DESIGN AND STRUCTURAL ANALYSIS OF ARMED VEHICLE LAUNCHED BRIDGE

K Aravind, Bhashamoni Akhilkumar, Kothakaapu Maheshwar Reddy, T Ganesh, K Kurumurthy, Mr. N. Vinay

Dept. of Mechanical Engineering, SVITS, Mahbubnagar, Telangana, India.

Abstract: The Armored vehicle launched bridge (AVLB) is an assault bridge employed during battles. The existing AVLB has huge capacity. However a need was identified to increase its Load bearing capacity above with higher factor of safety while engaged in military operations. This report presents the improved design of AVLB. The Sections installed in design promotes high moment of inertia and stiffness which makes it resistant to bending moment. The web of Sections provides resistance against shear force. In this project work has been taken up on the different aspects of Materials like Aluminum and Duralumin materials to cover the research gaps to present the results. The 3D Model of AVLB is created in Catia. And finite element analysis was performed on the model of AVLB to identify the highly stressed components of design for static structural loads. The analysis using Finite Element Method (FEM) is used to determine shapes and this has been accomplished by the commercial finite elements package Ansys. And all the efforts made to ameliorate the original AVLB, along with additional safety to AVLB design by considering the factor of safety value.

I- INTRODUCTION

The Armored Vehicle Launched Bridge (AVLB) is an armored vehicle based on the M60 Patton tanks hull and used for the launching and retrieval of a 60-foot (18 m) scissors-type bridge. The AVLB consists of three major sections: the launcher, the vehicle hull, and the bridge. The M60 AVLB or Armored Vehicle Launched Bridge was introduced in 1963.

Fig 1.1: M60A1 Armored Vehicle Launched Bridge (AVLB)

This combat engineer vehicle was developed by the US Army Engineer Research & Development Laboratories under contract with General Dynamics to replace the previous M48 AVLB. It was designed to launch bridge for tanks and other wheeled combat vehicles across trenches and water obstacles in combat conditions. A total of 400 armored bridge launchers and bridges were built. 125 M60 AVLBs of all variants were constructed.

Design & Development:

In the early 1950s, the prototypes for US military Armored Vehicle-Launched Bridge (AVLB) were based on the M48A2 hull. This AVLB prototype launcher assembly used an M48 tank with its turret removed from the chassis, fitted with a launching system for the Scissors Bridge carried on top of the hull. This AVLB Bridge launching system was designed and tested by the US Army Engineer Research & Development Laboratories at Ft. Belvoir, Virginia. After the 1959 end of production of the M48, the chassis of the similar M60 was used, with 400 launcher assemblies and bridge units produced from 1958 to 1963. Many of these early bridge launcher units were later exported to Israel after the conclusion of the Vietnam War.

Description

The M60 AVLB is based on the M60 or the M60A1 hulls. Initial construction of the M60 AVLB was from 1963 to 1967. Most of the hulls for the M60A1 AVLB were former M60A2 Patton's converted to AVLBs from 1987 to 1996. All AVLBs were constructed at the Anniston Army Depot, Alabama under contract with General Dynamics Land Systems. The driver and commander are seated side by side in what would normally be the turret ring. Instead of a turret, launching equipment for a scissor bridge is fitted. The scissor bridge is carried in folded position on top of the chassis and the hydraulics for the launcher installed in the former driver's compartment. It is launched towards the front by means of a hydraulic launching arm. The driver has controls to launch and retrieve the bridge. The launching arm features a large bar that features as an outrigger during emplacement. After assault force vehicles have passed over the bridge, the AVLB can cross over, pick up the bridge on the far bank and continue along in support of assault forces. It can produce a limited smokescreen by dumping raw diesel fuel into the exhaust system to visually obscure the area around the vehicle. The smokescreen does not provide protection against infrared, thermal or laser detection. The vehicle does not provide full NBC protection to the crew.

II - LITERATURE SURVEY

Service History

United States Since its introduction in service in 1963, the M60 AVLB has supported the armored forces of the US Army and Marine Corps in many conflicts and military exercises. It was also exported to a handful of nations that also used the Patton series of tanks. Both the M48 AVLB and the M60 AVLB variants were deployed to Vietnam.

