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STRESS ANALYSIS OF LAYERED FOLDED PLATES RESTING ON ELASTIC FOUNDATION: APPLICATION TO CANAL LINING

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ABSTRACT

The lining of canal is an important feature of irrigation projects as it improves the flow characterizes and minimized the loss of water due to seepage. Lining is an impermeable layer provided for the bed and sides of canal. Selection of a particular type of lining, keeping in consideration the general requirements, as well as site specific requirements including structural stability, economy, availability of construction materials, machinery and equipment, skilled and unskilled labor, subsequent repeatability, ability to prevent weed growth, resistance against burrowing animals, structural stability during and after construction. The water lost through seepage in an unlined canal can be saved by construction of appropriate canal lining. The rigid lining, semi-rigid lining, flexible lining and combination lining. Combination lining includes Geo-membrane with Geo-textile in the old and new concrete line on sides, selecting the type of lining. The type of lining selected should not only e economics in initial cost, but also in repair and maintenance cost.

The cylindrical bending of elastic plates subjected to the mechanical transverse loading response under plain strain condition a complete analytical solution is presented for the cylindrical bending of multilayered orthotropic plates with simply supported edge conditions based on resister mandolin's first order shear deformation theory (FOST) gives an analytical solution of numerical investigation for normalized transverse displacement (w) are validate with ABAQUS SOFTWARE. The type of soils with various sub grade reactions plays an important role for cracks and buckled with deflection and stress at canal lining bed and side slopes of canal.

The study evaluate at Dudhganga Right Bank Canal, District Kolhapur, Maharashtra, India for exiting M10 concrete lining and composite geo-membrane with geo-textile and new concrete layer for canal lining. There is no seepage loss of water after provision of composite geo-membrane lining. The deflection and stress calculate with ABAQUS Software various types of soils and types of concrete exiting and newly composite geo-membrane lining. The loading applied with hydrostatic load, empty condition, pot holes and erosion. The deflection and stress should be maximum in Black cotton soil, Murum, sandy and loose soils as compared to clayey soil and hard rock.

KEYWORDS: *Canal Lining, Flexible Lining, Combination Lining, Geo-Membrane, Geo-Textile, Types of Soils, Cylindrical Bending, Deflection, Stress, ABAQUS Software**,** Hydrostatic Load, Empty Condition, Pot Holes, Erosion. Seepage**,** Maintenance and Economy*

INTRODUCTION

Maharashtra is one of the four littoral states of India that border the Arabian Sea. The annual rainfall in the state very from 450mm in the rain should ware as to 6000 to 7000 mm in Western Ghats of which 80 percent is received from June to October. The drought prone area 10.80 mtr. corers thirteen distends in central and western parts of Maharashtra recentaly 89 talucas, receive rainfall less than 750 mm annually. However, the area differs in the drought due to the variation in soil and climatic conditions.

The irrigation in the state has been increased with the help of multipurpose projects like Jayakwadi on the river Godavari, Koyana on the river Koyana, a tributary of the river Krishna and other minor irrigation projects. Additionally, some area in Sangli and Satara districts are irrigated through co-operative lift irrigation schemes on Krishna river.

The irrigation area is constantly and continuously being increased so as to ensure assured irrigation and to avoid crop failures due to famines and non-availability of water. To secure the benefits of irrigation land a tremendous amount of capital has been invested is the irrigation projects. So, the irrigation water is a costly commodity, and as such, there should be no wastage during its carriage from the reservoirs to the fields in India most of the unlined canals are constructed carry irrigation water, and hence a large part of the costly irrigation water is lost in percolation and absorption as seepage loss. This is a very serious loss and proportionality reduces the irrigation potential of the supplied water. The seepage can be avoided or minimized by lining the irrigation canal. There are found seepage loss results not only is depleted freshwater resources but also cause water logging, Stalinization and ground water contaminations canals in alluvium are lined in general reduce the seepage particular.

Lining of a canal is essential for efficient use of land and water resources control of seepage saves water for further extension of the irrigation network as well as reduce the water logging in the adjoining areas. The smooth surface of lining reduces the friction slope, which enables the canal to be laid on the flatter bed slope. This increases the command area of canal.

LITERATURE REVIEW

Published Papers

- Poonam V. Nimbolkar and Indrajeet M. Jain studied the cylindered bending of elastic and composite plates subjected to the mechanical transverse loading response under plinth strain condition, a complete analytical solution is presented for the cylindrical bending of multilayer orthographic plates with simply supported edge conditions based on Reissner Mindlin’s first order share deformation theory (FOST).

- Kant and Siyekar presented cylindrical flexure of piezoelectric plates by solving second order ordinary differential equation satisfied electric boundary conditions along thickness direction of piezoelectric layer.

- A. M. Zenkour and A. F. Radwan studied the effects of moisture and temperature distribution on the building responses of FG porous plates resting on to parameters elastic foundation the material properties of FG porous plates are affected by the variation of moisture and temperature loads. The governing equations according to FG porous palates are derived using the principle of mutual work based on the present theory including hydrothermal effect and foundation stiff nesses. Effects of the porosity factor, power law index and other parameters are all investigated. The obtained results are compared with those of other investigators for FG non-porous and porous plate.

