Main Activities and Solutions for the Installation of a Medium Caliber Gun on a Wheeled Light Vehicle

120 Gun Turret on CENTAURO Vehicle

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ABSTRACT

The aim of this paper is to describe and assess all the technical modifications which have been carried on in order to mount a 120 mm gun on a new modular and lightened turret derived by the 105 mm Low Recoil Force turret. The target of the project has been to install the new turret on the Centauro 8x8 wheeled vehicle.

The new turret and the new oscillating mass design solutions allow to obtain a considerable weight and recoil force reduction; the effect of these technical modifications have been evaluated using a 2D software model of the vehicle in order to examine the feasibility of the installation.

A prototype version of the vehicle has already carried on a firing campaign with good results.

INTRODUCTION

OTOMELARA in the nineties proposed the installation of a 105 mm gun on the Italian CENTAURO 8x8 wheeled vehicle and in this last years has designed the new 120 mm HITFACT lightened turret, conceived in order to mount a 120 mm gun on the same vehicle.

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MAIN DESIGN CONSTRAINTS

In order to verify the feasibility of the installation, three critical aspects have been identified and assessed:

- Vehicle structural stiffness;
- Vehicle mobility;
- Vehicle stability during firing actions;

Factors that could affect the vehicle stiffness are the higher turret weight, the stronger recoil force transmitted to the vehicle hull and to the turret and the efficiency of the suspension system.

An increased weight of the turret could also cause problems regarding the mobility aspect, in particular it is necessary to assess the power weight ratio of the vehicle. Other constraints on vehicle mobility to be carefully considered are brake efficiency, engine and transmission system performances and possible overload of the suspensions.

The weights distribution and the resulting centre of gravity position are the key points that determine the stability, that have to be evaluated also considering a firing action conducted from a slope.

TECHNICAL CONSIDERATION

Taking into account all this constraints, the new 120 mm turret design activity, using new materials and proposing optimised solutions, allows OTOMELARA to offer a new lightened turret, that can mount a 120 mm oscillating mass.

WEAPON OPTIMISATIONS

The gun, derived from the 120 mm Ariete oscillating mass, have been developed using a new high strength steel already used in the latest version of the company 127 mm naval gun; this allows to reduce the oscillating mass weight, while increasing the maximum chamber pressure of the weapon of about 1,000 bars, giving to the new gun a considerable increasing capability for the employment of new kinetic-energy ammunition of future development. The 120 mm obscillating mass weights 700 kg less than the Ariete gun of the same calibre.

TURRET OPTIMISATIONS

The new turret, whose shape is simplified compared to the Centauro turret, has a body produced in ballistic aluminium alloy, with an external ballistic steel add-on, this protection level is offered as the basic protection. The modular concept characterising the turret allow to choose ballistic protection in composite material according to the mission requirement.

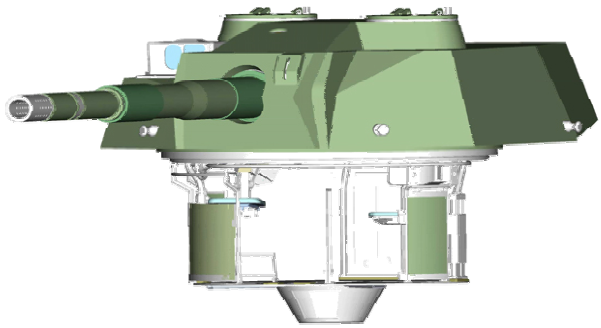
This building solution allowed to obtain a considerable weight save (about one ton), which is augmented by the adoption of an all-electric actuator system. The latter is proposed as an upgrade for the Centauro turret, and is able to maintain the angular speed and acceleration figures even with that turret which is

considerably heavier: All those weight saving solutions – in the gun and in the turret – allow to bring the weight of the new HITFACT turrets at 5,800 kg in the basic armour configuration, with commander's panoramic periscope, gunner's aiming optics, 7.62 mm coaxial machine gun, 7.62 mm commander's machine gun, and 12.7 mm loader's machine gun. The possibility for the actuator system to cope with a 7.5 tons turret shows the opportunity to increase armour potential of the turret, if it is required by the mission specific needs.

The increased recoil length, and the introduction of an optimised pepper box type muzzle brake allow to obtain a large reduction of the recoil force in the HITFACT turret with reference to 120 mm Ariete Turret.

