# Design of Electronic Wedge Braking System for Go-Kart

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**Abstract –** *This paper present the design of EWB braking system for Go-Kart. It is new way braking system i.e. braking without hydraulics like the conventional bakes .It can dramatically reduce stopping distance of Go-kart compared with conventional hydraulic braking system. EWB is based on wedge principle to provide a self-reinforcement mechanism, resulting in reduce current to the actuation motor. The clamping force and braking time of the proposed EWB are shown to satisfactory with respect to the required braking deceleration. A new design of electronic wedge brake system is presented to replace and to overcome the shortcomings of hydraulic brake system.*

***Key Words***:  Electronic wedge brake, Go-kart brake system, Wedge mechanism.

## 1. INTRODUCTION

The main concept behind this paper is that to give a efficient and reliable EWB braking technology for go karts.
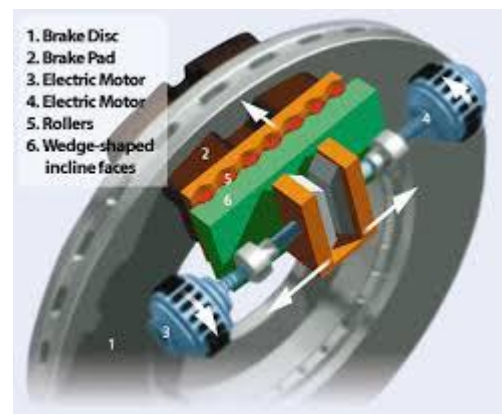
Brake system is one of the most important mechanical components in any moving vehicles. This system must be able to provide sufficient stopping effort in order to control longitudinal motion of the vehicles. Braking system of vehicles are always given the priority when the safety issues are addressed. Generally in Go-kart hydraulic braking system is used, but this type of braking system may leads to leakage and vaporization of hydraulic fluid at high temperature which will cause major problems such as hydraulic brake failure. For increasing performance of braking system we can use Electric Wedge Braking system (EWB).

The EWB is a pure electronically actuator that typically comprises of an electric motor driving the wedge mechanism to clamp and release the brake rotor. In Go-kart while doing drift and skid sometimes brake issues arise so we need assured braking system. In that case we can use EWB braking system rather than other conventional braking system. Other conventional brake takes between 140 and 170 milliseconds to generate full braking power, the EWB needs only about 100 milliseconds and therefore shorten the braking distance. The wedge uses a Go-kart's kinetic energy converting it into braking energy. By reinforcing itself this way, the EWB needs only one tenth of the actuating energy required by today's hydraulic braking system.

## 1.1 COMPONENTS OF EWB SYSTEM

The EWB is newly raised braking system. The EWB will be far superior to any brake system in present for go kart. The EWB system decreases stopping distance .EWB system mainly contains calliper, E-pedal, battery and main brake controller .The detailed information of this components is as follows.

### (1) BRAKE CALIPER-



**BRAKE CALLIPER**

EWB calliper contains brake pad, two DC motors, wedge shaped system and rollers .In EWB calliper piston and the fluid ducts are replaced by a double plate, slick on one side and the featuring wedge-shaped "teeth" on the other .The two teethed plates face each other and lodged between the teeth are small cylindrical rollers .In the calliper, as with a regular brake, the rubbing pad is set against the floating plate of the calliper. Two small electrical motors also located in the calliper move the wedge against one another. As a result when the brake pedal depressed, the wedge are activated; they push back both plates and force the pads against the disc. Here the wedge effect automatically increases the brake force that is applied. In reality; it's the kinetic energy of the moving vehicle that helps to slow it down. In other words, the faster the vehicle goes, the harder the brake reacts.
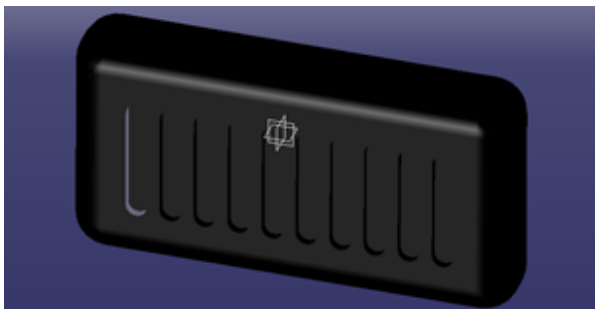
## (2) E-PEDAL



### E-PEDAL

The brake pedal is pedal that you press with your foot in order to make a vehicle go slower or stop. E-pedal is the connecter between battery and main brake controller. When the driver engages the brake pedal, the EWB system electronically transmits the activation sign to the interconnected brake modules. E-pedal is connected with battery and main brake controller.

