‘ Design of a platform safety system
for passengers in Indian Railways‘

Submitted in partial fulfilment of the requirements
of the degree of
Master of Design

By

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Design of a Platform safety system for Passengers in Indian Railways

P3 roject

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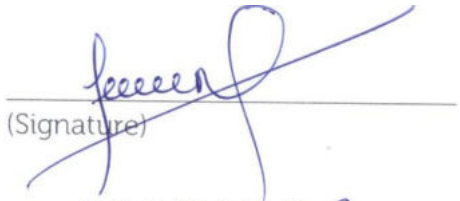
Declaration

I declare that this written submission represents my ideas in my own words and where other ideas or words are included, I have adequately cited referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified ant idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.



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Industrial Design Project 3
Design of a Platform Safety device for Passengers in Indian Railways

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is approved as a partial fulfilment of requirement of post graduate degree in Industrial Design

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Abstract

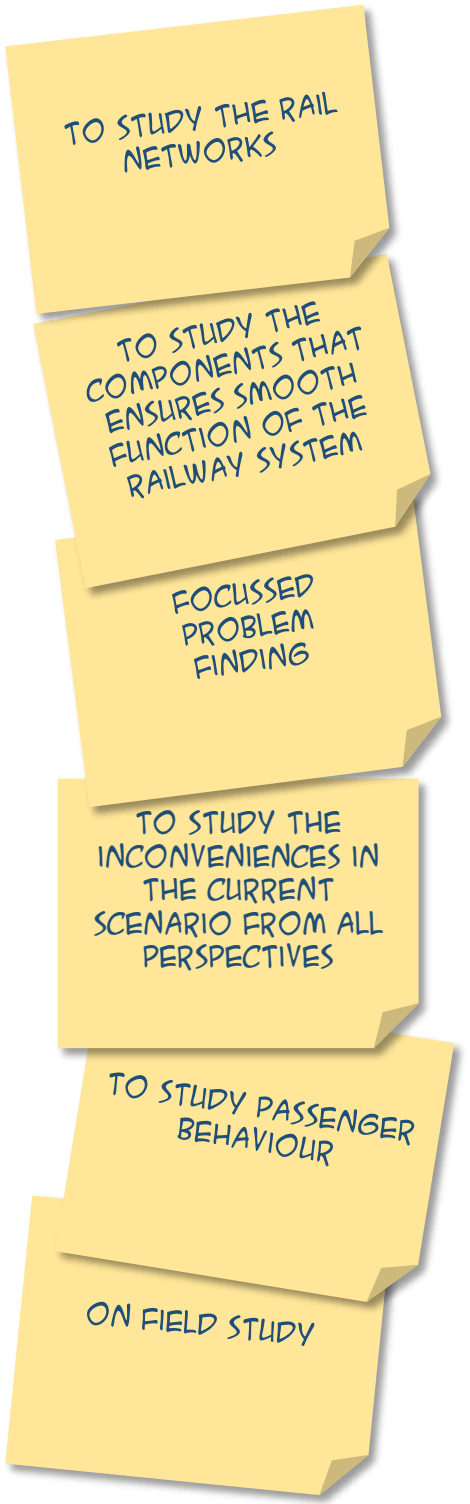
Indian Railways are one of the largest networks in the world which carries millions of people day by day from place to place. Such a big network is very difficult to handle. It has to address all the needs of the travelling population. So from these needs, what should be in the top priority? When we travel from place to place our prime need is to reach safely. So it is the main problem that has to be addressed in an area which is dealing with lot of people's life. So when we travel in the train, these questions come to our mind. Are we safe in the train? Do the authorities take any measures to make us safe in the travel? If not, what can be done to make that train travel safe? All these questions directed towards the need for a system of safety in the railways. To figure out where the problem lies and how can we solve the problem through design thinking.

So this project is aimed at a high level of safety for the Passengers in Indian Railways. And in the journey, the project was focussed into the passenger safety in Mumbai sub-urban rail. Mumbai sub-urban stations, trains, its passengers and their behaviour were studied to focus on a main problem. The gap between the train and the platform was identified as a major problem in the design. A platform gap filler was designed to give maximum safety and to prevent the commuters falling into the gap between the train and the platform while boarding and alighting the trains.

Contents

1. Objective

The objective of this project is to figure out the problems in the current scenario in Indian railways. So understanding the Railways is a must and this project will cover the various rail networks in India and their history. This project will also see how the passengers have been through it till now. To understand what is going wrong where, the understanding of the components which functions the system is a must. The study has considered the perspective of all users of the Indian railways including the passengers and the staff. The research is complete with a focussed problem that will solve a major issue in the current scenario. For the better understanding and to conclude to a focussed problem, the passengers need to be studied on filed.



2. Indian Railways: an introduction

Indian railways are one of the world's largest rail network owned by the Government of India through the ministry of Railways. It comprises of 115,000kms of track over a route of 65,000kms covering over 7.500 stations across India. It carries 9 billion passengers annually in which half of them are sub-urban passengers. It carries 2.8 million tons of freight everyday. The 2012-13 financial year gave the railways a net revenue of ₹1112 billion in which ₹286 billion are form the passenger tickets and the rest from freight. IR runs both long distance and sub-urban rail systems through broad, metre and narrow gauges. It also world's ninth largest in terms of the number of employees. As it runs more than 10,.000 trains daily, follows a 5 digit numbering system. Till date, only 36% of the total rail network is electrified and it runs on 25,000V AC traction though overhead delivery†.

† http://goo.gl/xASf accessed on 01.06.2014

3. History

The first train was shown the green signal from Bombay to Thane on April 16, 1853. A British engineer named Robert Brereton was responsible for expanding the rail network in India. Later on the East Indian Railway was established and was linked with the Great Indian Peninsular Railway on march 7, 1870. This made it possible to travel from Bombay to Calcutta*†*.

The rail network expanded to 14,500kms in 1880 connecting Bombay, Calcutta and Madras. By the end of 1910, almost all the Rail companies in India were taken over by the British India Government including the Great Indian Peninsular Railway*†*.

10 years since 1920 are known to be the period of economic boom which gave the British India Govt. a capital value of 700 million sterling carrying 600 million passengers annually. Later on , the IInd World War affected the Railways and since the independence, the Indian Govt, runs the railways*†*.

† http://goo.gl/HzWmos accessed on 01.06.2014

Fig.1 the first train form Bombay to Thane travelling 27 kms.

4. Organisational structure

For a better administration, the Indian Railways are divided into zones. Till date it has 17 zones. The zones are further sub-divided to a certain number of divisions. The divisions under these zones are 68†.

All the zones are headed by a General Manager who has to report to the railway board. The divisions are headed by the DRM (Divisional Railway Manager). Each divisional head quarters are further comprised of deferent departments like engineering, signal, mechanical, electrical, etc. Then comes the Station Masters under these divisions who has the power of a station†.

There are other departments of the railways like the R& D and the rolling stock. Indian railways manufactures most of its rolling stock and heavy engineering components in its 6 manufacturing plants across the country. Popular ones among them are Chittaranjan Locomotive Works, Chittaranjan and Diesel Locomotive Works, Varanasi for the Electric and diesel Locomotives. Passenger coaches are mainly made from Integral Coach Factory, Chennai and Rail Coach Factory, Kapurthala†.

† http://goo.gl/xASf accessed on 01.06.2014

5. Type of trains

The trains are classified with their average speed and the type. Basicaly there are 3 types of train services in India. The Long distance trains, The sub-Urban trains and the metros/ monorails†

The long distance trains are classified to 9 categories with their speed, class and number of stations they halt. They are the Durunto Express, Rajdhani Express, jan Shathabdi Express, Shathabdi Express, AC Express, Garib rath Express, Inter City Superfast/Express/Mails and passenger/fast passenger†.

The Sub-Urban rail has a major role in the public transport in India. Running in urban areas of Mumbai, Kolkata, Lucknow -Kanpur, Chennai, Pune, Delhi, Barabanki-Lucknow, Hyderabad. The Railways have plans for Ahmedabad, Bangalore and Thiruvananthapuram†.

The metros/ Monorails are designed for the Metro cities in India†.

Further down, the trains are classified in the class of the ticket we purchase. The class represent the standard of transport wee need. In the Long distance trains they are classified to 1st class AC (1A), AC 2 tier(2A), 1st class(FC), AC 3 tier(3A), AC 3 tier Economy(3E), AC Chair Car(CC), Executive Class Chair Car(EC), Sleeper Class(SL), Seater Class(2S) and Unreserved(UR). In the Sub urban trains, there are 1st class tickets and 2nd class tickets. In the Metro/ Monorails there is no different class†.

† http://goo.gl/xASf accessed on 01.06.2014

6. Components that needed for the smooth functioning of a railway system

So what are needed for the smooth functioning of the Indian Railway system? the flaws in this system will give the scope for a new design. Even though it is very difficult to change the entire system, we could come up with some alterations in the system that will make it better. so to understand the system properly, a study was needed to understand the railways and the components around it. So a mind map was created to identify what all elements are linked with the Passenger Continence in the Indian railways. Safety was identified as a major area to work on later.

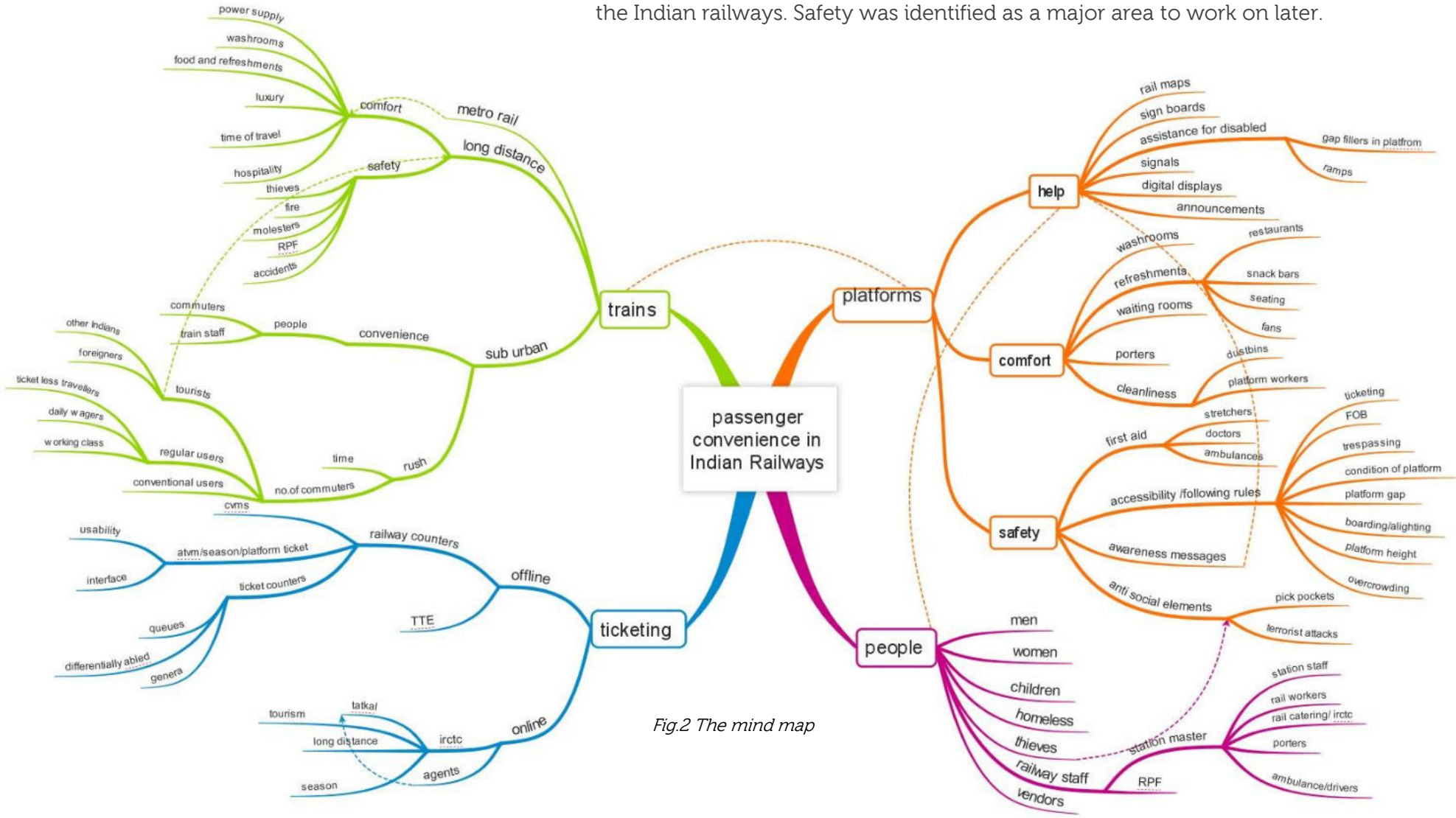


Fig.2 The mind map

7.Focussed problem finding

The mind map shows the components that are linked with the functioning of the railways. So where do the problem really does? It was identified that the Trains, Stations and the People are the major components linked with the railways. The field study and a series of interviews with the people gave the conclusion that safety is the area that has to be worked out a lot than making the services and the comfort better.

So the next question is to find out where the safety issue occurs? Is it different from the class of people or it different for kind of trains? Does safety for the passengers differ form place to place? This gave a conclusion to the mind map where the parameters surrounding the safety issue can be found. The need of the project to solve any of the major issue in the safety of the passengers directed towards the passenger safety in sub-urban rails.

8. Why to focus on the Sub-urban Rail?

Unlike the long distance trains, the sub-urban trains are overcrowded with the population. One reason is the high population of the country which leads to very densely populated cities in India. Another reason is the overflow of people to the major cities in search of job opportunities. Thus, these factors make the sub-urban routes flooded with rush which increases the chances of accidents. Time is another constraint that makes people to make mistake and make themselves in danger.

So, are the problems in the sub-urban rail networks are addressed properly? If not, what can be done to solve these problems? That is what we are going to find out through this project.

In India sub-urban rail runs the major cities like Mumbai, Chennai, Delhi and Kolkata. They have a major share in the mode of transport. The working class population depends on this network to reach the workplace in time. Thousands of people have lost their lives in major accidents in the Suburban railway network. Almost the same number of people have lost the body parts. So the project directed towards in identifying the problems in these networks and to identify is it the problem of the system or the people and how it can be solved.

