A MINE-RESISTANT AND DESERT-COMPATIBLE 6X6 MILITARY PERSONNEL CARRIER FOR UINITED NATION PEACEKEEPING MISSIONS

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***Abstract*-Transportation of personnel and equipment in volatile environments during operational and non-operational times is a universal concern in the planning and preparation phase of any military operation. To address the said requirement Sri Lanka Army was able to produce an array of Armoured Personnel Carriers (APC) feasible to be used for operational purposes in the country, since the Sri Lanka Army intends to increase its contribution to UN peacekeeping operations, a requirement arises for improving and readjusting the current APCs. Hence the concept vehicle of AVALON (proposed design) is introduced to feature individual wheel drive, a capacity for ten passengers, separate driver and commander compartments, and a 2.5-ton payload. The project involves analyzing the features of available military grade market chassis with over 250 HP engines and suitable for recommendations, incorporating design specifications inspired by the SLEME's Unicorn. The design specifics highlight the reliability of locally available suppliers in military and economic roles. The all-wheel drive chassis, solid frame, and V-shaped hull design ensure resilience against various conditions. The Avalon, based on the 6x6 chassis, operates in urban, mountainous, and rural terrains, with maximum dimensions of 8.5m x 2.5m x 3.5m and an 18,000kg gross vehicle mass. It accommodates a driver, commander, gun operator, and fourteen troops, equipped with bullet-proof windows and efficient door operations. Protection features intend to supersede STANAG 4569 Level 2 or NIJ level III standards, with armored hull design and blast protection. Detailed specifications of the chassis, engine, transmission, drive system, suspension, braking, winch, and electrical system are outlined. The air conditioning system's load calculation considers Mali's conditions, ensuring optimal performance. Bulletproof glass specifications, fire protection systems, seats, and the structural comparison of designs over time are detailed. The Avalon's performance metrics, material requirements (Armour plates and Bulletproof glass), and weight calculations are presented, the preliminary data gathering is done through secondary sources and the primary data gathering is considered as the foundation. The specification tables provided in the distributors' brochures are considered the statement for expense. In the current requirement criteria, the standardization is adopted from the common yardsticks to provide comprehensive insights into the development and capabilities of this advanced armoured vehicle design for inland and overseas deployment conforming to financial constraints in the country.**

Key words: Armoured personnel carrier (APC), Mine resistance, STANAG, Avalon vehicle, Hull design, Stallion hull chassis, NIJ level III

I. INTRODUCTION

Sri Lanka Army Electrical and Mechanical Engineers (SLEME) was able to produce an array of APCs feasible to be used for the operational purposes in the country, named Unicorn. This was an evolution of the African Buffel, and has been the primary utensil for personnel carriage in theatre. With the eradication of terrorism Sri Lanka Army has diversified its contribution to inland whilst reserving more commitment to UN peacekeeping operations. Currently due to the excessive financial consumption and the additional demand for automata, a requirement arises to upgrade the current line of APCs. Hence the concept vehicle "AVALON" as depicted in figure 1 is introduced by improving on particular aspects of Unicorn APCs. The design considerations for the upgraded vehicle are as follows;

a. Individual wheel drive.
b. Space for minimum 10 passengers.
c. Separate driver compartment for the driver and commander.
d. Payload up to 2.5 tones.

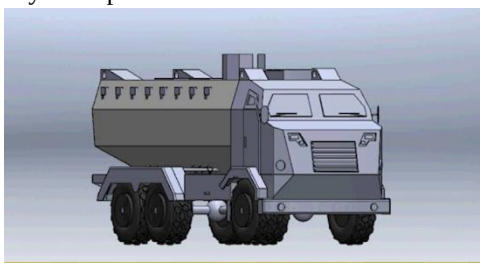

Figure 1. Proposed design for Avalon 6x6

This research is carried out through analyzing the chassis in the present market along with the engines compatible with them. The objective is to design and implement systems and sub systems of the vehicle constrained to the specification of the selected equipment for the project commercially available in the market. Designing of the ancillary systems are done accordingly.

The preliminary data gathering was done through secondary sources and for the primary data gathering it is considered as the foundation. The specification tables provided in the distributors' broachers are considered the statement for expense.

