Structural Upgrades of Culverts: Application of Isolated Footings for Retrofitting

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ABSTRACT

As India is a developing nation which requires a good flow of transportation by means of road, air, rail and water for its proper and easy connectivity. For study we determine its present strength using N.D.T. test (rebound hammer) than we use analysis tool staad.pro to determine the best way of strengthening the structure by retrofitting technique using its existing strength and determine the variation in strength after retrofitting. Here I concluded that with the help of retrofitting technique we can provide strength and justify that staad.pro helped in implementing strengthening technique with present discharge rate and loadings without affecting the structure.

KEYWORDS: Discharge, Staad.pro, Retrofitting, N.D.T., Culvert, I.R.C. loading, Cost Analysis.

I.   INTRODUCTION

Culverts throughout the country are approaching or are past their original design lives. These `baby boomer' culverts will need to be repaired, rehabilitated, or replaced. Because entire culvert replacement is so expensive and intrusive, alternate measures to extend the culvert project life are growing increasingly popular. One such method is retrofitting, where a `strength developing section' is installed within an existing culvert barrel and stabilized. Footing support and column strengthening are very popular for retrofitting primarily because the material's lower Manning's roughness values allow for the culvert capacity to be maintained despite a reduction in culvert size.

Objectives:
- To generate a comprehensive details on culvert loading.
- To compare strength generation of slab and box culvert.
- To implement software implementation technique on culvert designing.
- To compare stress distribution and strength difference in slab and box culvert using analysis tool Staad.pro.

II.   LITERATURE REVIEW

F. Kale, et. Al. (2014) Contemplated the cost productive approach of fortify bond solid T-shaft brace. His primary target work was to decrease the aggregate cost in the outline procedure of the extension framework thinking about the cost of materials. The cost of each auxiliary part, for example, material, labor, cost for fortification, concrete and formwork. For every last extension its support length, width of scaffold, deck chunk profundity, width of web of brace and support profundity are considered for the cost minimization of the scaffold framework, the structure is displayed and broke down utilizing the immediate plan techniques. Cost productive issue is defined in NLPP (non-direct programming issue) by Sequential Unconstrained Minimization Technique. The model is investigated and intended for a streamlining reason by utilizing Mathematical lab (Matlab) Software with SUMT, and it is equipped for demonstrating absolutely with high likelihood of least plan factors. Improvement for strengthened bond solid T-shaft support framework is delineated and the consequences of the ideal and regular outline systems are looked at. Watched that Significant funds in cost over the ordinary plan can be accomplished by the advancement. However the correct sparing acquired from ideal plan of strengthen bond solid T-pillar support rely on the traverse of section and grade of material. The cost of support is specifically relative to review of cement.

K. Pathak (2014) Concentrates different practices like bowing, shear, hub and torsion for on a level plane bended fortify bond solid box spans considering three measurement FEM utilizing SAP programming. This approach disentangles investigation and the preparatory plan of bended scaffold segment. The expansion in the torsion for any arrangement of chart is relatively increments than that of bowing minutes, shear powers and pivotal powers which demonstrate that case segment is having high torsional firmness and is nonlinearly change with level of bend. From the examination it is watched that different traverse, the duplication factor for variable level of ebb and flow is shifting directly for hub compel and bowing minute, which is around 1.20 to 1.30 for 90° ebb and flow. Duplication factor for torsion minute is shifting nonlinearly having 1.80 to 1.90 for 90° bend, while there isn't important to apply augmentation factor for shear constrain.

Kumar, et. al. (2015) This current research's goal was to evaluate the monetary significance of the railroad cum street connect. This paper was done to discover the decrease in cost of development by giving single scaffold to both street and additionally railroads. The investigation and configuration period of the task was finished using STAAD PRO V8i. It was watched that the development of a solitary scaffold lessened the cost of two separate extensions for street and railroads, additionally arrive procurement issue is diminished to some degree.

