LAYOUT OF DRIVERS’ CAB IN ASIAN RAIL VEHICLE

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SUMMARY

Human error accounts for a great portion of railway accidents. The main factors influencing the physical and mental states of the driver on board are the environment of the drivers’ cabs of locomotives, arrangement of the drivers’ cabs of locomotives, and workstation. Therefore, evaluation and improvements of these factors are needed. Several railways of Europe have already suggested the standards and evaluation method for drivers’ cabs of locomotives. In contrast, there is no action for harmonized drivers’ cabs in Asia. Asians’ sizes are different from those of Europeans. Design that is not suitable for the human body fails to maximize productivity and causes many accidents. Thus, the drivers’ physical features must be reflected on the design. This is the reason why an Asian drivers’ cab is required. In the research, a guideline to define the requirements for the layout of Asian drivers’ cabs was produced with UIC jointly. Asian drivers’ sizes was analysed and Asian anthropometric averages was drawn out as well to find out Asian universal dimensions with adequate adjustability. This paper introduces the results of this research project.

INTRODUCTION

Large-scale railway accidents are caused by complex reasons, but it has been turned out that the human factor is one of the most important accident factors. It is reported that 30~60% of all accidents are caused by human errors. In the case of the UK, 60~70% of all accidents were caused by human errors. These statistics show that human error accounts for a great portion of railway accidents. Humans are imperfect, so to speak; thus, there is always the possibility of accidents caused by human errors. As such, a working situation designed to be suitable for the worker can lower the error probability much more compare to the situation that is not suitable for the worker.

Standardization brings convenience, efficiency and economical advantage. The projects for standardization of a drivers’ cab were completed in Europe, e.g. EUDD (European drivers’ Desk, 2001-2003), MODTRAIN/EUCAB (2004-2008) and EUDDplus (a drivers’ desk for Europe, 2006-2010). In contrast, there is no action for harmonized drivers’ cabs in Asia. Asians’ sizes are different from those of Europeans, by which the drivers’ desk designed according to European UIC codes is not suited for Asian drivers. In detail, drivers’ cabs are designed according to anthropometric data. But anthropometric data provided by UIC 651 represents the European population. For example, anthropometric data for Korean population are different from UIC 651. This is the reason an Asian drivers’ cab project is required.

Also for this reason, the UIC project conducted UIC Asia project on the layout of drivers' cab in Asian rail vehicles (2013-2015). With the UIC project, a guideline to define the requirements for Asian drivers' cabs was produced. The guideline will deliver the following results focused on Korea railway first.

- Analysis of Korean anthropometric data

- Investigation of Korea Railway work environment

- Deriving the need for the requirements on drivers' cab focused on Korea in Asian rail vehicles

Next, the results focused on Korea railway were extended to the Asian Railway. Asian drivers' sizes were analyzed and Asian anthropometric averages will be drawn out to find out Asian universal dimensions with adequate adjustability. Requirements for Asian drivers' cab were also generated. Furthermore, used of computer-aided design and the simulation were followed.

In the research, a guideline to define the requirements for the layout of Asian drivers' cabs was produced with UIC jointly. Asian drivers' sizes was analysed and Asian anthropometric averages was drawn out as well to find out Asian universal dimensions with adequate adjustability. This paper introduces the results of this research project.

Work Environment in Drivers' Cabs

The concept of working environment in the drivers' cabs is about creating working environment of the drivers' cabs such that the human performance of the driver who does the driving could be optimized. If we call the driver-oriented control panel design "Man-Machine Interface (MMI)" design, the driver-oriented environment design can be called "Man-Environment Interface (MEI)" design. In these concepts, MEI is applied to the design of the working environment in the drivers' cabs. Likewise, when the working environment of the drivers' cabs is designed, consideration should be given to ergonomic design for the optimization of the drivers' human performance and aesthetic design for a pleasant and comfortable working environment.

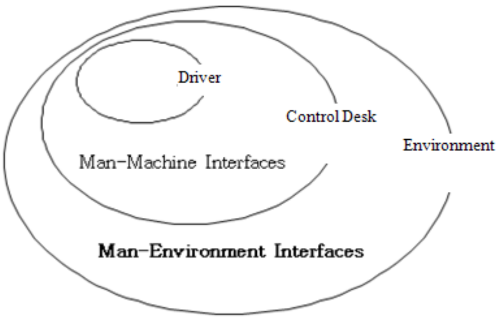


Figure 1: Concept of working environment of drivers' cab

Arrangement of Facilities

When the driver uses various displays and controls in the drivers' cab, the expectation of the driver should coincide with the purpose of the system. With such coincidence, the arrangement of facilities can be considered appropriate. When controls and displays are arranged, the importance of devices, frequency of use, and combination of such are considered. Nonetheless, the distance between them should also be considered to prevent mishandling by the driver. Therefore, when space and facilities are designed, usability and stability should be also considered while functionality is regarded as important. Such comprehensive design can reduce human errors and accidents.