The inspiration from Unicorns fabricated in the SLEME is acquired to the new design. In the current requirement criteria, the standardization is adopted from the common yardsticks.

Through market analysis it was decided to incorporate a commercially available Military chassis for the concept vehicle to build upon in order to meet time constraints and knowledge gaps.

It is a requirement for our production that the chassis provided is compatible with the adverse fluctuation of the weather conditions and severe effects of gravity caused by nominal behavior.

The all-wheel drive chassis employs unique features to allow each axel to move independently with improved steering and maximum tire-to-ground contact.

A 3-dimensional space solid frame created by the connection of the backbone tube and conventional ladder frame is exceptionally rigid against torsion and bending.

The unique chassis and block suspension design gives the vehicle exceptional resistance to shocks and vibrations, protects superstructures from torsion and stresses and allows it to be driven fast on rough roads.

The APC features a V-shaped wall body on a chassis armoured hull design. It is based on the chassis 6x6 heavy-duty vehicle and can operate in urban, mountainous and difficult rural terrains.

The vehicle is 8.6m long, 2.4m wide and 3.3m high, and has a gross vehicle mass of up to 18,000kg. It is equipped with an air conditioning system to minimize crew fatigue.

The vehicle can accommodate a driver, a commander, a gun operator and up to sixteen troops. The front section is fitted with two doors for the driver and commander. The rear section incorporates sixteen folding seats with safety belts for the troops.

Sixteen small bullet-proof windows are fitted on each side of the vehicle, providing increased visibility for the troops. The rear doors can be opened or closed in seven seconds.

II. PROBLEM STATEMENT

Planning and Designing of mine-resistant and desert-compatible 6x6 military personnel carrier for UN peacekeeping missions with following considerations.

a. Competing with New Technology
b. Safety of both crew and vehicle
c. Cruise range maximum 500 km per
d. Spare part availability
e. Maintenance easiness
f. Price factor

The existing Unicorn APCs are encountering issues stemming from high financial costs and increased demand for military automation in defense manufacturing. Consequently, there's an urgent necessity to enhance and adapt these APCs accordingly. Furthermore, given the substantial deployment of soldiers in United Nations operations, there's a need to design specialized APCs that can compete with the latest technology in the defense industry. Additionally, there's a strategic imperative to conserve foreign currency by avoiding purchases of new APCs with advanced technology from developed countries.

III. METHODOLOGY

The methodology for this project encompasses various crucial steps. Firstly, vehicle body design involves integrating past experience and explosion test results using CAD software. Secondly, focused reverse engineering is employed for chassis selection. Thirdly, bulletproof glass undergoes standard drop tests and small arm firing assessments according to NATO standards. Fourthly, seat design is validated through standard drop tests. Lastly, A/C and electrical systems are designed using standard calculations and methods to ensure efficiency and reliability.

Planning and Design of a military vehicle is not an easy task. Specially Military type productions data/information's, methodology's, manufacturing methods highly restricted to outside. Best option will be the past experience of designing and ground testing. This is call continues improvement in Engineering.

IV. DESIGN SPECIFICATIONS OF MECHANICAL AND ELECTRICAL SYSTEMS

A. Protection Features

The Avalon 6 x 6 armoured vehicle is designed to protect the occupants against both blast and ballistic threats, up to STANAG 4569 Level 2 standard or NIJ Level III. The Driver and Crew compartment is completely armoured for protection against damage. Hull bottom accommodates a water tank to absorb the blast effect. Wind shields and windows are made out of bullet proof glass. “V” shaped bottom hull is placed to enhance the protection from explosions both underneath and side. Run flat tires will accommodate additional mileage in an emergency situation.

