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Automotive Safety Rolling Barrier

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Abstract: ***The government is always looking at the latest technology that can ensure safety of road users, as outlined in the construction industry transformation plan. A small Korean manufacturing company invented a new concept longitudinal barrier, (The Rolling Barrier) which had continuous pipes covered with urethane rings. This study aims to evaluate the effectiveness of the "Rolling Barrier" and to understand the Rolling Barrier's characteristics of crash cushioning, how to correct the vehicles running direction and the required strength of barriers. They convert that impact energy into rotational energy to propel the vehicle forward rather than potentially breaking through an immovable barrier. When a car hits the barrier, the rotating barrel converts shock from the vehicle to rotational energy. Upper and lower frames adjust tires of large and small vehicles to prevent the steering system from a functional loss. The Rolling Barrier can be effectively used in curved roads sections, ramps, medians and entrance or exit ramps in parking garages. In this paper, the description and studies of Rolling Barriers are elaborated. In 2015, there were 63,805 traffic accidents over on the Maharashtra, India, with 54.2 % composed of vehicles that crashed into longitudinal barriers. Such accidents can be drastically reduced if more safe barriers are installed for traffic safety. A small Korean manufacturing company invented a new concept longitudinal barrier, the Rolling Barrier (RB), which has continuous pipes covered with urethane rings. This study aims to evaluate the effectiveness of the RB & to understand the RB's characteristics of crash cushioning, how to correct the vehicle's running direction & the required strength of barriers. Experiments with barriers performance & crashing vehicle behavior at curved sections using a 1.3-ton passenger car & a 3.5-ton truck showed satisfactory vehicle behavior as they ran parallel with the RB after crashing. The structural problem of the RB wasn't found during the time of the crash. In the strength performance test using the 8-ton truck & in the passenger protection test using the 1.3-ton passenger car, the RB satisfied the Ministry of Construction & Transportation's " Guidelines for Installation & Management of Road Safety Facilities." The differences between the RB & conventional barriers where crash cushioning & required strength of barriers were involved were verified by mathematical equations. The RB can be effectively used in curved road sections, ramps, medians & entrance/exit ramps in parking garages. Keywords: -accidents, longitudinal barrier, rolling barrier, traffic barrier, vehicle, collision***

I. INTRODUCTION

The Rolling Barriers are the barrier that absorbs impact energy and converts that impact energy into rotational energy and directs the vehicles forward rather than potentially breaking through an immovable barrier.[1] In India, the year 2016 has recorded the highest number of road accidents around 4,80,652 which comprised 1,50,785 deaths. The Indian Express, dated 11 Sept. 2017 has claimed in the report by Transport Research Wing under Ministry of Road Transport and Highways, Government of India that there are 17 deaths on road every hour in India.

As per the records, 34.5 % India. Accident deaths occurred on National Highways, while 27.9 % accident deaths took place on state highways. The report says that over speeding is the biggest cause of casualties i.e. 66.5 % of all road accident with 61% of death due to over speeding. Other factors constitute the unchecked surge in motorization and human errors. Cities with large population saw majority of accidents.

Chennai leads with 7486 accidents followed by Delhi 7,375 accidents. . Even though efforts are being made by the Govt. to reduce the severity of road accidents but the results have not been significantly fruitful. Primarily it is based on 4 E' s i.e. Education, Engineering, Enforcement and Emergency care. Nearly 700 Accidents prone spot have been found out by Ministry of Road Transport and Highways (MRTH) .

Safety road roller are also being used as a barrier for safety of the road users in certain countries like Malaysia Road Accessory (RB) prevents driver and passenger from fatal and destructive accident by not only absorbing shock energy but also converting shock energy into rotational energy. Safety roller can be recycled andeco-friendly.

Safety roller barriers are easily adjustable by adding or removing a roller.

Figure 1.1: Rolling Barriers at the Roadside and vehicle collision

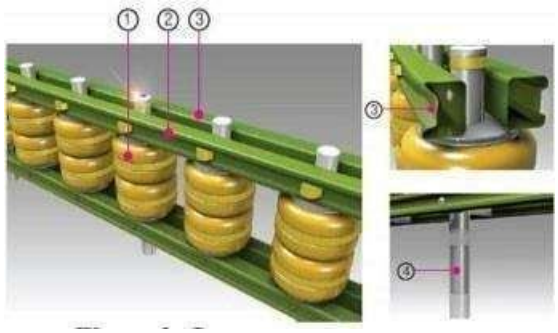

Figure 1.2. Components

1) Roller absorbs collision shock (shock energy to rotational energy)
2) Front rail absorbs 2nd shock
3) Back rail absorbs 3rd shock
4) Metal pipe inserted in to strengthen post.

Kim et al (2004) in a study concluded that the use of longitudinal barriers results in reduction of the accidents by more than 50 percent in a year. In a strength performance test of the 8-ton truck, and in a passenger protection test with 1.3-ton passenger car, the RB satisfies the MOCT' s Guidelines for Installation and Management of Road Safety Facilities.. Wadekar et al (2017) published that the accidents that occurs on major roadways like expressway has observed 14,500 accidents resulting to 1,400 deaths since its inception. India, being on the threshold of fetching a the place among the developed country needs to make its efforts that withstand on Shock Absorbing Rolling Barrier. RB can help to reduce accidents and fatalities. Rao. et al in 2017 his analysis of road accident data 2015 exposes that about 1,374 accidents and 400 deaths takes place every day on Indian roads which further interprets that 57 accidents and loss of 17 lives on an average every hour in the country. He concluded, the RB safes life and also prevents maximum damage level of the vehicles and established that the rolling barrier systems are the future technology in transportation engineering. Reddy et al (2017) perceived that every year approximately 1.25 million people die over the world due to road traffic crash. The federal highway administration suggested that the guardrail installed in the road way can minimize the large number of accidents. A Korea based company ETI (evaluation in traffic innovation) is involved in design rolling barriers system

A. Barrier

Barrier or traffic barriers also known in North America as guardrails or guard rails and in Britain as crash barriers. Barrier is a type of obstruction that try to try to keep vehicles within their road lane and prevent them from collision with dangerous obstacles or other vehicles. Such as sign supports, trees, bridge abutments, buildings, walls, and large storm drains, or from traversing steep (non-recoverable) slopes or entering deep water. They are also installed within medians of divided highways to prevent errant vehicles from entering the opposing carriageway of traffic and help to reduce head on collisions. When the barrier situated at the middle portion of road called as median barrier used mainly for prevent head on collision. Traffic barriers can also be used to protect vulnerable areas like school yards, pedestrian zones, and fuel tanks from errant vehicles.
While barriers are normally designed to minimize injury to vehicle occupants, injuries do occur in collisions with traffic barriers.