Fig 2.1: REFORGER 1985, an M60 AVLB deploying its bridge on the banks of Lahn River

During the Cold War, the M60A1 AVLB was deployed to West Germany with US Army Combat Engineer units in support of NATO, notably during annual REFORGER exercises through 1991. The US Army retired the M60 AVLB from combat use in 2003 and has been superseded by the M104 Wolverine. As of 2018 the vehicle is still in service with the Army National Guard.

The US Marines received their first M60A1 AVLBs in the late 1980s. They have been deployed with Marines Corps armored divisions during Operation Desert Storm in Kuwait and Iraq in 1990 and 2003 Iraq War as well as Operation Enduring Freedom in Afghanistan. As of 2009, the Marines had an inventory of 55 bridges and 37 launchers in service.

Israel The IDF refers to the AVLB as the Tagash. The first armored bridge layers to enter service with the Israel Defense Force were constructed from captured Jordanian M48s. The United States supplied launcher and bridge assemblies for the AVLBs through the 1970s. They were mated to M48 and M60 series hulls by Israeli Military Industries TAAS Slavin Plant. The Tagash AVLB has supported the IDF in the Yom Kippur War, 1982 Lebanon War, 2006 Lebanon War and the 2014 Israel-Gaza Conflict. The IDF continues to use the M60A1-based bridge layers except with modifications.

IJMTARC – VOLUME – IX – ISSUE – 38, APR - JUN, 2022 ISSN: 2320-1363

Fig 2.2: AVLB with bridge section

Vehicle modifications included new all-steel Merkava tracks and drive sprockets, although some vehicles continue to use the original T142 track. Due to the growing use of a number of trenches in fortifications and the greater number of natural narrower obstacles rather than larger ones, a tandem assembly bridge called the Tzmed or tandem was engineered. Two bridge sections can be fitted to any M60 AVLB system without any modification to the launcher. The main advantage to an up-and-out system compared to a horizontal system is the reduced mechanical complexity. The Tzmed assembly also enables the AVLB to bridge gaps in which the elevation of the opposing bank and the bridge itself, when laid out, is steep. The Tzmed assembly weighs in at only 13.5 tons with two bridge sections.

III - DESCRIPTION ON PROJECT

Armoured Vehicle Launched Bridge (AVLB) systems

Enable combat engineers to overcome a variety of gap-crossing challenges to help maintain the momentum of friendly forces on the battlefield.

Keeping the way clear and unimpeded, so friendly troops can keep moving and maintain mobility on the battlefield, is a primary role of combat engineers. Clearing minefields and overcoming obstacles, for which a variety of specialized engineer equipment is available, are just two typical activities on an engineering unit's very long task sheet. Gap crossing is another and no matter how wide, from the widest river to the narrowest ravine, having the right equipment at their disposal to bridge a gap helps the combat engineer get the job done.

Mobility and counter-mobility is what combat engineering is all about and the equipment employed by these specialist troops can alter the course of a battle by keeping friendly forces on the move, while at the same time denying ease of movement to the enemy.

While spanning the widest rivers requires floating bridge systems like the M3, its smaller gaps and some of the AVLB systems in use and evolving in Europe is the basis which this article is chiefly focused.

Gaps – No Match for European AVLBs

Gaps on the battlefield come in all shapes and sizes. Some are dry, some are wet, some are marked on the map, while others can appear unexpectedly out of nowhere, missed by the cartographers, or, perhaps, having appeared as a result of battle damage. Dealing with the multitude of smaller to moderate gaps anywhere from a few metres up to 60m (by deploying multiple bridge spans) or so in width, is largely the preserve of AVLB-type systems and having a choice of such bridging systems makes for more efficient and effective bridging operations. AVLBs enable vehicles of almost every kind to cross such obstacles, although it is the rapid advance of main battle tanks (MBTs), armored fighting vehicles (AFVs) and infantry fighting vehicles (IFVs), that is key and for which unimpeded mobility is essential. AVLBs help ensure battlefield momentum is maintained and the fight taken to the enemy.