- Rule of Importance: The priority is decided depending on how important the functions of the equipment are for the achievement of the system's purpose. In other words, it is a matter of deciding which is more important in operating devices to achieve the purpose of the system.
- Rule of Frequency-of-use: Frequently used devices should be arranged in advance to optimize the circulation of driving work.
- Rule of Function: Functionally related devices should be collected and arranged accordingly.

- Rule of Sequence-of-use: Equipment should be arranged matching the sequence of use for the worker to handle the nearby equipment according to the sequence.

Investigation on the Working Environment of Drivers' Cabs

To investigate the satisfaction level of drivers with drivers' cabs, a questionnaire was administered to drivers of high-speed rolling stock, electric rail car, new model electric locomotive, and Diesel electric locomotive. The subjects of the questionnaire were 402 Korean drivers. The degrees of difficulty and inconvenience felt at the environment of drivers' cabs in locomotives were scored with a 7-point scale. A score of 1 stands for "very difficult and inconvenient," whereas a score of 7 means "very easy and convenient." Drivers were supposed to write the specific reason for the difficulty and inconvenience. To enhance the reliability of the questionnaire, the environmental factors of drivers' cabs by vehicle type were explained beforehand. The environmental factors enumerated in the questionnaire were driving control desk, noise, vibration, indoor ventilation, and air conditioning/heating systems; a total of 8 questions were included.

For the results of evaluation of the environment in locomotive drivers' cabs, Diesel electric locomotive was 2.84, new model electric locomotive was 3.00, high-speed rolling stock was 3.39, and electric rail car was 3.44. Figures in brackets mean "difficult and inconvenient" when nearer to 1 and "easy and convenient" when nearer to 7. The results suggest that the environment of drivers' cabs in Diesel electric locomotives was the worst, followed by that of new model electric locomotive, high-speed rolling stock, and electric rail car.

Table 1: Result of evaluation of the environment of drivers' cabs in locomotives

Evaluation Item	Diesel Electric Locomotive	New Model Electric Locomotive	High-Speed Rolling Stock	Electric Rail Car	Mean	Std.
	1: Very difficult and inconvenient 4: Mediocre 7: Very easy and convenient					
Operation and control are difficult or inconvenient.	2.76 (1.08)	3.37 (1.27)	3.72 (1.53)	3.77 (0.71)	3.40 (1.21)	1.218
Difficult or discomfort because operating while seated for a long time is inappropriate	2.80 (1.38)	2.88 (1.29)	3.49 (1.25)	3.17 (.935)	3.09 (1.25)	1.254
Difficult or inconvenient because the lighting supported inside the vehicle is inappropriate	3.03 (1.56)	3.37 (1.48)	3.44 (1.44)	3.67 (1.07)	3.38 (1.42)	1.422
Difficult or inconvenient because the lighting (daytime, night) generated from the outside of the vehicle is inappropriate	2.93 (1.39)	3.04 (1.10)	3.62 (1.20)	3.47 (1.09)	3.26 (1.24)	1.239
Difficult or uncomfortable because of noise inside/outside the vehicle	2.23 (1.32)	2.29 (1.34)	2.46 (1.25)	3.43 (0.99)	2.60 (1.33)	1.329

Difficult or uncomfortable because of vibration inside/outside the vehicle	3.07 (1.27)	3.34 (1.29)	3.36 (0.66)	3.65 (0.98)	3.35 (1.14)	1.139
Difficult or uncomfortable because indoor ventilation is not smooth	2.90 (1.39)	2.90 (1.41)	3.36 (1.43)	3.35 (1.07)	3.13 (1.34)	1.342
Difficult or uncomfortable because the air conditioning /heating system of drivers' cabs of locomotives is not good	2.91 (1.40)	3.21 (1.53)	4.00 (1.26)	3.33 (0.72)	3.36 (1.32)	1.323
Average	2.84	3.00	3.39	3.44		

※ ( ) is the standard deviation.

Korean Physical Features

Data on anthropometric variables are widely used as major design factors to develop products and design working space using human anthropometrics. Realistically, however, it is difficult to reflect these design factors 100% in the design of products and working space. Currently, in terms of satisfying at least 90% of design subjects, the limit of 5, 95 percentile was suggested as the guideline and is being used (NASA-STD-30000T, 1996, MIL-STD-1472D, 1989). When human body variables are assumed as normal distribution, their rate of change are highest in the 5, 95 percentile. Therefore, this guideline is used as the second best way wherein cost and space maximize the limit (Brian Peacock, et al, 1993). In the case of sharing of male and female, male 95th percentile and female 5th percentile are generally used. Likewise, in the US CFR (Code of Federal Regulation) 49, the regulation on drivers' cabs states the size that male 95% and female 5% of American adults can use.

