Uncontrolled traffic in service roads
- Abandoning canal for long time

Growing of Weeds or other Plants

Growing of Weeds or other Plants

Decreasing Flow Velocity Due to Vegetation and Sedimentation

Abandoning Canal For Long Time

Improper Servicing of the Gates

Improper Servicing of the Gates

Social and Cultural Issues

-Destruction of canals by farmers to obtain more water

-Destruction of canals due to differences between farmers

-Filling of canals for transportation purposes

-Damage to canals due to sewage discharge

-Dumping rubbish into canals

-Vandalism and damage to hydro-mechanical equipment

-Over due of water costs

-Lack of participation in maintenance and operation


Damages to canal lining for water removal

Damage to the Structures for Illegal Exploiting of Water

Damages to Regulating Structures

Vandalism

Dumping Rubbishes

Sedimentation Due to Over Trafficking of Service Road

Conclusions

- In spite of great achievements in design and construction of modern irrigation networks, there are many technical and managerial issues facing these projects in Iran.

- Technical problems are mostly caused by special geological features which have caused presence of several types of problematic soils all over the country. Expansive, dispersive and soluble soils are the most common problematic soils which have caused severe damages to the irrigation structures.

- **Lack of training and lack of farmers' participation are other main issues facing modern irrigation projects which have caused unsuccessful performance in many cases. Organizing water user associations (WUA) and participatory irrigation management (PIM) are the best solutions in this regard. So far, minor steps have been taken, but are not enough and should be extended in many ways.**
- **Regional and international exchange of experiences in design, construction and managing irrigation projects are vital for the success of such projects. Holding joint seminars, workshops and other technical sessions and publishing the results of gained experiences are good examples for such activities.**

Example of A Canal well Constructed and Maintained