Fig 3.1: The MLC 80+ classification ANACONDA can support the latest and heaviest variants of the LEOPARD 2, M1A2 ABRAMS and CHALLENGER 2

A typical AVLB enables AFVs and IFVs to cross anti-tank ditches, blown bridges, craters, railroad cuts, canals, rivers and ravines, usually by unfolding its ready-made-bridge payload to span the obstacle in only a matter of minutes, typically without additional support equipment. The vehicle then detaches from the bridge once it's in place and moves out of the way to allow the bridge to be crossed. After the last vehicle has passed the AVLB launch vehicle crosses over itself, re-attaches to the bridge on the opposite side of the obstacle and retrieves the span before moving onwards.

Yet, while AVLBs continue to operate in the same scenarios as they always have, leading industry experts consider the AVLB market is no longer as easily categorized in terms of the traditional medium and heavy system nomenclature as it once was. More often nowadays, individual countries set their own categories. Some may categorize their assets in terms of the bridge length carried by the AVLB, such as 26m, 22m and so on. And while 'armoured' is indicative of the bridge being carried atop a tracked or wheeled AFV/IFV type chassis, a wider variety of wheeled systems are entering the space (though will not be considered in great detail in this article) with some up-armouring prior to operational deployments.

IV - OBJECTIVES AND METHODOLOGY

The objective of this project work is to successfully develop a design and analysis for an Armored Vehicle Launched Bridge (AVLB). The design is to be reliable, simple and practically feasible. The aim of this mechanism is to provide stability to the product on unbanked curves, so as to enable added threshold on curves in comparison to narrow areas. This system is also supposed to enhance comfort as the side force felt taking a turn is comparatively less in Armored Vehicle Launched Bridge (AVLB).
Initially Armored Vehicle Launched Bridge (AVLB) design was adopted from an already existing design and minor changes were made to suite our purpose. This design is tested due to following objectives.

General Objectives

To find a suitable bio material for mechanical testing under static loading conditions
To obtain the desired results which will be calculated and strength is matched with the nearest value of Armored Vehicle Launched Bridge (AVLB) material strength.

Specific Objectives

Study on the drawing of the Armored Vehicle Launched Bridge (AVLB)
Optimizing the design of the Armored Vehicle Launched Bridge (AVLB) using Catia V5
Adding the materials and extracting its Characteristics (bill of material) to the Armored Vehicle Launched Bridge (AVLB)
Structural Analysis on the Armored Vehicle Launched Bridge (AVLB) using Ansys Workbench
Due to these disadvantages, the design was dropped and a fully new design was defined. The software to be used in design is Catia V5 and testing of design is Ansys.

Engineering Design

Catia Elements offers a range of tools to enable the generation of a complete digital representation

IJMTARC – VOLUME – IX – ISSUE – 38, APR - JUN, 2022

ISSN: 2320-1363

of the product being designed. In addition to the general geometry tools there is also the ability to generate geometry of other integrated design disciplines such as industrial and standard work and complete wiring definitions. Tools are also available to support collaborative development.

Analysis

Ansys Elements has numerous analysis tools available and covers thermal, static, dynamic and fatigue FEA analysis along with other tools all designed to help with the development of the product. These tools include human factors, manufacturing tolerance, mould flow and design optimization. The design optimization can be used at a geometry level to obtain the optimum design dimensions and in conjunction with the FEA analysis.

V - DESIGN METHODLOGY OF ARMORED VEHICLE LAUNCHED BRIDGE (AVLB)

Introduction to CATIA

CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the French company Dassault Systems. Written in the C++ programming language, CATIA is the cornerstone of the Dassault Systems product lifecycle management software suite. CATIA competes in the high-end CAD/CAM/CAE market with Cero Elements/Pro and NX (Unigraphics).

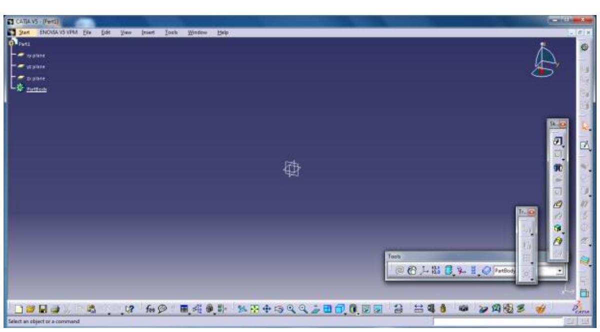

Fig: 5.1: Home Page of CatiaV5

Modeling of AVLB in CATIA V5

This AVLB is designed using CATIA V5 software. This software used in automobile, aerospace, consumer goods, heavy engineering etc. it is very powerful software for designing complicated 3d models, applications of CATIA Version 5 like part design, assembly design.