They should only be installed where a collision with the barrier is likely to be less severe than a collision with the hazard behind it. Where possible, it is preferable to remove, relocate or modify a hazard, rather than shield it with a barrier. To make sure they are safe and effective, traffic barriers undergo extensive simulated and full scale crash testing before they are approved for general use. While crash testing cannot replicate every potential manner of impact, testing programs are designed to determine the performance limits of traffic barriers and provide an adequate level of protection to road users .

Rolling Barriers are also known as guardrails, longitudinal barriers. RB retain vehicles on their check vehicles from hitting with hazardous obstacles and roadway such as rocks, traffic sign posts, bridge supports, trees and construction walls. Rolling Barriers are characterized in two types, by the functions they serve and conferring to the degree that how much they can deflect a vehicle when it hits into the RB.

B. Types Of Barriers According To Its Functions

1) Roadside barriers: Its primary function is to protect traffic from outside obstacle and hazards. The hazard could be such as steep slope, heavy rigid body (eg. stone) and accumulated water body.

2) Median barriers: Its function is to prevent vehicles to cross over a median to avoid head-on collision.

3) Bridge barriers: it is generally having greater dimension in comparison to road side barriers. This barriers prevent vehicles from crashing off the side of the bridge and jumping onto the river, railways and roadways below.

4) Work zone barriers: they are temporary barriers and can be reallocated depending upon the work zone. It prevents the traffic from work zone hazards.

5) Types of Barriers according to stiffness

6) Flexible barriers: it consists of weak post corrugated guide rail and cable line barriers.

7) Semi rigid barriers: They Includes heavy post blocked out corrugated guiderail with a line box beam guiderail and thrie-beam rail. They deflect 3-6feet (0.91 to1.83m).

8) Rigid barriers: they are simple rigid body and made with cement concrete. The deflection of rigid barrier is almost zero

Table 1. Percentage of collision of vehicles on various objects/obstacles

S.no	Objects of impact of vehicle	Total percentage
1.	. Concrete Barriers	23%
2.	Guard rail	19%
3.	Flowerpots and curb stones	15%
4.	Bridge wall	13%
5.	Overhead bridge pillar/tunnel wall	13%
6.	Trees	5%

Figure.1.2.1

C. History of barrier

Concrete safety barrier designs have evolved over the past fifty years as a means to slow, redirect, or stop an errant vehicle from causing a crash with coming traffic from other side or traffic in neighboring lanes. They can be used between lanes of opposing traffic (median barrier), at the edges of roadways (roadside barrier), on bridges (bridge rail), as temporary safety barriers during construction, and in many other applications. There are multiple styles and shapes of these concrete barriers and they have changed and evolved with our highway system. Designed and tested by the New Jersey State Highway Department in 1959, the New Jersey barrier was one of the first concrete safety barrier designs to be used on a large scale. During the 1960's and 1970's "Jersey Barriers" spread throughout the country and became, the most commonly used type of concrete safety barrier .

D. Reason Of Using Barrier

Roadside barriers are typically installed to prevent errant vehicles from colliding with hazardous roadside objects such as signs trees, abutments (bridge, pier), rock outcrops, culverts, bodies of water, embankments, cliffs, ditches, electricity substations, retaining walls, poles etc. Roadside barriers are also sometimes used to protect pedestrians, bystanders or property. Road safety apparatus are required to protect drivers, passengers, as well as other road users in case of an accident. In the case of a steep decline, a truck may experience a braking malfunction and start rolling down the road like a runaway train. Where the road is a dual carriageway, the drivers on the other side of the lane may not be aware of such an emergency. At a sharp bend, the truck may be unable to steer the vehicle as appropriate and could drive straight to the other lane, thereby endangering the lives. A properly fabricated road divider can stop the truck from crossing over and knocking the oncoming traffic. Similar barriers in the form of bollards can also protect a vehicle from rolling down a cliff in the case of a slippery road surface occasioned by snow and rainfall. Fixed road bollards significantly minimize the risks of major accidents as a result of placing of permanent road barriers along strategic and high-risk sections of the highway. There are instances where burglars use vehicles to ram into the shop fronts to gain access. These happen in secluded areas where the criminals take advantage to implement suchmethods.

With the erection of fixed barriers, this situation cannot occur . As such, your business premises, as well as your employees and customers, are safely protected from ram- raiders. Protection of an out of control vehicle from breaching the media lane to confront the opposite traffic. For this reason, a continuous fixed road barrier is typically erected to divide the two sections of the

CFig

E. Importance Of Barrier

Each street or highway should be built in a way that certifications and guarantees agreeable, helpful and in particular, safe transportation of individuals and different sorts of products and materials. But car crashes, collisions and other comparable mishaps are extremely regular occasions on the streets, and once in a while profitable lives are lost. There is a requirement for defensive gear to be introduced on the streets, for example, road safety fences and road safety barriers.

Security street obstructions are utilized to restrict vehicles from entering particular territory. They are exceptionally straightforward and proficient. A road safety barrier is utilized as a part of numerous applications including mishap scenes, police barricades and building destinations, and so on. There are distinctive kinds of street boundaries which vary in weight, shape and size contingent upon the application.

Each sort of a street security boundary has a proposed reason.

1) Main reasons for installing road safety barriers on the roads are:

a) To secure and keep wild vehicles from going into the path of different vehicles. Consequently, the road safety barriers are put on the middle of theroad.

b) To shield the vehicles from falling into a lope. The road safety barriers are ought to be set toward one side of the street if there is a drop of at least 5 meters close to the street

c) To keep a crazy vehicle from slamming and hitting a street sideobject.

2) The importance of safety road barriers can be seen by the benefits they provide:

a) high containment

b) increased safety

c) low maintenance costs

d) Reduced traffic jams and congestion, etc.