In the Korea regulation on rolling stock drivers' license, there is no body size standard in the physical examination for obtaining the driving license. The 2009 statistical data of the Korea Employment Information Service shows that the number of subway drivers was 13,858, and that the rate of male and female was 98.4% and 1.6%, respectively. Average age was 41.5 years old. Therefore, reflecting both male and female on rolling stock design is deemed reasonable.

Table 1. Comparison between the result of 5th body size measurement of the Korea Agency for Technology and Standards and the body size of UIC 651

[unit: mm*]*

Classification	Male (Percentile)			Female (Percentile)			UIC 651	
	5th	50th	95th	5th	50th	95th	Min	Max
Stature	1603	1700.5	1801	1486.5	1571	1662.5	1600	1900
Eye Height	1489	1586	1683	1379.5	1462.5	1549	1500	1775
Sitting Height	866.5	919.5	973.5	807.5	856.5	902.5	840	980
Eye Height, Sitting	753	804.5	856.5	699	745.5	791	740	855

Buttock-Knee Length	527.5	566.5	611.5	501	538.5	578.5	555	660
Knee Height, Sitting	468.5	506.5	547.5	436.5	471.5	506.5	500	605
Popliteal Height	362.5	396.5	433.5	331.5	365.5	401.5	395	475
Thigh Clearance	126.5	151.5	177.5	116.5	136.5	158	120	180
Buttock-Popliteal Length	422	464.5	508.5	409	443.5	481.5	440	520

In case of stature, Korean male 5th and 95th percentile are included in the scope suggested by the UIC 651 standard, but the stature of Korean female 5th percentile is shorter by about 12cm than the minimum stature of UIC. Moreover, in the case of male, stature, sitting height, sitting eye height, sitting thigh clearance height, etc. are included in the scope of the UIC standards, but eye height, buttock-knee length, sitting knee height, popliteal height, and buttock-popliteal length of the male 5th percentile are not included in the scope proposed by UIC 651, where body size is the arithmetic mean of male and female aged 20 to 60.

Working Space of the Driving Control Desk and Drivers' Seat

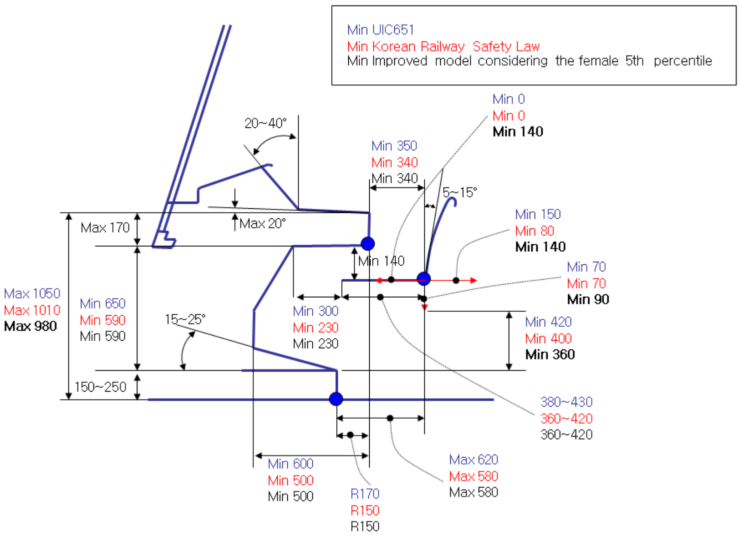


Figure 2: Dimension of Arrangement Space of Steering Wheel and Seat in drivers' Cabs

We compared the design requirements of the control desk considering the Korea Railway Safety Law, UIC 651, and driver model of the female 5th percentile through these. In this regard, although the model suggested by the Korea Railway Safety Law reflected the Korean body size unlike UIC 651, it shows a difference from the proposed model in this study since it has reflected only the male body size. The difference lies in the height of the driving control desk and the arrangement of the driving seat. The height of the driving wheel was lowered considering the female 5th percentile, and the seat was designed to be movable back and forth by a minimum of 140mm, which needs more room than the seat suggested by the Korea Railway Safety Law. In addition, the height of the chair is adjustable by a minimum of 90mm; this means more room by 20mm is needed compared to the previous adjustment.

One of the factors that should be reflected to design the working place for driving is the "work space envelope." Work space envelope is usually defined using the "normal working area" and "maximum working area" based on the scope that the arm can reach when stretched in a horizontal working plane. The "normal working area" and "maximum working area" are defined as follows:

- Normal working area: Scope that the forearm reaches when moved with the upper arm placed naturally on the body

- <u>Maximum working area</u>: Maximum scope that the arm reaches when stretched with the shoulder point as the center

In the actual driving of the rolling stock, however, the controller can also be placed in the scope that the arm can reach when the upper body is moved, not only the shoulder point. Therefore, reflecting this point, the working space can be classified as follows:

Table 2: Classification of the working space in drivers' cab

Zone[1)]	Usual Ergonomics Area[2)]	Body Condition
-	Normal Working Area	Scope that the forearm reaches when moved with the upper arm placed naturally on the body
Zone 1	Maximum Working Area	Maximum scope that the arm reaches when stretched with the shoulder point as the center
Zone 2	-	Scope that can be controlled by the movement of arm and shoulder
Zone 3	-	Scope that can be controlled by the movement of arm and body

1) Zone suggested in the railway field (UIC 651)

2) Zone applicable to ergonomics in the industrial field (Refer to Ergonomics for Occupational Safety and Health Manager.)

