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A Critical Study of Water Loss in Canals and its Reduction Measures

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ABSTRACT
Water is a very precious natural resource. When this precious resource moves through the canals certain part of the water is lost by seepage, evaporation etc. This loss is known as conveyance loss. The conveyance loss was calculated experimentally by different researcher on different canals around the world. In this paper author have tried to review some of the research work and recommend an average water loss from the canal irrespective of the soil and other environmental condition. There are different materials which have been used in canal lining to reduce this water loss. No such material can be said it is the best material for reducing water loss because it depends on the site and its environmental condition. Now a days geosynthetic alone or geosynthetic with concrete or precast concrete is used to for canal lining in this paper they have tried to see the strength, durability etc. of different geosynthetic material and its application in canal lining.
Keywords **-** canal lining, conveyance, geomembrane, geosynthetic, water loss

I. INTRODUCTION

Water is a precious natural resource. It is required by human in doing different daily activities. This precious resource while travelling through the canal is lost from the canals through seepage from the sides and bottom of the canals and by evaporation from the top of the canals, i.e. conveyance loss(the ratio of water reaching form turnouts to that released at the source of supply from a river or reservoir). The seepage rates from the unlined canals can be extremely large, even lined canal never seem to eliminate water loss through side and bottom, but by lining we can reduce the water loss. Water loss from these canals has major impacts on surface water supplies and needs management, and should be minimized, if not altogether be eliminated. Perhaps this is most cost effective method for augmenting water supplies [1]. The main causes responsible for water losses are high density of vegetation, sediment deposition, siltation problem, leakage, lack of maintenance, sharp curves [2][3]. Water losses comprises of both evaporation and seepage loss. The evaporation loss is the function of temperature, humidity and wind velocity. Practically, evaporation loss can't be controlled but seepage loss can be controlled by providing impervious medium such as brick, concrete, asphalt, geosynthetic material etc between porous soil and water flowing in the system. Seepage loss in a canal is a major reason of water loss from the canal as compared to the other form of water losses [4]. So, it becomes important to reduce this seepage loss for increasing conveyance efficiency i.e. the reason why lining have became a choice for reducing this water loss. Canal lining is done not only to reduce seepage loss it reduces erosion of canal banks and beds, reduce flow resistance i.e. hydraulic roughness, avoid water logging of adjacent areas, reduce piping of canals. With time different lining material came as an option. As a result, cost of lining and working at that site and environmental condition became an important concern another most important parameter is the availability of material locally. Concrete used in lining is durable but cost of applying it is very high whereas, geo-synthetic material used is easy to apply and less costly but some protective covering required to resist weathering action and other physical and environmental impacts. Therefore, concrete with geosynthetic or precast concrete with geosynthetic came as an option but the cost again increases.

Different Empirical equations [5] **in determination of seepage losses**:

i). Mortiz Formula (USSR)

$$S = 0.2 * C * (Q/V)^{0.5}$$

where;
S: is the seepage losses in cubic foot per second per mile length of canal,
Q: is the discharge (ft^3/sec),
V: is the mean velocity (ft/sec), and
C is a constant varies from 0.34 for clay and 1.1 for sand soil.

ii) Molesworth and Yennidunia (Egypt)

$$S = C * L * P * R^{0.5}$$

Where,
S is the conveyance losses for a given canal length in m^3/sec
L is the length of the canal in km.,

P is the wetted perimeter in m,
R is the hydraulic radius in m, and
C is the constant depends on soil types, for clay equal 0.0015 and for Sand equal 0.003.

iii) Indian Formula

$$S=C*a*d$$

Where;
S is the total seepage losses in ft^3/sec;
a: the area of wetted perimeter in million ft;
d: the depth in ft; and
C: factor depends on soil types and varies from 1.1 to 1.8.

iv) Pakistanian Formula

$$S = 5.Q^{0.0652}.P.L/106$$

Where;
S: seepage losses;
Q: the discharge(ft^3/sec),
P: the wetted perimeter and
L: length of channel in feet.

v) Hungarian Formula

$$S=1700*da*H*(b+ H*So)$$

Where;
S is the seepage losses in m^3/day/per meter length of canal;
da is the effective size diameter of the grains of the soil;
H : the water depth;
b : the bottom width of canal; and
So : the bed slope.
This equation is used for calculating seepage losses for trapezoidal canal.