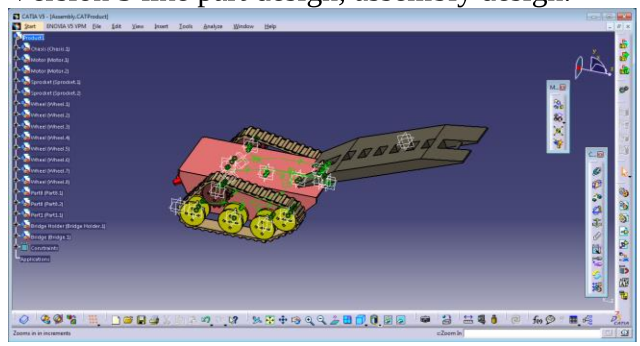

Fig: 5.2: Model design of AVLB in CATIA-V5

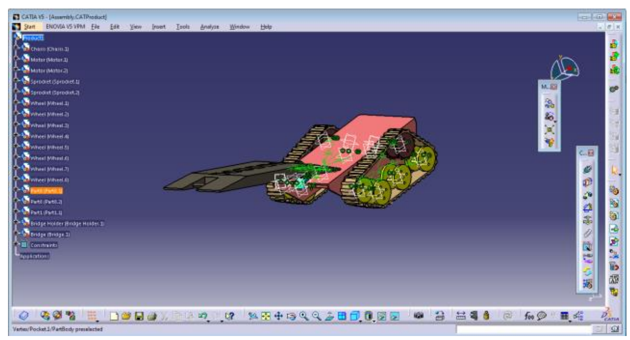

Fig: 5.3: Model arrangement in CATIA-V5

VI - ANALYSIS OF AVLB

6.1 Procedure for FE Analysis Using ANSYS:

The analysis of the AVLB is done using ANSYS. For compete assembly is not required, is to carried out by applying moments at the rotation location along which axis we need to mention. Fixing location is bottom legs of rod assembly machine.

6.2 Preprocessor

In this stage the following steps were executed:

- **Import file in ANSYS window**

File Menu > Import> STEP > Click ok for the popped up dialog box > Click

Browse" and choose the file saved from CATIAV5R20 > Click ok to import the file

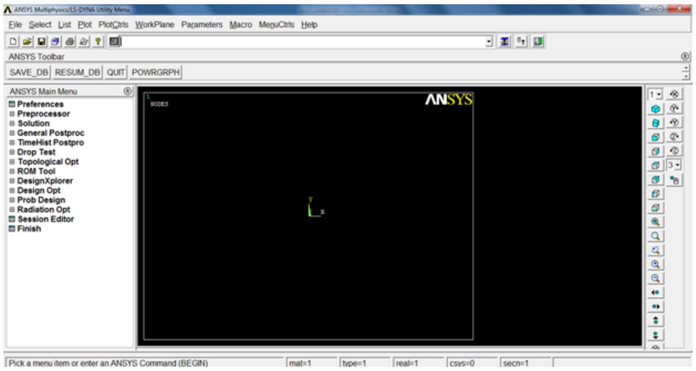

Fig.6.1: Import panel in Ansys.

It is modeled with 1d element and shown as above and assembled with adjacent components. Few components are solved using Thermal Analysis for checking the stress and displacements while flowing the fluid.

After completing the meshing of each assembly components next is to do analysis based on the OEM (Original Equipment of Manufacturer) application. So all the models which are analyzed, we need to mention in the Ansys software to get accurate results as per the original component. Some of the components are needed to be solved using thermal analysis.