Fig.3 Commuter packed Suburban train leaving Dadar WR station

9. A case study: Mumbai Sub-urban Rail

The rail route†:

The Mumbai Sub-urban rail consist of rapid transit on exclusive inner sub-urban rail with the commuter rail on the outer suburbs. It serves the Mumbai Metropolitan region. It spans over 465kms. It runs with 7.25 million commuter everyday and it is Asia's oldest and the second busiest rapid transit system in the world. It as more than 2,300 train services in the network. The train services daily from 4am to 1am.

It is operated by 2 zonal divisions. The Western railway(WR) and the Central Railways(CR). WR operates the Western line whereas the CR operates the central line, harbour Line, Trans-harbour Line and the Vasai Road-Diva-Panvel line. The Western line stretches from Churchgate to Dhanu Road (120kms). The Central line comprises of Chatrapati Shivaji Terminus Mumbai(CSTM) to Kalyan(54kms). Then the route splits to two. Kalyan-Kasara(67kms) and Kalyan to Khopoli(61kms) and Vasai road to Panvel. The Harbour line runs from CSTM to Andheri and then to Panvel and run by CR. The Trans-harbour line connects Navi Mumbai(Vashi/Nerul) to Thane.

The Services†:

- *Slow local trains* which stops at every station
- *Fast local* which skips small stations and stops only at few major stations until a certain station. Then from that particular station the train runs as a slow local.
- *Fast/Super fast/Double fast/Bada-fast* runs express for various lengths of the train route
- Women special trains. They are completely reserved for the ladies. There are also semi-ladies special which are partially reserved for the ladies. Ther are slow as well as fast ladies special.

On-board Accommodation†:

There are 2 classes of travel on fare basis, the 1st class and the 2nd class. The 1st class fares are almost 10 times that of the 2nd class fare resulting in a less crowded 1st class in Mumbai Suburbs. But the classes are again divided into compartments. They are:

† http://goo.gl/r4bpXY *accessed on 01.06.2014*

- The general compartment (2nd class for both men and women)
- The general 1st class(1st class for both men and women). The coach is designated with red and yellow slanting stripes on the body. The seats are cushioned or better than the 2nd class.
- Ladies compartment (2nd class reserved for ladies). Indicated by green and yellow slant stripes. In addition, an illustration of a woman is depicted on the walls of the coach. And also, the 'ladies only' sign is depicted. Male child below the age of 13 can travel in this compartment.
- Ladies 1st class(1st class reserved for ladies) indicated by slant red and yellow stripes.
- Differentially abled and cancer patients compartment (for both men and women). Indicated with cancer patient/ differentially abled signage. On the platform where this coach halts, there is a 'beep-beep' sound for the blind passengers to locate the compartment.
- Senior citizen's special coach(for both men and women above 60)
- The luggage compartment. Reserved for this purpose.

Ticketing†

Mumbai sub urban rail uses the Proof–of–payment mode of ticketing. The tickets can be purchased from all the stations`. There is penalty for travelling without ticket or travelling in a higher/reserved class with the lower class ticket. Ticket can be purchased for one way or return trip. Once a ticket is purchased, the journey should commence in 1 hour. And a return ticket is valid for 24 hours if its purchased on a weekday and till the next Monday if it was purchased on a Friday. The tickets can be purchased from the counters or to save time and to avoid long queues, the passenger can avail the facility of a CVM(Coupon Validating Machine) or an ATVM(Automatic Ticket Vending Machine). The Passenger can purchase a leaflet of ticket coupons from the counter for ₹35/ ₹50. This will have different leaves of ₹4, ₹3, ₹2 and ₹1. these coupons can be validated in a CVM machines before travel. It marks the station and the time of travel. ATVM are ticket vending machines placed on the stations. The user has to chose his/her destination to print the ticket.

The tourists can avail the Mumbai sub-urban tickets called the 'Tourist ticket'. Under this ticket the passengers can travel unlimited time on the network anywhere. For one day the fare is ₹270, ₹365(2days) and ₹430 (5 days)

Platform tickets are needed to enter any station if you are not to board a train. And also, season tickets are another option for the regular commuters.

Rolling stock†

The suburban networks are by the EMU's (Electric Multiple Units). It has a network of 191 rakes. There are rakes with 12cars, 15 cars and 9 cars. Due to the high crowd of the passengers the 9 car rakes are almost removed from the network and replaced with 12 car network. The 15 car rakes were introduced in 2009. the rakes are made by Jessop, Kolkata (most of the old rakes in CR and WR) and ICF (Perambur). They run at a speed(max) of 85kph. The newer rakes are the MRVC Siemens rakes with a speed(max) of 100kph. The average speed of the rakes on slower lines is 35kph and faster lines is 50 kph. The newer rakes were introduced in 2007. There is another 72 brand new Bombardier rakes expected to join the fleet in the late 2014. They will be fully automated with sliding doors thus reducing the chance of on platform accidents to the passengers. A 12 car train can seat 1,168 passengers and can accommodate 2,336 standees and a total of 3,504 passengers per rake. The new 129 rakes introduced in 2007 is built in SS, has non cushioned seats, bigger windows, fluorescent lights, better suspension, GPS and roof mounted force ventilation system.

† http://goo.gl/r4bpXY accessed on 01.06.2014

10. Passenger behaviour in Mumbai suburbs

Mumbai sub-urban rail faces one of the world's most over crowding. It is the second highest crowded sub-urban rail in the world. With 7.24 million commuters per day, each 9 car rake is over loaded at peak hours with 4500 commuters against the maximum capacity of 2628 commuters per rake. This results in a crush load density of 16 standing passengers per square metre of floor space. This increases the chances of passengers falling of the train†.

On an average, 3600 people die per year in this network due to different accidents like falling off the train, falling on the gap between train and platform and by trespassing the track. Last 10 years saw the death of 36,000 people and nearly the same number of people lost their body parts†.

Mumbai being one of the major red alert cities in the world, it is prone to major terrorist attacks in the train. Till now in 8 blasts about 400 people have lost their lives and nearly double of that number has become handicapped†.

The passengers tend to break the rules by trespassing to the rail area where the trains are large in frequency. They cross the tracks to move from place to place than using the Foot Over Bridge(FOB). The passengers even cut across the tracks in a station to change the trains. For example, when a slow rake reaches Ghatkopar station, suddenly the commuter finds that there is a fast train halted in the station to the direction he/she want to go, he/she cut across the track than using the FOB to catch the fast train which will take him/her to the destination faster.

Commuters travel without ticket causing huge loss to the railways. The commuters may not be intended to travel without the ticket. But as he/she sees his/ her train on the station which is not frequent to his/her place or the time required in waiting long queues for the tickets makes them to travel ticketless.

They often board and get down a running train. The stop time in major stations are observed to be a maximum of 25 sec- 30 sec whereas in the smaller stations it is observed to be 20 sec. This time frame is not enough for the commuters to board/ alight the train at peak hours which compel them to board/get down a running train.

There are people who does not care for the public property. They spit and litter around the station and premises. There are also commuters who uses unsafe modes of travel like the rooftop travel and hanging outside the footboard. Extreme cases has been reported where commuters exhibited acrobatic stunts and lost their lives.

† http://goo.gl/r4bpXY *accessed on 01.06.2014*

11. Design brief

The commuters safety was being questioned all these years in the Mumbai sub urban network and nothing much has been done in this area. So considering the sensitivity of the topic and guidance from Prof. B K Chakravarthy, the design brief of this project was set to be:

'To design a system that ensures platform safety for the commuters while boarding and alighting the Mumbai sub-urban trains. The design will ensure a cost effective and easily installable system'

Fig.4 Suburban train leaving Ghatkopar station

12. Accidental deaths in Mumbai Suburbs

The following Table.1 shows the accidental deaths in the Mumbai Sub-urban networks in 2013. In all, In all, 3,506 commuters were killed and 3,318 commuters were injured between Jan-Dec 2013*†*.

reason	3 worst divisions (No. of cases)			Total cases
Track crossing	Kalyan (246)	Kurla (214)	Thane (203)	1826
Falling in gap between train and platform	Mumbai central (7)	Churchgate, borivali (3)	Dadar CR (2)	19
Falling off the running train	Kurla (121)	Borivali (97)	Dombivali (86)	310
Hitting the railway pole	Kurla , Karjat, Vasai (2)			8

Table 1 : Accidental deaths in Mumbai Suburbs between Jan-Dec 2013

† The Times of India dated 19th Feb, 2014

13. On filed study

An on field study was conducted to figure out what is the problem causing to the death of these huge number of commuters. One reason is the over crowding in the rakes at the peak hours which leads to forced/unforced errors causing an accident.

Track crossing: The study showed that the people die not only on the platform while boarding/ alighting the running train but also on the tracks while trying to cut across the tracks. Every place in Mumbai is sub-divided to western and eastern zones by the rail lines. For example, people who needs go to Kanjurmarg East form Kanjurmarg West has to cut across the track. Even though there are FoB's, people tent to use the shorter path by trespassing through the rail lines. The city is divided in such a way that no roads disturb the rail lines. i.e; if there is a road that travels from east to west or vice versa, it flies over the rail or under the rail. So cut across the rail is not allowed in any means. In 2013, 1826 people lost their lives while trying to cross the track. It could be the local population or the commuters looking for a short cut. This is because either the fencings are not adequate enough to restrict the people from trespassing or there are no fences at all.

Falling between the gap of train and platform: 19 cases were reported where people die falling between the gap of the train and platform. The main problem is that this gap is different in different stations.

Falling of the running train: the passengers tend to board/ alight the running train. This happens not only at the peak hours where there is overcrowding but also on the non –peak hours. The *Mumbaikars* are used to do this everyday. One problem is at the peak hours the time given for each stop is not adequate enough for the commuters to alight/ board. The observations showed that the people standing near the door are urged by the people behind them to get down the train before the train stops so that they can also get down in the time frame. The people jump down the running train that may cause accidents. In the mean time the people who want to board the running train runs along the platform parallel to the rake they want to board. Once the passengers are alighted in the platform, they are pushed to side by the huge population waiting to board the train. Most of these commuters gets through the doors of the rake but the few cant get in as the rakes starts to move. They run behind and board the gradually speeding train. This can cause the passengers fall of the train and cause accidents. People fall off the running train while they travel hanging on the doors. This happens mostly when there is over crowding. Falling of the running train was reported to be 310 commuters in the previous year.

Hitting the railway pole: Some commuters generally the young local generation tends to hang on the train doors and travel. This was observed even when there is no overcrowding in the trains. The people loves to enjoy the fresh air than to get stuck in
the sticky hot atmosphere inside the rakes. And these people exhibit stunts on the rakes. Cases have been reported where people died hitting the pole while doing these things or hanging on the doors.

In the above mentioned categories, people falling between the gap of the platform and train has been a sensitive topic since 16 year old Monika More lost her both arms falling to the signal pit gap in the platform on January 11, 2014. Three accidents took place and those people lost their lives between the train and the platform after that which made the commuter population rise against the platform safety issues. Even though more number of people die in track crossing and falling off the train, the railways are not ready to take action against these problems since these errors are made by the people by not following the rules. But in the case of falling between the gap of the train and platform, it is a system level error which can be solved.

Measuring the platform-rake gap in WR and CR:

So to identify how much gap is there between the platforms and the train and how much it has to be reduced to save the commuters from falling into the gap, a study was conducted on the following stations in CR and WR. The following table shows how much gap is there between the platform and the trans. The height A represents the total gap between the platform and the train. The height B represents the total height that the commuters has to raise their foots to enter the compartments. In addition to the height of the gap there was noticeable distance between the platform and the train. The distance was too much in some stations and there was no distance at all in some stations.

Fig.5 measuring the platform gap and the footboard height at Dadar CR

Fig.6 measuring the platform gap and the footboard height at different stations of Mumbai

Inferences:

The Gap height (height A was observed to be closer to 1 feet (30 cms) in most of the station which would easily allow a normal person to fall off to the rails. In addition to that the commuters had to climb another 10 cms to reach the foot board. So in a total average of 40 cms were observed as the climbing height B for the commuters.

Some stations had a gap distance C (the distance between the platform and the rakes). But in some stations this distance observed to be zero or negative since the rakes overlapped over the platforms.

Station	Platform No.	Platform Height (A) (cms)	Platform height (B) (cms)
Churchgate	1	29	37
Marine Lines	1	27	36
Charni Road	2	18	27
Grant Road	1	28	36
Mumbai central	2	29	35
Mahalaxmi	2	27	36
Lower Parel	2	26	35
Dadar (western)	2	31	39
Matunga Road	1	29	38
Mahim	2	29	37
Bandra	3	34	43
Khar road	2	28	37
Santa Cruz	2	29	37
Ville Parle	1	31	39
Andheri	1	22	30

Table 2: platform gap and footboard height data collection

Station	Platform No.	Platform Height (A) (cms)	Platform height (B) (cms)
Nahur	1	30	38
Ghatkopar	2	23	31
Vidyavihar	2	29	38
Kurla	1	33	41
Vadala	4	23	31
Dockyard road	2	32	41
Sandhrust road (harbour)	2	32	41
Sandhrust road (central)	1	23	31
Matunga Road	1	29	38

Table 3 :platform gap and footboard height data collection

Table.2 depicts the study on a continuous travel on the western lines from Churchgate to Andheri. Whereas Table. 3 shows random stations studied when visited different parts of Mumbai.

14. Study on the passengers

The passengers were studied on different stations to know their behaviour manners and how they board/alight the train. Videos were shot to see how different people travel at different scenarios. Observations were made on how healthy men and women, physically challenged and Senior citizens board/get down the train. Observations were made at major stations like Dadar Central, Kurla, Thane and Dadar Western at peak and non-peak hours.

Fig.7 A passenger at Kanjurmarg station. Considerable platform gap can also bee seen


Fig.8


Fig.9


Fig.10


Fig.13


Fig.12


Fig.11

Clock wise from top left: Fig.8 A healthy man trying to board the stationary train in Andheri, Fig.9 A senior citizen boarding 1st class coach in a local in Dadar WR, Fig. 10 ladies boarding the ladies 2nd class compartment in DadarCR platform no .1, Fig.11 a visually challenged person boarding the train at Dadar WR in the reserved compartment for the differentially abled, Fig.12 a differentially abled person boarding their reserved 2nd class compartments at Kurla. Fig.13 Senior citizen Women boarding the Women's 2nd class compartment at Bandra.