III.   METHODOLOGY:

Two cases has been considered for comparative analysis:

- First Existing Box culvert.
- Second Box culvert with retrofitting technique.

The following three activities must be performed to achieve that goal -

   a. Modeling of the frame using STAAD.Pro.
   b. The calculations to decide the explanatory results.

- Result check is all empowered by devices contained in the framework's graphical Environment.

Analysis of culverts 6 m span expansion to expansion has been considered for the parametric analysis of vehicle critical load position as per I.R.C. loading standard which are analyses with the help of staad pro software. Proposed steps are as followings:

Step 1: Selection of the geometry of superstructure by using coordinate system in STAAD Pro or plot over the AUTO CAD, which can be import in Staad-Pro as per dimension of girder, c/c distance of bearing, expansion to expansion distance and no.of diaphragm etc. Schematic sketch of the superstructure.

Step 2: Culvert as per existing strength is modelled and one model with retrofitting is prepared of same dimension and same loadings as per Indian standards. finite element modeling of the model considering the above parameters.

Step 3: Computation of existing culvert strength by N.D.T. rebound hammer method to determine its present condition.
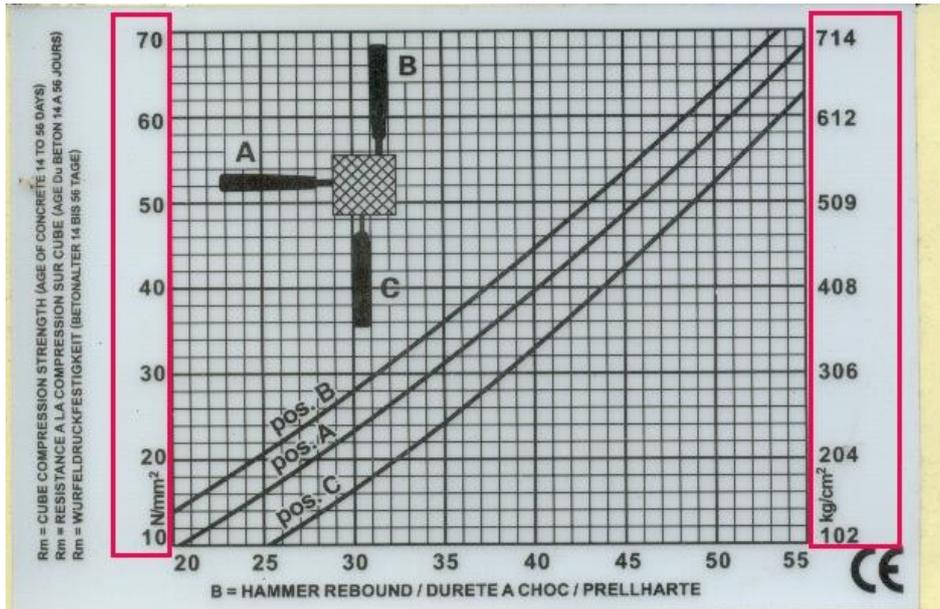

Fig:1 NDT Testing

Fig:2 NDT Graph

Step 4: Modelling in staad for same strength and apply the material property, after that support condition has been considered at the bearing locations of the superstructure which is pinned / hinged

Step 5: After apply the support condition, now the next step to be considered for the Deal Load of the superstructure i.e. "selfweight".

Step 6: After apply the Dead Load, now the next step to be considered for the **Vehicle I.R.C. 70-R two lane load**load.