- Equilibrium equations of a functionally graded plate resting on two parameter elastic foundations are derived using hyperbolic shear deformation theory studied by A. M. Zenkour and A. F. Radwan.
- The effect of transverse normal strain on cylindrical bending of multilayered laminated composite and sandwich plates is examined a sinusoidal shear and normal deformation plate theory (SSNPT) has been developed for the analysis for the analysis. The present theory is recommended for the accurate structural analysis of laminated composite and sandwich plates under cylindrical bending studied by Sayyad and Ghugal.
- S. Ved and R. Batra studied an exact three dimensional state space solution is obtained for the static cylindrical bending of simply supported laminated plates with embedded shear mode piezoelectric actuators and subjected to mechanical and electric loading on the upper and lower surfaces. Each layer of the laminate is made of either an orthotropic elastic material or a piezoelectric material whose poling direction lies in the plane of the plate with perfect bonding between adjoining layers. The displacements and stresses for a homogenous piezoelectric plate for various length to thickness ratios are compared with those obtained by the first order shear deformation theory.
- Canal lining which stabilization of canal banks reduce the maintained and reduced seepage also recommends the size of new canal lining work and old canal operational objectives and instructions to canal system. The material and constructions details of the height of the lining and use of geomembrane. A studied by Charles Burt and Cal Poly ITRC.
- This paper is to used the close circular conduits for the entire 64 km a reach of canal in place of open canal irrigation network to minimized the convince losses. The closed circular conduits system can through out for the implementation so as to operationally utilize the irrigation water. The case study of Nashik left bank canal of Nashik District, Maharashtra, India studied by Gayatri R. Gadekar and Dr. Sunil Kute.
- Tony L. Wani and Dale J. Lentz studied the test facilities, instrumentation and methods used to artificially control model boundary conditions to effectively simulate the behavior of a long canal reach within a relatively small laboratory area. Numerical modeling was also used to study the dynamic response of a canal to a breach event, free from the physical constraints of the laboratory facility.
- B. T. McMahon, S. K. HAIGH and M. D Bolton studied the use of an ellipsoidal cavity expansion model to estimate the bearing capacity and settlement circular shallow foundations on clay is presented.
- A summary of innovative analyses performed to select and design the geomembrane liner system. Two mechanisms that induce tensile stress and strain in the geomembrane following the development of cracks in the supporting sub grade resulting in the deflection of the geomembrane over the cracks under the applied water pressure were analyzed. The analyses uses the concept of “co-energy” a geomembrane property that evaluated its ability to stand stress and strains together studied by J. P. Giroud, Neil Jacka, Christopher Dann and Jeremy Eldridge.
- The relationship between the seepage control effect change in the canal lining and service time by ponding tests. The cracks and holes in different lining materials were surveyed, and the attributions of the cracks in concrete and holes in the geomembrane to increase seepage loss were analyzed. A simple liner formula established to represented the relationship between the seepage control reduction factor and the service time, which was used to

estimate the water efficiency of the lined canal system after certain service time, studied by Xudong Han, Xiugui Wang, Yan Zhu, Jiesheng Huang, Liquing Yang, Zhifu Chang and Feng Fu.

REPORT AND MANUALS

- Manual for lining in irrigation canals in West Bengal recommends structural stability seepage control retention of shape of canal, increased hydraulic efficiency, increased resistance erosion and abrasion, low operation and maintenance cost. The depending on soil type and soil characteristics in various districts the irrigation projects have been classified in four zones. The size, thickness and type of lining for all zones and all categories of sub grade and soil condition are recommends for thickness of M20 Plane Cement Concrete lining Cast in Situ according to capacity of canal. Also recommends criteria for fixing the thickness of Cohesive Non-swelling Soil (CNS) layer.
- The Government of Maharashtra Water Resources Department circular dated 01/09/2015 recommends the revised design procedure of open canals and distributaries network. This recommends details of hydraulic design of canals according on the basis of crop water requirement, rotation period of canal capacity factor the water requirement of the individual Water User Association (WUA) and all the WUA in command area of all canals of project. The basic parameters like co-efficient rugosity (n) for lined and unlined canals, Breadth to depth ratio, bed Gradient, inner side slopes permissible velocity and calculations of designed discharge of canal section. The other parameters also recommends like free board top width of bank, outer side slope of embankment, Cut Off Trench (COT) for embankment, berms, ramps, embankment, catch water drains, driving head, transition, canal curves, cross Regulator and Escape, Ghat and cattle ramps, protection to outer slopes of strategic banks, Measuring devices and guidelines for canal alignment and economical design of structures.
- The U. S. Department of the interior Bureau of Reclamation Technical Service Centre Material Engineering and Research Laboratory recommends a Technical memorandum of research priorities to Enhance Canal Infrastructure Sustainability includes the existing needs of aging infrastructure and identify key research needs establishing a framework for research road mapping. The need statements for height priority research needs with prioritized draft research road map of canals infrastructures like canal sub grade, canal lining for outcome, process, causes, frequency and concern gap analyses and research needs.

DESIGNS

- The office of the Engineer-in-Chief, water resources Odisha, Bhubaneshwar, recommends guidelines for lining of irrigation canals includes all the new canals in state will be designed as lined canals and existing canals may also be considered to be converted to lined canals in due course in phased manner for prevention of seepage loss and for optimal and judicious use of water. This guidelines based on IS 10430:2000, types of lining, selection of type of lining, lining of existing earthen canals, cement concrete lining, preparation and thickness of in-situ concrete lining, parameters for design of lined canals like inner side slopes, outer side slopes, free board, Berm, coping, cross sections and velocity, under drainage, pressure relief arrangement, longitudinal drains, and pressure relief valves. Also recommends the lining of canal expansive soil with criteria for fixing minimum thickness of Cohesive Non-swelling Soil (CNS) layer and constructions procedure. The preparation of Details Project Reports with specifications of materials, specification of works and quality control and assurance.

- The lining of irrigation of canal and economics linings includes advantages of lining like, seepage control, prevention of water logging, increase in channel capacity, increase in command area and reduction in maintenance cost. Also includes financial justification and economics of canal lining based on Annual Benefits and Annual Cost. The project justification, benefit cost ration must be greater than unity. The requirements of good lining with economy, structural stability, durability and reparability. The details of safety ladders in lined canals.

Soil Structure Studies Installments and Conditions

- Characteristics, Problems and Remedies of Expansive Soil of Rajasthan, India N. K. Ameta, D. G. M. Purohit and A. S. Wayal studied the properties of expansive soils of Rajasthan, India at various locations. The effect of gypsum and addition fo dune sand of swelling pressure, it is found that swelling pressure decrease with addition of dune sand and gypsum. Effect of dry density and molding water content is also presented. Swelling pressure increases in dry density and decreases with increasing molding water content swelling pressure also decreased due to addition of gypsum an d dune sand. Various remedial measures are presented in the paper to overcome the problem of swelling pressure.

- Soil stability analysis in irrigation canals: a case study by Jebelli, J and Meguid, M. A. studied A 30.5 km long main irrigation canal currently under construction in Gambella Alwero Rice Project in Ethiopia is part of an irrigation water supply scheme to render regulated water to 10,000 ha downstream rice fields. The soil stability analysis shed clarifying light on the decision making process the convincible side slope 1.5 H 1V proves risky and unstable, hence constructing side slope 2H : 1V deems safer not only for rapid drawdown condition but also in all other future operational situations such as end of construction and steady seepage.

- Naeini S. A., Ziaie Moayed R. Allahyari F studied the relationship between subgrade reaction modules of elasticity and corrected standard penetration test blow count (N) is presented for southern part of Qazvin alluvium which mainly consists of clayey soils with low plasticity.