TURRET / GUN SYSTEM MAIN CHARACTERISTIC

Here below the main characteristics of the HITFACT turret are summarized



- CALIBRE: 120 mm
- LENGTH:45 caliber
- BARREL Smooth bore
- MUZZLE BRAKE: Pepper box
- OSCILLATING MASS WEIGHT: 2500 Kg
- TURRET WEIGHT :5800 Kg

OTHER TURRET EQUIPMENT

The HITFACT Turret can also be equipped with the following secondary armament:

- 7.62 Coax Machine Gun
- 12.7 AA Machine Gun
- 7.62 ToT; 7.62 AA Machine Gun
- Grenade Launcher

The Digital FCS is composed by the following items connected in a digital network (standard bus star architecture)

- BALLISTIC COMPUTER
- 32 BITS MICROPROCESSORS (DSP)
- CAN BUS
- BUILT IN TEST EQUIPMENT
- AUTODIAGNOSIS
- VOICE WARNING MESSAGE

The turret mounts a stabilized gunner's sight and a panoramic commander's stabilized sight

SIMULATION MODEL

To evaluate the effect of all this optimised solutions and to examine the crucial aspect of the installation a simulation using Working Model 2D software has been performed.

The step followed are the following:

- Construction of a 2D model of the CENTAURO vehicle;
- Validation of the model with recorded results;
- Evaluation of the vehicle behaviour during the firing action for different elevation and bearing angles and with the vehicle on a slope;

Main model characteristics

The deeply detailed computer model of the vehicle, based on the new geometrical data of the HITFACT turret, takes into account the suspension effect, modelled as an actuator element in parallel with a damper and a rope element. Also the presence of the wheel is considered, as it is put in evidence by the figure 1, the data provided by the vehicle manufacturer has been corrected taking into account the elastic behaviour of the wheels. The damper element coefficient is set to 12500 Ns/m.

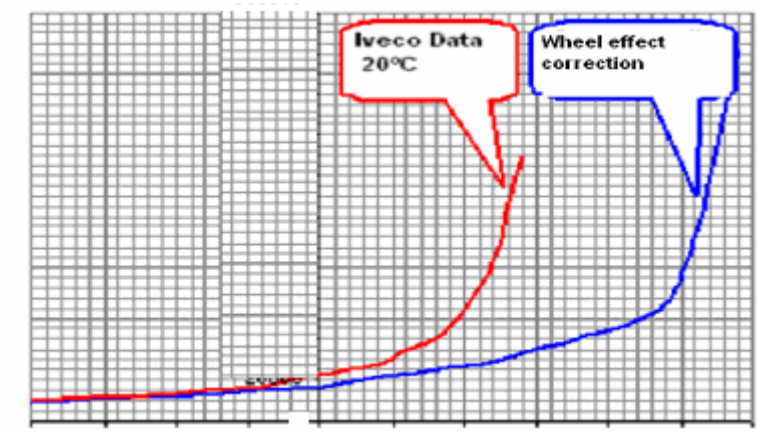


Figure 1Suspension model

The ammunition choosen for the simulations is the APFSDS – T whose force is reported in the figure,

The recoiling brake is modelled using a damper element, the oscillating mass recovering system is simulated using an actuator whose force is determined according to recorded data.

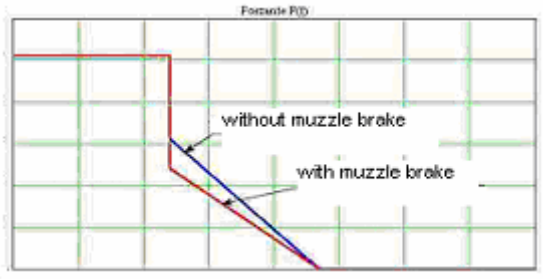


Figure 2: APFSDS- T force

The 2D analysis is chosen to speed up the running time but some approximations have to be made, the more important is the wheel-suspension system scheme. In the side view model each suspension-wheel of the model represents two real wheels, while in the front view model each wheel-suspension represents a group of four wheels.

Model validation

To minimize the impact of these approximations the model has been validated by the comparison between recorded data and simulated data for the 105 mm CENTAURO turret in the present configuration. In particular the vertical movement of selected points of the vehicle (like the rear high corner of the hull) is analysed and parameter are set to determine the highest correspondence of the amplitude and frequency of recorded and simulated data.