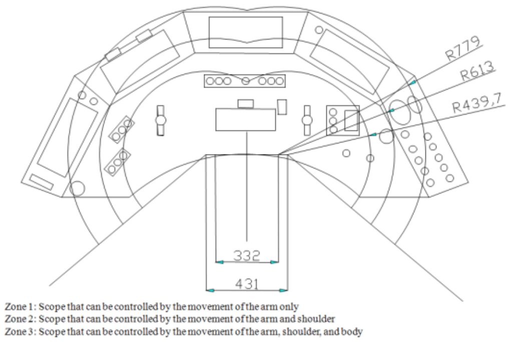


Figure 3: Diagram of Radii of Optimum Accessibility of the Hands

The working space synthesized using the skeleton model of the male 95th percentile and female 5th percentile suggested earlier and designed considering more room of 40mm for arm movement is presented in Figure 4-4, where each radius was classified based on the working space used in the railway field. A radius of 440 represents Zone 1, where frequently and importantly used devices are mounted. Zone 2 can be classified as the second-most important area with radius of 613. Zone 3 can be seen as the appropriate site to mount devices which are infrequently used or have relatively low importance.

As mentioned earlier, another factor influencing the arrangement of equipment is the field of view. The standard for this is mentioned in KS A ISO 9355-2:2011; since this is about machinery and equipment, however, it is desirable to classify on the basis of prEN 16186-1:2010 considering the correlation with railway. As the aforementioned ergonomic factors for the design of drivers' cab are applied in the automobile, operational devices in drivers' cab should be arranged considering not only working space, but also arrangement of devices providing information. In arranging devices, the appropriate main sight line is 35 degrees downwards from the front; the range of 15 degrees from such main sight line is the optimal sight line. Therefore, it is recommended to place devices providing major information in this area.

Figure 4: Optimal sight line

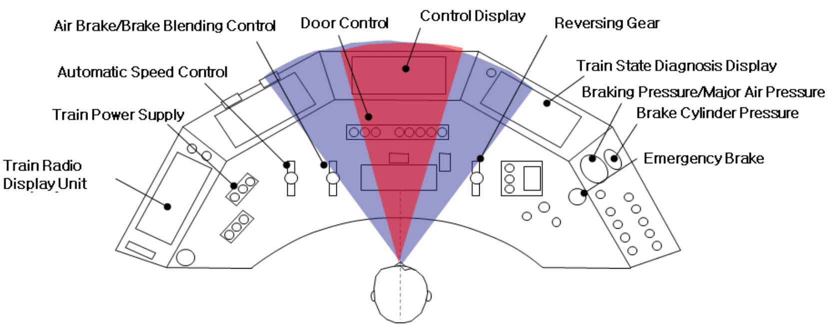
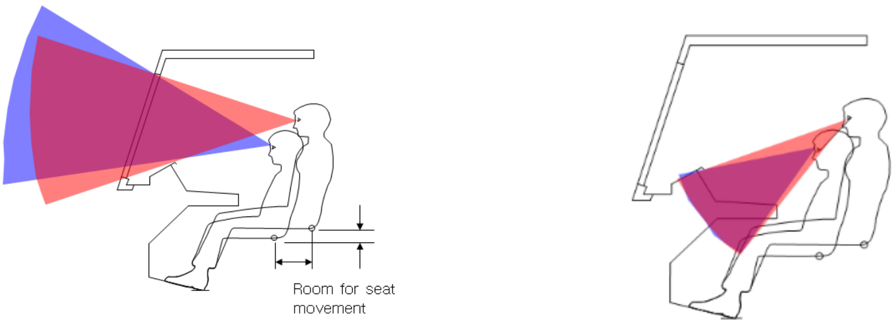


Figure 5: Arrangement of equipment considering sight line

Based on the above, we can suggest a plan for the arrangement of equipment as illustrated in Figure 4. First, working space refers to the area marked in red, which is the optimal area. The area marked in blue is the tolerable area. It is desirable to arrange major devices considering these.

In this respect, with the main sight line, one should be able to perceive the state of the railway in front only with eye movement. The sight of vertical direction should be arranged to allow checking the upper front and lower front signals under the influence of the roof of the train and dashboard. Figure 6 describes the cases wherein the drivers' eyes are kept forward and focusing on the dashboard respectively, considering the physical condition.