- M. GadEIRab Hussein studied five different backfill materials of known relative density have been prepared in a large scale testing facility. Plate load test have conducted to asses the effect of soil density on the sub grade reaction and soil modules. The relationship between the applied pressure and the corresponding soil movement has been established at the surface as well as at different depths. The modulus of sub grade reaction is determined based on the measured stress settlement relationship at the surface whereas the Young's modulus profile has been stabilities using the measured soil displacements at different depths. A comparison between the measure soil modules and sub grade reaction and profiles for granular backfills.

IS Codes

- Amendment no. 1 August 2005 to IS 10430: 2000 criteria of lined canals and guidelines for selection of type of lining includes function of lining, requirements of lining, different type of lining, selection of lining and parameters of design of lined canals.

- Criteria for design of cross section for unlined canals in Alluvial soils includes design like side slopes, free Boards, Back Top Width, Radius of Curvature, Berms, Dovels, Bed width, Depth and Slope, Falls, Hydraulic Grade Line and Lacey's Method for Design of unlined canals in alluvium.

- Amendment No. 1 September 2000 to IS 3873:1993 laying of cement concrete and stone slab lining on canals—code of practice includes preparation of sub grade, laying of In-Situ concrete lining, laying of precast concrete tiles and stone slab lining and safety ladders.
- Amendment No. 1 September 2000 IS 9451 : 1994 Guidelines for lining of canals in Expansive soils includes Cohesive Non-swelling Soils (CNS) for treatment criteria for fixing the thickness of CNS layer, construction procedure, lining and under drainage arrangements and joints in lining.
- IS 9214 :1979 Method of determination of modules of sub grade reaction (K-value) of soils in field includes the determination of plate bearing test, evaluation of sub grade test results.

Finite Element Method

- Simulation for Frost Heaving Damage of Concrete Lining Channels by Using XFEM studied by Jingjun IJ, Xingli He and Bolin Zhou represents the numerical simulation model of frost heaving damage of concrete lining channels is established. The temperature field is accurately simulated through an equivalent equation of heat conduction. The extend finite element method combined with the thermal coupling method is used to analyze the frost heaving damage of the lining channel.

PURPOSE AND SCOPE

The seepage losses are considerably reduced if the channels are lined. A lined canal costs about 2 to 2.5 times as much as an unlined canal. The saving of costly irrigation water may itself be sufficient to fully justify the capital expenditure on lining. Prevention of seepage by lining would reduce their inbounding capacity. Lining of cannel prevents seepage and thus protects cultivable land combined with land drainage schemes, lining helps to reclaim water logged areas. The lining presents a smooth surface and, therefore, causes less resistance to the flow of water. The water therefore flows faster and hence more of it is carried than that in an unlined canal. There, lining increases channel capacity and consequently reduces the required channel section. A lined channel will require lesser dimensions and hence, lesser earth work.

The consequent saving in earth work handling and acquisition of land a lined canal can be designed not only smaller in cross-section but also shorter is length. The flatter slope can be provided without silting on a lined channel compared to these on an unlined channel. Therefore help to bring high areas under command. The unlined canal involved huge recurring expenditure, generally annual repair and maintenance of the canal system. The lining reduces the periodical removal of silt deposited on the bed and sides of the canal section, minor repairs like plugging of crack, cuts and uneven settlement of banks and removal of weeds and water plants. An unlined canal formed on weaker foundations in always in danger, and a breach may occur at any time. Unlined canals washing away of considerable length of embankment leading to flooding of certain areas and causing scarcity of irrigation water, hence the canal was out of service at a critical time for crops. A strong concrete canal lining removes all such dangers.

The concrete lining structure will be damaged from the base soil frost hence deformation such as crack and even rapture. The remediation includes three reaches of the canal with geo-membrane liner to improve the overall durability and longevity of the canal.

A STATEMENT OF AIMS AND OBJECTIVES

Canal lining will be considered as folded layered plates resting on elastic foundation analysis and testing and design will be carried out to obtain design stresses in concrete and geo-membrane lining.

The section of the canal is considerably reduced there is a saving in cost of excavation and land acquisition, lower maintenance cost, pilfering water logging and effloresces of adjacent land due to seepage of canal waters, reduce bank erosion and banks.

Canal lining are provided to reduce seepage to stabilize channel bed and banks to avoid piping through and under channel banks to decrease hydraulics roughness to avoid water logging and weeds.

The seepage loss results not only are depleted freshwater resources but also cause water logging, Stalinization and ground water contamination. Canals are alluvium are lined in general and reduce the seepage particular.

The Resources to Use the Geo-Membrane Lining

- To save water (reduce seepage).
- To stabilize channel bed and banks (reduce, erosion).
- To avoid piping through and under channel banks.
- To decrease hydraulic roughness (flow resisters).
- To promote movement rather than deposition of sediments.
- To avoid water logging of adjacent land.
- To control weed growth.
- To decrease maintenance cost and facilitate cleaning.
- To reduce excavation costs (when extract material is unsuitable).
- To reduce movement of contaminated from water plumes. The side of the channels to be lined should preferably keep at the natural slope of the soil as than there will be no earth pressure against the lining.

BACKGROUND AND GOAL

There are various types of canal constructed by various materials like soil mixed with cement, fly ash, masonry, concrete reinforced and unreinforced, plastic, asphalt, and synthetic rubber. The selection of the geo membrane based on its ability to maintain its integrity in the event of cracks developing in the supporting sub grade and evaluation of the resistance of the geo membrane liner to hydraulic forces include by the canal flows. The bed and side should preferably be constructed independent of each other with the lining of the sides resting on the wall if practicable canal lining will be considered as folded plates resting on elastic foundation analysis and testing and design will be carried out to obtain design stresses in concrete and geo-membrane lining.

Figure 1

Figure 2

Figure 3

Figure 4

Numerical Investigation Validates with ABAQUS Software:

The cylindrical bending of elastic plates subjected to the mechanical transverse loading response under plain strain condition a complete analytical solution is presented for the cylindrical bending of multilayered orthotropic plates with simply supported edge conditions based on resister mandolin's fast order shear deformation theory (FOST) Poonam V. Nimbolkar and Indrajeet M. Jain 2014 gives an analytical solution of numerical investigation for normalized transverse displacement (w) are validate with ABAQUS Software.