Road safety barriers help minimize the number of accidents associated with run-off road and direct vehicle crashes. Therefore, they should be considered and included in every road construction project.

II. TYPES OF BARRIER (CATEGORY)

There have some different types of barrier by category. It does mainly identify where it is situated. If it situated at the side termed as roadside barrier, when it is situated at the middle or I land known as median barrier. When it use in bridge then it called as bridge barrier. Here's the brief description of barriers by category

1) *Roadside Barriers:* These are used to prevent traffic from roadside obstacles or hazards or do not fall down from hill in hilly areas. Such as slopes steep enough to cause rollover crashes, fixed objects like bridge piers, and bodies of water. Roadside barriers can also be used with medians, to avoid vehicles from colliding with hazards within the median. (Figure 2.1.1)

Fig 2.1.1

2) *Median Barriers:* These types of barrier are used to put a stop to vehicles from crossing over a median and striking an oncoming vehicle in a head-on collision. These barriers are situated at the middle of total length. (Figure 2.1.2)

Fig 2.1.2

3) *Bridge Barrier:* In bridge barrier categorically there have two types of barrier. Side barrier and median barrier. In side barrier prevent to do not fall vehicles from bridge and median barrier used for divide the road similarly and prevent the head on collision. (Figure 2.1.3)

Fig 2.1.3

4) *Work Zone Barriers:* These types ofbarrier are used to guard vehicles in work zones. Their distinguishing trait is they can be moved as conditions change in the road works. Two common types are present in it that is a temporary concrete barrier and water-filled barrier. Both barriers can move other place after finishing work. Temporary barrier mainly used for warning peoples or vehicles and improved safety of workers in construction work zones. Concrete barriers are the preferred temporary rental barrier. It can be free-standing, bolted or pinned (Figure 2.1.4).

Fig 2.1.4

5) *Impact Resistant Barriers:* These types of barrier can reduce or stop the forces of car or truck impact. Typically it's used to protect a fixed structure from vehicular damage. A common form of this barrier types arebollards.
6) *Others:* There have many types of traffic barriers. Like, impactabsorbent barrier which is capable to absorb the impact of traffic. It also known as safer barrier popularly used in race tracks side . Others barriers are impact deflection barriers, composite barriers, rolling barriers . Removable Metal crash barriers, collapsible bollards, fixed Crash barriers, concrete Crash bollards, architectural bollards, Fig 2.1.5 stainless steel bollards. Some barrier can be designable it can also both safety and beautification. (Figure 2.1.5)

Fig 2.1.5

A. Features

1) LED guide lamp (solar energy).
2) Two Pieces.
3) Material is eco-friendly.
4) It reduces the speed of vehicle.
5) Reduces costs in repairing & maintenance due to Roller's resilience.
6) Made of special chemical compound like hardrubber.
7) Easy to maintain due to separated barrels(recyclable).
8) Stopper boards installed on the top and the lower part of the barrels to guide objects back to the road.
9) Easy to adjust height, noticeable to drivers due to noticeable coloration and self- luminescence.
10) Noticeable to drivers due to noticeable coloration and self-luminescence.

B. Types of Barrier (Materials)

There have many types of barrier using many types of materials. Day by day new theory or ideas are coming for barriers. A new type of barrier means obviously better form old theory. It will be cost efficient than older. Now a days, introducing new types of materials use also in barrier like plastic, foam etc. Here discussed briefly about the material of barrier can be used and about their behavior.

1) *Roller material- Urethane Ether polyurethane:* Excels in mechanical strength, Low heat resistance, Superior water resistance compared to ester polyurethane High impact resistance.
2) *Ester Polyurethane:* Excels in mechanical stremght but has low heat resistance and chemical resistance. 30-100% more mechanical strength to ether polyurethane. Superior in oil resistance to ether type. Has low impact resistance.
3) *Concrete:* The most common type of barriers are concrete barrier, most use because it's easy to maintain and very effective. In concrete barrier there uses steel also. (Figure 2.1.2).
4) Steel: These barriers consist of a metal beam (shaped like a W) (Figure 2.2.1) which is supported by a series of wooden or steel posts designed to give way slightly under impact. This prevents the vehicle from leavingthe roadway and helps to minimize the shock of impact that travels back to the vehicle and those in the car. (Figure 2.1.1).

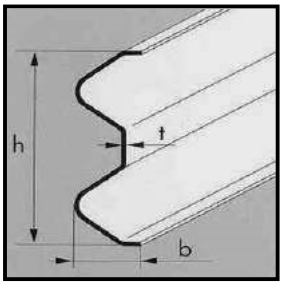

Fig 2.2.1

7) *Cable:* Rope-like cable barriers are also in place along stretches. It's mainly use in the median of the road. These cable barriers try to prevent median cross over crashes. Cable barriers reduce the forces on the vehicle occupants which reduces chance of injury. Also, the open design of the cable system minimizes visual obstruction, reduces accumulation of drifting snow along the roadway, and provides better sight lines on curved roads. (Figure 2.2.4)

Fig 2.2.4

III. ROLLING BARRIER

Our main topic is about Rolling barrier. The concept of rolling barrier is, a structure equipped with continuous pipes covered with urethane rings. Its general feature resembles an erected abacus. As the rolling barrier activates the rolling friction when vehicles hit the barrier, the rolling barrier reduces severity of traffic accidents. There have a rolling box which is attested with stainless steel. The rolling box can rotate when it will hit by traffic. It's made of special chemical compound like hard rubber which is capable to absorb the impact of the vehicle. In concrete or steel barriers there target to save the life of the humans but the vehicle situation would be worst and cable barrier try to reduce the impact of the vehicles.

Fig 3.1.1

Sometime these three types of barrier fail to achieve its target and human lost his life. A new type of barrier **"Rolling barrier."** we can say that rolling barrier have same features of these three types of barriers simultaneously. Figure 3.1.2 is showing that where we can use the rolling barrier. We can use it at road side, median, bridges.