## (3)MAIN CONTROLLER or ELECTRONIC CONTROL UNIT (ECU)



### MAIN CONTROLLER

Electronic control unit is the main system to operate the DC motor by controlling the EWB actuator. The interior design of ECU is based on minimum system of microcontroller unit (MCU) and motor driver circuit17. The MCU is installed based on the microcontroller minimum system (minsys) circuit. The minsys refers to the minimum circuit configuration in order to operate MCU properly. The minimum circuit system provides necessary input or output (I/O) port to support the MCU. The output port from MCU will provide signal to drive the motor. However, the signal obtained from MCU alone cannot directly control the motor because the current is very low. Hence, motor driver circuit will act as current buffer for the MCU to drive the DC motor.
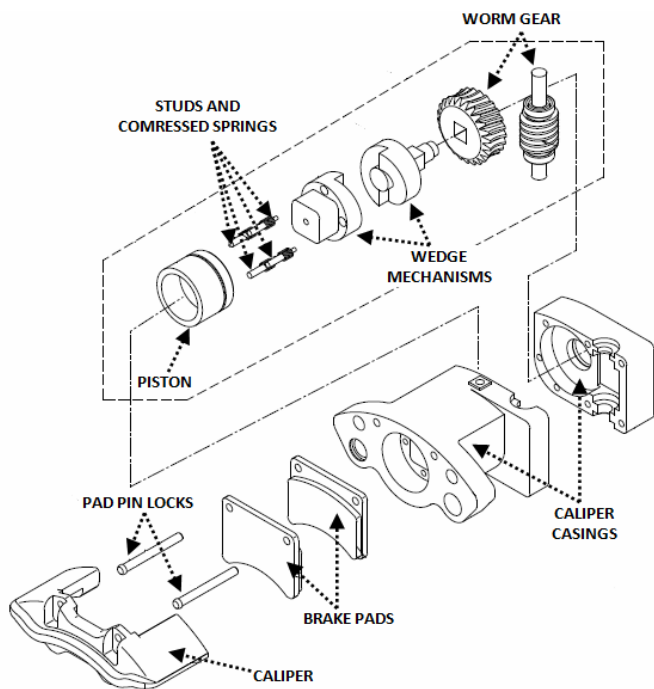
## (4) BATTERY-



### BATTERY

The battery is the main source of electrical energy in go kart or any other automotive. It only stores chemicals not electricity.

The typical 12-volts wet cell type battery is used in go kart which is mostly used in automotive. Battery is six cell units and is made of plastic enclosures with each cell having a set of positive and negative plates immersed in an electrolyte. Each cell has a voltage of around 2.1 volts when fully charged, leading to combined battery voltage of about 12.6 volts.

The main purpose of the battery used in go kart Or any automotive is to operate the starter motor and to provide sufficient current for the ignition system during engine cranking. But in this EWB braking system battery used for one more purpose that is to provide a sufficient current to a caliper through e-pedal. By which caliper does further working .Battery plays vital role in this EWB braking system.

### 1.2  THE EWB

The prototype of EWB system has been developed through the modification of conventional brake calliper taken from an existing automotive brake system. The model showing the internal components of the EWB actuator can be seen fig. 1

**INTERNAL   COMPONENTS OF EWB ACTUTOR**

The DC motor drives the input through worm pinion in rotational displacement. The worm pinion rotation is then redirected as clamping motion by means of worm gear reducer coupled with thrust ball bearing to reduce Tooth friction. Backlash between gears can be ignored since the motion is one way although involving both left and right rotational movement. This is due to the fact that Clamping force only occurs on worm gear at its first tooth face. The worm gear reducer is mounted along with the first wedge mechanism where wedge mechanism is designed with slider shape inner cylinder so that it can maintain its alignment with the second wedge mechanism.
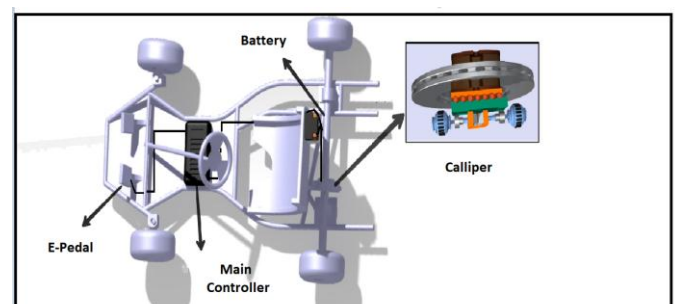
The second wedge mechanism is mounted along the piston and located in between a cavity boundary. The cavity boundary located at the centre of calliper casing has been Designed square shaped so that the second wedge mechanism could slide linearly without rotation during countering the rotational motion of the first wedge. Studs are added to the piston aligned with the cavity boundary to reduce shear friction between cavity wall and wedge mechanism. Compression springs are installed around studs to provide spring back motion at the piston. By acting against cavity boundary, the compression spring act to retract back the piston to avoid the piston from jammed on brake pads and also to reduce noise between brake pad and first wedge mechanism due to floating nature.