A complete analytical formulation and solution for a laminate under cylindrical binding simply (diaphragm) supported along 'x' axis is presented. The geometry of the laminate under cylinder bonding is such that the side 'a' is along 's' axis and side 'b' is on 'y' axis, which is assumed to be infinite. The thickness of the laminate under cylindrical bending is donated by 'n' and is coinciding on 'z' axis. The reference mid-plane of the laminate under cylindrical bonding is at h/2 from top or bottom surface of the laminate as shown is following figure. The formulation is assuming fiber direction r of the lamina is coinciding with 'x' axis of the laminate cylindrical bending. The figure also illustrate the mid-plane positive set of displacement along s-y-z axes. In laminate under cylindrical bending, the dimension (along y direction) is considered as infinite compared to other dimension (along x and z directions). In such problems, the strain along y direction are very small as compared to x and z direction and can be neglected. Then problem is assumed to be in tow dimensional and in a state of plane strain. Neglecting the strains along x direction i.e €y = 0, $r_{xy} = 0$, r_{xz}, the stress-strain-strain relationship for a two dimensional orthotropic body under plane strain conditions can be stated as Ey =0, $r_{xy} = 0$, $r_{xz} =0$.

Geometry of a laminate under cylindrical bending with positive set of displacement and axes. The cylindrical bending of elastic plates, single layer of homogeneous isotropic plate far normalized transverse displacement (w), in plane normal stress (bs) an isotropic plate under cylindrical bending has been done from numerical investigation for layered. Plate with orthotropic layer simply supported on two edges at x = 0 and x = α with following materials properties.

Normalized transverse displacement (w) by numerical investigation and be using ABSQUS Software for various Aspect ratio by using

$$\overline{w}(a/2,0) = \frac{100E}{qS^2H}(w)$$

Table 1 show the numerical investigation and ABAQUS Software solution are use the software form displacement (w) and stress (fs) in concrete plates.

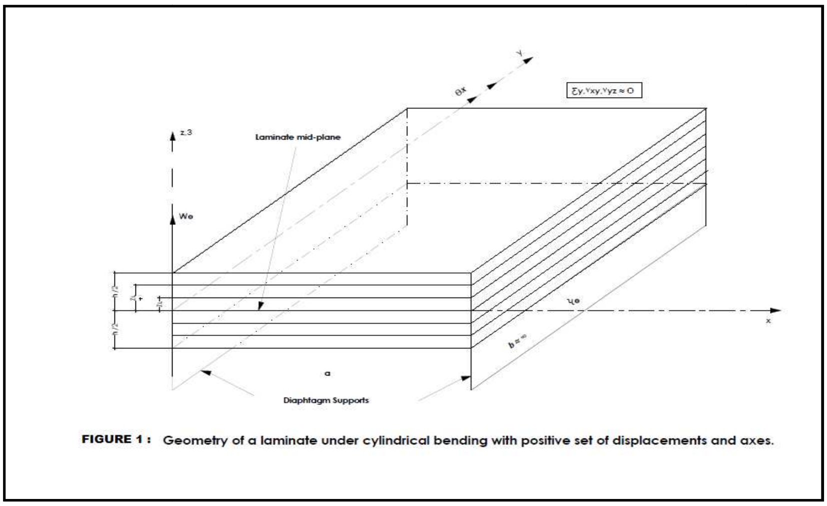

Figure 5

Table 1: Boundary Conditions (Bcs).

Sr. No	Edge	B_{cs} on Displacement Field	B_{cs} on Stress Field
1	x = 0	w = 0	bx = 0
2	x = a/2	a = 0	Txz = 0
3	z = -h/2		bz = P(x); Txz = 0
4	z = -h/2		bz = 0, Txz = 0

Table 2: Boundary Conditions (Bcs).

Sr. No	Source	Materials Properties	
1		E1 = 172.4 GPa	r_{12} = 0.25
2		G12 = 3.45 GPa	
3		E2 = 6.89 GPa	r_{13} = 0.25
4		G13 = 3.45 GPA	
5		E3 = 6.89 GPa	r_{23} = 0.25
6		G23 = 1.378 GPa	

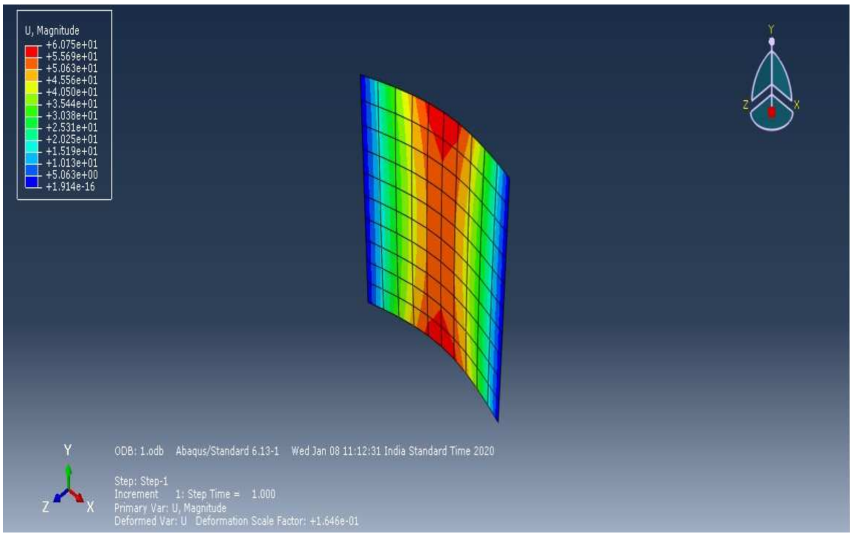

Figure 6: Displacement with h/4 Aspect Ratio.

Table 3

Sr. No.	Aspect Ratio	Source	W(a/2,0) mm
1.	4	Kant[1]	12.947
		Pagano	12.947
		Kant[2]	16.364
		Fast	13.593
		Present Analysis	**15.007**
2.	10	Kant[1]	11.489
		Pagano	11.490
		Kant[2]	14.563
		Fast	12.530
		Present Analysis	**13.109**
3.	20	Kant[1]	11.279
		Pagano	11.280
		Kant[2]	14.303
		Fast	12.378
		Present Analysis	**12.764**
4.	30	Kant[1]	11.241
		Pagano	11.241
		Kant[2]	14.255
		Fast	12.350
		Present Analysis	**12.687**
5.	40	Kant[1]	11.227
		Pagano	11.228
		Kant[2]	14.255
		Fast	12.340
		Present Analysis	**12.652**
6.	50	Kant[1]	11.220
		Pagano	11.220
		Kant[2]	14.232
		Fast	12.336
		Present Analysis	**12.639**

CASE STUDY EVALUATION

Silent Features

- Length of right bank canal: 24 km.
- Irrigated area: 1808 ha.
- Main right bank canal discharge (5 to 7 km): 22.78 cumecs/second: 804 cubic ft./second
- Bed width: 3.66 m.
- Full supply depth: 3.10 m.
- Free : 0.90 m.
- Side slope: 1:1.50
- Bed gradient: 1:6000
- Rugosity factor: 0.02
- Velocity: 0.903 m/sec.