Empirical equation for determination of evaporation loss:

Evaporation of water occurs from the surface of the water. Thus, it is directly proportional with the top width of the canal deducting the width of the lining i.e. free surface.When E is the evaporation loss from a canal than the evaporation discharge per unit length can be expressed as

$$q_e = E \times T$$

Where,
q_e = evaporation discharge per unit length of canal (m^2/s) and
T = width of free surface (m).

II. COMPARISON OF WATER LOSS IN UNLINED AND LINED CANNAL

From the above discussion it can be said that conveyance efficiency in lined canal is more than unlined canal because seepage losses will be more in unlined canal than lined canal. Different researcher in different times tried to calculate the seepage loss and conveyance efficiency of different canal around the world. In this paper they have tried to compare the work of the different researcher.

PERI (1993) [6] estimated the conveyance efficiency of improved earthen and unimproved earthen as 32% and 39% respectively i.e. 61% loss of water was reported.

P.B.JADAV et al (2014) [7] has seen that conveyance efficiency was increased from 52% from 75% by lining of the canal

In a study by ARSHAD et al (2009) [8] in Indus basin of Pakistan it has been seen that lining reduced the water loss from 66% to 43.5% i.e. 22.5% reduction occurs. In addition, it is also seen lining reduce the capacity of the water course due to overtopping and silting.

By SARKI A et al (2008) [9] the study conducted on earthen water course IR Qaiser minor the water loss has been estimated as 30.895%

ASFAQUE A. MEMOM et al (2013) [10] studied the effect of lining in Dadu canal it has been seen lining reduce the seepage loss to 40% from 50% and it has also been seen conveyance efficiency increase from 70% to 90%.

A study conducted on kakrapar right bank canal (unlined) by KAVITA A KARADIYA et al (2014) [11] seepage loss calculated by different empirical formula varies from 5.19 m^3/s to 1.43 m^3/s.

MS K.D UCHDADIYA et al (2014) [12] has studied in Kim branch canal, Gujrat and found seepage losses can be reduced to nearly 87.68%,99.3% and 99.7% by using brick lining, P.C.C lining, P.C.C with L.D.P.E film lining respectively.

Seepage loss depends upon the soil characteristics of the canal through which water is flowing. In this paper it has been tried study the general range of water loss in canal. In a study conducted by MAGDY H MOWAFY (2001) [5] seen that with the increase in cross-section dimension and discharge the seepage loss increases.

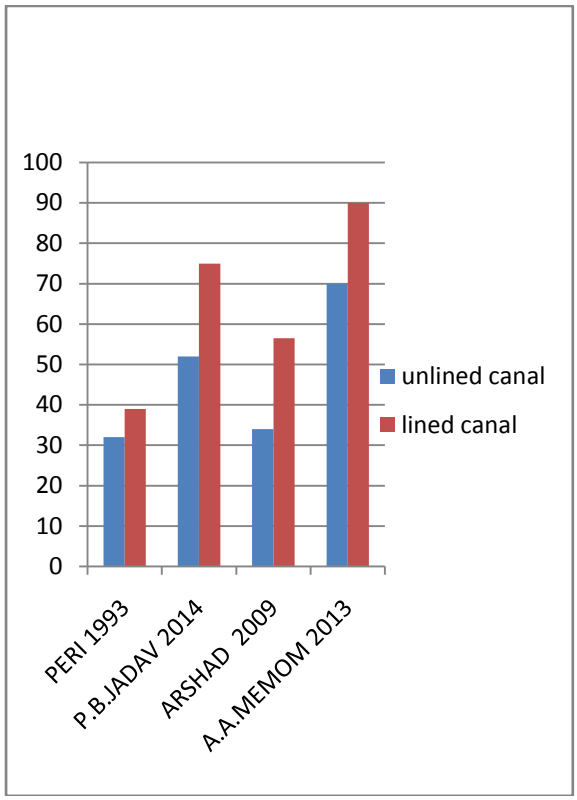

Figure 1: Conveyance efficiency of different canal before and after lining.