All these scenarios showed that the height of the rakes are too much for the commuters to board/ alight. The older people even finds the stairs not easy to climb at homes. An average of 35 cms they have to climb or jump to board or to get down respectively. Even though it seemed to be easier for the younger commuters, it felt very difficult for the differentially abled, senior citizens and the middle aged women. It was surprising to notice that in the study that the visually challenged commuters climb/ get down the rakes very easily without any help. There was the beep-beep assistance on the platforms to direct them to their compartment.

15. Recent developments from the Govt. perspective

The heights of the platforms were always a question in the recent past. The Research, Designs and Standards Organisation (RDSO) who sets the standards in the railways said that the height of the platforms has to be between 760mm to 840mm. But the recent issues in the Mumbai sub-urban rail forced the Railway Board to direct the CR and WR to raise the platform heights to 920mm without the green signal form the RDSO. The Railway Board made proposals to raise the height of the platforms in 74 stations in Mumbai. But RDSO doubted the safety of the commuters if the platform is raised to 920mm. The rakes may brush with the platforms and that could injure the commuters standing near the doors. RDSO stuck to the upper limit of 840mm and asked not to raise any mm further. In addition to that, they asked to raise the platform height to 840mm where ever was less†.

Anti trespassing project was another initiative by the Govt. in which they have planed for the installation of escalators, inter connection FOBs and fencing through Mumbai Railway Vikas Installation Project worth of ₹ 120 Crores†.

Recently the RDSO conducted a test to find the optimum height of the platforms for a safe travel by the orders of the High Court. They used a 12 car rake for the test ride with 3 of the cars fitted with sensors that will record the height of the platforms that they pass through. The initial reading were taken when the trains passed with top speed over the platforms and when the train was stationary. Another test was conducted by loading one compartment with rubbles weighing 36tonnes which is the weight of a fully packed compartment and another partially loaded and the last one kept empty. The test was conducted on the WR starting from Churchgate. The tests were conducted with BHEL, Bombardier and the brand new Siemens rakes. The RDSO officials finally showed the flag to raise the platform heights to 920mm height††.

† Courtesy: The Indian Express: Mumbai News line, 20th Feb, 2014
††The Mumbai mirror , 27th Feb, 2014

16. Where does the problem lies in Mumbai?

- The floor height of Siemens rake varies from 1195mm to 1220mm above the rail level.
- There are platforms in which both sub urban and long distance train take a halt. The long distance trains leave a gap between the platforms whereas the sub-urban trains overlap most of the platforms. In the rest, they leave a gap between the rakes and the platforms.
- Different type of rakes (Old DC BHEL, AC/DC Siemens and Bombardier rakes) are used in the network. The old DC EMU stock has coil springs , Siemens and Bombardier with air suspension. So at the peak load hours, the spring compresses and the rake height gets reduced whereas the newer rakes are equipped with air suspension which uniformly maintains the rake height at peak load hours. Moreover, these rakes have different footboard heights.
- In monsoon, the tracks are raised to avoid water logging. The base of the tracks are not rigid and this offers a creation amount of elasticity. During monsoons, the soil under the track sinks and this could result in the brushing of the rakes with the platform.
- BEST(Brihanmumbai Electric Supply and Transport) fares are higher up to 6-7 times that of the fare in the locals causing huge crowds. In Kolkata, the sub-urban fares are almost same as the bus fares. So that given another option to the passengers thereby reducing the crowd in the locals.
- Many stations are curved in Mumbai sub-urban network. The rakes being long and straight halts at these curved stations leaving huge gaps between the train and the platform. This can be easily understood by considering platform as a circle and the compartments as tangents to it. Although many of the sub-urban stations in the world are curved, they follow a safety oriented approach which makes the train commuting better. That would be discusses in the following chapters.
- Wear and tear of the wheels could be another problem in having the height of the train reduced. As the gap is more, more the days the wheels will run †.

† *Courtesy: The Mumbai mirror , 16th Jan, 2014*

17. Emergency care in the network

- Except Dadar, none of the 108 stations in the city cant handle serious case of emergency. Only Dadar comes with a trauma care centre and full time Duty Doctor. But no ice stock anywhere in the stations to transport the severed limbs to the hospital.
- Even though all the stations have stretchers and wheel chairs, there are no trained staff to assist the injured at the time of medical emergency.
- There are a few major stations with ambulance parked in the premises. But there are no driver near it. It may take at least 20 mins to trace him and get the ambulance started to get the injured to the hospital. Also, these ambulances are donated by social groups in Mumbai. So the drivers are paid by them and are not accounted on the railways side. They are reluctant to do their duty and the railways can not take any actions against them.
- Statistics shows that Airoli has high accident frequency and every time when an accident occurs, Porters are hired from Vashi or Thane by the Station Master. This takes at least half an hour to attend a victim. Each SM has a budget of ₹1150 to attend an accident victim (₹ 400 for porters and rest for ambulance).
- The first 45 mins are most critical in attending a injured to save their life. At the present scenario, it is very difficult to get the injured to the paramedics team to stabilize him/her †.

† Courtesy: The Mumbai mirror , 16th Jan, 2014

18. Sub- urban rail: around the world


Fig.14

Fig.15

Fig.17

Fig.16

Clock wise from top left: Fig.14 London underground temple tube station. The station is curved with leaving a huge gap between the platform and the rakes. The platforms are depicted with a 'MIND THE GAP' signage. The message is also announced through the PA. Fig.15 is the Mind the gap signage in London underground stations, Fig.16 Leeds, UK commuter train and Fig.17 Manchester, UK commuter train *†*.

† all images above http://goo.gl/usfqL2 accessed on 01.06.2014


Fig.18


Fig.19


Fig.20


Fig.23

Fig.22


Fig.21

Clock wise from top left: (1)Fig.18 sub-urban rain in new Jersey. The platforms are laid with yellow tiles behind which the passengers has to stand, (2)Fig.19 Passengers interchange between the London Under ground and a National Rail service at Stratford station in London, England. The trains come to the same platform so that cutting the track to interchange the train is not needed. In the other case when the trains come to 2 different platforms, the passengers cut across the track than using the FoBs putting their life in danger, (3)Fig.20 Yamnote commuter rail in Tokyo, japan one of the biggest networks in japan, (4)Fig.21 KAI commuter rail service of Jakarta, Indonesia, (5)Fig.22 the classy and elegant commuter rakes of Auckland, New Zealand, (6)Fig 23 The commuter rail in Toronto, Canada *†*.

† all images above http://goo.gl/usfqL2 accessed on 01.06.2014


Fig.24


Fig.25

Fig.26


Fig.27


Fig.28


Fig.29

Top row: New York subway, USA at old South Ferry Loop. The platforms are curved leaving a huge gap between the platform and the train. It was corrected by a platform gap filled installed on the platform. The gap fillers slides out the platform and touches the train as the train makes a halt in the station. The doors are opened only after the gap fillers are in position. As the train leaves the station, it gently pushes the gap fillers back to the platform *†*.

Bottom row: suburban rail in Tokyo, Japan. The train will leave the platform only if all the doors are closed. So the railway have a special force to push the passengers gently into the compartment. It can be called as passenger stuffing in a train. The train leaves as soon as the doors are closed. It takes at least 1minute in the peak hours *†*.

Conclusion:

Unlike in India, all the networks in the world are run by rakes that have automatic sliding doors which will leave a station only if all the doors are closed. Old or new rakes, they follow some standards. They have clearly indicated caution messages and markings where the passengers has to wait to board the train. Hence, the accidents and fatalities are very few when compared to that happen in India. So the question is either about changing the system or the components in that system to make the Mumbai commuter rail more safer.

† courtesy: http://goo.gl/Jv5Oyk

19. Scope of the project:

India being a developing country would not completely change its system on a go. It would be a gradual change to become one among the developed nations in the world. In that perspective, a design solution which will alter the entire system is not advisable since it will take ages to see the lime light. So what can be incorporated to fit into the current system than completely altering the system need to be considered. The rest of the project will take to the design processes to find a solution for the persisting problem.

Even though the railway board has directed the WR and CR to concrete the stations, it is not going to be easy. It will take such a long time to concrete all the platforms to the new height which will be still not standardized since the use of different kind of rakes in the network having different rake heights. Moreover, the major stations like Kurla, Dadar has very large platforms compared to the smaller ones. so there is a design scope in this project to find a easy installable solution that would allow the smooth passage of all kind of rakes in its network. A design that would not disturb the commuter population from accessing the network during the works in the platform.

20. Ideations

The initial ideations are the ideas that come into our mind that we note down with out even thinking about the feasibility of that concept. These ideations helps to narrow down to the final concepts that would fit into ones design brief.

Ideation 1:

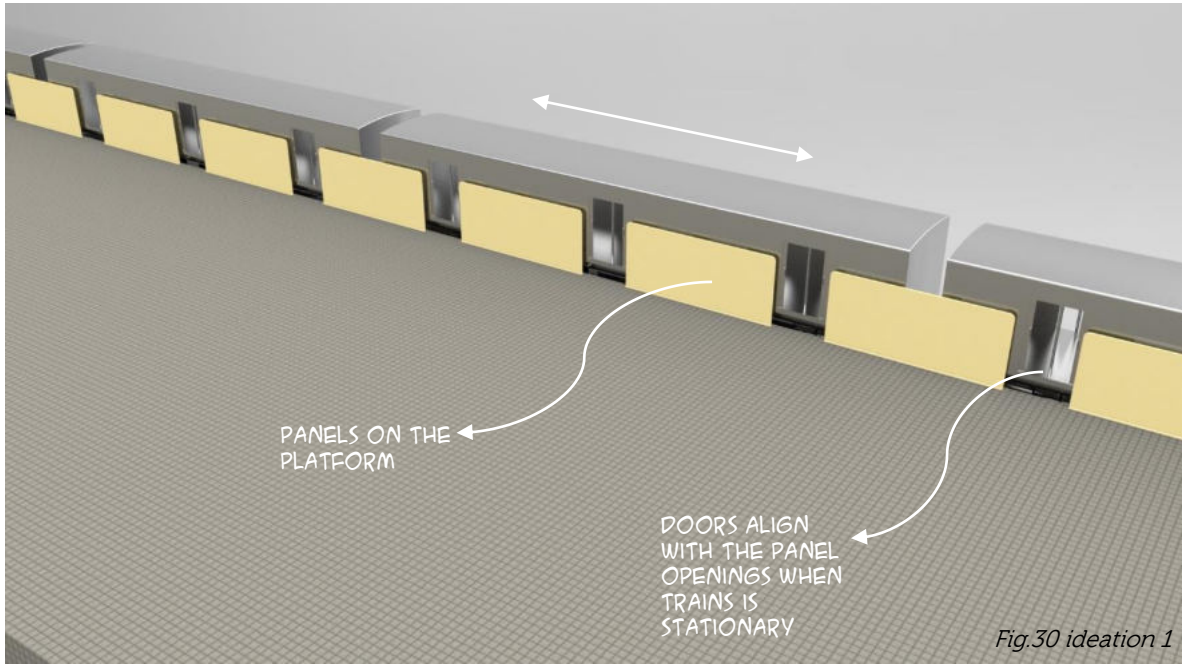


Fig.30 ideation 1

The above ideation shows how the over crowding in the trains and the accidents can be controlled. This was the first thought that came into mind. by having panels like those, the passengers can board/ alight only when the train is stationary. But this will end up with over crowding in the platform.

Ideation 2:

Another idea got derived form the observations made on the senior citizens and the physically challenged. So this comes with a platform that elevates to the height of the footboard when the train halts at the station thus making it easy for the senior citizen to board the train.

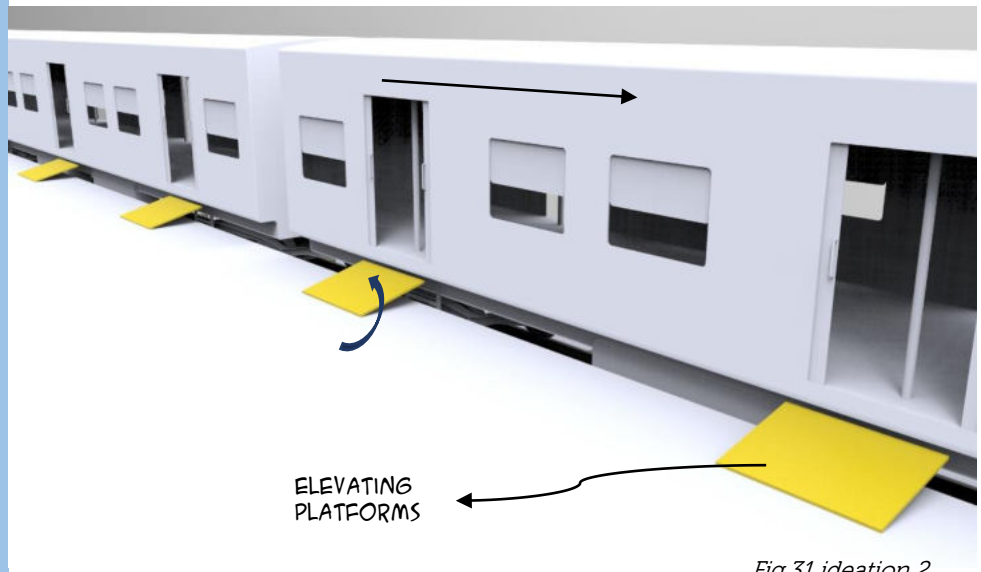


Fig.31 ideation 2

The above figure depicts how the ideation2 works.