Fig 3.1.2

A. How Does it Work?

The rolling barriers do more than absorb impact energy. They convert impact energy into rotational energy to propel the vehicle forward rather than potentially breaking through an immovable barrier. The ETI product has a rotating barrel made of EVA with excellent shock absorption power, 3D buffering frames & dense props supporting the frames. Rotating Barrels comes with attached reflective sheeting for good visibility. EVA has a better flexibility & elasticity compared to other polyethylene resins & has most similar features to rubber. In fact, its lighter than rubber & most elastic than urethane. In shorts, it's not easily damaged. When a car hits the guardrail, the rotating barrel converts shock from the vehicle to rotational energy.Upper & lower frames adjust tires of large & small vehicles to prevent the steering system from a functional loss. Railways rails & liquid props absorb shock from accidents vehicles & frames with the smooth surface adjust tires of the vehicles & guide them in the moving direction to prevent second rear – end collisions. The 3D structure of the D – shaped frame & buffering bracket distribute & absorb the second shock. Props at an interval of 0.7 m increase bearing power to prevent vehicles from further derailing. As the props are independent only damaged parts need to be replaced. This keeps maintenance costs pretty low. They consist of both flexible property and semi rigid property of barrier stiffness. RB are different in mechanisms than the other types of normal barriers. It also reduces the hazard and road accidents. Urethane has become the material of choice in so many of today's performance driven applications because it illustrate extraordinary physical and mechanical properties that other material simply can' t match. Roller Barriers absorbing the collision shock in three points, the barrel, the buffering bracket, and the liquidity of the rail shocking mechanism. The shock energy absorb from a curved crash is absorbs then the shock is converting in a rotational energy. Shock energy absorbs the gain by its upper and lower safety guard rail. Shock energy will be again by the back side of safety rails. Finally the safety roller barriers will leave the cover back to the lane. Thus, this decreases the car damage and ensures the safety of drivers and passenger in the vehicles. Besides strong resilience and shock energy absorbing capacity of RB the cost and maintenance of repair significantly less, this is another economic advantage of this technology.

Table 2: Percentage of type of accidents

S. no	Types of accidents	Constituting percentage
1.	Run off road to left	32%
2.	Run off road to right	23%
3.	Collision with another vehicle moving ahead or waiting	21%
4.	Collision with another vehicle which starts, stops or stationary	10%
5.	Collision with another vehicle moving laterally in same direction	5%
6.	Collision with another oncoming vehicle	2%

Figure.3.1.3. Rolling Barriers at the midroad and vehicle collision with diversion

Figure.3.1.4. Rolling Barriers at the Uturn

Rolling Barriers can be for two way traffic by installing them at the midroad and used as dividers (figure 3). Roller Barriers can be used at turning of roads to avoid accidents at turnings. The figure 4 shows is the RB installed at the U turn, to reduce fatal damage during the turning. U turns are much prone to accidents.

B. History of Rolling barrier

A small South Korean manufacturing company invented the "Rolling barrier." After the rolling barrier was installed at two downgraded and curved roads sections in Busan (South Korea), the accidents at the sections were reduced by more than 50% in a year . This consists of both flexible property and semi rigid property barrier stiffness. They are different in mechanism than other types of barriers also reduces the hazards or accidents. Urethane has become the material of choice in so many of today's performance driven applications because it exhibits extraordinary physical and mechanical properties that other materials simply can't match. October 2016 Malaysian Government set to be used Rolling barrier to reduce the accident and achieve more safety .

Fig 3.2.1

C. Advantage of Rolling Barrier

Every new invention has to be better than from its previous invention. Every invention has some advantages. Without advantages people or Government will not accept the invention. About rolling barrier the first advantage of it, is safety of the vehicle and human. The features of barrier are

1) *Shock Absorbs System:* The hard rubber type material (the roller) can absorb the impact of the vehicles. It reduced the speed of vehicle after hit the barrier. If car speed is 40km/h then the accident percentage reduced 80%. If a driver tries to control his traffic which is failed if that time the vehicle hit the barrier then the speed will reduce and it will be in control.
2) *Convert Shock Energy To Rotary Rotational Energy:* It is one of the great advantages of rolling barrier that absorb the shock and try to divert shock energy to rotary rotational energy. That's why the crashed vehicle tries to stay in the track. Not get out from the track. If there is a hilly area and its fail to stay in the track then it will get out from track and can be happenedfatalities.
3) *LED light:* one of the main features is the LED light which is operated by solar power can be helpful for the drivers. He can see the barrier in night clearly and the accident will be reducing in night.

Figure.3.3.1

4) *Stainless Steel:* This one of the most important elements of rolling barrier.The roller is stand by supported by this stainless steel. Without it the barrier is unusual (figure 3.1.2).

Figure3.3.2

5) *Color of Barrier:* the color of the roller is yellow. Yellow color can focus with a long distance. Driver can see the barrier from a long distance and he will also alert from a long distance. That's why some concrete and steel barrier colored in yellow.

6) *Reflective Tape:* Reflective tape is a one kind of tape (figure 5.1.2) that can be bright when the flash of the vehicle will hit that tape. In every roller there use a reflective tape to alert the driver. It helps in night because when the light of vehicle hit the tape and it reflect clearly and alert the driver that there have a barrier (figure 3.3.1)

Fig 3.3.3

7) *Easy to Install:* Another great advantage is that the installation process is much easier than other barrier. About the changing the roller it's also very easy for the worker. Just remove the horizontally situated stainless steel bars, remove the damaged roller, set the new roller and the pin of the horizontally situated steel bar's pin.
8) *Recyclable Materials:* The using chemical composite rubber type hard materials are eco-friendly and recyclable. So, the maintenance cost also reduces.
9) *Environmental Impact:* Earth is heat day by day because of carbon emulsion. So, concrete barrier is not eco-friendly because concrete also reduce carbon-di- oxide. But rolling barrier's materials are totally eco-friendly. So, it will not harm the environment.

D. Problems of Rolling Barrier

Though the rolling barrier is better in terms of costing, easy to set, much safer than concrete barrier, steel barrier, cable barrier, impact absorb barrier. Rolling barriers have the same advantages of cable barrier, impact absorb barrier and steel barrier. But rolling barriers has also some problems. Such as,

1) *Maintenance:* The maintenance cost of rolling barrier is very high. After crashes the roller is totally damaged. Though it can be recycling again but it has to change immediately after a major crash.
2) *Workers:* Because of heavy and repeated maintenance, there should need a good number of workers for changing it. Though the changing process ismuch easier.
3) *Permanent Deformation:* After hit the barrier by a heavy truck or car, there occurs a permanent deformation in the steels. Though it can change easily and it will not affect the barrier much (figure 3.4.1) .
4) *Temperature:* This is one of the great problems of rolling barrier. The roller is made by hard rubber type materials. When summers, the temperature also higher than before. So, the roller losing its durability or hardness. So, it should be in regular check and proper maintenance.