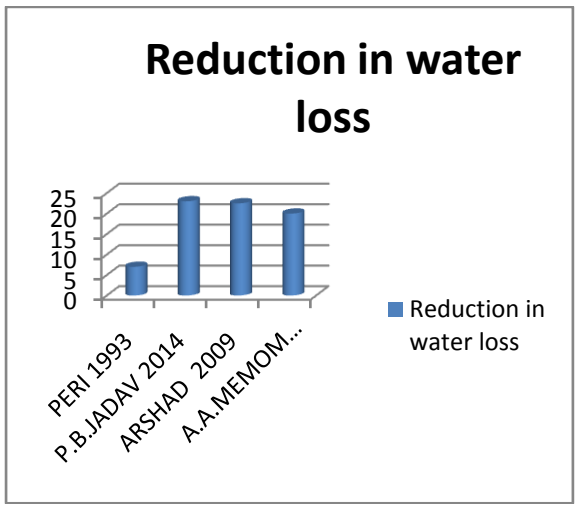

Figure 2: Reduction in water loss by lining

By the above two figure it is clear that the lining has reduced water loss i.e. conveyance efficiency has increased. The average water loss reduction is by 18% to 19%

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III. GEOSYNTHETIC AS A LINING MATERIAL

Geosynthetic is a polymeric product which has been used to solve many problems in civil engineering and other fields also. A wide range of geosynthetic material find its application in irrigation structure i.e. geomembranes, geotextile, geocomposites, geogrids, geodrains, gabions and mattresses. Out of which geomembranes are commonly used. The main type of geomembrane liners are PVC, HDPE, LDPE, CSPE, EPDE and polyolefin.

R.M.Koerner et al. (2003) [13] in study has seen that the aging of the thermoplastic polymers has been considered to occur in three distinct zone as shown in figure 3. Antioxidants present in the resin prevent polymer degradation. Thus, the polymer containing more antioxidant will have more service life. Out of HDPE, LLDPE, fPP, PVC, CSPE, EPDM resin. HDPE is the material which lifetime is more.

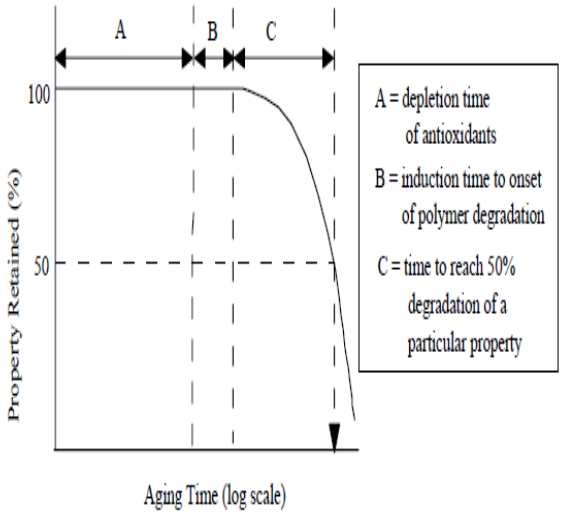

Figure 3: Three Conceptual Stages in Chemical Aging of Polyolefin Geomembranes

In a study by RIDHI P.DAVE et al (2014) [14] it has been found polyolefin material and breaking strength is 5 times as compared to LDPE and HDPE flim. Compared to HDPE, LDPE and polyolefin material the polyolefin has one rough sided surface compare to other two and provide easy lying. Cost of polyolefin is more compared to other two.

T.D.STARK at el (2009) [15] studied the durability, seepage loss of different type of channel lining used with geomembranes with different exposure condition. They have seen 90% reduction in seepage has occurred due to channel lining. They have also seen placing a concrete or shortcrete cover over geomembrane increase durability but cost is also increased.

No such single material can be recommended for canal lining because it depends on the sight and environmental condition. The most favorable geomembranes are geomembrane under in-situ concrete, geomembrane under precast concrete, geomembrane under sandon the bed and mattresses on the bank. (M.Riaz et al, 2005)[16]

IV. CONCLUSION

i) Lining reduced the water loss on an average by 18% to 19%.
ii) HDPE is the geomembrane whose lifetime is more than any other membrane.
iii) Concrete with geomembrane can be used to increase the durability of lining.
iv) Polyolefin material has high breaking strength and can be used as canal lining because of easy placing, light weight than any other material.
v) However, material recommendation for canal lining depends on the locally available material, budget, most importantly soil characteristics to infiltration and the environmental condition of the site.