Ideation 3:

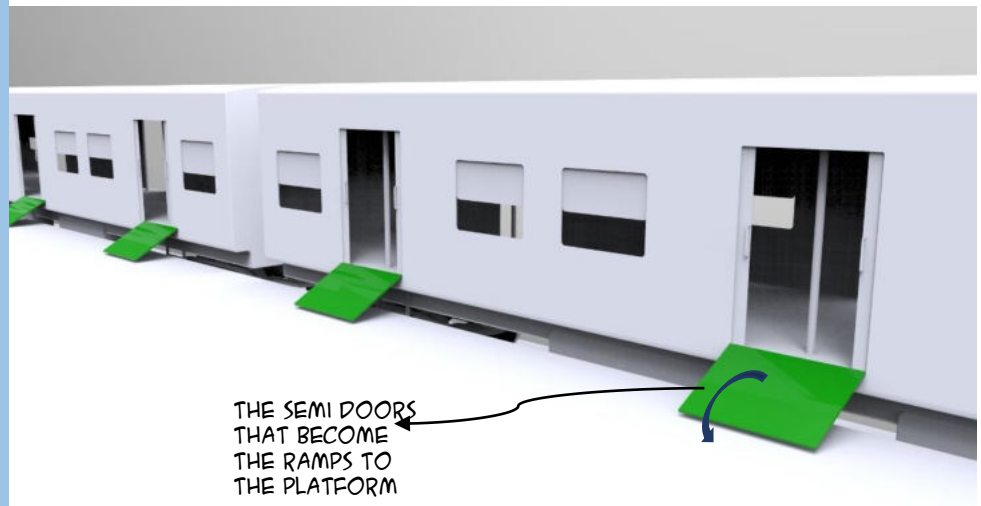


Fig.32a ideation 3

In Ideation 3, instead of the platforms getting elevated, the part door in the train falls to the platform as the ramp. As the passengers board/alight, the ramp closes to become a safety door that prevents the passengers form falling down the running train.

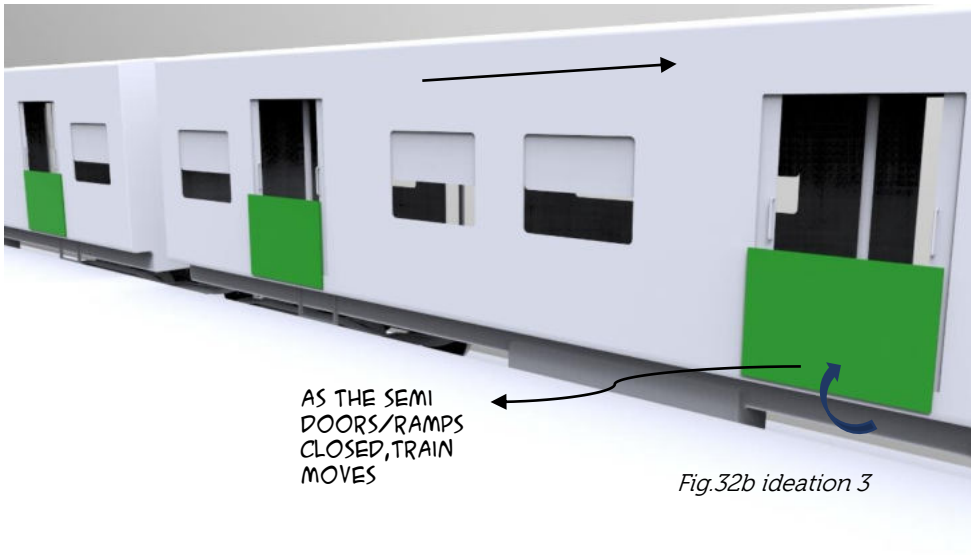


Fig.32b ideation 3

Ideation 4:

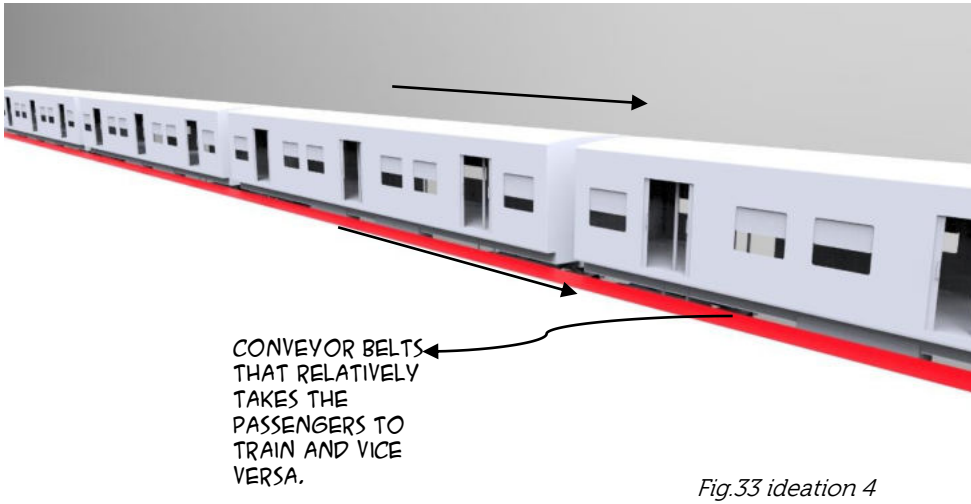


Fig.33 ideation 4

Ideation 4 is based on the study conducted regarding the time of the halt of trains in the station. As the number of passengers are so huge, this time is not enough for boarding alighting the train. So short conveyor belts that run in the platforms relatively to the trains acceleration, makes it easy for more passengers to run behind and board the train, or run down the decelerating train. (since the train and the belts are relatively stationary, it is same like boarding, alighting a stationary train.

Ideation 5:

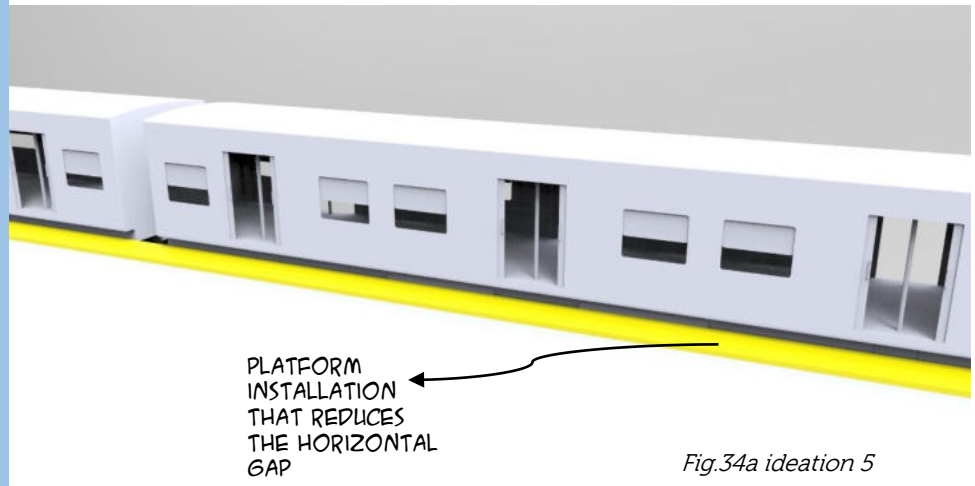


Fig.34a ideation 5

The gap between the train and the platform can be either decreased by reducing the height of the gap or by decreasing the distance between the platform and the rake. Ideation 5 is an installation on the platform to decrease the horizontal gap between the platform and the train.

Ideation 6

It is an installation through out the platform to reduce the height of the gap.

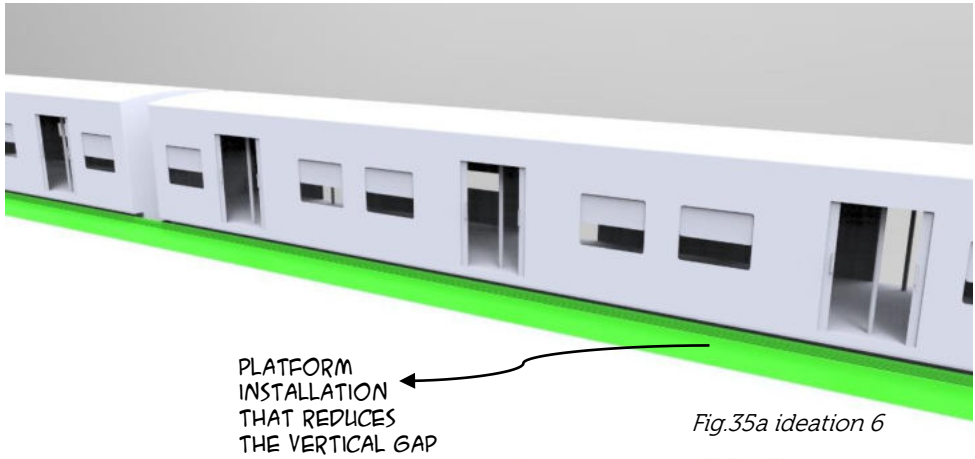


Fig.35a ideation 6

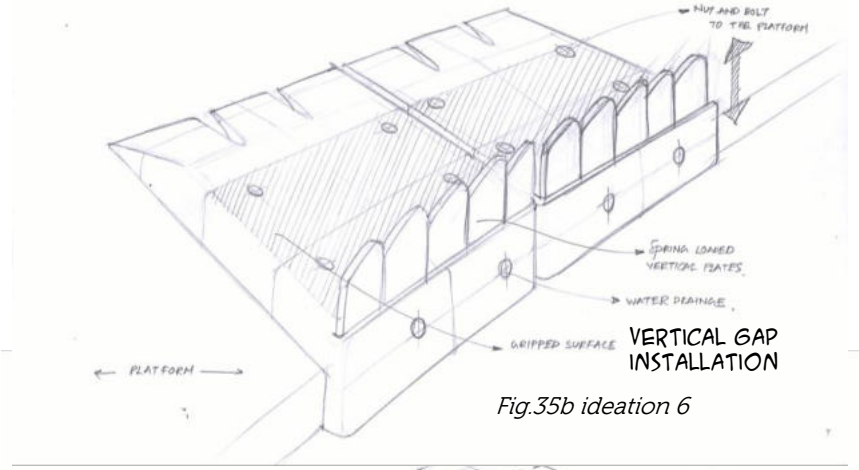


Fig.35b ideation 6

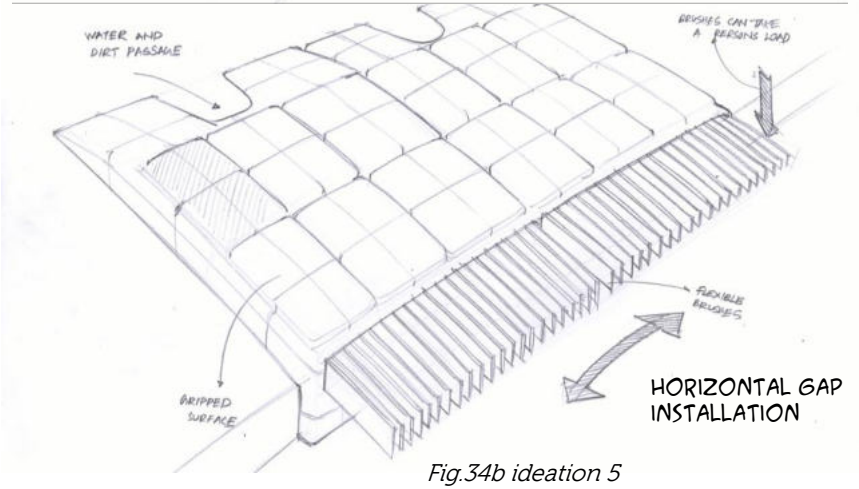


Fig.34b ideation 5

Ideation 7

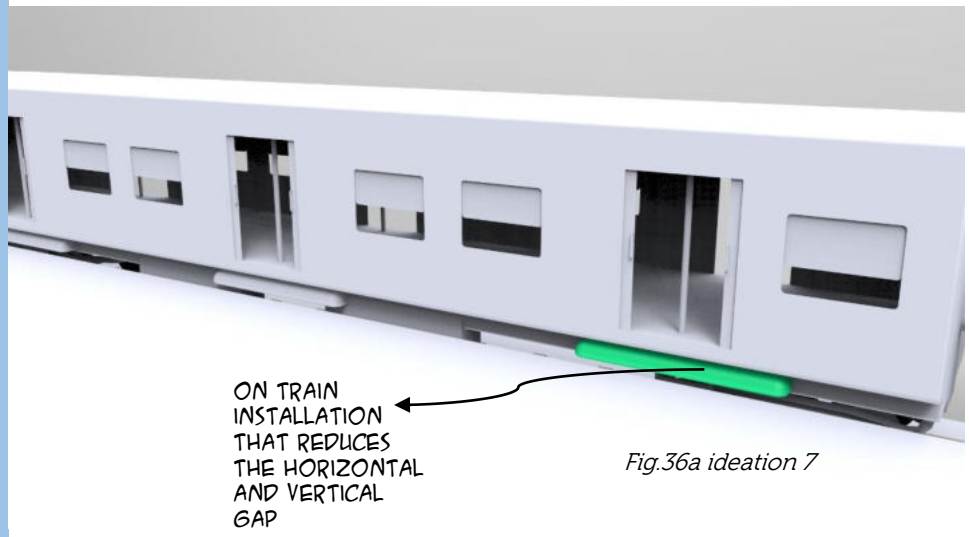


Fig.36a ideation 7

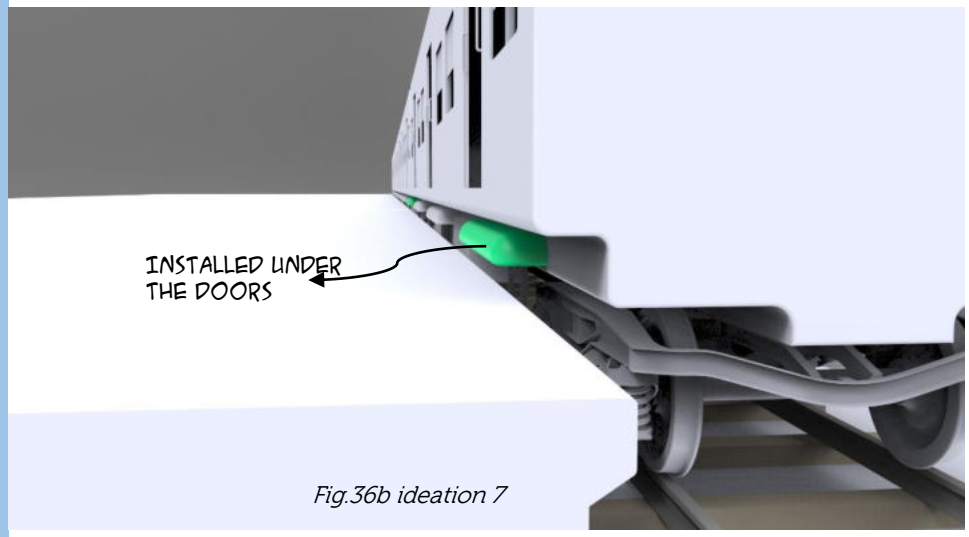


Fig.36b ideation 7

The above concept fills the gap width and the height. It is installed on the train and does not run through out the train. It is installed just below the doors.