Step 7: After applied all the boundary condition and forces, now the model has to be "Analyze" for getting the results i.e. Axial force, shear force, deflection and support reactions etc.
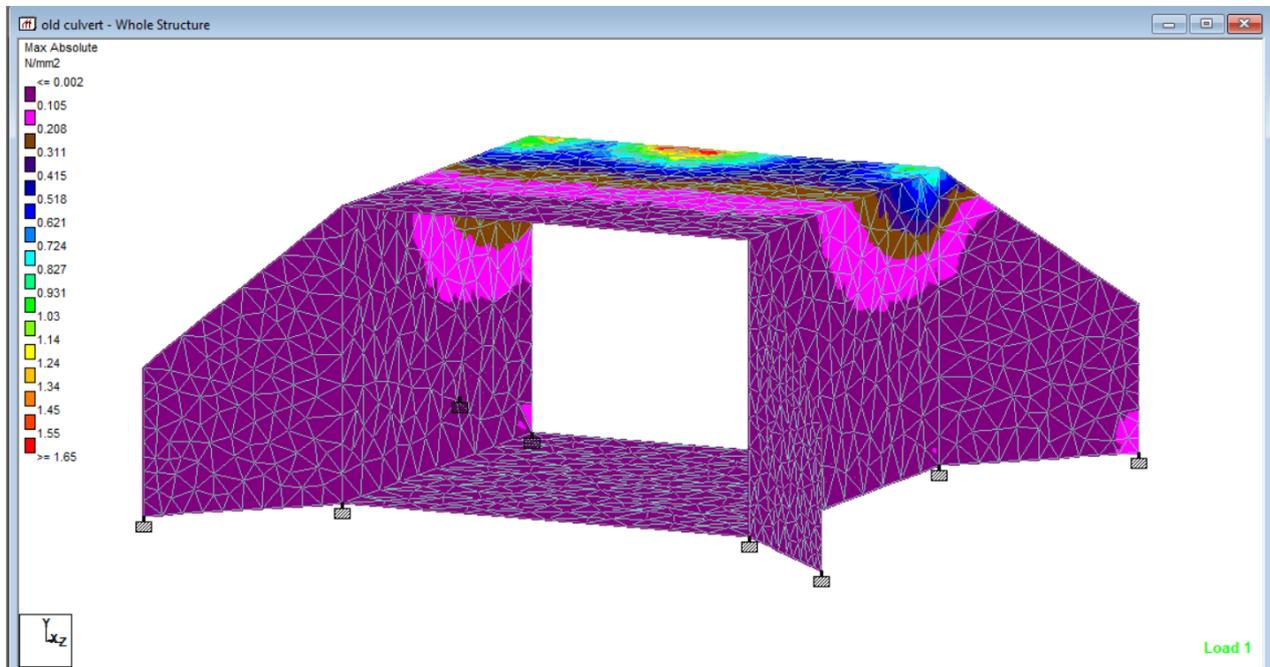

Fig:3 stress distribution

Step 8: After optimization process comparative results are drawn in all cases to determine the best one with the help of graph using M.S. Excel.

Table 1 Description

s. no	Description	Values
1	Culvert length	6 meter
2	Culvert width	4.8 meter
3	No. of lanes	Two
4	Carriageway length	4.2 meter
5	Slab thickness	.8 meter
6	Pier height	5 m
7	Size of beam	230 x 400 mm
8	Retrofitting support section	400 x 400 mm