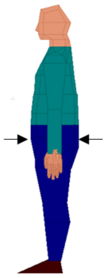


(a) Case wherein the driver keeps his/her eyes forward

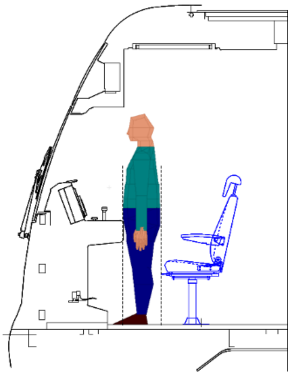
(b) Case wherein the drivers' eyes focusing on the dashboard

Figure 6. Arrangement of equipment according to the position of the drivers' eyes

Consideration of Somatotype in Human Body Model



(a) Hip depth size



(b) Arrangement of the drivers' seat and desk when driving in standing position

Figure 7: Consideration of somatotype in human body model

In ergonomics, somatotype is classified and applied to many cases. For the arrangement of the drivers' seat, we would like classify the somatotype largely into 3 categories -- fat, balanced, and thin -- and review the effect of its application. Although the somatotype can have various factors influencing driving, this study looks into the drivers' somatotype in relation to the arrangement of desk and chair.

Hip depth can have a direct impact and hip width (hip breadth) can also wield influence as the body size related to the arrangement of the drivers' seat. In particular, hip depth is considered to be most influential as shown in Figure 7.

Through the hip depth, the somatotype of the driver model is classified into fat, balanced, and thin as shown in Figure 8. Figure 8 shows the results of each application to the male 95th percentile.

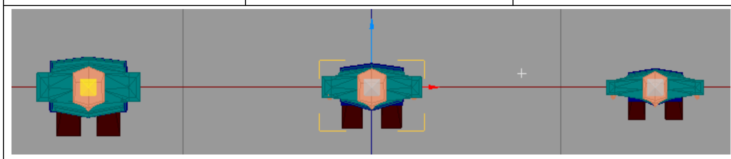
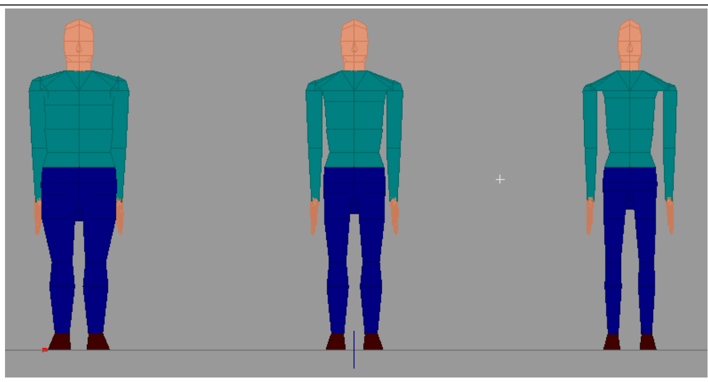
Fat driver model	Balanced driver model	Thin driver model
		
		

Figure 8. Somatotype of the Korean male driver model

In the design of the drivers' seat, suggesting the minimum distance is desirable. Therefore, we can see that the minimum distance between the desk and the drivers' seat should be more than 287mm considering the fat somatotype of the male 95th percentile.

Analysis of Asian Anthropometric Data

We have carried out a survey of the data on anthropometric measurements for Asian countries to build up drivers' body model for each Asian country. Although measuring body measurement data should be taken as an essential element for developing products suited to people of each country, such measurements are not being conducted properly due to several matters for Asian countries and, naturally, it was hard to find related data accepted internationally. Considering such current situation, we have analysed the data on Asian countries (Japan, Korea, China, Thailand) provided in statistical summaries of anthropometric measurements of working age populations from ISO/TR 7250-2 (2010) and ISO/DIS 7250-3 (2014). While there are sources for individual member body data of several countries in ISO/TR 7250-2, ISO/DIS 7250-3 is to be used whenever worldwide or anthropometric data of regions including Asia and Europe are needed. We think it is more reasonable to use the international standard of the anthropometric measurements than other measurements.

We have summarized anthropometric measurements of Asian people based on those results. Also, we have made comparison between the maximum and minimum values for each size to build up driver models using the anthropometric measurements and put those values on the very right side of the table. (Female model included.) This table could be used for the approach to form driver models of each country. Also, we have made a relatively detail description on the table for differentiated approaches to predicted models of each gender.