Ideation 8

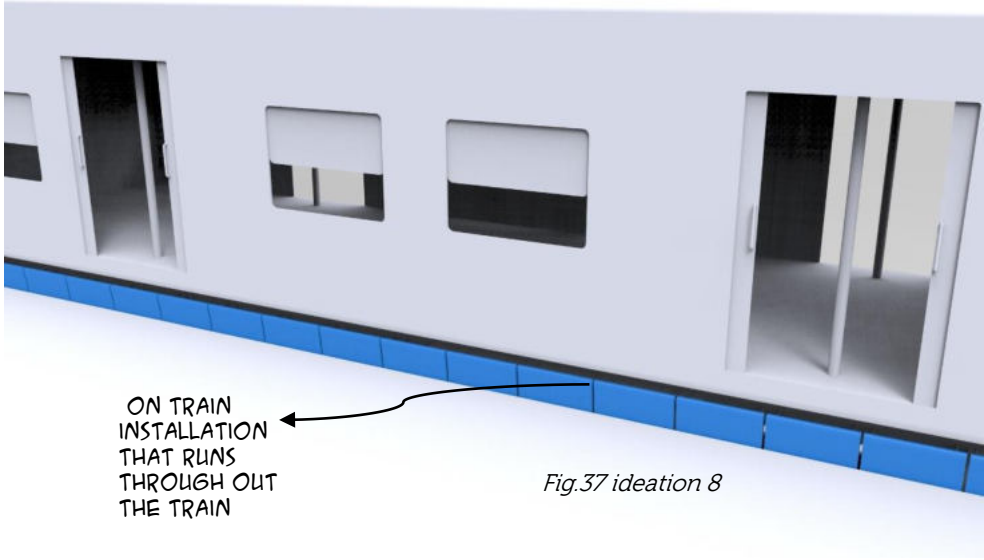


Fig.37 ideation 8

The gap can be reduced either form the platform of from the train. Ideation 8 shows an installation on the train that fills the gap as it reaches the platform. As the train approaches the station, the gap fillers comes in contact with the platform and eliminates the gap. This can be either sensor controlled or spring loaded.

21. concepts

Where the ideations are creations of the first thoughts, the concepts generated from those should satisfy the design brief and that has to possible in the practical approach.

For example, there is no point in generating a concept that would be very expensive than concreting all the platforms in the stations. Then there is no point in the new design. The main problem in the current scenario is concreting the entire platforms in all the stations in Mumbai suburbs. And this process would be time consuming which may well affect the service. The concepts are designed with an approach that it fits into the system than completely changing the system that has been for years and will run for years.

Concept 1

what's in the design?

Safety: reduces gap and height

modular

Easy installation

Self adjusting

Rainwater drainage

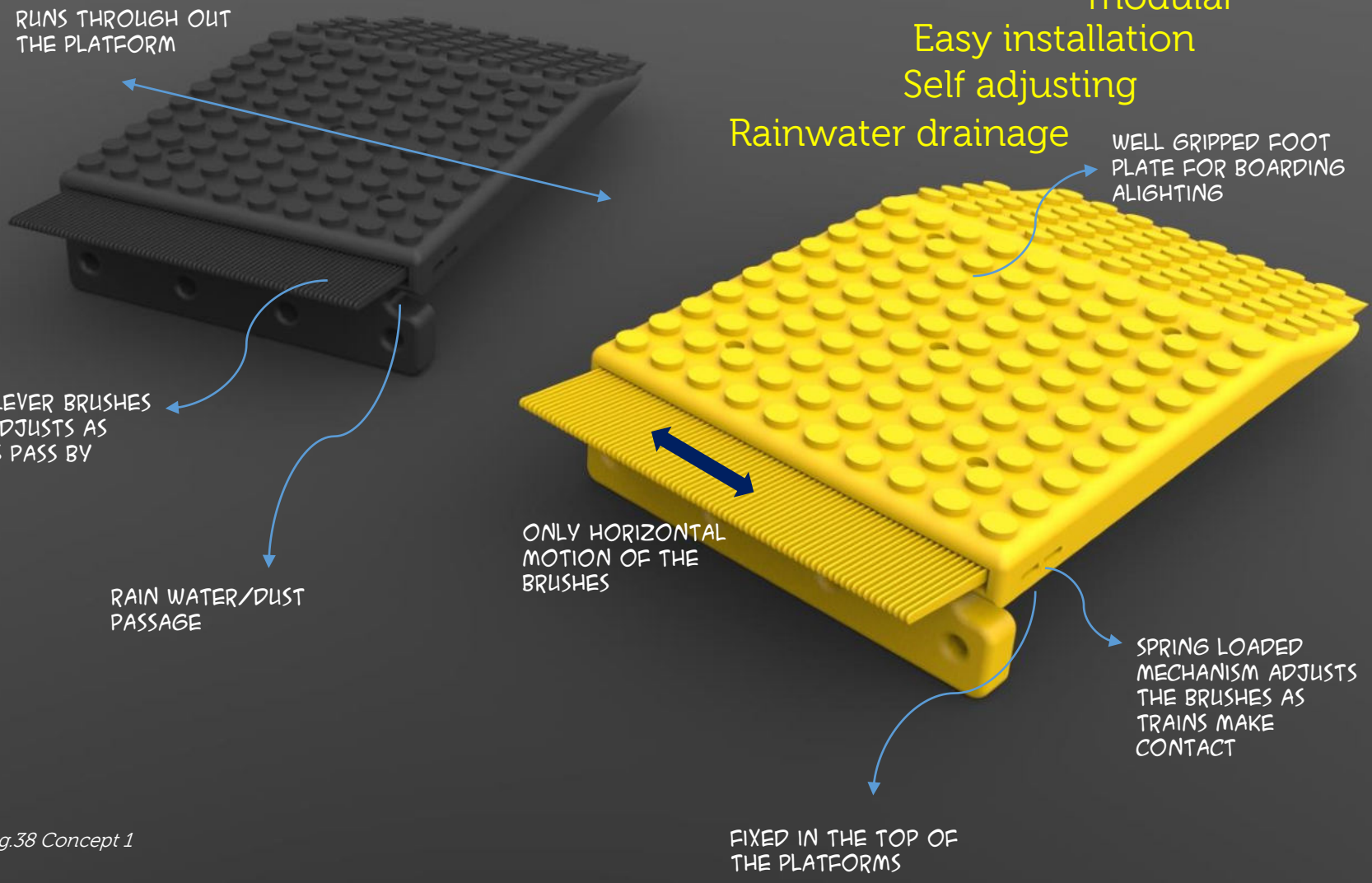


Fig.38 Concept 1

Concept 1: installation

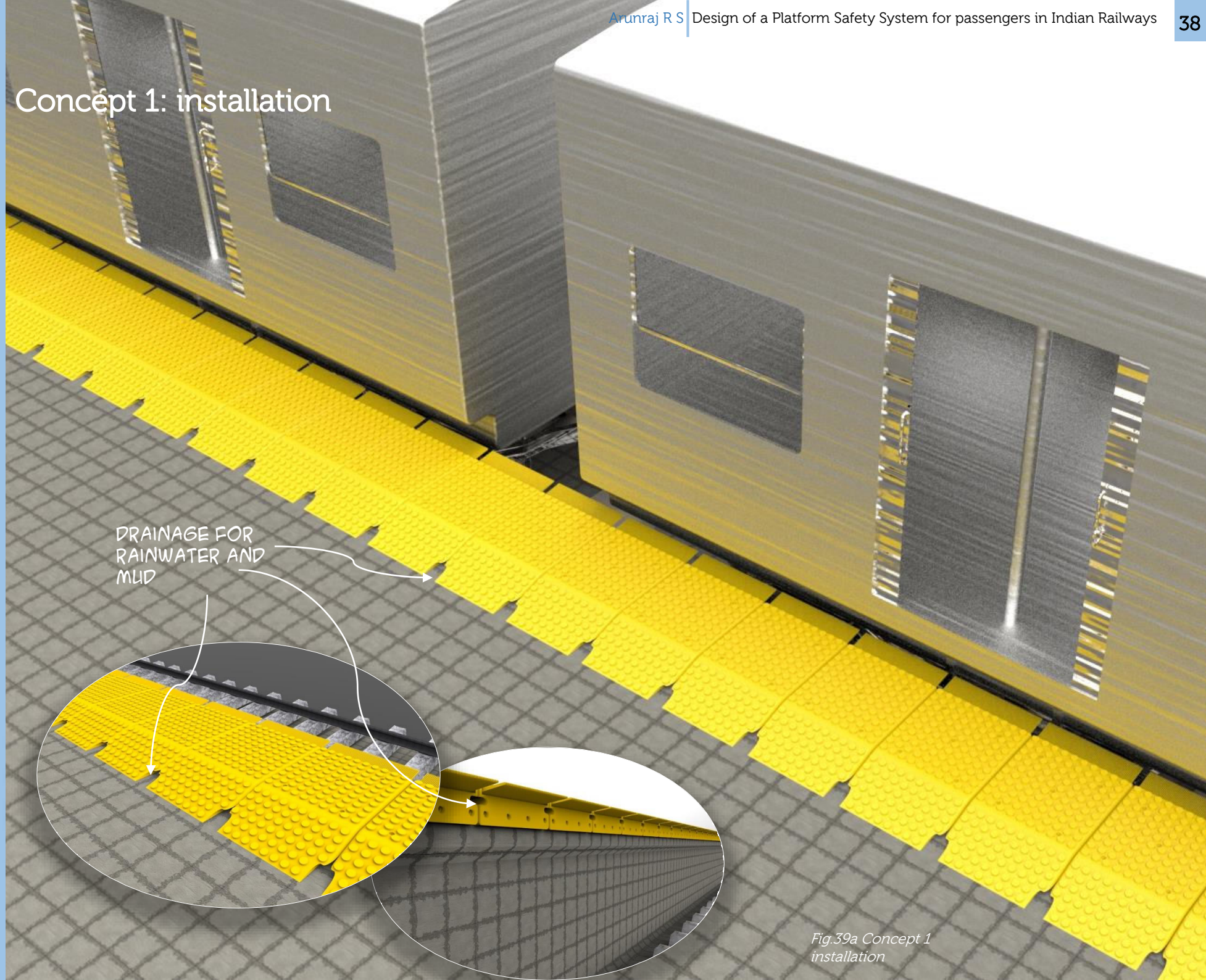


Fig.39a Concept 1 installation

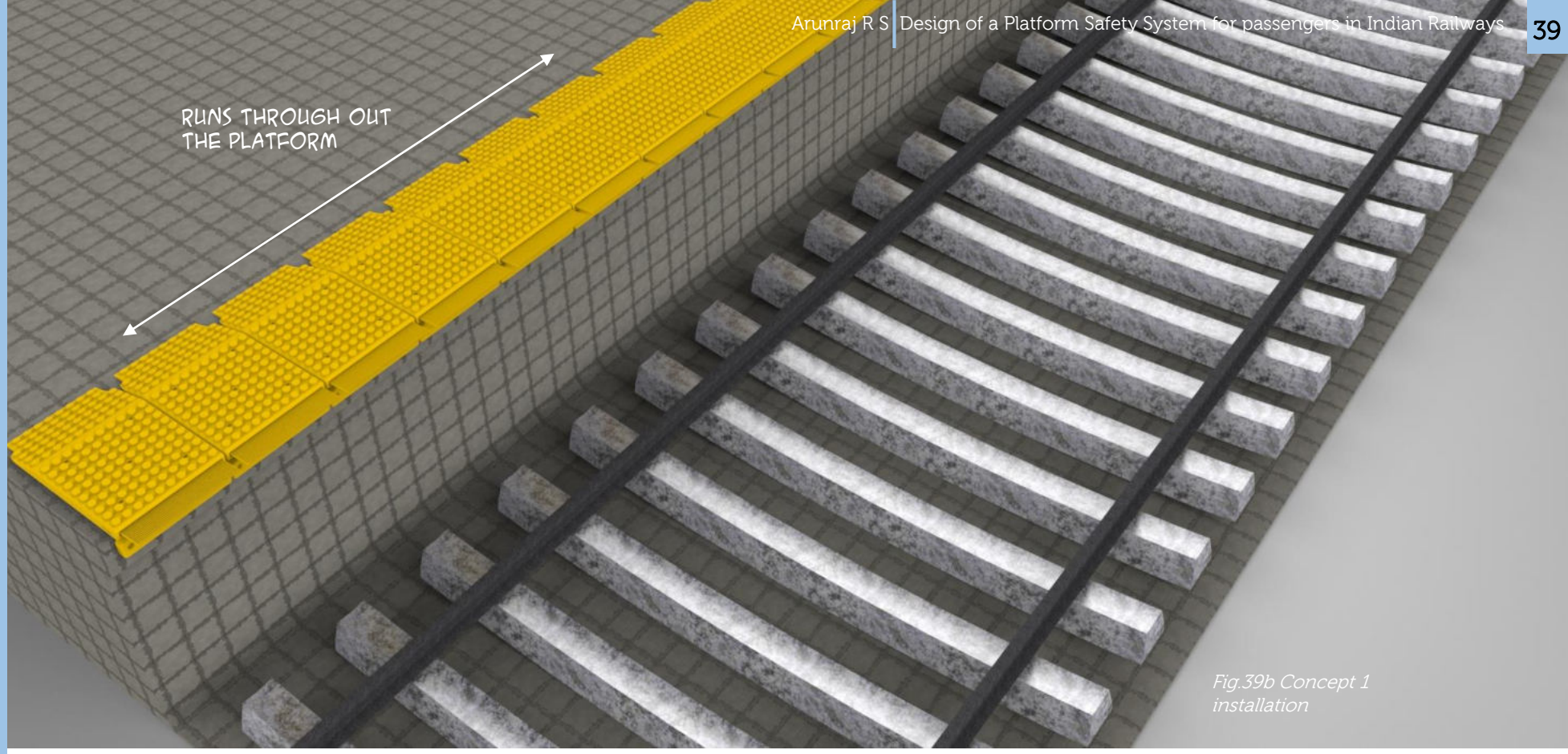


Fig.39b Concept 1 installation

- Easy installation : no concreting needed. Screwed to the current platforms.
- Cost effective, no need to concrete the entire platforms
- Visually and physically appealing: trust and safety to the commuters
- Prevents the commuters from cut acrossing.