B. Chassis with Engine

1) Chassis

Commercially available Military type 6 x 6 chassis model selected after analyzing primary data and secondary data, the chassis for Avalon is selected based on, stability, mobility and financial economy suited for county. It’s expected to endure a variety of terrains and resilience to shocks and vibrations. The selected chassis is equipped with a strong backbone ladder structure, Minimum dimensions of 4.3m wheel base, and 330mm ground clearance and 30-degree approach and departure angles [1]

2) Engine and compartment

After data analysis recommended minimum engine characteristics are as follows, four-stroke and turbocharged diesel engine. Should be capable of producing 160 kW (at 2,500 RPM) of power and 800 Nm of torque at 1,900 rpm. With a 250-liter fuel tank, in order to exhibit a minimum cruise range of 200km. The engine compartment is armored in addition to the powertrain, which protects it from possible harm from shrapnels.

C. Transmission System

The Avalon's transmission system is a critical component. Which should have range of gears to function as well as possible and be flexible to the driver. It offers consumers versatility by coming in manual (6 speeds). The transmission system's innovative design, which includes 1 reverse speed and 5 forward speeds (5F+1R), guarantees seamless gear changes.

Military personnel carriers, also known as armored personnel carriers (APCs), are vehicles specifically designed to transport troops and equipment safely across various terrains, including rugged landscapes and combat zones. These carriers are built with armored plating to protect occupants from small arms fire, shrapnel, and other battlefield threats.

The transmission system in a military personnel carrier plays a crucial role in transferring power from the engine to the wheels, allowing the vehicle to move efficiently and navigate different terrains. The transmission in these vehicles is often robust, designed to withstand heavy-duty usage and provide reliability in demanding conditions.

Modern military personnel carriers may use various transmission types, including automatic, manual, or semi-automatic transmissions. The choice of transmission depends on factors such as the vehicle's intended purpose, operational requirements, and technological advancements. Some carriers also incorporate advanced features like multiple speed settings, adaptive systems for terrain response, and enhanced torque distribution to handle challenging environments effectively.

Transmission systems in military personnel carriers are engineered to provide a balance between power, control, and durability, ensuring optimal performance while safeguarding the occupants during transport in combat situations.

The Avalon's integration of this cutting-edge gearbox system not only improves performance but also demonstrates a careful engineering process that guarantees the vehicle's flexibility throughout a range of driving conditions.

D. Drive System/ Steering System

Military personal carriers employ sophisticated drive systems to transfer power from the engine to the wheels efficiently. These systems vary depending on the vehicle type, but they commonly include features such as:

Transmission: As mentioned earlier, the transmission is a critical part of the drive system, responsible for changing gears and transferring power from the engine to the wheels.[2]

Axles and Differential: Heavy-duty axles and differentials distribute power from the transmission to the wheels. Military personal carriers often have robust axles and differentials to withstand the rigors of off-road and combat operations

Drive Modes: Many modern military personal carriers have selectable drive modes (such as 4x4, 6x6, or even more) to optimize traction and stability based on the terrain they encounter.

Steering System: The steering system is crucial for controlling the direction of the military personal carrier. Key components of the steering system include:

Steering Mechanism: This includes components like the steering wheel, steering column, and linkage systems that translate the driver's input into directional control for the vehicle.

Power Steering: Many military personal carriers are equipped with power-assisted steering systems to reduce the effort required by the driver, especially in off-road conditions or when maneuvering heavy vehicles.

Steering Modes: Some advanced military personal carriers may offer different steering modes, such as crab steering (where the vehicle moves sideways) or differential steering, allowing for enhanced maneuverability in tight spaces or challenging terrains.

Military personal carrier drive and steering systems are engineered to provide reliability, agility, and control in diverse environments, ensuring that troops and equipment can be transported safely and effectively during both combat and logistical operations. Continuous advancements in technology aim to improve these systems for better performance, adaptability, and response to evolving battlefield needs.

E. Suspension System and Tyres

The suspension system in military personnel carriers is designed to absorb shocks, vibrations, and impacts encountered during movement over rough terrain. It helps maintain stability, enhances traction, and improves ride comfort for occupants.

These systems typically consist of springs, shock absorbers (dampers), linkages, and other components that work together to manage the vehicle's weight and maintain optimal ground contact for the tires.

Some military carriers feature adjustable suspension systems that can be modified on-the-go to adapt to different terrains, varying loads, or combat situations, allowing for improved performance and stability.