Table 4. Comparison between the maximum and minimum values of Asian countries (ISO/TR 7250-2)

[unit: mm]

Classification	Gender	China		Japan		Korea		Thailand		min max	
		P5	P95	P5	P95	P5	P95	P5	P95	P5 min	P95 max
Stature (body height)	Male	1583	1775	1597	1795	1608	1805	1576	1770	1576	1805
Stature (body height)	Female	1484	1659	1481	1664	1491	1670	1467	1633	1467	1670
Eye height	Male	1474	1664	1484	1675	1493	1687	1462	1650	1462	1687
Eye height	Female	1371	1541	1372	1552	1384	1556	1353	1515	1353	1556
Sitting height (erect)	Male	858	958	856	964	869	974	813	925	813	974
Sitting height (erect)	Female	809	901	800	898	811	905	778	873	778	905
Eye height, sitting	Male	749	847	738	842	755	857	705	810	705	857
Eye height, sitting	Female	695	783	687	780	701	792	814	714	687	792
Lower leg length (popliteal height)	Male	383	448	370	442	365	437	380	450	365	450
Lower leg length (popliteal height)	Female	342	405	340	403	333	403	355	423	333	423
Thigh clearance	Male	112	151	129	171	128	179	124	163	112	179
Thigh clearance	Female	113	151	114	152	117	159	117	159	113	159

Knee height	Male	456	532	456	540	470	552	470	556	456	556
Knee height	Female	424	493	418	492	439	511	463	532	418	532
Buttock-popliteal length (seat depth)	Male	421	494	429	507	424	511	416	522	416	522
Buttock-popliteal length (seat depth)	Female	401	469	412	483	410	483	437	515	401	515
Buttock-knee length	Male	515	595	525	608	530	616	520	611	515	616
Buttock-knee length	Female	495	570	497	570	504	581	507	587	495	587

Table 5. Anthropometric measurements for potential Asian train driver

[unit: mm]

Classification	Min. (5th percentile)	Max. (97th percentile)
Stature (body height)*	1467 (1497)	1805 (1835)
Eye height*	1353 (1383)	1687 (1717)
Sitting height (erect)	778	974
Eye height, sitting	687	857
Lower leg length (popliteal height)*	333 (363)	450 (480)
Thigh clearance	112	179
Knee height*	418 (448)	556 (586)
Buttock-popliteal length (seat depth)	401	522
Buttock-knee length	495	616

Reference Position of the Eyes for Conditions of Visibility of Signals

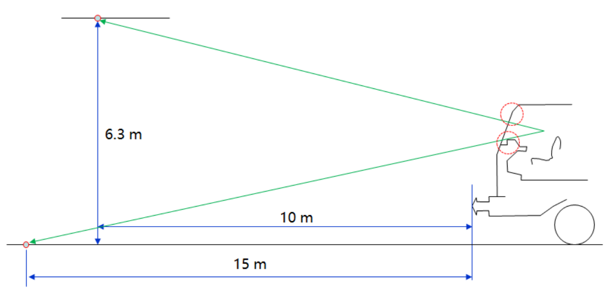


Figure 9. Condition of visibility for drivers' cabs (UIC 651, unit: m)

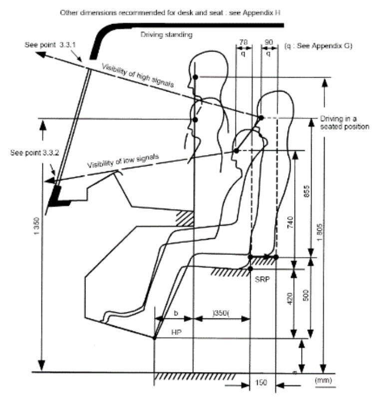
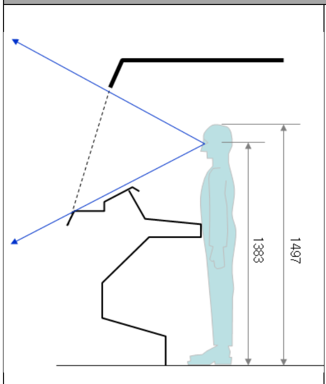
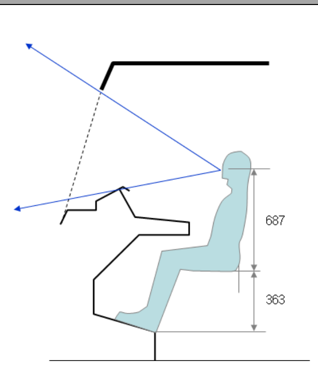
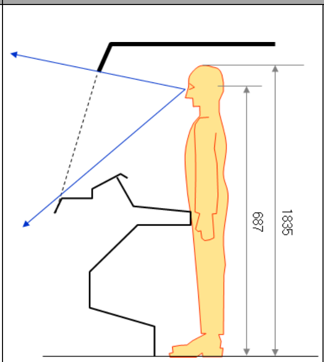
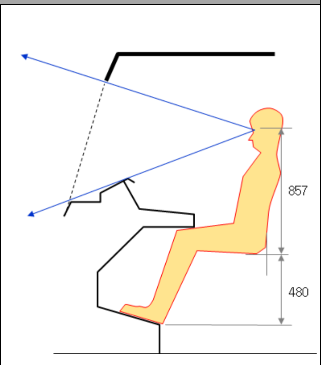