The working:

The concept 1 is designed to remove the horizontal gap between the trains and the platforms. The series of installed safety plates has a large chain of brushes designed in such a way that they act like a cantilever beam together to take the vertical load. The brushes are flexible in the horizontal direction that moves like a tooth brush if the trains make a contact. These brushes would wear out in time and could be easily replaceable to the plate. So if somebody falls into the platform while boarding/alighting, he/she will never fall into the gap since the brushes will carry the load of the person. However, this design will not help a commuter from falling down.

Concept 2

what's in the design?

Safety: reduces gap and height

Modular

Self adjusting

Easy installation

Easy maintenance

Simple design

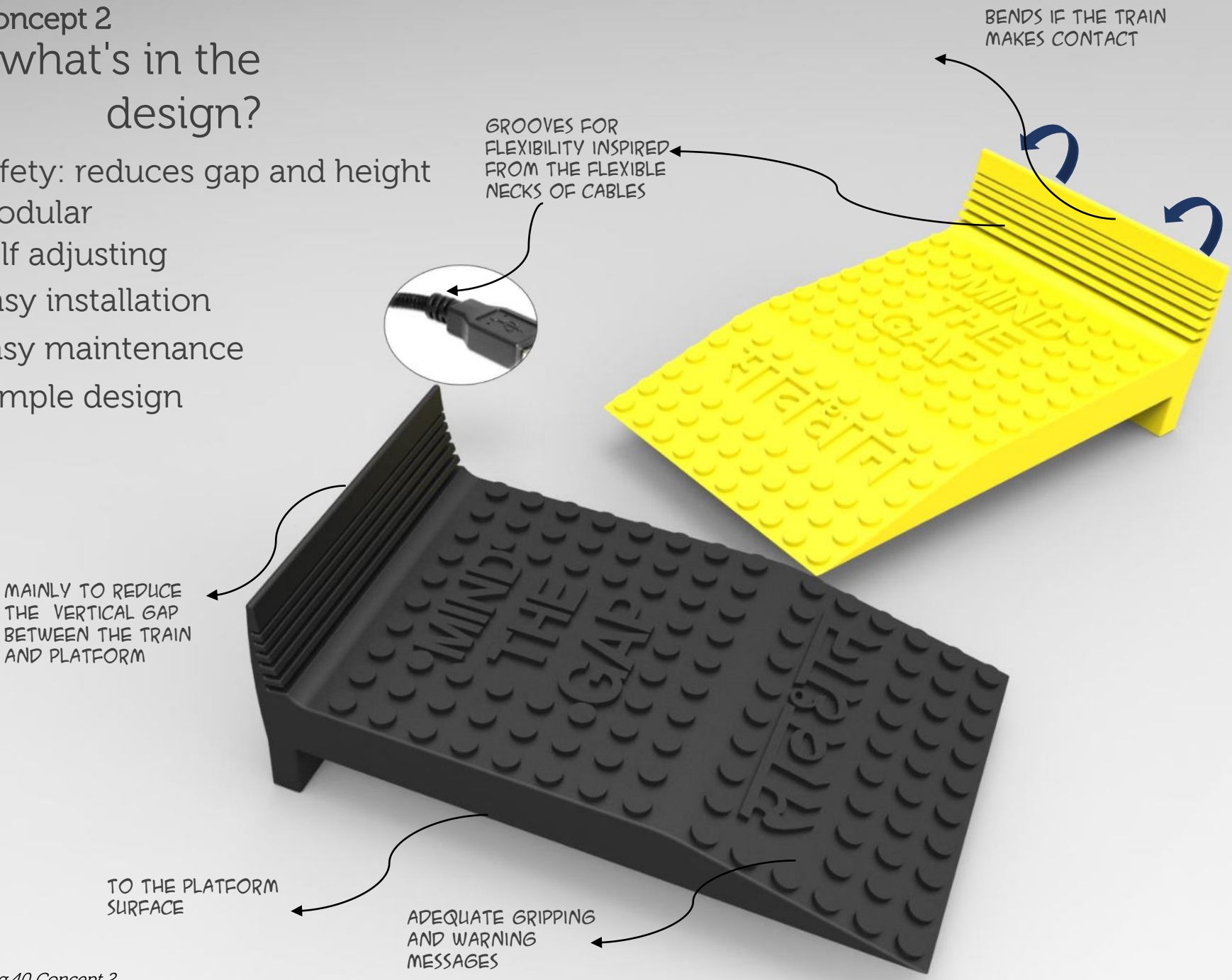


Fig.40 Concept 2

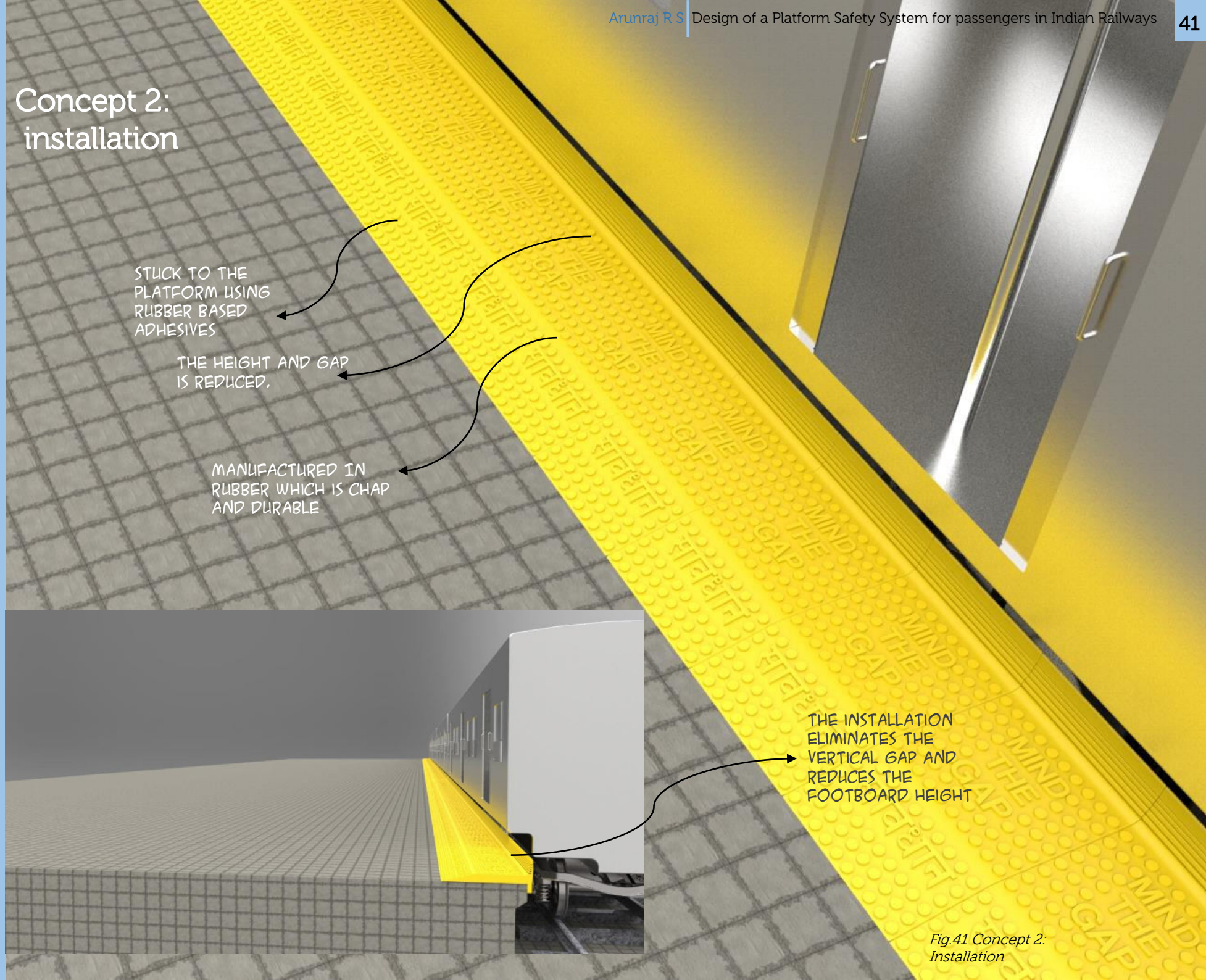


Fig.41 Concept 2: Installation

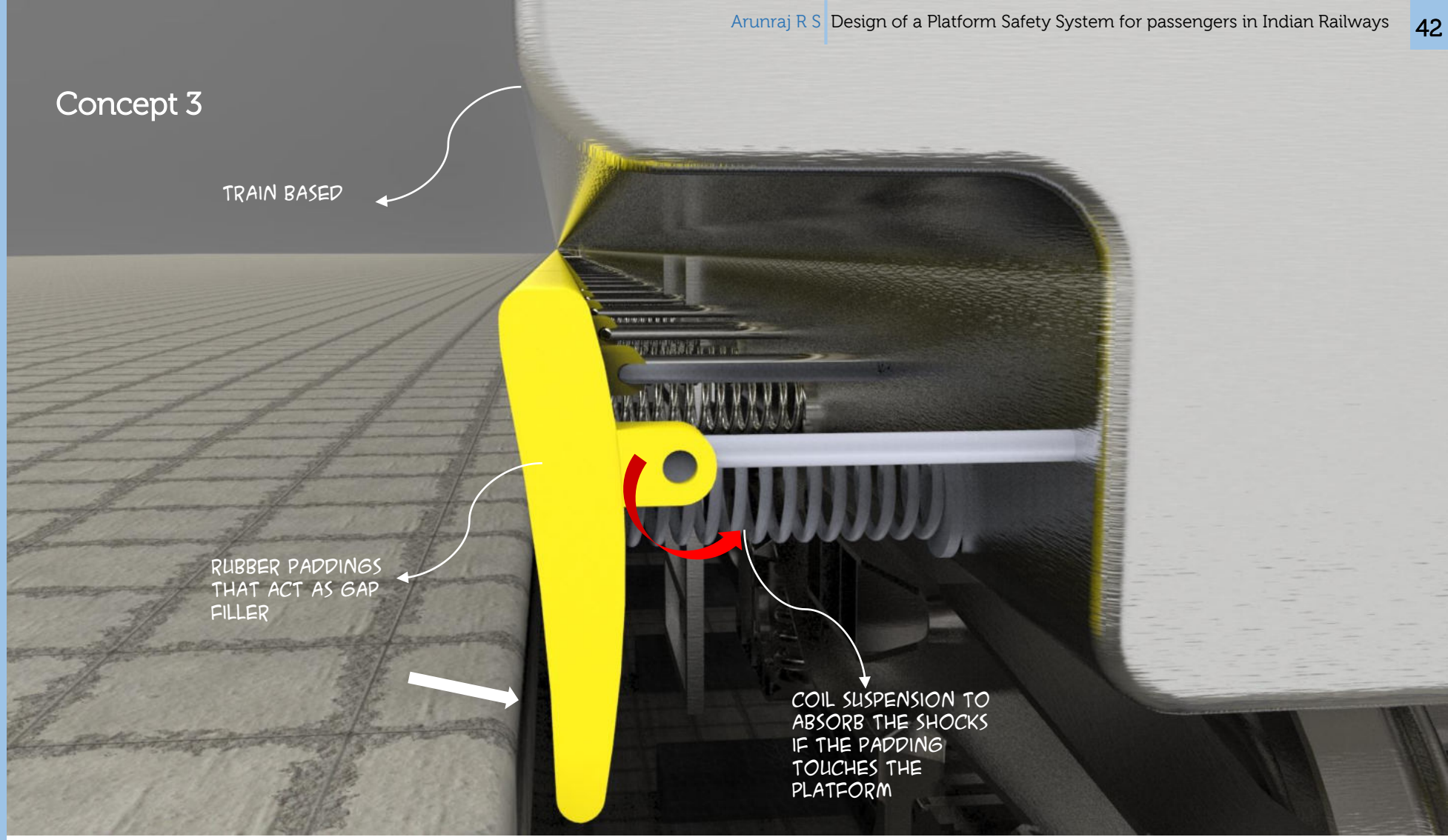


Fig.42 Concept 3

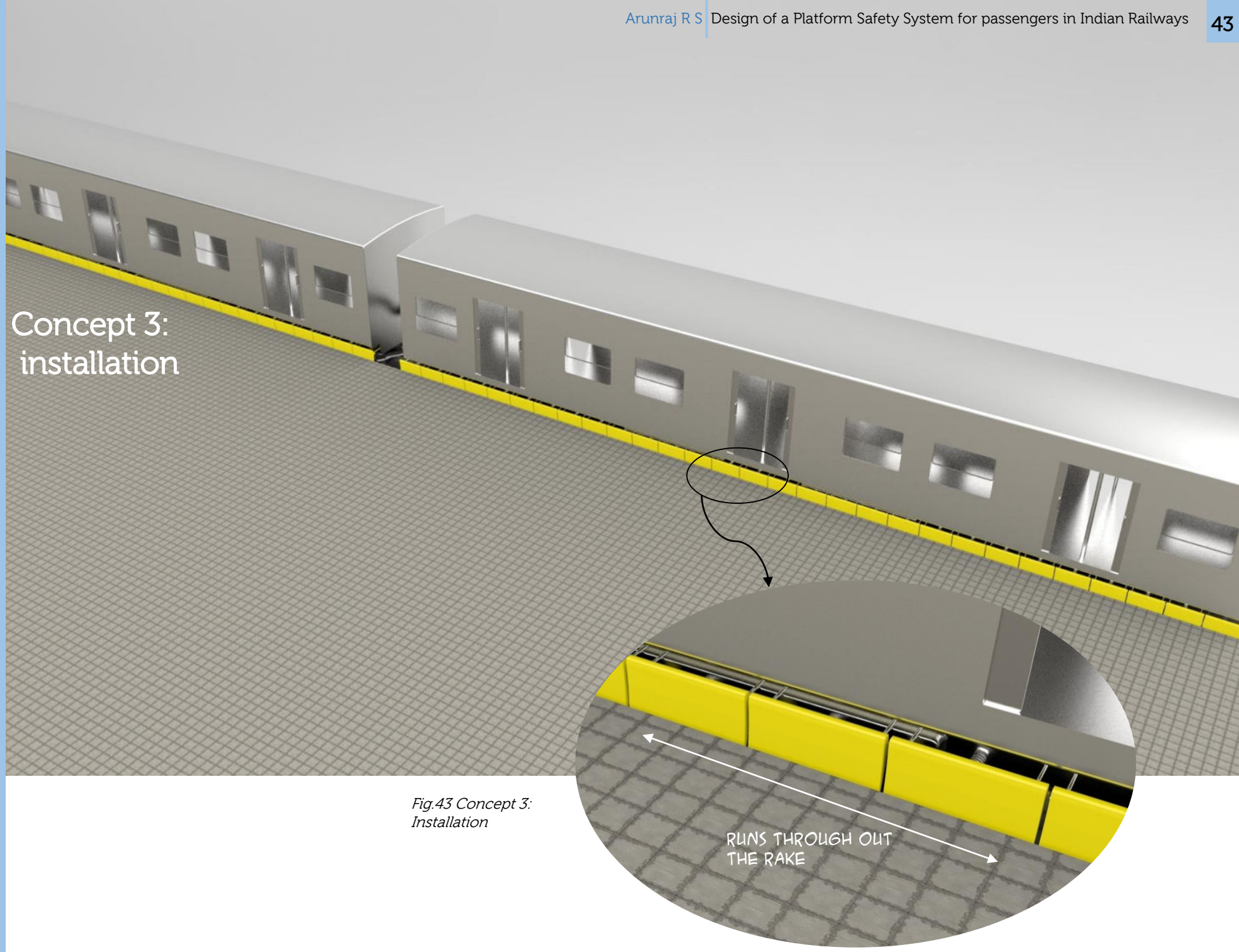
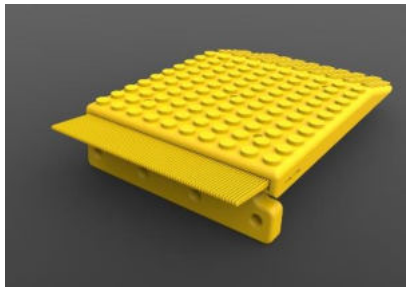
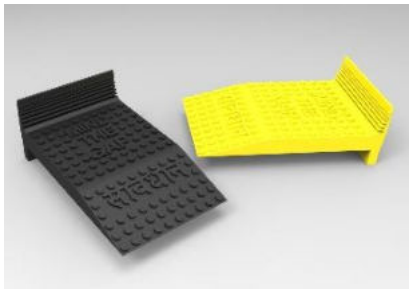


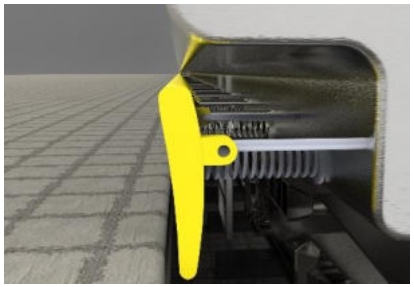
Fig.43 Concept 3: Installation

22. Concept evaluation

The concepts are evaluated on the following parameters'.







Parameter	Concept 1	Concept 2	Concept 3
Simplicity in the design	🔴	🟢	🔴
Safety for the passengers	🟢	🟢	🟢
Cost effective	🔴	🟢	🔴
durability	🟢	🟢	🟢
Easy and fast installation	🟢	🟢	🔴
Long lasting	🔴	🟢	🔴
Passage for dust and rain water	🟢	🔴	🔴

Table 4 .Concept Evaluation

🟢 Positive

🔴 Negative

So, concept 2 is chosen to be the final design which satisfies the above parameters in accordance with the design brief.

23. GRP ltd.

The final concept is developed considering the material and manufacturability of the product. As mentioned earlier, concreting the entire platform is not a good solution in Mumbai. A material which can be easily manufactured and which will last long has to be considered. Thus came the idea of manufacturing the platform plates with recycled rubber which are durable for the purpose. They can be easily installed on the concrete platform surface with the help of rubber based adhesives which has great bonding strength.

As A result, the project was linked with GRP Ltd. (formerly known as Gujrat Reclaim and Rubber Products Limited), a pioneer in manufacturing high quality and cost effective recycled rubber products. They are the largest producer of reclaimed rubber products in Asia. The produce reclaimed rubber from the scrap of whole tyres, tread peelings, natural rubber tubes, butyl tubes, and moulded rubber products for different applications in both tyre and non-tyre rubber products. †

† Courtesy: http://www.grpweb.com accessed on 08.08.14

The final Concept

The final concept
what's in the design?