Table 2 Material property

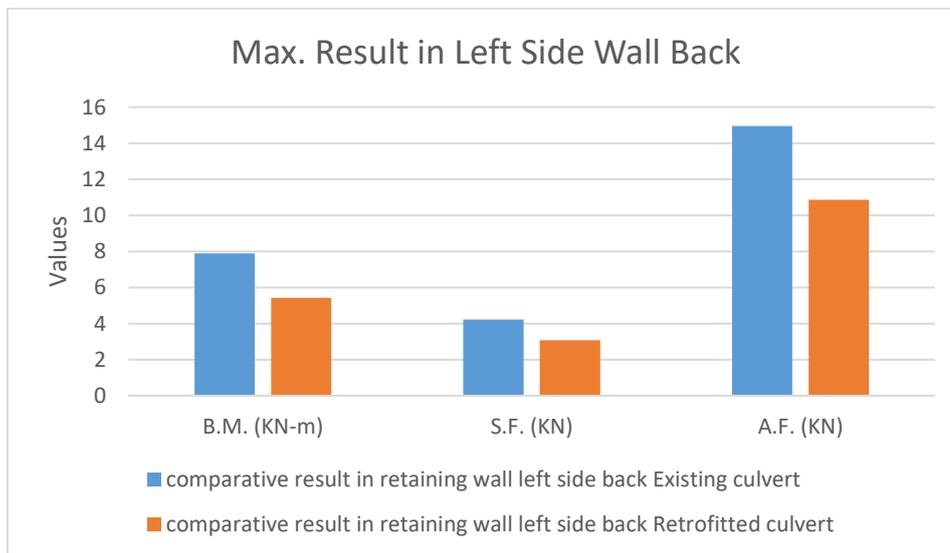| s. no	Description	Values
1	Material property	Values
2	Grade of concrete	M-30
3	Young's modulus of concrete, E_c	2.17×10^4 N/mm^2
4	Poisson ratio	0.17
5	Tensile Strength, Ultimate steel	505 MPa