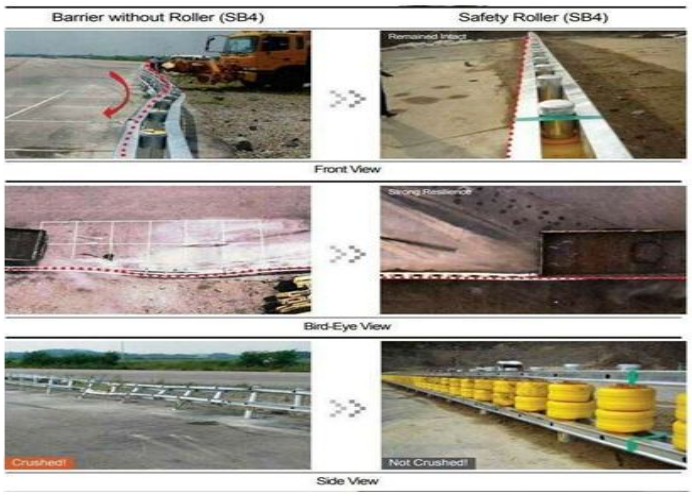

Fig 3.4.1

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IV. DESIGN

Design of the rolling barrier is provided by the South Korean company "KSI". In this design all dimensions are in mm. Here given the name of roller is A. The total diameter of the roller is 370m and the rounded stainless steel's diameter is 246mm. the distance between one posts to another post below the soil is 1400mm. A span's distance is 4200mm. one roller to another roller center to center distance is 700mm. the vertical distance from ground level (GL) to further is 1200mm and the height of upper side is 1000mm. There have inner post, sub post, w rail style stainless steel, shock absorber roller, post cap etc. All things are shown at (figure 4.1.1.)