Figure 10. Reference position of the eyes (UIC 651, unit: mm)

The effect of anthropometric measurements on the drivers' seat shall be as below. As described previously, stature (body height), eye height, sitting height (erect) and eye height (sitting) are related to the visibility of the signal set up in the air and the ground signal. UIC 651 specifies that the upper part of the driving desk should not disturb one to see the signal set up on the ground 15m ahead. There should be no difficulties caused from the upper part of a vehicle's front for perceiving a signal set up 10m ahead with 6.3m height. UIC 651 specifies the reference position of the eyes as shown Figure 10. From the Anthropometric measurements for potential Asian train drivers, the reference position of the eyes of potential Asian train drivers is modified as shown Table 6.

Table 6. Reference position of the eyes for potential Asian train driver

[unit: mm]

Short person		Tall person	
			

Desk/Seat Coordination of Asian Drivers' Cab

- Lower Leg Length

The figure presented above provides reference sizes for the height and the location of a drivers' seat offered from UIC 518. As for the potential Asian models, more than 360 mm seems appropriate, not over 420 mm.

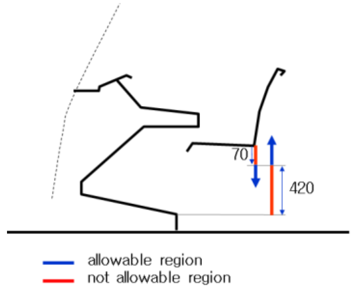


Figure 11. Sizes specified from UIC 651 as related to lower leg length (unit: mm)

- Thigh Clearance

As for the thigh clearance of potential Asian models, the minimum is 112 mm and the maximum 179 mm. It wouldn't correspond when the minimum spacing 140 mm presented from UIC 518 becomes the maximum height, but it is expected to be overcome by adjusting the height of drivers' seat as suggested by UIC.

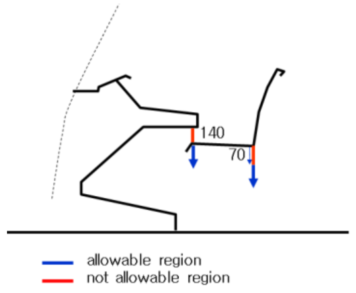


Figure 12. Sizes specified from UIC 651 as related to thigh clearance (unit: mm)

- Knee Height

As the maximum length of the part being effected by knee height becomes 586 mm when one wore shoes, it is expected to be satisfied if over 600 mm, which is presented by UIC 518, was maintained.

Figure 13. Sizes specified from UIC 651 as related to knee height (unit: mm)

- D. Buttock-Popliteal Length (Seat Depth)

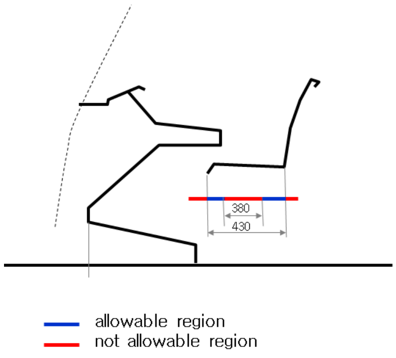


Figure 14. Sizes specified from UIC 651 as related to Buttock-Popliteal Length (unit: mm)

If the maximum depth of the seat width becomes 430 mm, the lower leg would be touched and it would cause discomfort for Asians with short Buttock-popliteal length (seat depth). (See the figure below)

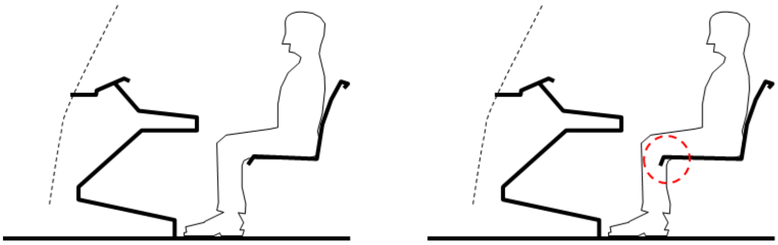


Figure 15. Discomfort related to the maximum depth of the seat

Buttock-popliteal length longer than chair width shall offer stability. However, if chair width becomes longer than Buttock-popliteal length, then it becomes uncomfortable touching the front part of the chair. For this reason, the maximum 400 mm of seat depth seems appropriate for Asian drivers.

- <u>Buttock-Knee Length</u>

Figure 16 presents design elements of a drivers' seat that have effect on Buttock-knee length. The minimum length is supposed to be over 650 mm, but then drivers with small body type could not lean on back of a chair. Therefore, it is expected that the appropriate sum would be 490 mm. 350 mm, the space between the desk and the chair, is related to body types and it should be fine to reduce it proportionally.

