Introduction

- A Bridge Deployment Vehicle (BDV) is a combat support designed to assist militaries in rapidly deploying armoured fighting vehicles across gap-type obstacles.
- The BDV's job is to allow vehicles to cross craters, anti-tank ditches, blown bridges, canals, rivers and ravines, when no bridge is conveniently located.
- The bridge layer unfolds and launches its cargo, providing a ready-made bridge across the obstacle in only minutes.
- Once the span has been put in place, the BDV vehicle detaches from the bridge, and moves aside to allow traffic to pass. Once all of the vehicles have crossed, it crosses the bridge itself and reattaches to the bridge on the other side. It then retracts the span ready to move off again.


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Problem Definition

- Manual bridge deployment is a very labour intensive and time consuming process.
- Such operations are needed in emergency situations and are carried out by military or paramilitary forces.
- Time and man-force are decisive factors in any emergency situations. Every manual process inherits human errors. Errors in such situations is unacceptable.

Problem Definition

The idea proposed here is meant for use in military application, mainly for transportation of heavy duty military vehicles across otherwise impossible to conquer terrains.

The proposed **bridge** should satisfy the following requirements:

- Strong enough to sustain load to military vehicles
- Foldable into compact spaces
- Light weight
- Broad enough to carry all types of vehicles safely
- High fatigue resistance for longer life-time

The proposed **vehicle** should satisfy the following requirements:

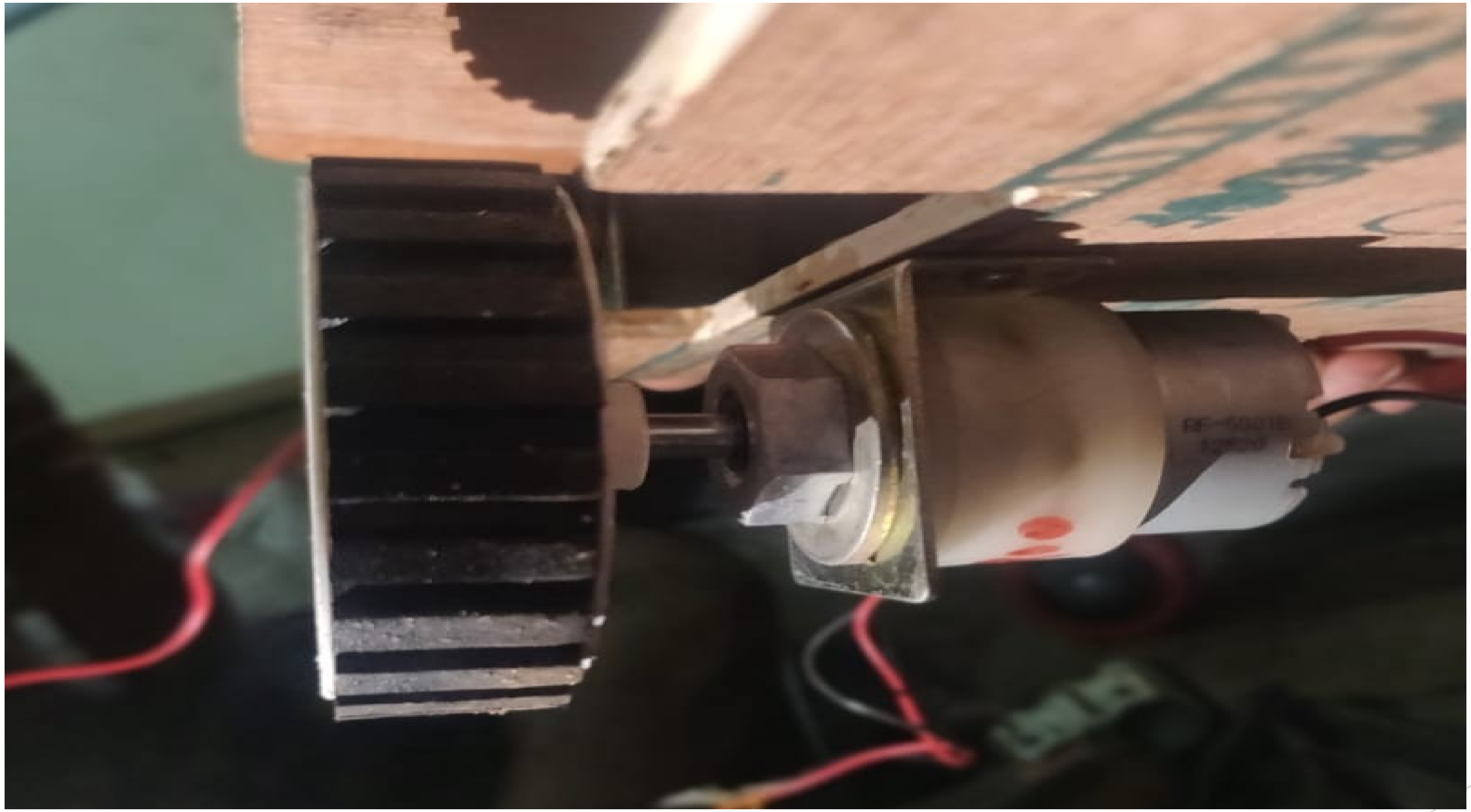
- Weight should be suitably distributed to balance forces and torques.
- Should be able to carry and transport the bridge as fast as possible.
- Should carry proper actuator controls to carry out operation.