Military personnel carriers use specialized tires designed for rugged conditions. These tires have robust tread patterns and are made of durable materials to withstand rough terrains, debris, and potential hazards encountered in combat zones.

Many military carrier tires incorporate run-flat technology, allowing the vehicle to continue moving even after sustaining damage, such as punctures, by enabling them to travel limited distances at reduced speeds. Depending on the vehicle's design and purpose, military carriers might use various tire configurations, such as all-terrain tires, off-road tires, or even tracks, offering different levels of traction and mobility based on the operational requirements.

Both the suspension system and tires of military personnel carriers are engineered to enhance off-road capabilities, maneuverability, and overall performance in challenging environments. Continuous advancements in materials and technology aim to improve these components to ensure greater resilience, agility, and reliability for military operations across diverse terrains and conditions.

F. Braking System

A strong braking system built for dependability and safety is a hallmark of the Avalon. Reactive and efficient stopping force is ensured by the braking system's full air-dual line arrangement. The vehicle has pneumatic front brakes and spring rear brakes for safe parking, providing a complete and reliable solution for both dynamic and stationary braking needs. The Avalon's dedication to operational safety and control is highlighted by the thoughtful integration of braking technologies.

The braking system is essential for controlling the speed and stopping the vehicle when necessary, ensuring the safety of occupants and cargo, especially during emergency situations or combat operations.

Efficient brakes contribute significantly to the vehicle's maneuverability, allowing for controlled turns, stops, and reversals, crucial in tactical movements and navigating diverse terrains. Military personnel carriers may use either disc brakes or drum brakes. Disc brakes offer better cooling and more efficient stopping power, while drum brakes can be more rugged and have higher tolerance to environmental factors.

Most modern military vehicles use hydraulic brake systems. These systems transmit force from the brake pedal through hydraulic fluid to actuate the brakes, providing responsive and reliable stopping power. Some military carriers are equipped with ABS, which prevents wheel lock-up during hard braking, maintaining steering control and traction, especially on slippery surfaces.

Military carriers are equipped with parking brakes to secure the vehicle when stationary, enabling the crew to safely exit or perform maintenance tasks. Military-grade braking systems are engineered to withstand harsh environments, extreme temperatures, and heavy usage, ensuring durability and reliability in combat situations.

Braking systems in military personnel carriers are designed to adapt to various conditions, terrains, and loads, providing consistent performance regardless of the operational environment.

The braking system in military personnel carriers undergoes rigorous testing and design considerations to ensure it meets stringent military standards for safety, reliability, and effectiveness in combat and logistical operations. Continuous improvements in materials and technology aim to enhance braking systems to meet evolving military needs.

G. Winch

The Avalon features a self-recovery winch with a substantial 60 meters of rope and a maximum pulling force of 100 kN. This feature highlights the vehicle's operational resilience and self-sufficiency by guaranteeing its capacity to traverse and recover in difficult terrains.

1) *Self-recovery winch.*
2) *100 kN max pulling force.*
3) *60 m rope length.*

a) Function and Purpose:

The self-recovery winch allows the military personnel carrier to free itself from mud, sand, ditches, or other obstacles that might impede its movement without relying on external towing assistance.

In addition to self-recovery, this winch can also be used to assist other vehicles that may be immobilized or stuck, helping to extract them from difficult situations during operations.

The winch is equipped with a durable and high-strength cable or synthetic rope capable of withstanding heavy loads and providing the necessary pulling power. The winch is powered by a robust motor coupled with a gear system, enabling it to reel in or release the cable with considerable force.

There are typically controls within the vehicle's cabin that allow the operator to manage the winch, controlling the direction, speed, and tension of the cable. Safety mechanisms prevent overloading and ensure safe operation. The self-recovery winch is securely mounted to the vehicle's frame or chassis, often requiring reinforced structural components to handle the stresses and loads involved in recovery operations.

The presence of a self-recovery winch significantly enhances the vehicle's capability to navigate challenging terrains, promoting operational mobility and self-sufficiency. In combat scenarios, where mobility and agility are crucial, the self-recovery winch helps maintain operational readiness by swiftly recovering immobilized or stuck vehicles without external assistance.