Case study of use of geo-membrane in seepage lose for Dudhaganga irrigation project right bank canal 5 to 7 km at Tal. Radhanagari, Kolhapur, Maharashtra, India.

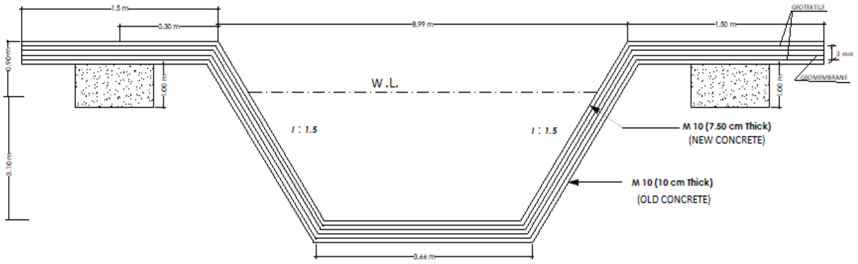

FIGURE 2 : CROSS SECTION DUDHGANGA RIGHT B BANK CANAL @ 5.50 Km.

Figure 7

Table 4: Material Properties Concrete and Geo-Membrane

		Psi	**N/mm^2**		**Psi**	**N/mm^2**
Facesheet	Ex	25000000	172350	Gxy	500000	3447
	Ey	1000000	6894	Gyz	200000	1378.8
	Ez	1000000	6894	Gzx	200000	1378.8
Core	Ex	40000	275.76	Gxy	16000	110.304
	Ey	40000	275.76	Gyz	60000	413.64
	Ez	500000	3447	Gzx	60000	413.64

Displacement and stresses by using ABAQUS Software.

The sub grade reactions from sub grade test results of various types of soil K(MN/m^3).

- Very light loose sand to average sandy soil: 10
- Sandy loam: 15
- Sandy Gravel and murum: 27
- Black cotton soil: 38
- Clayey soils: 52
- Rock: 80

Existing Canal M10, With 10 cm Thick Concrete Lining

PCC Cross Section with Hydrostatic Load

Table 5

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	134.9	51.54
Sandy Soil	0.015	91.9	40.52
Murum	0.027	152.6	31.09
Black Cotton soil	0.038	113.8	26.42
Clayey Soil	0.052	59.52	22.63
Hard rock	0.080	16.08	18.16

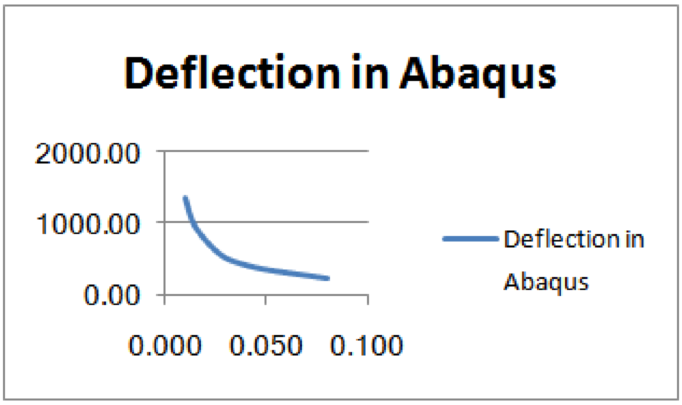

Figure 8

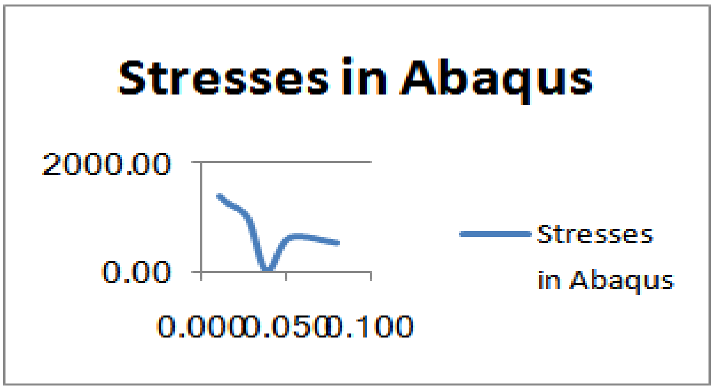

Figure 9

Grades of Concrete Maximum Values for All Type of Soils

Table 6

Type of Concrete	Deflection in Abaqus	Stresses in Abaqus
M10	134.90	51.54
M15	140.70	54.54
M20	263.60	72.6
M25	500.09	64.49
M30	90.81	68.64
M35	146.30	72.11

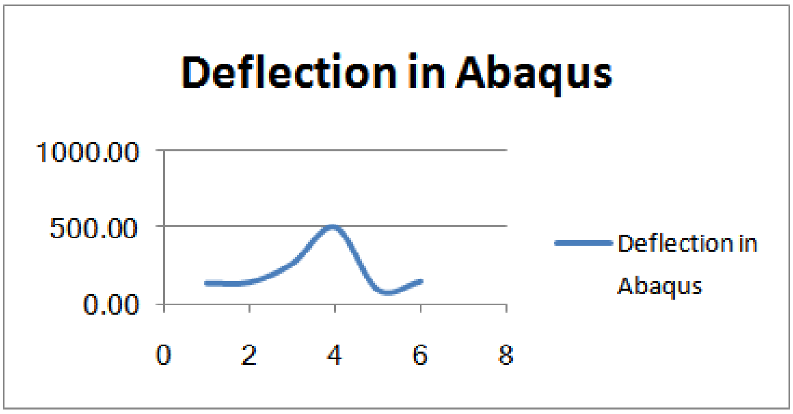

Figure 10

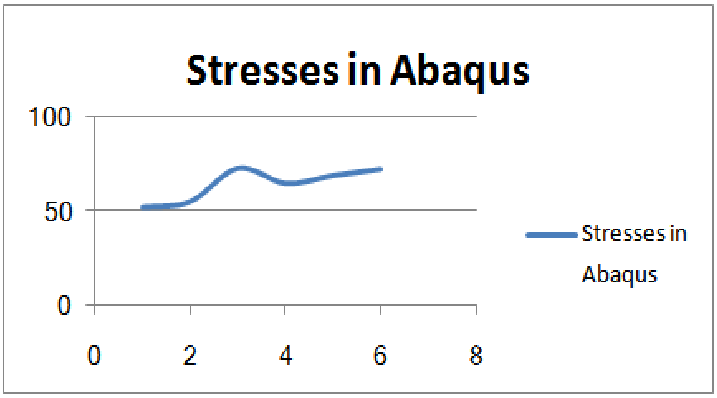

Figure 11

PCC Cross Section with Uniform Load (Self Weight)