## 2. DESIGN OF EWB SYSTEM ON GO KART

A go kart is a simple small open wheel vehicle used for basic motorsport events. Because of these types of events efficient braking system playing important role. The efficient braking system like EWB is very useful for in events like drifting, skidding and always very useful for long racing events.

The components that are used in EWB braking system are attached in go kart at comfortable position. E-pedal is placed at as same as normal pedal position. EWB brake controller is the important part of this braking system and this is placed in front of sheet and on the chassis. Battery is attached backside of the sheet. Caliper is imposed on the disk which is connected to the shaft. The systematic arrangement of EWB braking system for go kart is as   shown in following computer aided design (CAD) model:



**MODEL OF GO KART**

### 2.1 CALCULATIONS –

We consider -

(1) Kart-weight=200kg.
(2) Disc diameter=200mm.
(3) Mean effective radius (re)=100-10=90
(4) Speed of kart=45 kmph=12.5
(5) Coefficient of friction between pad and disc= (μ) =0.4
(6) Force generated by roller=$F_{roller}$=11255.55 N
(7) Wedge angle=β=30°

As per above consideration we calculate,

(1) Force generated by caliper pad on disk-

$$F_N = F_{roller} \times \cos β$$

$$= 11255.55 \times \cos 30°$$

$$F_N = 9747.5922 \text{ N}$$

(2) Clamping Force ($F_{CL}$)

$$F_{CL} = 2 \times F_N$$

$$= 2 \times 9747.5922$$

$$F_{CL} = 19495.1845 \text{ N}$$

(3) Braking Force ($F_B$)

$$F_B = \mu \times F_{CL}$$

$$= 0.4 \times 19495.1845$$

$$F_B = 7798.0738 \text{ N}$$

(4) Braking Torque ($T_B$)

$$T_B = F_B \times \text{Effective radius}$$

$$= 7798.0738 \times 0.09$$

$$T_B = 701.8266 \text{ N/m}$$

(5) Max Deceleration -

$$\text{Max Deceleration} = \frac{\text{Braking Force}}{\text{Weight}}$$

$$= \frac{7798.0738}{200}$$

$$\text{Max Deceleration} = 38.99 \text{ m/s}^2$$

(6) Stopping Distance –

By using kinematic equation

$$S = \frac{V^2 - u^2}{2a}$$

$$= \frac{0 - (12.5)^2}{2 \times 38.99}$$

$$S = 2.0037 \text{ m}$$

∴ Stopping distance of Go-kart running at a speed of 45 kmph is 2.0037 m.

(7) Stopping Time

By using kinematic equation

$$S = 1/2 \, (u+v) \, t$$

We have  S = 2.0037 m

$$2.0037 = 1/2 \, (12.5+0) \, t$$

$$t = \frac{2.0037 \times 2}{12.5}$$

t = 0.32 sec

∴ Braking time of Go-kart is 0.32 sec.

## ADVANTAGES USING EWB SYSTEM IN GO KART-

(1) It is a very efficient braking system.
(2) It responds faster compare to other conventional braking system and having faster reaction time.
(3) There is no need for brake lines, vacuum boosters, servo units and because of these elements are eliminates some amount of weight is also reduces.
(4) It requires one tenth of the energy compare to other conventional braking system.

## DISADVANTAGES USING EWB SYSTEM IN GO KART-

After some time battery get discharged due to continues supply to caliper or other electronic elements, hence Battery discharging is main disadvantage of this system in go kart.

## 3. CONCLUSION

As per above discussion, the design of EWB braking system in go kart have a faster reaction time which make the braking system more efficient. It reduces the stopping distance by 15% as compare to hydraulic braking system. The results show that this system using in go kart make braking system more effective and effectual.  The braking system is more reliable.

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