Military personnel carriers equipped with self-recovery winches undergo training to ensure operators understand their capabilities, limitations, and safe usage. These winches serve as essential tools, enabling vehicles to maintain operational effectiveness and mobility in diverse and demanding environments encountered during military operations.

H. Electrical System

The Avalon's electrical system, operating at 24V, is a sophisticated configuration comprising two 12V, 180 Ah batteries, 120 A/28 V alternators, and a designed wiring setup adhering to ADR63/00 standards. The battery system, featuring heavy-duty 200Ah batteries, utilizes Acid Lead Battery technology. The vehicle's power needs are met by a robust Heavy Duty 24V, 110A output alternator and a 12V 10T Denso starter motor. The wiring system accommodates various cross-sections for optimal functionality in CAN bus communications, control functions, and different load requirements. [4]

1) Electric equipment

a) Nominal voltage : 24V

b) Batteries : 2 x 12 V, 180 Ah

c) Alternators: 120 A/28 V

2) Electrical wiring diagram

For Avalon design wiring is preferred ADR63/00 specifies a minimum cross section of 5 mm2. The wiring gauge chose to safely carry the maximum load current and to provide acceptable voltage drops. Often voltage drop considerations determine the choice of wire gauge. The supply currents flow through a heavy-duty two-pole connector and the seven-pole connector only carries control circuits.

3) Battery

Heavy duty extra long-life batteries 12 V 200Ah

a) Type: Acid Lead Battery.

b) Voltage: 12 V

c) Rated capacity (20hrs): 200Ah

d) CCA: 1030A

e) Applicable temperature: -40 ℃ to +70 ℃

4) Alternator

Heavy Duty 12 V, 110 A output Nissan patrol

a) Voltage : 12 V

b) Amperage: 110 A

c) Mounts : 175

5) Starting

Starter motor : 24 V 10T Starter motor .

a) Voltage : 24 V

b) Power : 4 kW

c) Rotation : Clockwise.

d) Tooth count: 10

e) Gear Od : 38.25mm / 1.506 in.

6) Cables

a) 1 mm2 cross-sections are often used for CAN bus communications.

b) 0.85 and 1.25 mm2 cross-sections are often used for control functions.

c) 1.25, 2.0 and 3.0 mm2 cross-sections are often used for light loads.

d) 5.0 and 8.0 mm2 cables may be used for heavy loads.

7) Wiring plugs

Heavy duty 7-pin trailer connector is selected (Australia standard AS4735 for lights and power).

I. Air Conditioning System

1) General Specifications

a) Location : Mali /Africa

b) Latitude : 17.5707° N, 3.9962° W

c) Driver height: 1.7m

d) Driver weight: 70kg

e) Passenger height: 1.7m

f) Passenger weight: 70kg

g) Ambient temperature: 38oC

h) The walls of the automobile are consisted with two plates one as armour plates and one as Mc foil respectively each conducting heat in series.

2) Analysis of the loads & calculation of the total thermal load and estimate of the cooling capacity of ac system

Load calculations were conducted prior to selecting the air conditioning system for this.

a) Metabolic load. The metabolic activities inside human body constantly create heat and humidity. This heat passes through the body tissues and is finally released to the Avalon cabin air.

b) Radiation load. The heat gain due to solar radiation is a significant part of the cooling loads encountered in vehicles

i. Direct radiation load.
ii. Diffuse radiation load.
iii. Reflected radiation load.
iv. Ambient load
v. Engine load

An air conditioning system is the second biggest energy consumer component in Avalon 6x6. If the air conditioning system is driven by the main engine, the driver can easily feel the drop in the vehicle power when the electromagnetic clutch is engaged.[5]

Hence we selected roof mount air conditioning system according to the temperature of Mali and horse power of the vehicle.

According to the air conditioner unit mounting location, we selected dual type air conditioner where cold air is blown out from the front and rear. As per the function we selected all season type air conditioning system. A device for leading the fresh outside air into the car that also serves for ventilating the car.[6]

J. Seats

The suggested seats are tubular lightweight systems with a unique resettable as shown in figure 2. An energy-absorbing (EA) system is designed into the seat. The design of the seat gives the occupant not only increased protection in a mine blast event but also offers excellent protection in the event of an accident or impact. The all-belts-to-seat (ABTS) design allows to optimize the installation of the seat within the hull. An integrated footrest can also be incorporated into the seating system for additional lower-leg protection.