VII - DISCUSSION ON ANALYSYS RESULT

7.1 Results of Displacement analysis:

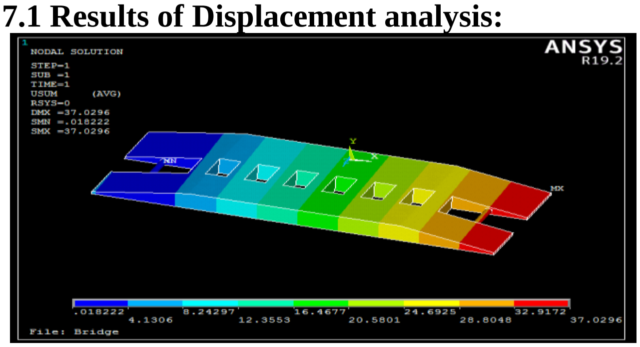

Fig: 7.1: Displacement of Bridge – Aluminum

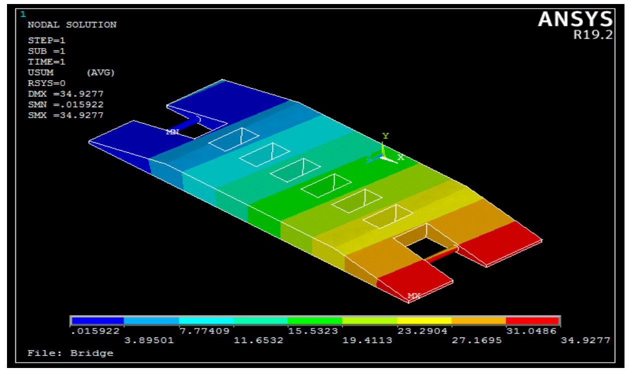

Fig: 7.2: Displacement of Bridge – Duralumin

6.2 Results of Stress analysis:

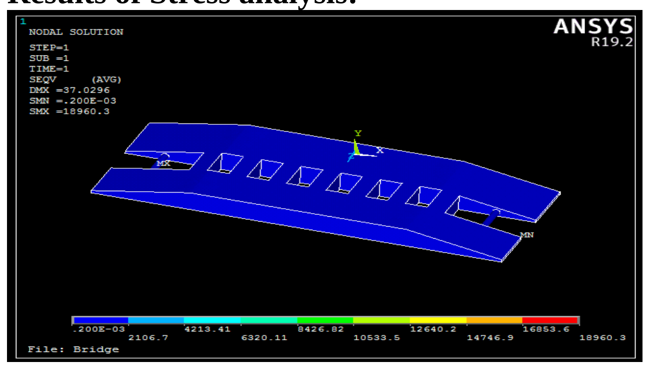

Fig: 7.3: Stress Analysis of Bridge – Aluminum

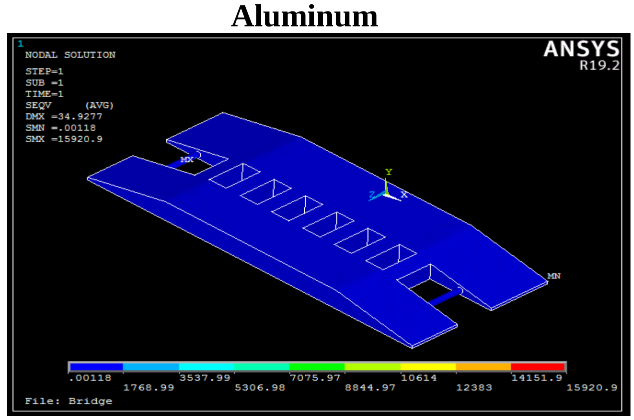

Fig: 7.4: Stress Analysis of Bridge – Duralumin

7.3 Results of Strain analysis:

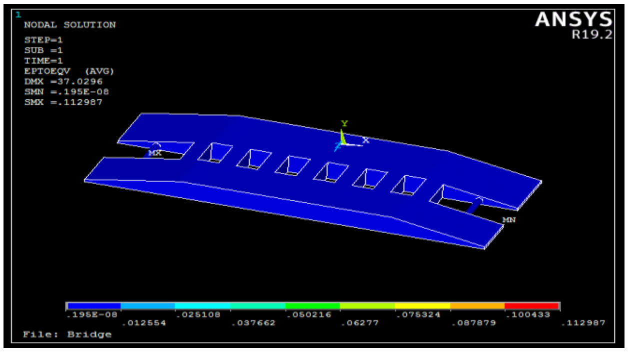

Fig: 7.5: Strain Analysis of Bridge – Aluminum

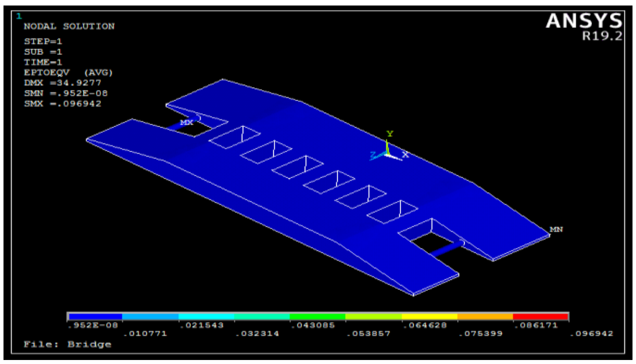

Fig: 7.6: Strain Analysis of Bridge – Duralumin

VIII - CONCLUSION

It can be seen from the above result that, our objective to find the Structural Analysis of an armored vehicle launched bridge (AVLB) in a curve has been successful.

As shown above figures the displacement of the Armored vehicle launched bridge (AVLB) design is meshed and solved using Ansys and displacement is very less. This is showing us that clearly each component in of different materials (Aluminum and Duralumin) is having minor displacement. Stress is at the fixing location (Minimum Stress which is acceptable).

Structural Analysis Results

S.No	Description	Aluminum	Duralumin
01	**Displacement Result**	**37.0296 mm**	**34.9277 mm**
02	**Stress Result**	**18960.3 MPa**	**15920.9 MPa**
03	**Strain Result**	**0.112987**	**0.096942**

The value which is very less compared to yield value; this is below the yield point. The Structural are the results that we approach in Ansys workbench. The maximum stress is coming, this solution solving with the help of Ansys software so that the maximum stress which is very less. The analysis a result of the design of the bridge has to withstand a force caused by military vehicles.