Materials

- Plywood
- DC Motors
- Screws and Nuts
- Spring
- Electrical Connections and Controls
- Wheels
- Clamps
- Washers
- Power Supply

Analysis of Components

Wheel Shaft



Analysis of Components

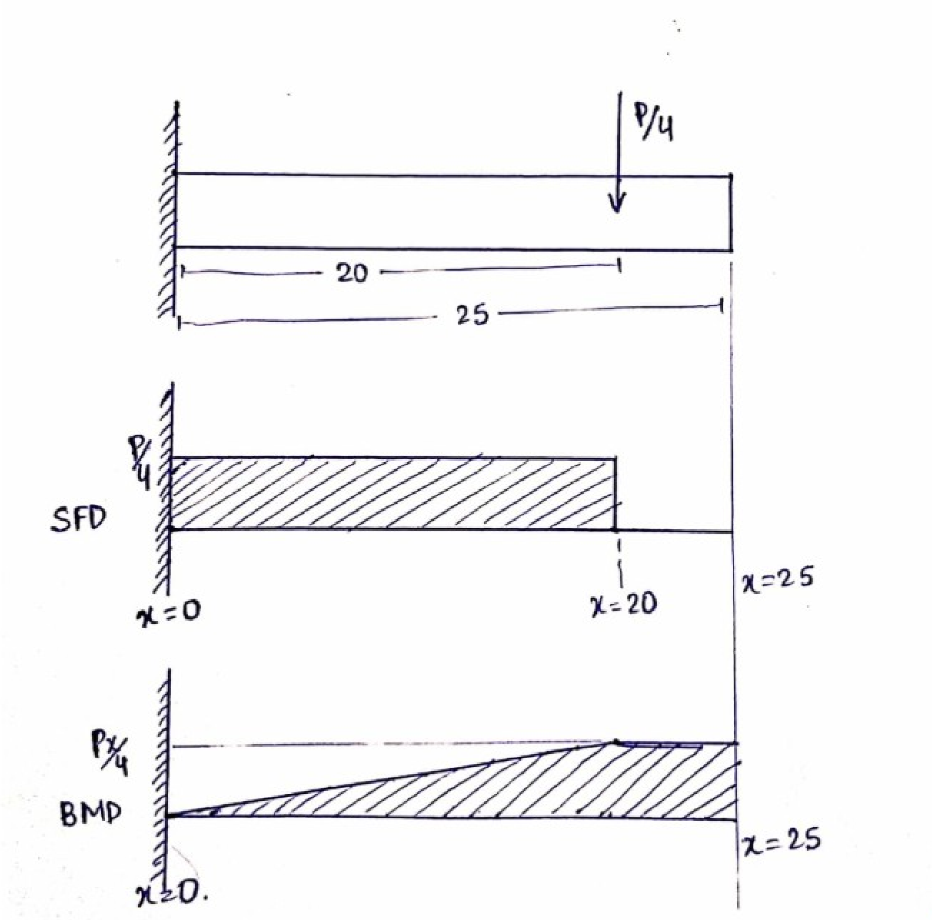
1) <u>Wheel shaft</u>:

<u>Material:</u> C40 steel (σ_{YT} = 324 N/mm^2)

Let the diameter of shaft be 'd'.

a) <u>Bending stress calculation</u>:

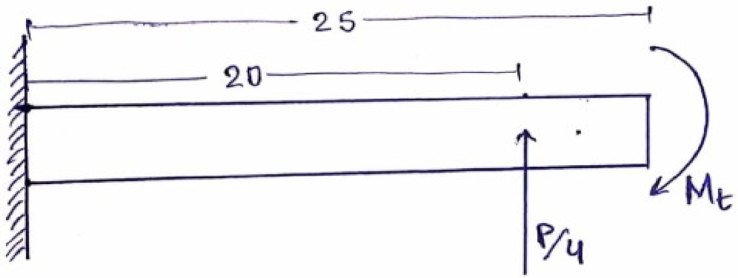
The Free Body diagram and the corresponding SFD and BMD are as shown below:



Analysis of Components

b) Torsion Calculation:

The Free body diagram of the shaft under torsion is as shown:



Let the Total Force acting on the 4 wheel shafts be 'P'. Therefore, Force acting on each of the shaft will be $\frac{P}{4}$.

From BMD, Maximum bending moment, M= $\frac{P}{4} \times 20$ N.mm

Taking Factor of Safety (FOS) = 5 ,

$$\sigma_{Allowable} = \sigma_{YT} / FOS = 324 / 5 = 64.8 \text{ N/mm}^2$$

We assume that the Maximum Load acting on the 4 Wheel Shafts combined will be P=15kg.