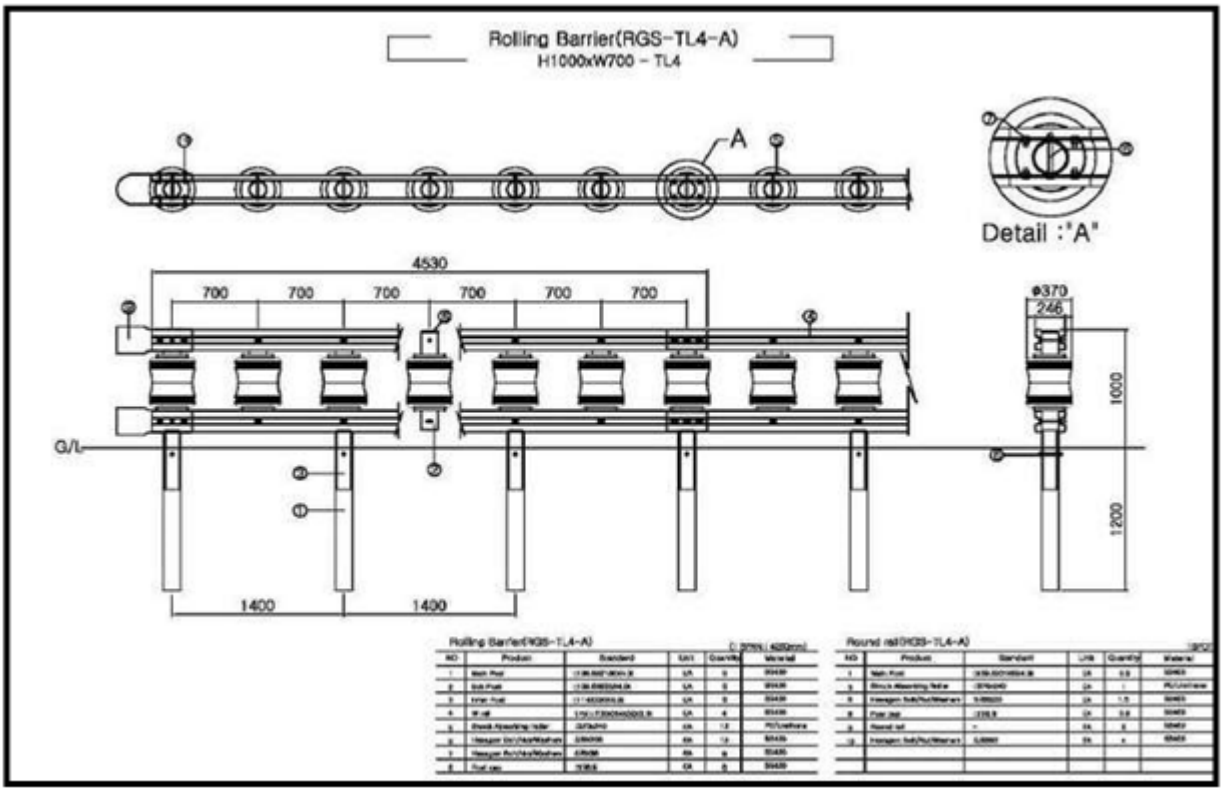


Fig 4.1.1

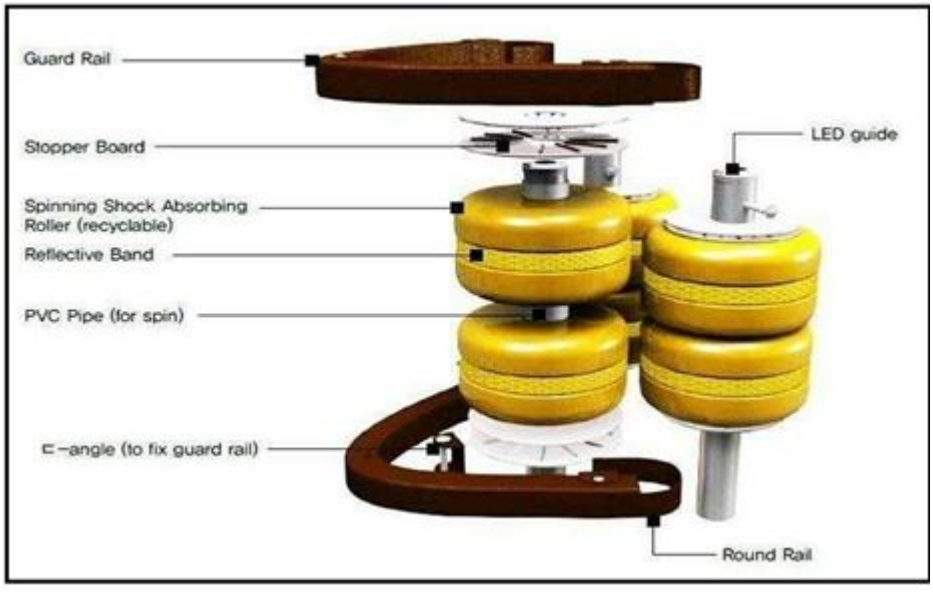
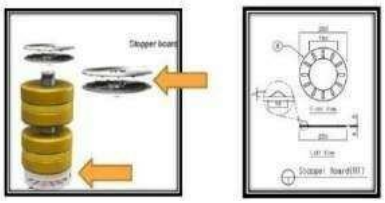


Fig 4.1.2

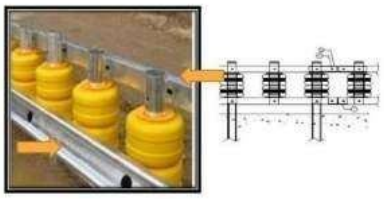
A. Rolling Barrier

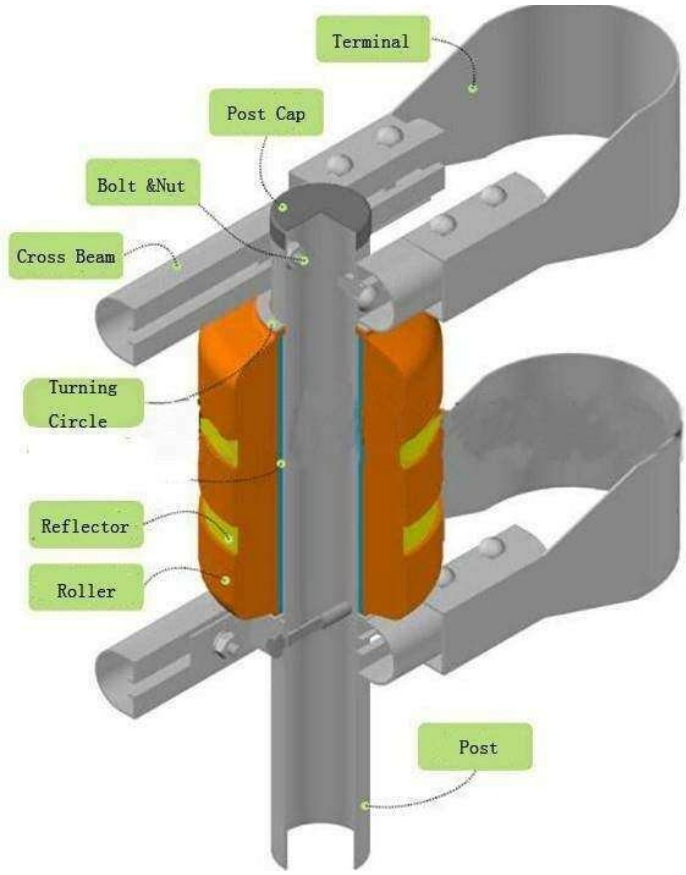
Item	Unit	Urethane Rubber				
Hardness	Shore A	95	90	70	50	30
Specific Gravity	-	1.13	1.13	1.12	1.15	1.2
Tensile strength	Mpa	44.1	44.6	31.3	27.4	18.5
Elongation	%	400	530	650	690	600
Heat Resistance	C	70	70	70	70	70
Low temperature Resistance	C	-40	-20	-20	-20	-20

- System Component-Stopper Board



- System Component- Top & Bottom Rails





Saftey Roller	Dia.350*510mm
Post	Dia. 140*2200*4mm
Beam	100*80*4mm
PVC Tube	Dia.147*510*6.5mm
Bolts	M20*60,120,180mm
Post Cap	Dia.145*30mm
End Cap	1300*130*4mm

B. Test

1) Test performance comparison during crushing between conventional barriers and RB: Performance test has been carried out to compare normal and RB to measure the degree of damage imparted to the barrier during a vehicle impact. The SB4 Crash test shows the representations of the crash test (test 1). It was observed that the conventional barriers experienced more damage in comparison to RB. In a similar crash test (test 2) a comparison is done between passenger car and heavy vehicle impact to a RB, as shown in SB5 Crash test. It was seen that impact of passenger car delivered no damage to the RB, while slight damage is recorded in case of heavy vehicle.

2) Findings of crash test

SB5 crash test level

a) Passenger Safety Performance

i) Theoretical head impact velocity (THIV): 32.4km/hr (below 33km/hr)

ii) Post impact head deceleration (THD): 9.9 m/s^{-2} (below 20 m/s^{-2})

b) Scatter prevention performance

i) No scatters of the fifty barriers.

c) Test vehicle behavior performance

i) Not over thrown or a sudden stop after collision.

ii) 76.9% (Exit speed: 74.8km/hr): 43.7% (Exit angle: 8.74 degree)

d) Synthetic results satisfied with criteria. Test 1: SB5 Crash test

Figure 4.2.1. Crash test comparison between conventional barriers and RB (KSI Korea)

C. Small Car

1) 900 kg car, 200 side collision during the evaluation, it was observed thatthe ETI product sends an accident vehicle back to the normal moving track, protects occupants and second vehicle accidents

2) Given Data: M=900kg V=100km/hr Ø=20°

By impulse-momentum relation $F \Delta t = mv$

Where

F=impact force on N

Δt= short time interval in milli secand

m= mass of car v= velocity of car.