After completing the meshing of bridge model next is to do analysis based on the application. So the model which is analyzed and mention in the Ansys software to get accurate results as per the conditions. The Duralumin is the better material then Aluminum as designed of the AVLB Bridge model is analyzed flawlessly in analysis as well. To demonstrate it is also working successfully, all these facts point to the completion of our objective in high esteem.

REFERENCES

- Fatigue Life Prediction For Armored Vehicle Launched Bridge (AVLB) For MLC 70 And MLC 80 Loads By Bernard Sia.
- The Dynamic Behavior of an Armored Vehicle launched Bridge by Samer Petro, Shen-En Chen, Suhas Venkatappa, and Hota GangaRao.
- The Fracture Analysis and Remaining Life Estimation of the AVLB Sub-Components Choi, J., 2000.
- Failure Analysis of Centre Pin Joint Used In Heavy Assault Bridge Dnyaneshwar J. Sushir, Prashant N. Ulhe
- Experimental and Numerical Studies of the Scissors-AVLB Type Bridge by Wieslaw Krason, Jerzy Malachowski.

- Bridge Construction Practices Using Incremental Launching By Mike Laviolette.
- An Analysis of the U. S. Army Light Vehicle / Foot Bridge Design By Stephen J. Ressler and Celal N. Kostem.
- Dynamic Behavior of the Composite Army Bridge (Cab): Field Testing By J. B. Kosmatka.
- Hornbeck, B., Connor, R., Kluck, J., 2005, .Trilateral Design and Test Code for Military Bridging and Gap-Crossing Equipment.
- Fatigue Life Prediction For Armored Vehicle Launched Bridge (AVLB) For MLC 70 And MLC 80 Loads By Bernard Sia.

AUTHOR PROFILE

K Aravind B.Tech student in the Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR.

Bhashamoni Akhilkumar B.Tech student in the Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR

Kothakaapu Maheshwar Reddy B.Tech student in the Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR.

T Ganesh B.Tech student in the Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR.

K Kurumurthy B.Tech student in the Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR

Mr. N. Vinay, Asst. Professor Mechanical Engineering from Sri Visvesvaraya institute of technology and science, MBNR