Table 7

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	134.6	48.52
Sandy Soil	0.015	90.34	38.73
Murum	0.027	51.2	24.13
Black Cotton soil	0.038	26.02	19.12
Clayey Soil	0.052	59.52	15.46
Hard rock	0.080	16.84	12.14

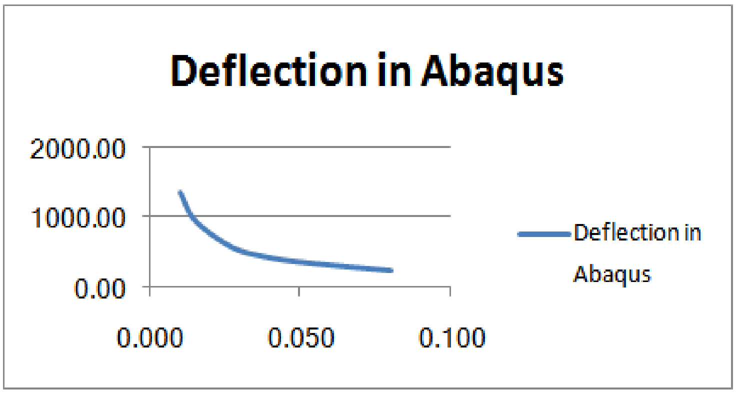

Figure 12

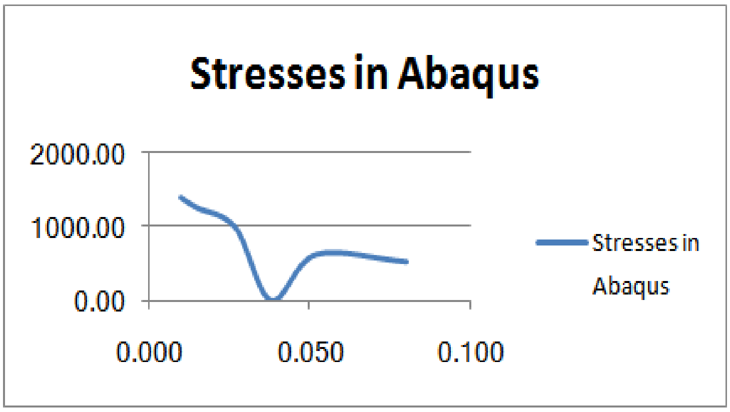

Figure 13

PCC Cross Section with Empty Condition

Table 8

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	1318.00	888.90
Sandy Soil	0.015	927.72	840.30
Murum	0.027	567.50	763.50
Black Cotton soil	0.038	432.90	714.60
Clayey Soil	0.052	335.10	667.60
Hard rock	0.080	239.00	601.50

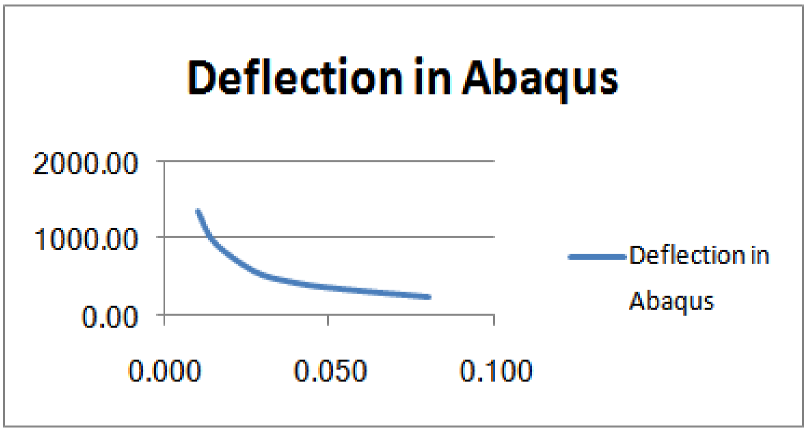

Figure 14

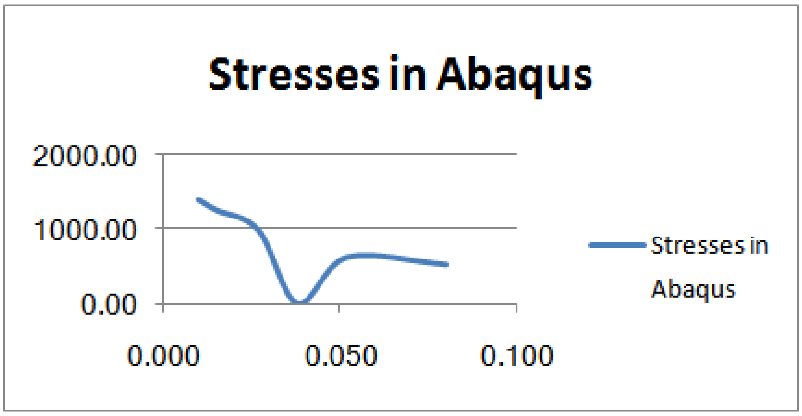

Figure 15

Composite Geo-membrane lining Along With Old and New Concrete Lining

Composite Geo- Membrane with Hydrostatic Load

Table 9

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	135.60	53.16
Sandy Soil	0.015	921.3	41.06
Murum	0.027	51.60	28.47
Black Cotton soil	0.038	35.71	23.25
Clayey Soil	0.052	25.67	19.40
Hard rock	0.080	16.50	15.23