6	Tensile Strength, Yield steel	215 MPa
7	Elongation at Break steel	70 %

IV. RESULTS

Fig.4 Retaining wall Left side
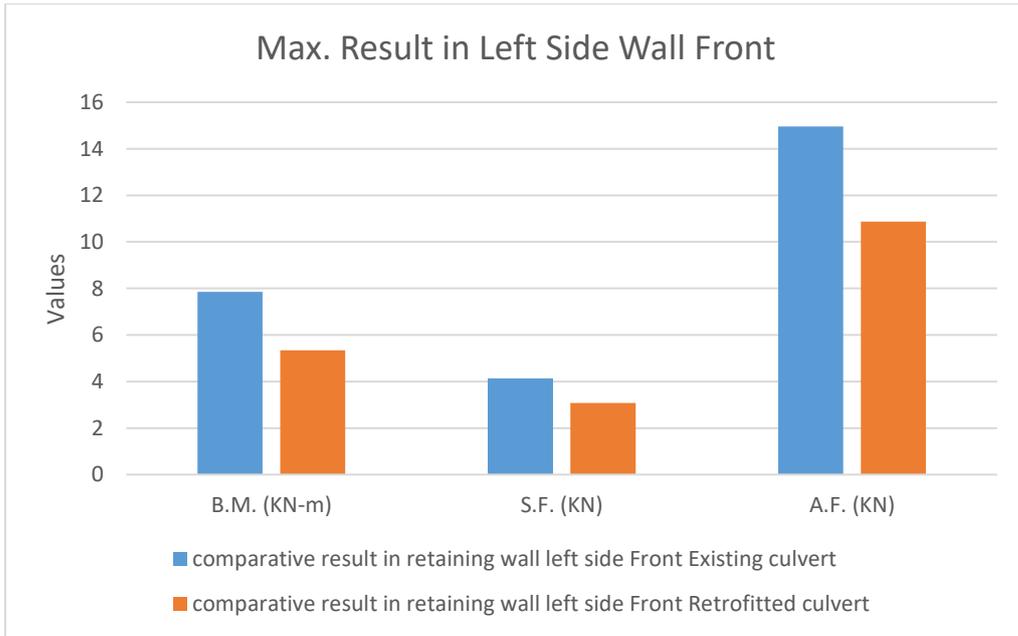
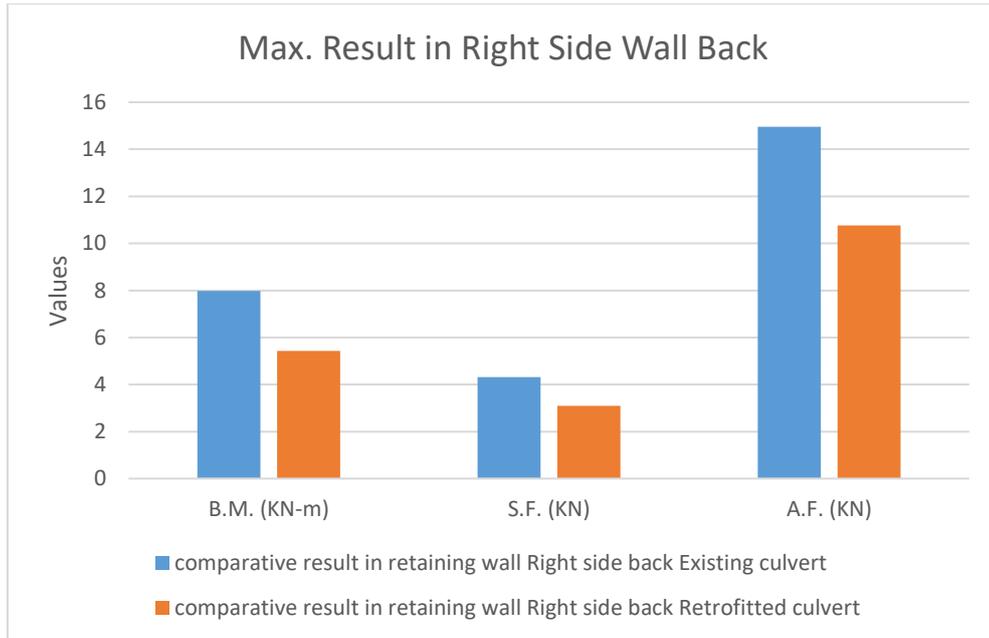*Fig 5 Retaining Wall Left Side Back*