1) Standard features.

a) Forward, rear, and side-facing installation (wall or frame mounted).

b) Low profile, space-saving seating solution.

c) Comfortable and durable seat surfaces (tear & flame resistant fabric, black color).

d) All belts to seat 4-point shock resistant, lightweight belt harness.

e) Spring loaded self-folding, storable seat pan.

Figure 2. Seat Design

K. Bullat proof glasses

a. Bulletproof glass type- Tempered and Laminated
b. Method of testing - Drop tests – ISO 3537,Small arm Firing – STANAG Level II

Glass Thickness (mm)	**Drop test**	**Small Arm Fire**
15	fail	fail
32	satisfactory	fail
50	pass	satisfactory
61	**Pass**	**Pass**

Table 1: Glass test results

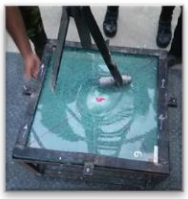

Figure 3. Drop Test

Figure 4. Small arm fire

The selection of bulletproof glass for military applications is of utmost importance. In adhering to our rigorous standards, we have meticulously followed both ISO and NATO guidelines. Through extensive experimentation and analysis, we have determined that the optimal choice for our design is the utilization of 61mm standard bulletproof glass for both the windscreen and the side walls.

V. EXPLOSION TEST OF THE BODY

UN standard – 8 kg of C4 Explosive
Tested – 10 kg of C4 Explosive

Test observations	Remarks
Blast doesn't make considerable damage to the crew cabin/hull	V (45 Deg.) shape minimized the blast effect
No any evidence of flame hazard inside the crew cabin	-
The human dummies which were inside the Unicorn dressed up with flak jacket and helmet were not damaged	Physical damages avoided
Differential and mechanical parts of the vehicle under chassis were damaged	Need to have under guard

With the collaborative efforts of the engineering team from the Sri Lanka Army, we conducted explosive tests that exceeded the UN standards. The outcomes were highly encouraging, affirming the robustness and efficacy of our vehicle design. The required test results are displayed on the screen for reference.

VI. FIRE PROTECTION IN ARMOURED VEHICLES

To provide optimal safety and control, we applied solutions to fire protection at two different points in the vehicle. In the engine room and the crews' quarter. While the engine room is provided with a fire-extinguishing system, a fire suppression system serves to protect the crews' quarters.

A combined solution of both systems offers optimized protection for man and machine.

1) Greater chances of survival/opportunities for crew and vehicle.

2) Additional protection against attack with Molotov cocktails.

3) Protection of vehicles during transportation and storage.

Fire protection system is online during the parking.

A. Fire extinguisher system description

Experience from recent wars has shown that almost all destroyed vehicles failed because of fire in the crew compartment.

The fire-extinguishing system consists of three main assemblies.

1) Fire detection system.

2) Extinguishing system.

3) Control unit.

B. Fire detection

Fire detectors in the engine room help detect fires. In the case of a fire, the detectors send alarm signals to the control unit and automatically trigger the firefighting process. Point detectors or linear sensors serve as detectors. They not only report a fire but also when the fire has been extinguished. All detectors, of course, are operational again after the successful firefighting.

C. Line detectors

Fire wire is the fire warning wire in the form of a stainless steel capillary with a coaxially seated electrode. At an increase in temperature, both the resistance and capacity change. If a certain threshold value is exceeded, the linear detector triggers the firefighting system.

D. The temperature detector

This is produced in standard lengths of 150 cm to 600 cm. using special couplings, elements can be interconnected up to a length of 30 m.

E. Point detector

Mechanical point detectors operate according to the principle of specific thermal expansion. If a fixed temperature is exceeded, they transmit a triggering signal to the respective control unit. After the fire-extinguishing process, the point detectors simply reset.

This detector essentially comprises fast-responding thermistors. They have extremely robust housing to protect against water and mechanical damage. In practice, the alarm temperature can be set using corresponding software individually in the control unit.