Safety: reduces gap and height

Modular

Self adjusting

Easy installation

Easy maintenance

Simple design

Channel for water/dirt passage

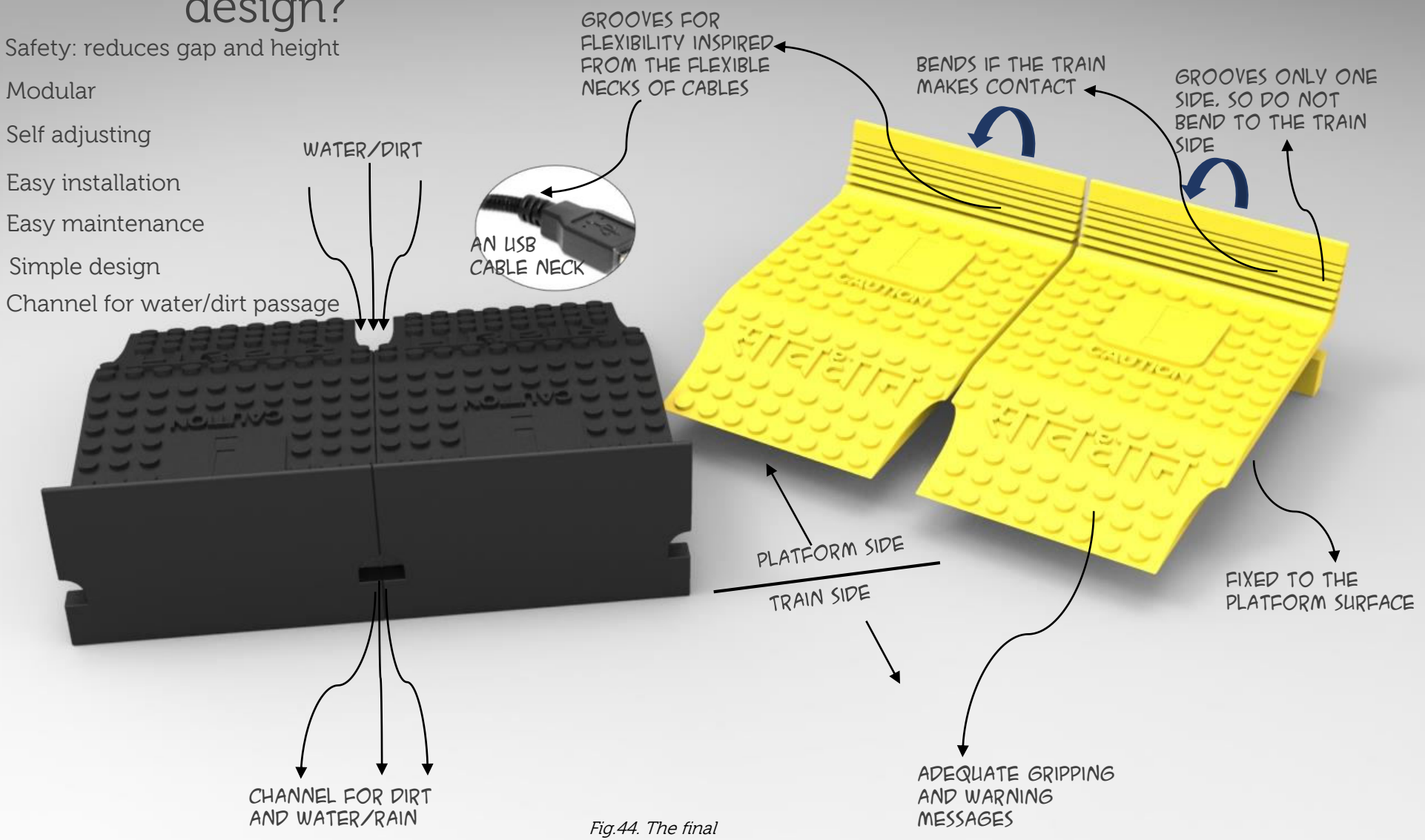


Fig.44. The final Concept

Final Concept: installation

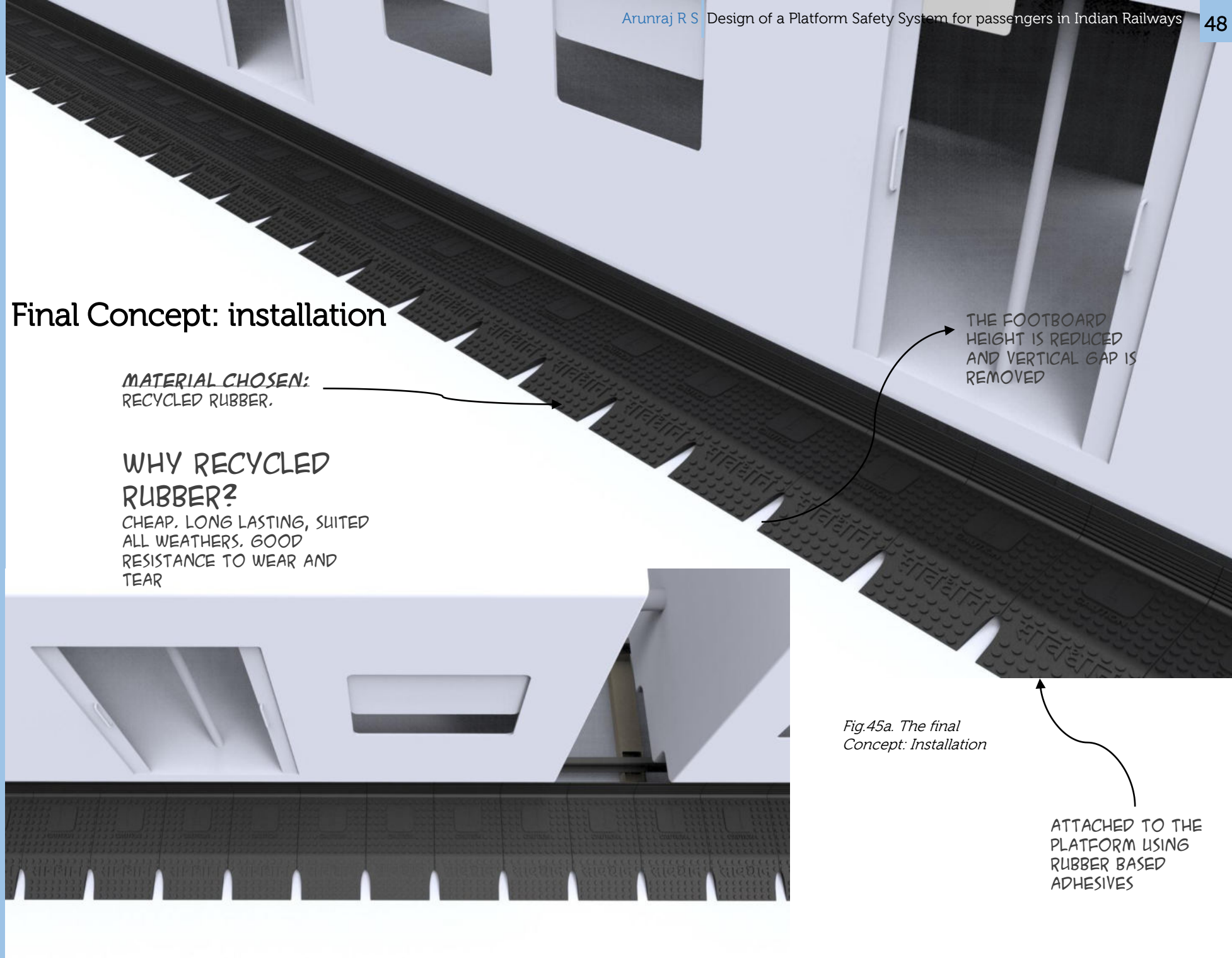


Fig.45a. The final Concept: Installation

Final Concept: installation

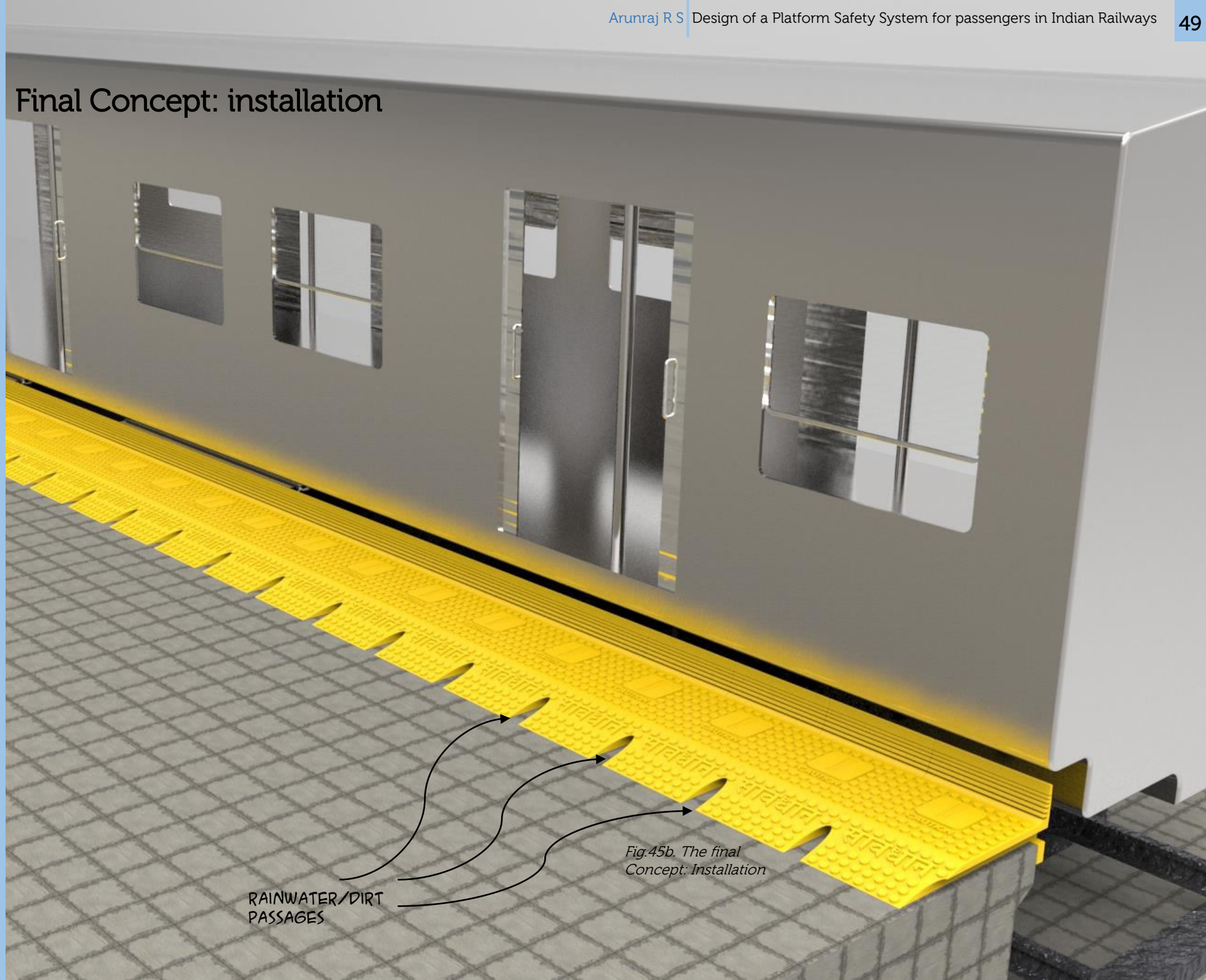