Fig 6 Retaining Wall Left Side Back

Max. Result in Right Side Wall Back

Legend:
- comparative result in retaining wall Right side back Existing culvert
- comparative result in retaining wall Right side back Retrofitted culvert

Fig: 7 Retaining Wall Left Side Front

Max. Result in Left Side Wall Front

Legend:
- comparative result in retaining wall Right side Front Existing culvert
- comparative result in retaining wall Right side Front Retrofitted culvert
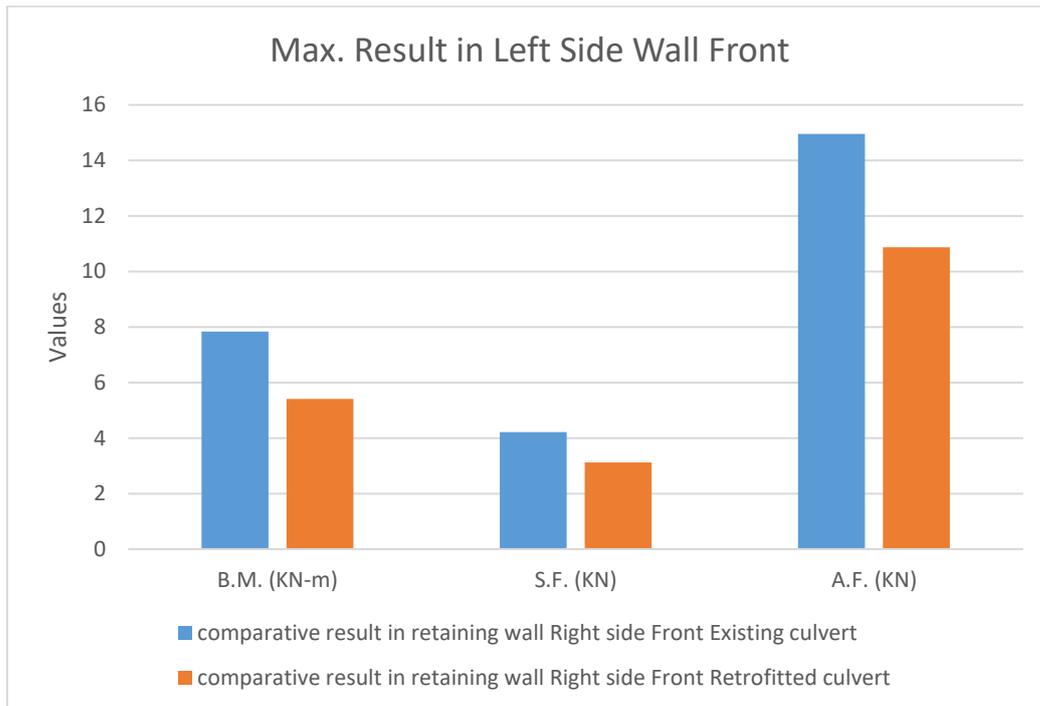
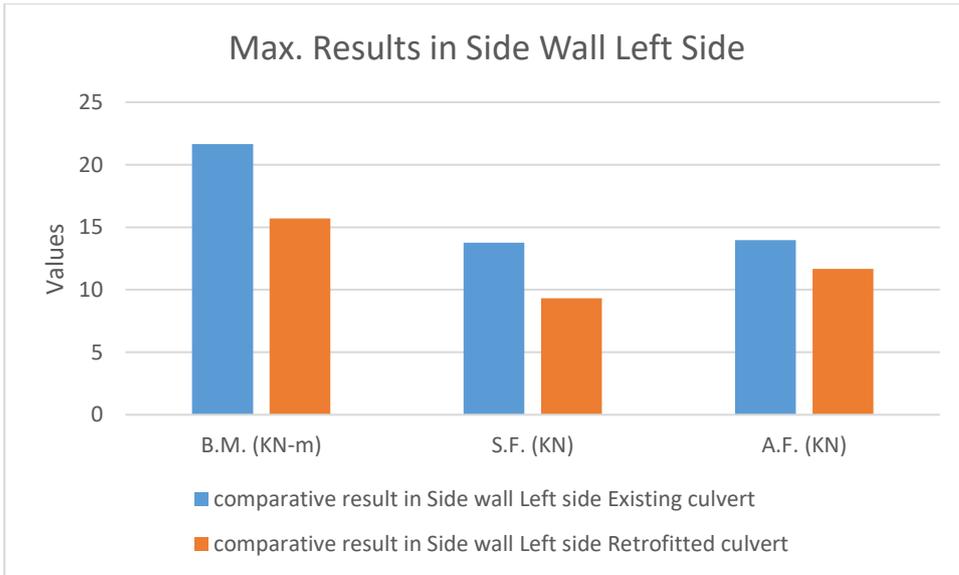*Fig: 8 Retaining Wall Right Side Back*
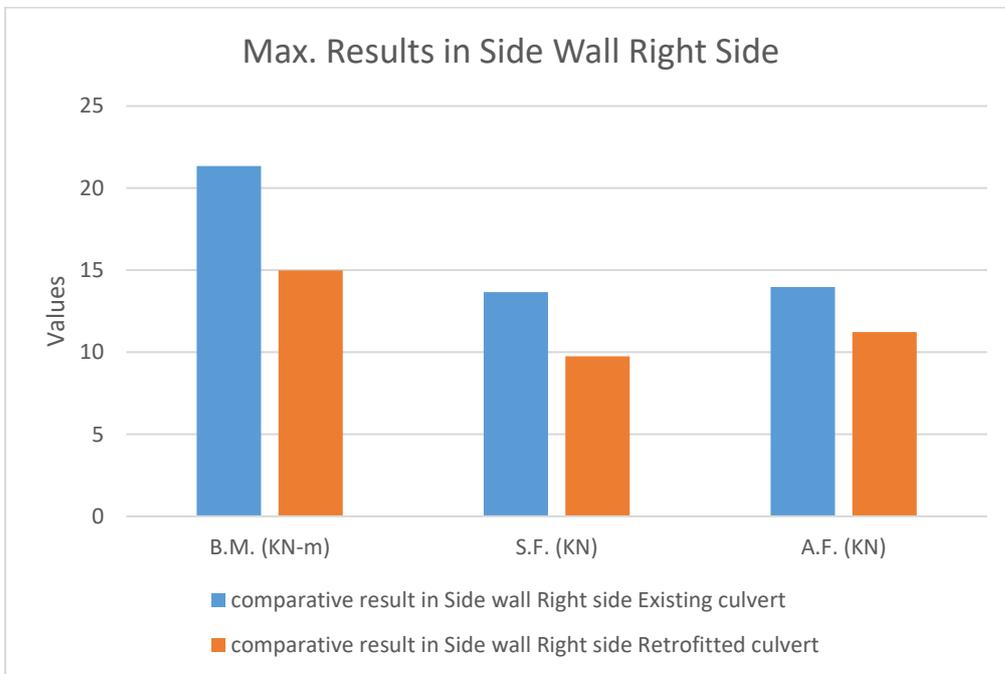
Fig,9 Left hand side wall
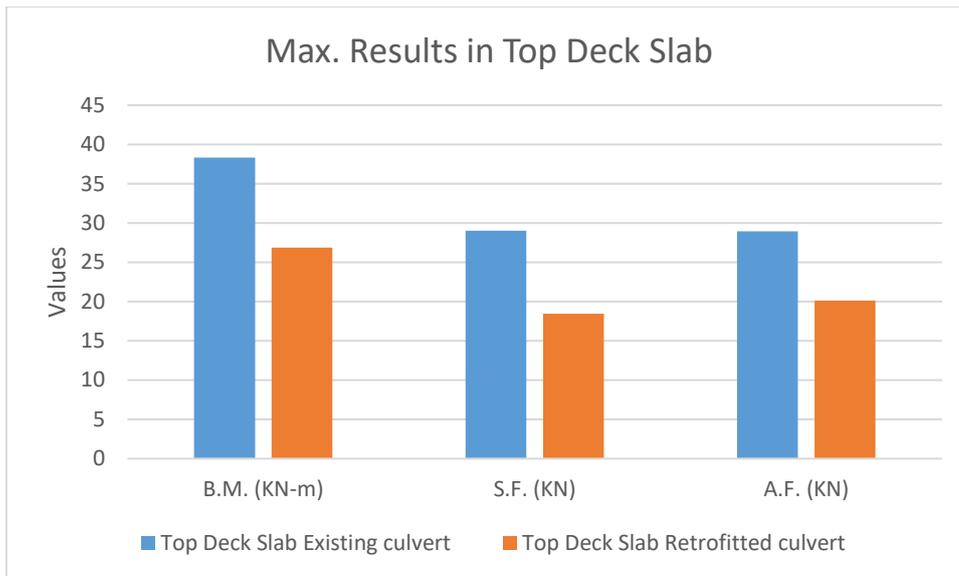

Fig 10 Right hand side wall

Fig: 11 Top Deck Slab

Fig 12 Comparative results on Bottom slab

V. CONCLUSION

Support Reaction

As discussed in the last chapters, we have considered vehicle load cases alongwith dead load &live load for the existing box culvert for analysisby using Staad-Pro software. Following are the salient conclusions of this study-

Shear Force

For the case of Shear force analysis, we have analysis different parts of the culvertforcritical loads and observed that in existing culvert value is maximum which means it is in the most severe condition showing more unbalance forces whereas after retrofitting its value decreased in all parts.

Bending moment

Top slab of box culvert is critical member which carries maximum bending moment. The bending moments of different members of box culvert are determined. In all parts of the culvert it is clearly observed that after retrofitting decrease in bending moment is observed which is resulting as a stable structure.

Axial Force

For the case of Axial force analysis, we have analysis number of cases forcritical the values and observed that Axial force values decreases with retrofitting technique due to propoer load distribution.

Cost analysis

As India is a developing country therefore there is a need of economical sections to have a cost effective design to bear same loading in lesser cost.

Here in our study we have selected the technique of retrofitting in which we are distributing the load with the help of providing extra joints and supports at the bottom which is the most economical method to make a structure stable again.

VI.   REFERENCES

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