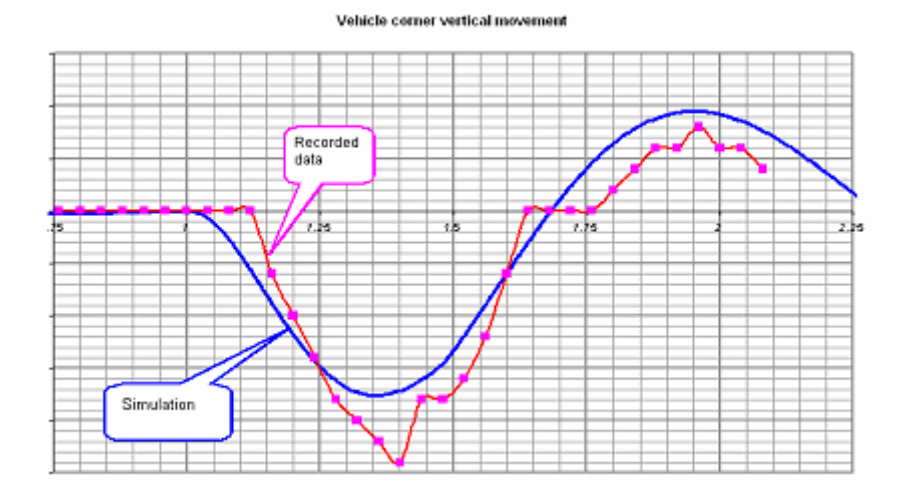


Figure 3:Recorded / simulated data comparison

Model Results

The following figure presents the results obtained for the 120 mm HITFACT turret compared with the data characterising the present 105 mm turret, a wider amplitude of the movement can be noted.

The firing configuration is:bearing angle = 0°, elevation angle = 0°;

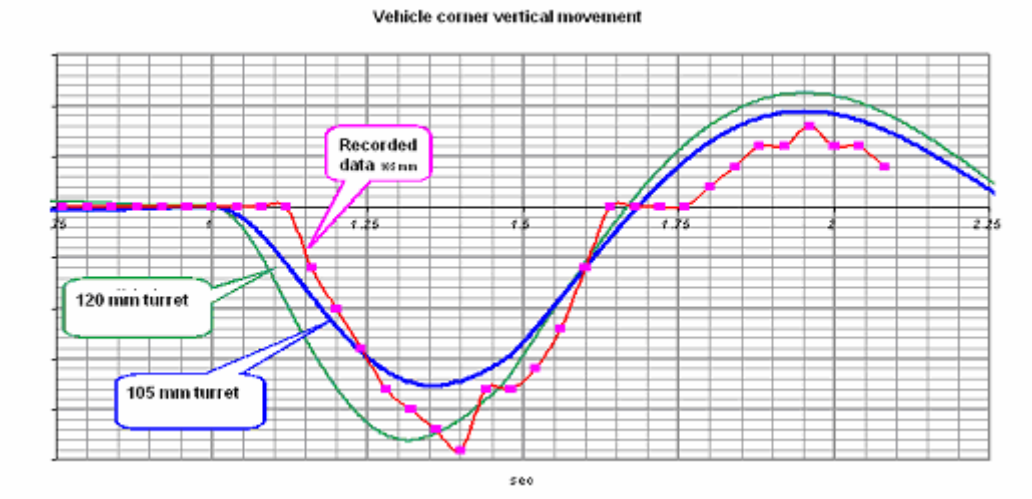


Figure 4:120 mm / 105 mm comparison

The simulation was conducted also to evaluate the stability of the vehicle in a more critical configuration, with a bearing angle of 90°, the elevation angle is set to 0°.