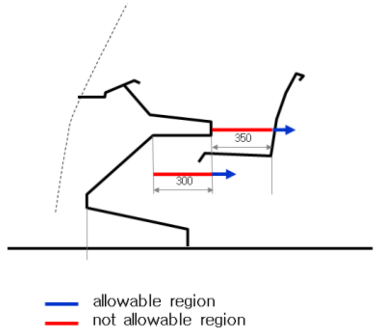


Figure 16. Sizes specified from UIC 651 as related to Buttock-Knee Length (unit: mm)

- <u>Driving Cab Appropriate for Potential Asian drivers</u>

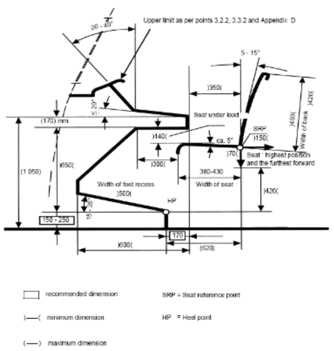


Figure 17. Recommended dimension and desk/seat coordination from UIC 651

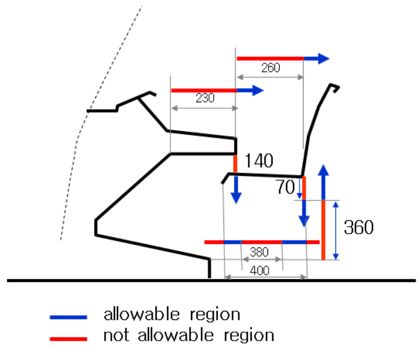


Figure 18. Recommended dimension and desk/seat coordination for Asia drivers' cab (unit: mm)

UIC 651 recommended all dimensions and desk/seat coordination as shown Figure 17. A driving cab appropriate for potential Asian drivers could be expected to become as Figure 18 based on the result of the study described above. Other dimensions of Figure 17 not specified in Figure 18 is maintained in Figure 18.

CONCLUSION

We conducts UIC Asia project on the layout of drivers' cab in Asian rail vehicles (2013-2015). In Phase 1 of the project, the strategic issues on the drivers' cab first were investigated. In Phase 2, the guideline to define the requirements for Asian drivers' cabs were produced.

The guideline delivers the following results focused on Korea railway first.

- Analysis of Korean anthropometric data

- Investigation of Korea Railway work environment

- Deriving the need for the requirements on drivers' cab focused on Korea in Asian rail vehicles

Then, the guideline extended the results focused on Korea railway to the Asian Railway. We have carried out a survey of the data on anthropometric measurements for Asian countries to build up drivers' body model for each Asian country. Although measuring body measurement data should be taken as an essential element for developing products suited to people of each country, such measurements are not being conducted properly due to several matters for Asian countries and, naturally, it was hard to find related data accepted internationally. Considering such current situation, we have analyzed the data on Asian countries (Japan, Korea, China, Thailand) provided in statistical summaries of anthropometric measurements of working age populations from ISO/TR 7250-2 (2010) and ISO/DIS 7250-3 (2014). While there are sources for individual member body data of several countries in ISO/TR 7250-2, ISO/DIS 7250-3 is to be used whenever worldwide or anthropometric data of regions including Asia and Europe are needed. We think it is more reasonable to use the international standard of the anthropometric measurements than other measurements.

With the anthropometric measurements of ISO/TR 7250-2 (2010) and ISO/DIS 7250-3 (2014), the Asian drivers' sizes were analyzed and Asian anthropometric averages were drawn out to find out Asian universal dimensions with adequate adjustability. Requirements for Asian drivers' cab were also generated. These requirements included the following information.

- Principal anthropometric measurements of the shortest and tallest driving staff,

- Reference position of the eye for visibility for signals,

- Recommended dimensions and desk/seat coordination and

- Optimum accessibility of the hands.

Furthermore, opinions were collected from Asian railway organizations, and used of computer-aided design and the simulation was followed.

For future of the guideline, the periodic updating and application of body measurement data will be followed to reflect the newly available data. Also, UIC 651 is need to be revised to reflect the results of the guideline and the worldwide anthropometric data.

A standardized Asian drivers' cab design will bring about drivers' work efficiency, reduction of drivers' cab manufacturing costs, and reduction of driver training costs for railway operators. Also, it is expected to decrease drivers' human errors and railway accidents related to human errors. Therefore, the standardized Asian drivers' cab will help the Asian railway industry boost competitiveness. In addition, this project will form the basis for the next generation of Asian cross-border railway traffic.

Acknowledgements

The authors would like to thank Mr. Vincent VU from International Union of Railways (UIC). This research was supported by a grant from "UIC Asia project on the layout of drivers' cab in Asian rail vehicle" of UIC and R&D Program of the Korea Railroad Research Institute, Republic of Korea.

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