$F \Delta t = 900*100(5/18)$

$=25000N$

Assume,

t= 0.076s

F=(25000/0.076)

= 328947.36N

=328.9kN

Assume,

d= 300mm

A= (π*㎜^{2}/4)

= (π*300^2/4)

= 70685.83㎜㎜^2

$\tau\tau$ = (Ft/A)

= (328947.36*cos(20)/70685.83)

=4.37Mpa

Σ = (Fr/A)

= (328947.36*sin(20)/70685.83)

= 1.59Mpa

D. Large Car

1) 10 ton truck, 150 side collision during the evaluation, it was observed thatthe ETI product changes the collision method to rotational friction to make collision continue for a long time and thus minimize momentary shock.

E. Bus

13 ton bus, 200 side collision during the evaluation, it was observed thatthe ETI product changes the collision method to rotational friction to make collision continue for a long time and minimize momentary shock.

Test 2: SB5 Crash test

Figure.4.2.2. Crash test for car and truck collision at RB (KSI Korea)

F. Rolling Barrier in India

India, being on the verge of becoming a developed country needs to channel its efforts that sustain its development process. Inefficient infrastructural systems leading to loss of citizenry and hence a huge human resource deficit can prove disastrous. The use of modern technological innovations like the rolling barrier system on the Mumbai-Pune expressway can help reduce accidents, diminish fatalities and also stimulate national growth. It will not only reduce the impact of collision but also help in redirecting to the actual path, by converting the impact energy into rotational energy. Considering the diverse terrain of the expressway, there can be several solutions to address the problem. But the rolling barrier system can prove to the panacea for most of the road transport ills, if correctly designed, properly installed and regularly supervised during the normal service. Moreover, the eco-friendliness of EVA being conducive to sustainable development makes the employment of the rolling barrier system a win- win situation. In India, the transportation sector has grown leaps and bounds since the beginning of the 21st century. The expressway has witnessed 14,500 accidents leading to 1,400 deaths since its inception. The Mumbai-Pune Expressway, inaugurated in the year 2002, is an epitome of technological and infrastructural advancement of the country. Albeit it has paved the way for a faster and a comfortable journey, it has also witnessed thousands of fatal accidents. These accidents impose a huge socioeconomic cost in terms of untimely deaths, injuries and loss of potential income. Moreover, accidents lead to traffic jams resulting in an overall delayed journey, contradicting the basic purpose of construction of such expressways. Therefore, road safety and management of the expressway has consequently become an issue of national concern.

V. COST

This material is not introduced India yet. So there have no specific costing about it. But in internationally there have the cost of rolling barrier. The features of rolling barriers are LED light, the hard rubber type plastic material (round shape), stainless steel, we use a lighting tape, when the vehicle's light hit the tape it will brighter known as radium tape or reflective tape. The price of a roller is 40-45 USD (2930-3297rs) (figure

In this rate the LED light and the radium tape or reflective tap also included. But the price of the tape is 6 USD (439 rs) per roll (figure 5.1.2) . The main thing of this barrier is the stand which is made of stainless steel. The price of stainless steel is 2-5 USD per kg (146-366 rs). Some company giving the whole part of the rolling barrier the cost of the total barrier is 230-290 USD per meter (16852- 21248)

Fig 5.1.1

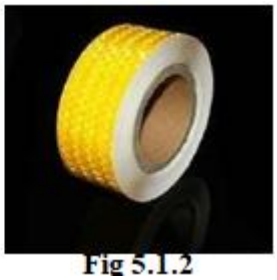


Fig 5.1.2

A. Maintenance Cost

Here write about the problems of rolling barrier before. The main problem of rolling barrier is, its maintenance cost is very higher than concrete and steel made barriers. Due to periodical inspection, maintenance of the rolling barrier system is in high level. At high temperatures in summer season, the rubber characteristic material is that it tends to low resistance property. So, that plays a major role in rolling barrier system but can be restricted or maintained by proper inspections periodically (once in two to four weeks or once in a month). Also a technique to cool down the heat is to sprinkle water on this rolling system, etc . Because of temperature or after crash the rolling barrier is damaged much so there need more maintenance. More maintenance means more labor work but advantage is that the maintenance system is easy. Just change the damaged roller of the barrier .

Fig 5.2.1

Fig 5.2.2

VI. DIFFERENCE BETWEEN CONCRETE BARRIER AND ROLLING BARRIER

There have some advantages of concrete barriers but also have disadvantages. Main difference between concrete and rolling barrier is in costing. Rolling barrier is much cost efficient then concrete barriers. The maintenance cost also higher than rolling barrier. If a vehicle hit a concrete barrier it will damage and have to repair it immediately and sometimes have to change the full block. The repair cost is much higher than rolling barrier repair cost. In rolling barrier, there just have to change the damage roller material which is made of rubber type hard material. The damage part of the roller can be repaired again but the damage part of concrete part can't repair again.

Engineers have to think about the environmental issues. Earth became heated day by day because of carbon-di-oxide releasing. The existing scale of carbon-di- oxide is much higher. So, it needs to be reduced. Concrete release carbon-di-oxide and this effects the environment. Other hand, rolling barrier's material is eco-friendly and do not harm the environment. We can also set the rolling barrier at front of existing concrete barrier .

Figure 6.1.1

A. Difference Between Steel Barrier And Rolling Barrier

There have many types of steel barriers, designable steel made barriers but the designable barriers are not in highways. The designable barriers are mostly in the residential are because of beautification. Most common steel barriers are normal steel barriers (figure2.1.1). These barrier are more strong than concrete barriers but problem is this types of barrier's height is much low for heavy truck or large vehicles (buses) it is unable to give the security of life and main think is it damaged the vehicle much which is not economical. Rolling barriers made by hard rubber type materials, which is attested with stainless steel, which give you as same as the strength of steel barriers but main advantage of rolling barrier is it can be less damage of vehicle than steel barrier and life safety is also more than steel barrier. Figure 6.2.1 is showing the damages of steel barrier and figure 5.2.1 and 5.2.2 showing the damages of rolling barrier .

Fig 6.2.1

B. Difference Between Other Barriers And Rolling Barrier

There have many types of barriers but concrete and steel barriers are common. Cable barrier also a type of barrier we write it before. But the cable barrier is not durable.

The main think of cable barrier is to absorb the vehicle impact. There have some other barriers to absorb the impact like safer barrier. But safer barrier is must costly than rolling barrier, though cable barrier is low cost than rolling barrier but durability of rolling barrier is much better than cable barrier. The damages of the vehicle also much lower than cable barrier.