The thermo-differential alarm monitors the ambient temperature. An alarm is triggered not only if a preset temperature is exceeded, but also in the case of a rapid temperature rise. The latter is monitored by two balanced temperature resistors.

VII. STRUCTURAL DESIGN

The structure of the body is designed to maximize the advantages of aerodynamics and to assist the ability to ricochet direct small arms fire and protect crew from shrapnel due to indirect fire. The detailed mechanical drawings of Avalon 6x6 is are shown in figures 3, 4 and 5.

The "V" shape of the hull is incorporated by placing a water tank under the floor boards of the crew compartment (as in figure 6) to absorb the shockwave of an antitank mine or improvised explosive device.

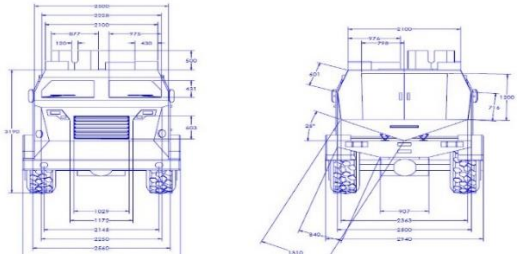

Figure 5. Front/Rear view of Avalon 6x6

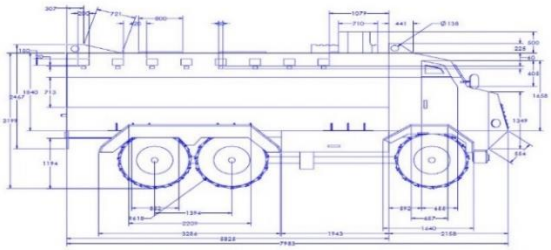

Figure 6. Side View of Avalon 6x6

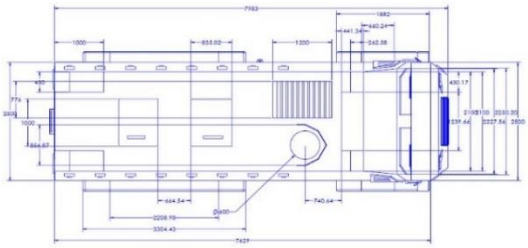

Figure 7. Top View of Avalon 6x6

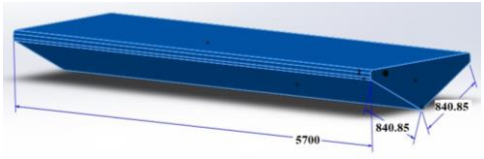

Figure 8. Water Tank under the Floor Board

VIII. Other Important Design Features

A. Gun Shield

In terms of offensive capabilities, our APC is planned to be equipped with a Machine gun mount, strategically located on the vehicle roof adjacent to the commander's compartment. With additional shielding, a 180-degree traversing angle, and 20-degree elevation, the gun mount offers versatility and firepower, allowing our crew to adapt to varying combat situations.

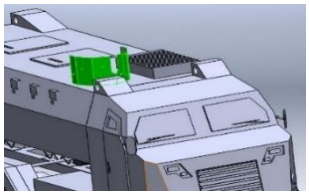

Figure 9. Gun Shield design

B. Rear, Roof and Side Doors

Proposed APC features multiple entrances and exits, meticulously designed to facilitate rapid mounting and dismounting of both crew and assault troops. These specific door configurations prioritize efficiency and safety during operations.

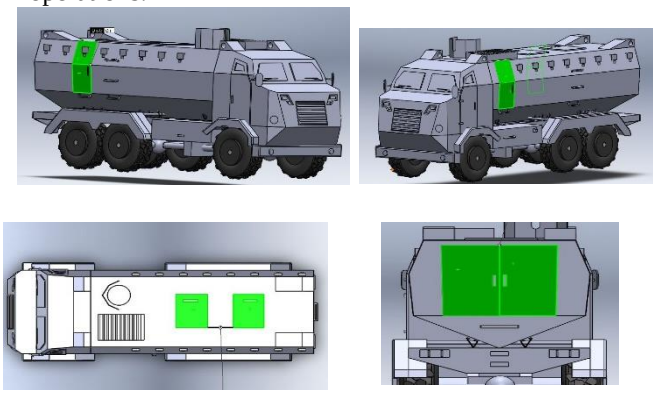

Figure 10. Rear, Roof and Side Doors designs

C. Hull Mounting Design

1) Placements of the hull mount assembly

The integration of mounting hooks securely anchors the hull to the chassis, ensuring stability and resilience during traversals across rough terrain and maneuvers. Grouped in triplets as hull mount assemblies, these hooks reinforce the structural integrity of proposed design.