Fig.45b. The final Concept: Installation

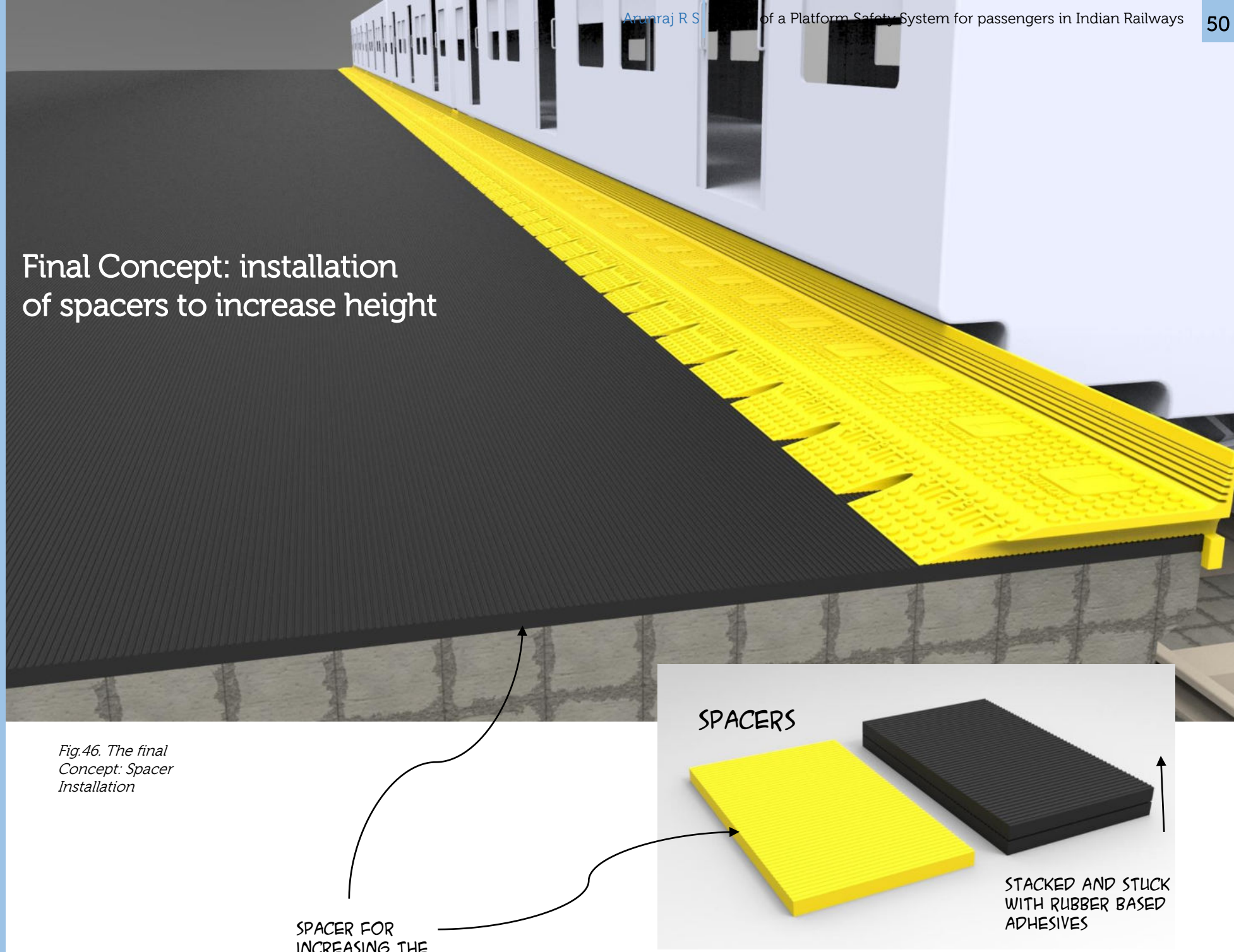
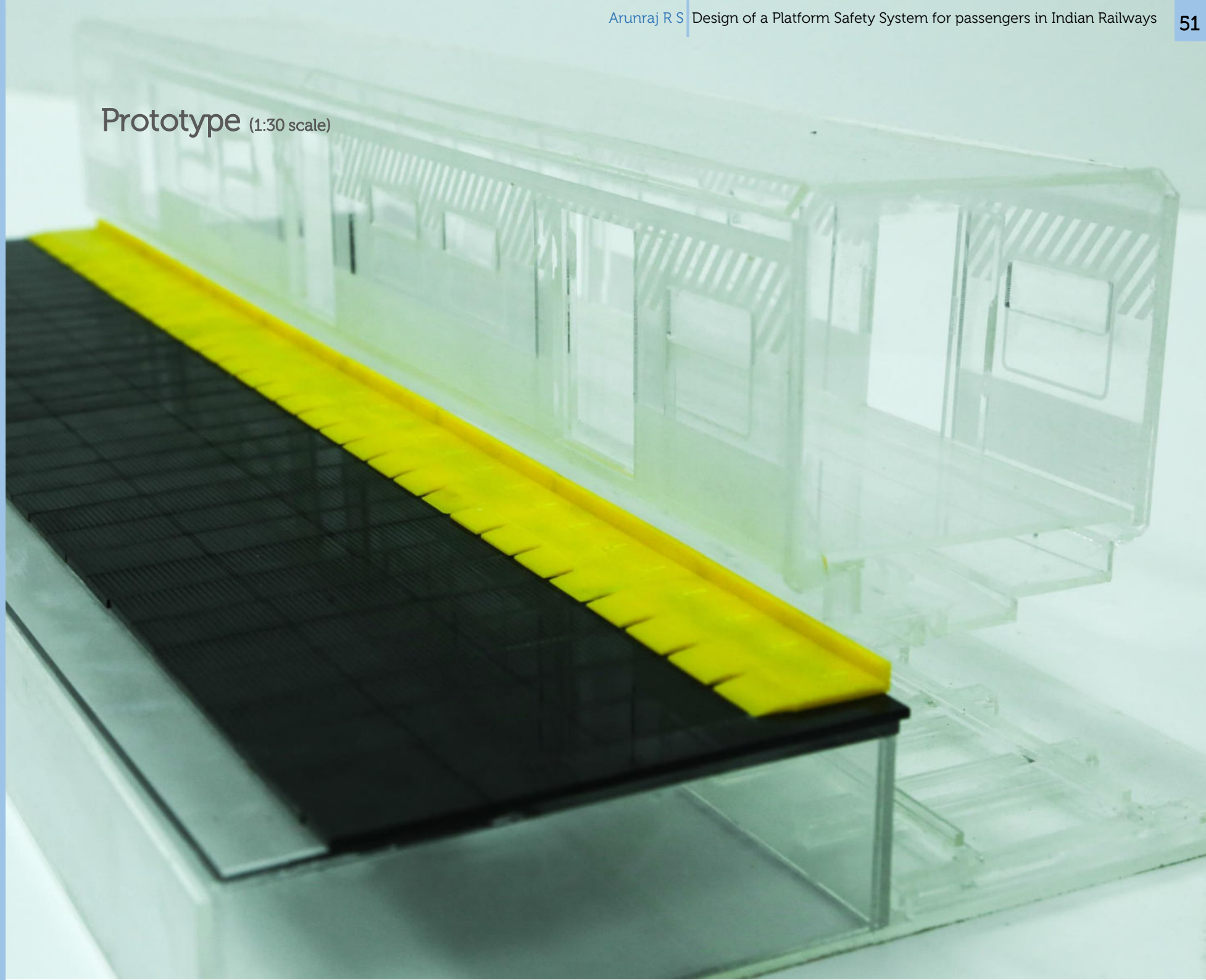


Fig.46. The final Concept: Spacer Installation

Prototype (1:30 scale)



Dimensional drawing:

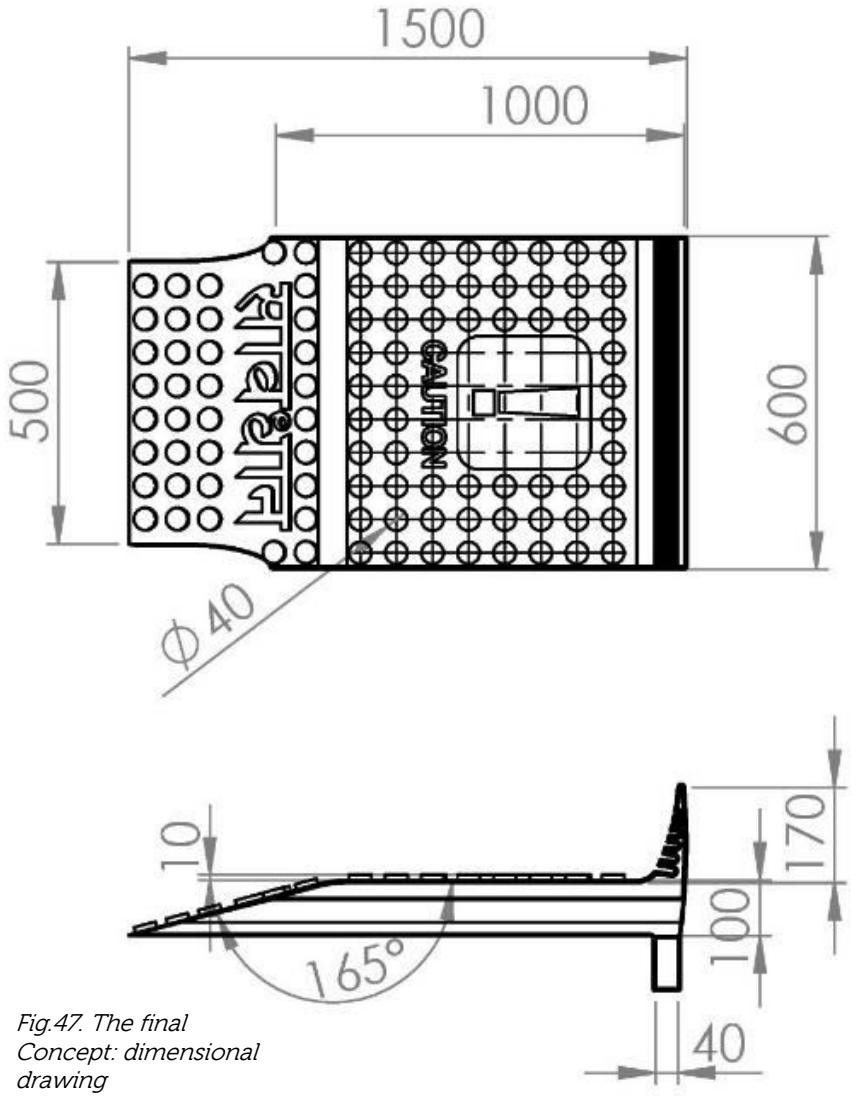
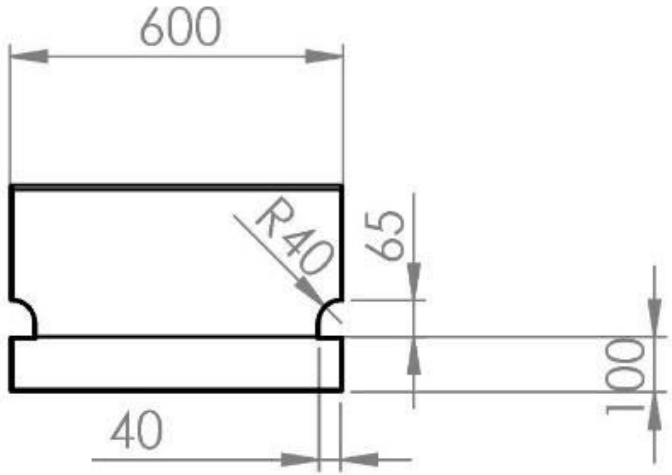


Fig.47. The final Concept: dimensional drawing



(All dimensions are in millimetres)

thank you

idc
iit bombay
2014