We know that Bending stress $\sigma_b = \frac{32M}{\pi d^3}$

Therefore to find d, $64.8 = \frac{32 \times 5 \times 15 \times 9.81}{\pi d^3}$

Solving, we get ***d = 4.86 mm ≈ 5 mm***

Analysis of Components

The torque on the shaft due to the 30 rpm motor will be M_t = 117.72 N.mm

Now , $\tau_{Allowable} = (0.5 \times \sigma_{YT}) / FOS = 32.4\ N/mm^2$

We know that $\tau = \frac{16Mt}{\pi d^3}$

Therefore, to find *d*, $32.4 = \frac{16 \times 117.72}{\pi d^3}$

Solving, we get ***d*= 1.405 mm** ≈ 2 **mm**

Thus, we select the shaft with ***d* = 5 *mm***

Analysis of Components

Bridge Beam

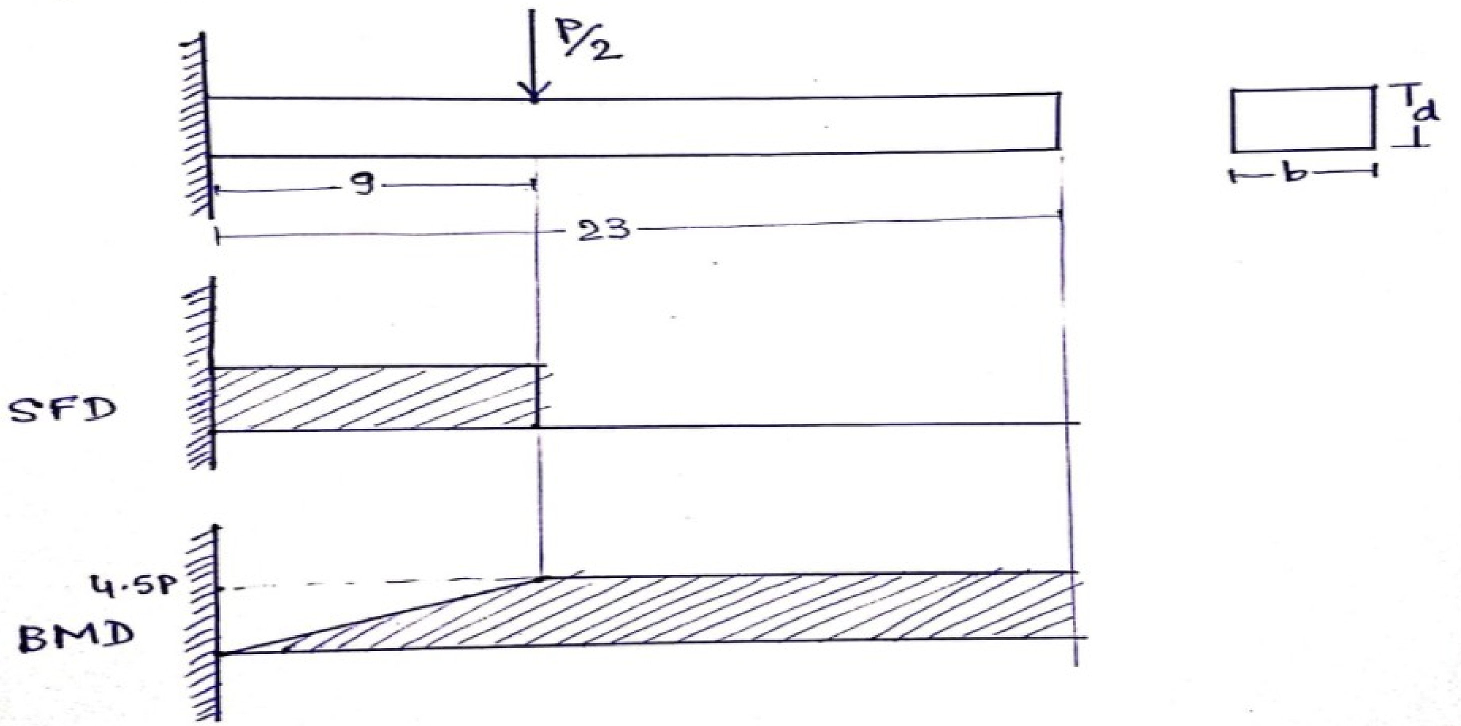
Analysis of Components

2) <u>Bridge Beam:</u>

<u>Material:</u> Plywood ($\sigma_{UTS} = 28\ N/mm^2$)

Since the bridge beam will take the load of the platform (which is normally heavy), we consider the Maximum load P to be 16 kg. Thus load on each beam will be P/2 = 8kg. Also, since the case is of heavy duty loading, we consider factor of safety, FOS = 10.

The Free body diagram with the corresponding SFD and BMD is as shown:



Analysis of Components

Let the breadth of the beam be *b* and depth be *d*. Due to availability, we take $b = 5mm$.

Now, $\sigma_{Allowable} = \sigma_{UTS}$ / FOS = 28/3 = 9.33 N/mm^2

Also, since in this case of loading, the load will act exactly at the centre, the load will be resisted by only half the depth of the cross section (d/2).

We know that Bending stress for rectangular cross section,

$$\sigma_b = \frac{27P}{bd^2}$$

Substituting P= 8 kg $\times$ 9.81, $d = d/2$, $\sigma_b = 9.33\ N/mm^2$, $b = 5$ mm and solving for *d* we get $\boldsymbol{d = 24.605\ mm \approx 25mm}$.

Thus, we select a beam with $\boldsymbol{b = 5mm}$ *and* $\boldsymbol{d = 25mm}$.

Analysis of Components

Spring

Analysis of Components

3) Spring:

Material: Cold drawn steel (σ_{UTS} = 1050 N/mm^2 and G = 81370 N/mm^2)

We select the maximum load P = 4.5 kg and Spring Index, C = 12.5. Also maximum allowable spring displacement $\delta = 8mm$ and total axial gap = 10 mm.

Now, $\tau_{Allowable} = 0.5 \times \sigma_{UTS}$ = 525 N/mm^2

Therefore, Wahl's factor K = $\frac{4C-1}{4C-4} + \frac{0.615}{C}$ = 1.114

We know that $\tau = K\left(\frac{8PC}{\pi d^2}\right)$

Analysis of Components

Substituting K=1.114, P=4.5 $\times$9.81 , C = 12.5 , and τ= 525 N/mm^2 , we get

d=1.726mm* $\approx$ *2mm.

Thus, we get ***D= 25mm.***

Also, from $\delta = \frac{8PD^3N}{Gd^4}$, we find number of active turns $\boldsymbol{N = 1.88 \approx 2}$

$$Total\ Number\ of\ turns = \boldsymbol{N_t = N+1 = 3}$$

$$Solid\ length = \boldsymbol{N_t \times d = 6\ mm}$$

$$Free\ length = \boldsymbol{L_f = N_t} \times d + \delta + \boldsymbol{10mm = 24mm}$$

$$Pitch\ \boldsymbol{p} = \frac{L_f}{Nt-1} = \boldsymbol{12mm}$$

Results

<u>Diameter of Wheel Shaft</u> = 5mm

<u>Bridge beam</u>:

Breadth = 5mm

Depth = 25mm

<u>Spring</u>:

Wire diameter = 2mm

Mean coil diameter = 25mm

Maximum deflection = 9mm

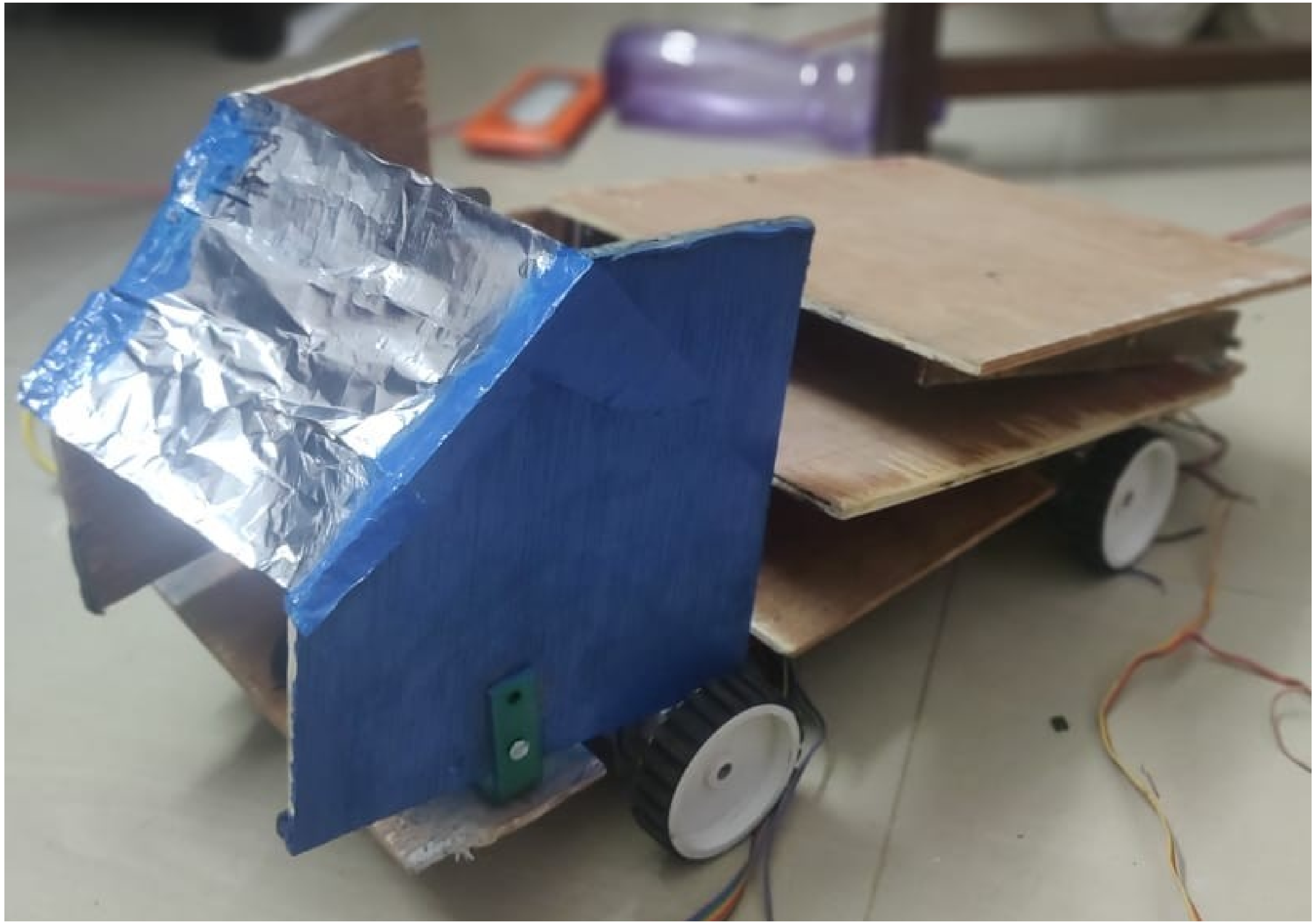
Number of active turns = 2

Total number of turns = 3

Solid length = 6mm

Free length = 24mm

Pitch = 12mm



Conclusion

- Our goal was to build a system which is efficient to deploy military purpose bridge with the help of Bridge Deployment Vehicle.
- With the scope of improvement, the project is done to fulfill the demands of military applications. The objective was to fulfill the need of military in situations where saving time and man-force is of utter importance.
- With this state-of-the-art technology, the efficiency of military applications is estimated to increase exponentially. It has solved the problem of traditional way of building temporary bridges in which the soldiers had to spend hours to construct a bridge which was not suitable for vehicle transportation.
- Since time is a decisive factor in any military operation, this machine has a unique advantage.
- This machine will be a great boon for militaries around the globe.