VII. CONCLUSION

India is among those developing economies in the world which will soon take up the band of developed nations. The high growing economy not only requires monetary growth but also the life safety and high status of living of the nationals. Due to the high number of road fatalities it is imperative for India to take measures towards the safeguard of human life by eradicating or by minimizing road accidents. Rolling barriers in this context will serve a potential role for the achievement of higher degree of safety on road. RB not only absorbs the vehicle impact but also safeguards the vehicle damage and secondarily diverts the wrong moving vehicle. By implementing RB in the cities India will come in that group of countries who have already using this technology. The Indian highways records large number of accidents and this technology will definitely elucidate this problem in a highly efficient manner. RB will safeguard the vehicle & human life and also increase the overall efficiency of the traffic flow. As the undue traffic jams due to accidents will be decreased. The accidents are the errors which are occurred or done by humans while on the usage of motor vehicles and also sometimes the nature creates problems like rainy and cold weather conditions for slippery surfaces of roads, which will create chaos situations and tends to hit the other vehicles or hit the barriers installed on the outer edge of the roads. There have some different of accident and crash. Accident means it just happened there had no way to prevent the accident but crash means it can be prevented the occurrence or can improve the situation to prevent the accident. These barriers are of different types and have their own characteristic features but the new idea is about the installations of the rolling barrier systems which will stop the accidents occurring to surpass the road to gravel or steep hill down or other part of the road, and also saves life of the people present inside the vehicle. As above explanations of barriers and their proofs tells us that the rolling barrier systems are a high priority towards safety, better than other types of barriers in terms of stiffness and strength, high positive results in the crash test performances, etc. Ultimately life is more precious than vehicles but when it comes to rolling barrier system usage, it safes life and also prevents maximum damage level of the vehicles. The rolling barrier systems are the future technology in Civil Engineering or Transportation Engineering.

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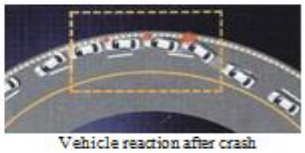
Appendix – A Rolling barrier


Joint system of rolling barrier


Vehicle reaction after crash


Manufacturing of inner post
(inside equipment of roller)


Roller


Secure a pier of a flyover

Appendix – B Concrete barrier


Concrete barrier


Crashed concrete


Crashed vehicle inconcrete barrier


Concrete barrier

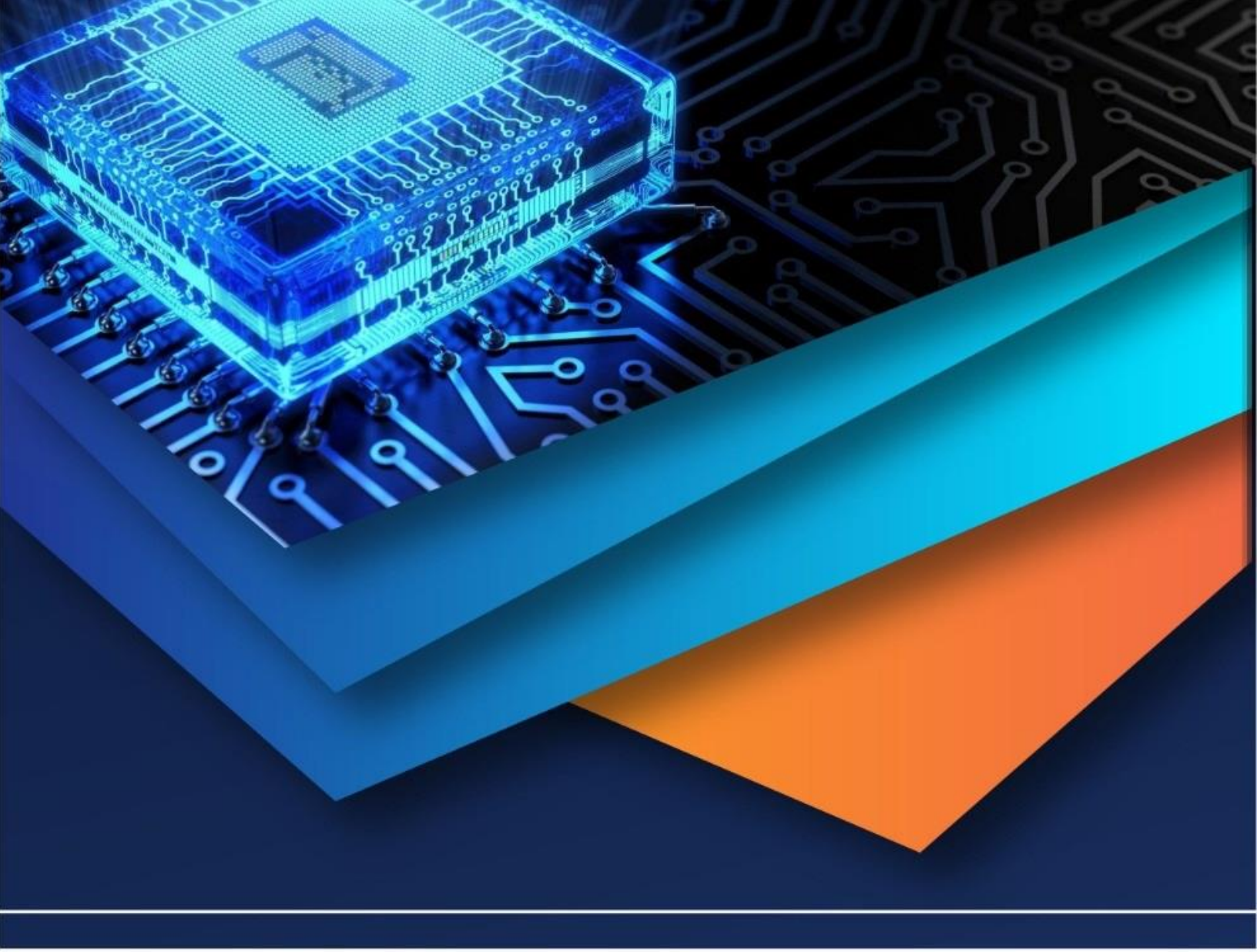
Appendix – C Steel barrier

Steel barrier

Damaged steel barrier

Steel barrier

Damaged Steel barrier



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