Figure 11. Huck Assembly

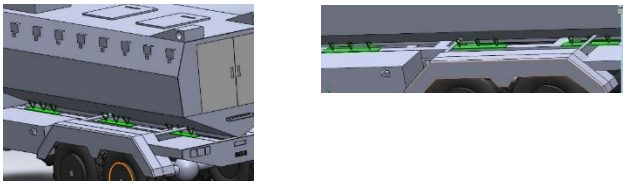

Figure 12. Placements of the hull mount assembly

2) FEA Results for Hull mount Huck

As first step we have carried out FEA for the proposed hull mounting huck and converged result as follow. For that we have used max loading conditions which we calculated weights. As per the FEA results we have identified 1.8 mm displacement of the top edge of the huck and locking to have a design optimization in future FEA proceedings. Other parameter values in feasible condition as per the results.

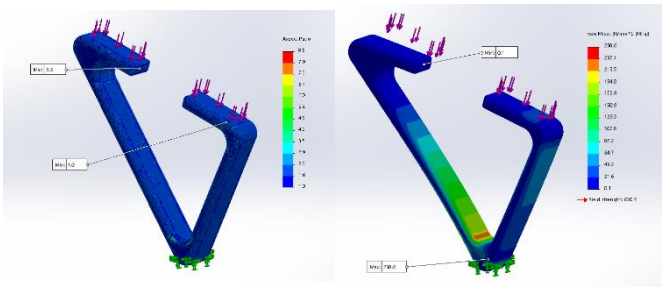

Figure 13. Displacement plot and Factor of Safety plot

IX. REQUIREMENT OF MATERIAL AND WEIGHTS

A. Armour Plate (Figure 7)

1) *Calculated total area of vehicle: 83 m^2*
2) *Additional value added: 10%*
3) *Final calculated area: 91.3 m^2*
4) *Default armour plate size: 3mx6mx6mm*
5) *Required armour plates for project: 6*

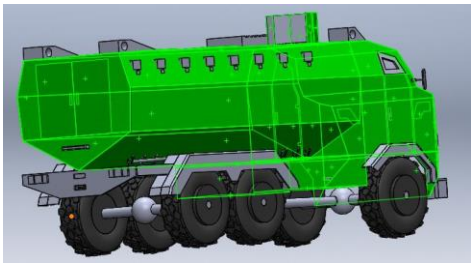

Figure 14. Armoured Plated Parts of the Body

B. Bullet Proof Glass (Figure 8)

1) *Calculated total area of glasses: 1.6 m2*
2) *Additional value added : 10%*
3) *Final calculated area: 1.76 m2*

C. Weights

1) *Separate Weights of Systems*
   a) *Armour plates : 4000 kg*
   b) *Glassware: 320 kg*
   c) *Seats: 500 kg*
   d) *Structure and others: 500 kg*
   e) *Passenger weight with full gear (95 kg PP) : 1700 kg*
   f) *Bottom water tank having: 2400 kg*

X. DISCUSSION

Avalon 6x6 is designed to withstand climates of intense heat and to endure journeys closing up to 500 kilometers. In order to increase the gas mileage of the vehicle it was required to incorporate engines with higher efficiency, however the convenience to repair and economy of the build as well as the spare parts outweighed the previous aspect in order for the design of the vehicle to effectively be considered as opposed to APCs currently in the use. The electrical system of the vehicle bears a heavy load due to extreme energy demand for the air condition system, even though the nominal voltage of the system had to be constrained to 24 V due to scarcity of ancillary installs in higher voltage.

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