REFERENCES

[1] IDWR. 2005. *Augmenting Water Resources. Water in Rajasthan.* Report of the Expert Committee on Integrated Development of Water Resources,India.
[2] Zeb, J., S. Ahmad, M. Aslam and Badruddin. 2000.*Evaluation of conveyance losses in three unlined watercourses of the Warsak Gravity Canal*. Pak. J. Biological Sciences 3(2): 352-353.
[3] T.U.Saeed and T.A.Khan 2014. *Impact of Water Losses and Maintenance of Canal Irrigation System on Agriculture (Case Study: Urmar Minor of Warsak Gravity Canal Pakistan)* American Journal of Experimental Agriculture 4(5): 550-562
[4] J.W. Badenhorst, M. De Lange, M.E. Mokwena and R.J. Rutherford, Water conservation and water demand management in agriculture development of water management plans by irrigation water suppliers in South Africa. In: ICID Eighteenth Congress Best Paper for 6th Hassan
[5] Ismail Award Paper, Montreal, 2002.
[6] Magdy H. Mowafy 2001 SEEPAGE LOSSES IN ISMAILIA CANAL *Sixth International Water Technology Conference, IWTC , Alexandria, Egypt*
[7] PERI. 1993. *Evaluation of On Farm Water Management Programme in Punjab*. Pub. 281.Punjab Economic Research Institute, Lahore,Pakistan.
[8] P. B. Jadhav, R. T. Thokal, M.S. Mane, H.N. Bhange and S.R.Kale 2014, *Conveyance Efficiency Improvement through Canal Lining and Yield Increment By Adopting Drip Irrigation in Command Area* ,IJIRSET, Vol .3
[9] M. Arshad, N. Ahmad, M. Usman and A. Shabbir 2009 *COMPARISON OF WATER LOSSES BETWEEN UNLINED AND LINED WATERCOURSES IN INDUS BASIN OF PAKISTAN, Pak. J. Agri. Sci., Vol. 46(4), 2009*
[10] SARKI A., MEMON S.Q., LEGHARI M. 2008 *COMPARISON OF DIFFERENT METHODS FOR COMPUTING SEEPAGE LOSSES IN AN EARTHEN WATERCOURSE*, AGRICULTURA TROPICA ET SUBTROPICA VOL. 41 (4)
[11] Ashfaque A. Memon, Khalifa Q. Leghari, Agha F. H. Pathan, Kanya L. Khatri, Sadiq A. Shah, Kanwal K. Pinjani, Rabi a Soomro, Kameran Ansar, 2013, *Design and Evaluation of Dadu Canal Lining for Sustainable Water Saving*, Journal of Water Resource and Protection, 5, 689-698
[12] Kavita A. Koradiya, R.B.Khasiya ,2014, *Estimate Seepage Losses in Irrigation Canal* System, Vol : 4 Issue : 5
[13] Ms. K. D. Uchdadiya, Dr. J. N. Patel, *Seepage losses through unlined and lined canals*, Int. J. Adv. Appl. Math. and Mech. 2(2) (2014) 88 – 91.
[14] R.P.Dave , F.S.Malekwala, C Rautela, S A Thakkar, 2014, *Importance of Geosynthetics for lining in Hydraulic Structures, vol. 2, Issue 01*
[15] T.D.Stark and J.M. Hynes, Urbana, Illinois,2009, *Geomembranes for Canal Lining*, *Geosynthetics* 2009, Salt Lake City, Utah
[16] Robert M. Koerner and Y. Grace Hsuan, 2003, *LIFETIME PREDICTION OF POLYMERIC GEOMEMBRANES USED IN NEW DAM CONSTRUCTION AND DAM REHABILITATION*, Proceedings Assoc. of State Dam Safety Officials Conference, Lake Harmony,Pennsylvania, June 4-6
[17] M.Riaz and Z.Sen, 2005, *Aspects of design and benefits of alternative lining system*, European water 11/12:17-27