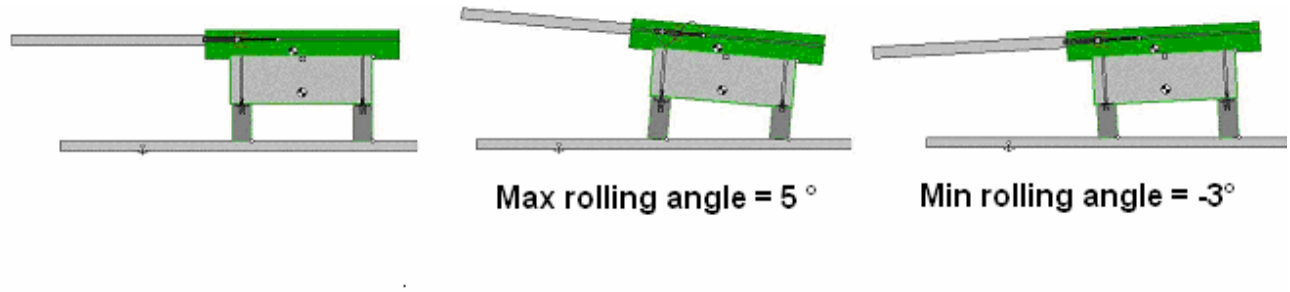


Figure 5:Rear view of the 2D model

The rolling angle is comprised in the range [-3°,+5°].

Simulation has been conducted also to evaluate the stability of the slanted vehicle during the firing action; with the elevation angle set to –6° and the bearing angle to 90°, simulations show the vehicle behaving well when it is situated on a slope of 17° (30% slanted), The simulations revealed a limit angle of 30°, for angles greater than 30° the vehicle risks to overturn. .

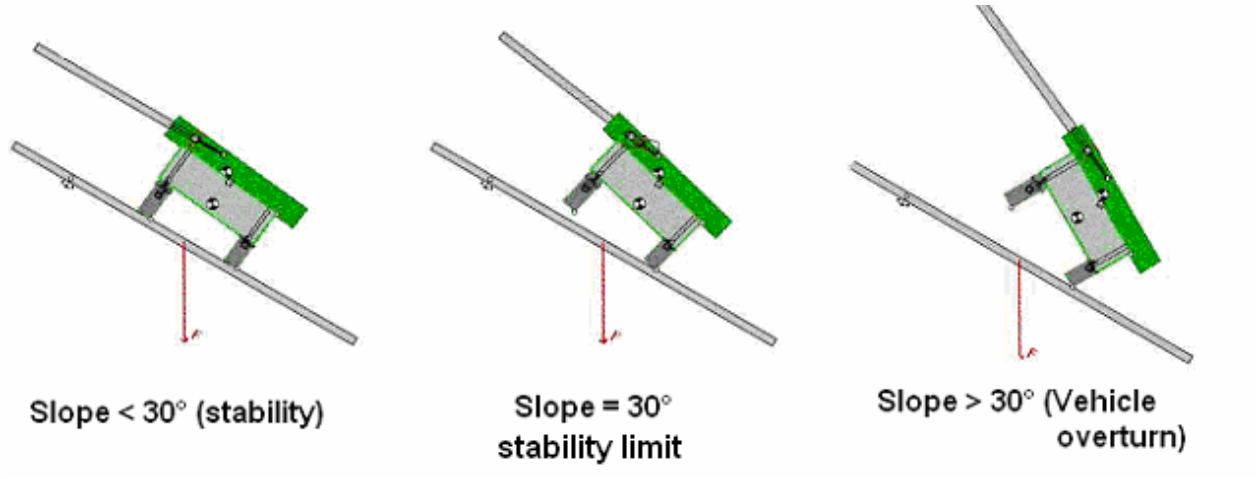


Figure 6:Firing action from slanted vehicle

According to simulation results CENTAURO chassy equipped with a 120 mm HITFACT turret is not affected by stability problems, also in the main critical situations

GROUND TESTS

Centauro chassis equipped with the 120 mm HITFACT prototype carried out the first firing session with APFSDS and HEAT rounds. The first round were fired in the twelve o' clock position, and were followed by firings with the turret in the nine o'clock position, the vehicle behaving well. The most critical test was carried out with the Centauro slanted laterally of some 11 degrees, firing with the turret at nine o'clock and the gun at the maximum depression of –7° .

CONCLUSIONS

The design activity carried out by OTOMELARA R&D departement focused optimised solutions that allow to obtain a lightened, low recoil force turret that could be installed on the CENTAURO wheeled vehicle. The simulation analysis revealed an EXCELLENT BEHAVIOUR of the vehicle equipped with the new turret and allowed the construction of a first prototype successfully tested.

The extensive firing tests carried on confirmed the computations and validate the feasibility analysis .