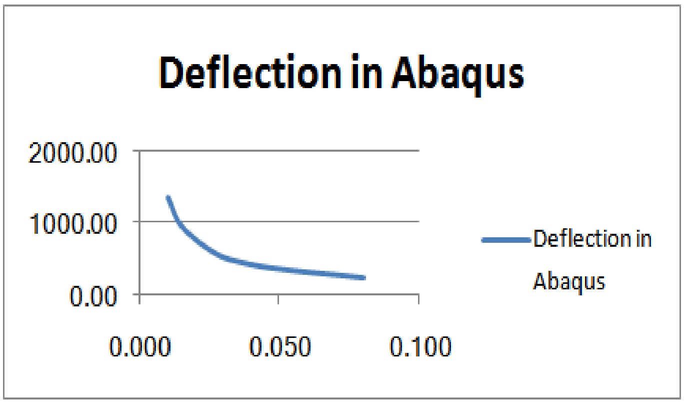

Figure 16

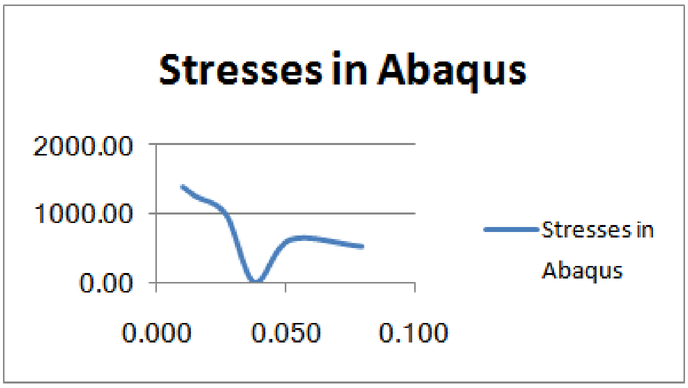

Figure 17

Composite Geo- Membrane with Pot Hole Hydrostatic Load

Table 10

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	232.10	52.03
Sandy Soil	0.015	153.4	35.82
Murum	0.027	134.40	23.58
Black Cotton soil	0.038	88.99	18.66
Clayey Soil	0.052	114.90	15.09
Hard rock	0.080	34.65	11.41

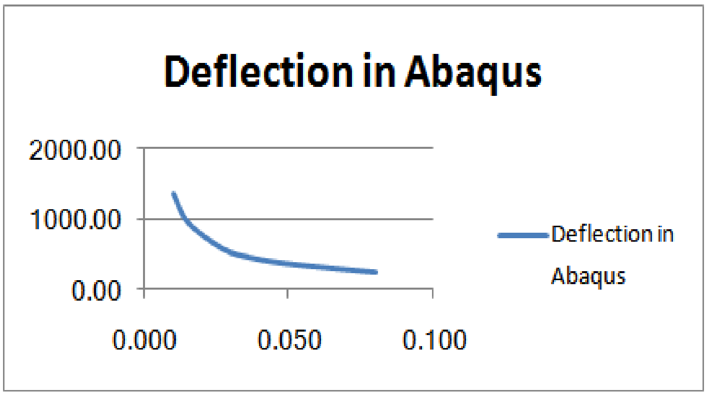

Figure 18

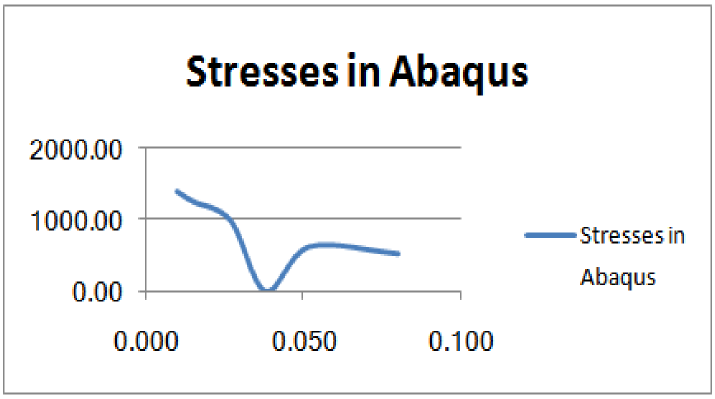

Figure 19

Composite Geo-Membrane with Erosion Hydrostatic Load

Table 11

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	25580.00	49.75
Sandy Soil	0.015	54540	40.44
Murum	0.027	43790.00	29.91
Black Cotton soil	0.038	34920.00	25.13
Clayey Soil	0.052	25000.00	21.44
Hard rock	0.080	19590.00	17,23

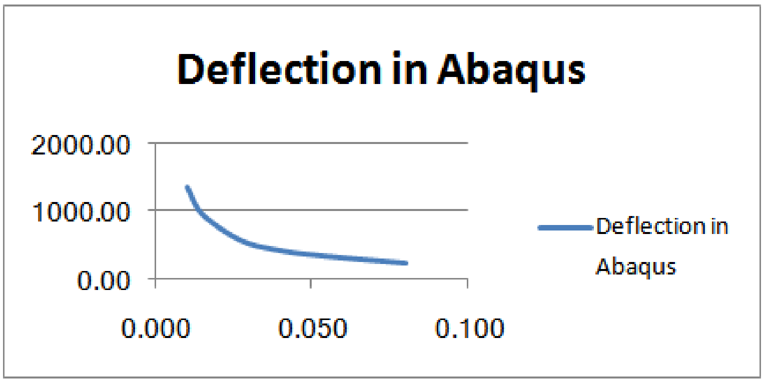

Figure 20

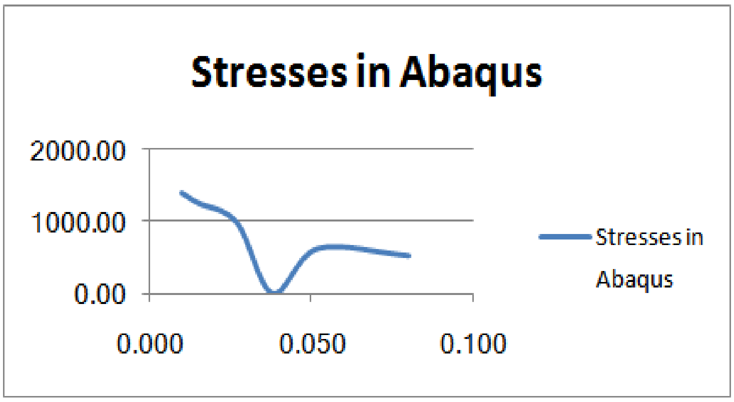

Figure 21

Composite Geo-Membrane with Empty Condition

Table 12

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	1204,00	926.80
Sandy Soil	0.015	860.6	870.50
Murum	0.027	531.60	780.40
Black Cotton soil	0.038	404.50	724.10
Clayey Soil	0.052	314.50	671,40
Hard rock	0.080	224.60	600.00

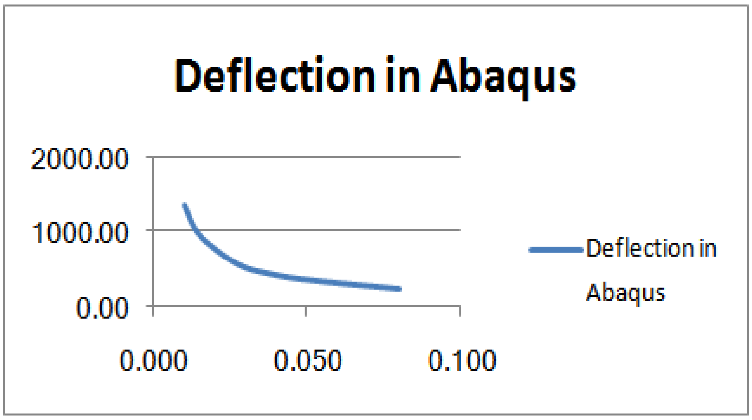

Figure 22

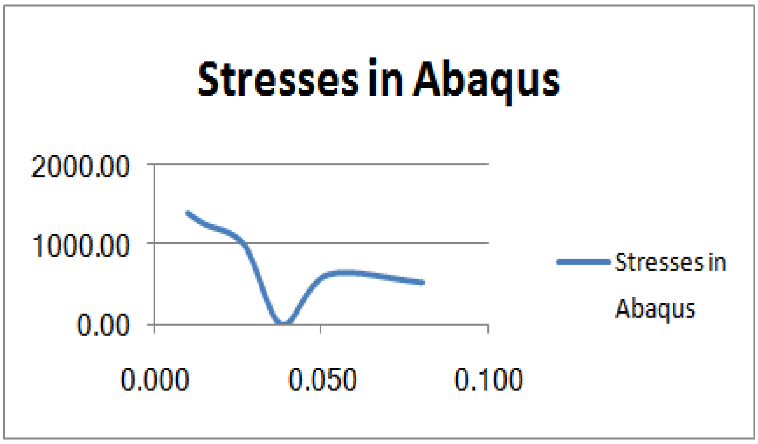

Figure 23

Composite Geo-Membrane with Pot Holes Empty Condition

Table 13

Type of Soil	Sub Grade Reaction	Deflection in Abaqus	Stresses in Abaqus
Lose Soil	0.010	1360.00	1391.00
Sandy Soil	0.015	954.8	1254.00
Murum	0.027	579.90	981.50
Black Cotton soil	0.038	442.40	797.7.
Clayey Soil	0.052	355.70	622.10
Hard rock	0.080	243.10	523.80

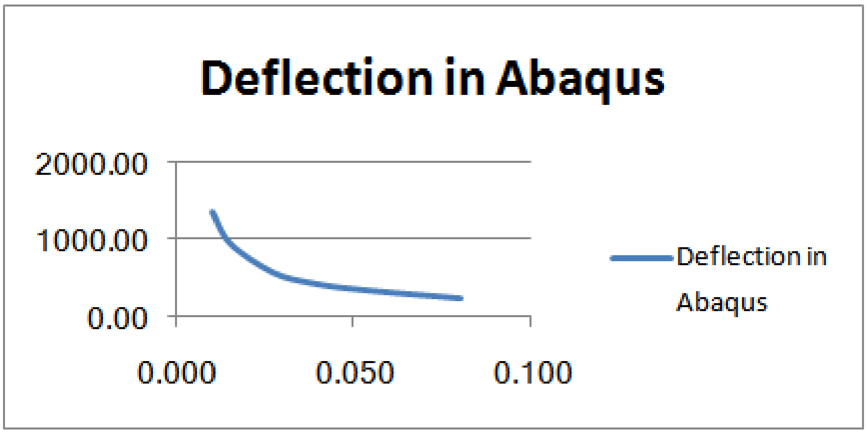

Figure 24

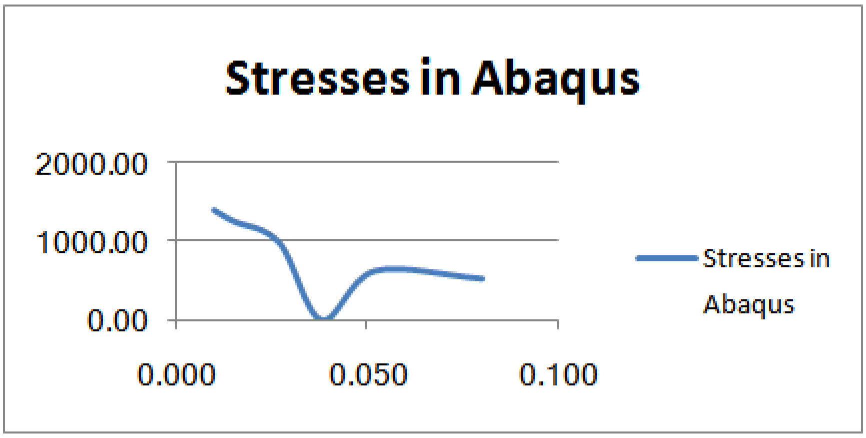

Figure 25

CONCLUSIONS

The concrete lining is one of the most congenital type of lining which has successfully been used in India and other parts of the world cement concrete lining is more preferable tuan any other lining where channel is to carry high velocity water because of its grater resistance to erosion.

There are found seepage loss results not only is depleted freshwater resources but also causes water logging, Stalinization and ground water contaminations canal is alluvium are lined in general and reduce the seepage particular.

The cylindrical bending of elastic plate, single layer of homogeneous isotropic plate for nasalized transverse displacement (w), in plane normal stress (fs) an isotropic plate under cylindrical bending has been done from numerical investigation for layered plate with orthotropic layers simply supported on two edges. Poonam V. Nimbolkar and Indrajeet M. Jain gives an analysis solution of Numerical investigation for normalized transverse displacement (w) are validate with ABAQUS Software.

The numerical investigation and ABAQUES Software solution is approximately same, hence the software useful for evaluate displacement (w) and stress (fs) in concrete. This also useful for composite plate for evaluate to three layer Geo-membrane in old and new concrete plate to monies the seepage loss in canal lining. The recommendations of studies are.

- All new canals will design as lined canals.
- The old unlined canal should be lined as per phased schedules in upcoming every year.
- The geo membrane concrete PCC lining in Black cotton, Murum,Sandy,Loose and clayey soil sections.
- The canal section should be lined at the base of canals as per site situation site in charge.
- The canal should be lining base and up to one third height from bed canal lining as per site situation site in charge.
- The M10, PCC lining with thickness of 7 cm to 10 cm should be provided.
- The cross section should be properly design in cohesive soils with Cohesive Non- swelling Soils (CNS) layer in partially embankment and full embankment sections.
- The deflection and stresses should be maximum in Black cotton, Murum,Sandy and Loose soils.
- The hydrostatic efficiency should be increased with geo-membrane lining sections in every rotation period.
- The safety parameters to resistance to erosion and pot holes in canal sections.
- There is a safety precautions to resistance to erosion and pot holes in canal section.
- There is no need full section should be composite geo membrane lining to Dudhaganga right bank canal throughout section it should be partially and selected patches for economy of lining.

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