European Cooperation in the field of Scientific and Technical Research

COST 335

Passengers' Accesibility of Heavy Rail Systems

Final Report of the Action

European Commission
Directorate General Transport

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Executive summary

This report is the output of a collaborative European project in which experts from seventeen countries and four international organisations took part. The participants represented railway operating and manufacturing industries, governments and academic experts in the field and representatives of disability organisations.

The purpose of this report is to provide guidance on best practice in meeting the needs of rail travellers with reduced mobility. The material in the report is drawn both from actual operating experience and from research in the participating countries and has been brought together by people with many years of experience in the subject.

The primary audience for this report is the rail industries and the public authorities responsible for transport.

For the purpose of this report, a disabled person is someone who encounters barriers in his or her environment, including transport, which prevent him or her from full and active participation as citizens. This could include people who have impairments, whether long-term or temporary, intellectual, emotional, sensory, communicative or physical, and these may be visible or hidden.

- Disabled people represent around 13% of the population of Europe. This is approximately 63 million people.
- The range of disabilities includes:
  - mobility disabled people (including wheelchair users and people unable to walk far, or at all)
  - sensory impaired people (including people who are totally blind or deaf)
  - people with cognitive and learning difficulties
  - other forms of disability, such as asthma or orientation problems.

- The share of the elderly in the total population of Europe is expected to rise from 21% now to around 31% by 2020, and to around 34% by 2050. Those aged 80+ are predicted to rise from 4% of today's population to some 10% by the year 2050. Thus, the elderly will be a larger part of the population - but with better health conditions than at present.
- When we also take account of accompanying persons and able-bodied people with temporary mobility restraints (such as young parents with baby buggies or with luggage) who would also benefit from accessible railways, we can see that accessibility already affects 35-40% of the population (170 to 194 million people). This potential market for railways could rise to at least 200 million people by the year 2020.

It will progressively become impossible for railways to resist this change. Indeed, given the large numbers of potential passengers involved, it is in the railways' interests to make positive developments to attract the extra passengers.

With regard to access to the train and to the facilities and services provided on the train, the key issues to be addressed are:

- Boarding/alighting through the doorway and the interface between platform and train floor;
- Circulation within the train;
- Seating and/or sleeping accommodation;
- Access to the facilities and services on the train (toilets, catering etc.);
- Provision of information (on board and outside the train).

Railway operators and rolling stock manufacturers must consider the needs of potential users and ensure that the train and the facilities and services provided on the train are accessible to all. This can only be achieved by basing

rolling stock design on functional criteria obtained from the knowledge of human capabilities (design-for-all).

Steps and gaps are a real barrier to persons in wheelchairs and even to persons walking with great difficulties.

Boarding aid devices such as ramps or lifts (at present operated by staff from the platform or from the coach) must be considered as a temporary measure to overcome gaps and steps between station platforms and trains. They pose problems of reliability, staff availability, safety and traffic management. Train operators need to consider technical issues, human factors and economic factors to improve welcome of their customers in the short term.

A real improvement of accessibility to trains for all passengers can only be made when station platforms and coach floor heights are at the same level and the horizontal gap (if greater than 50 mm) is filled by a bridging plate.

Good access benefits passengers because it is easier and safer to board and alight the train, and benefits the operator as it can reduce the stopping-time at stations.

In many ways access to rail travel for many people depends on the lay-out and facilities at railway stations and how well these are maintained. This report sets out its station design and procedure recommendations to planners and transport professionals. Many barriers to rail travel occur at transport interchanges. All rail journeys start and end at railway stations. Therefore it is clear that measures taken to improve access at railway stations are extremely important to the overall journey.

As part of this project a design handbook for accessible stations has been developed. The intention was to create a user-friendly handbook with examples of existing best practice for those responsible for planning and developing

both existing and new stations. The recommendations are not intended to be prescriptive, or to limit innovation. And the drawings provided in the handbook are examples only and are not intended to illustrate the perfect solution.

For the Stations Handbook, certain general features of station design such as visibility, design of steps and ramps are identified, and the design principles to apply to these features are outlined. Then the journey of a passenger through the station is followed, outlining the principles for each specific station feature encountered on the journey.

Everyone travelling by rail needs information in order to travel in safety, in comfort and independently. They need to evaluate the possible choices and then make informed decisions about the journey.

Disabled passengers may need more information than others because they cannot make assumptions about access to the different stages of their journey. In addition, the traditional ways that the rail industry provides information may not suit a disabled passenger – who may have, for example, a sight or hearing impairment and needs the information presented in a format accessible to him. In whatever form information is made available it should meet the four criteria: clear, concise, accurate, timely.

This report shows the various stages of a journey from A to B, the sort of information people need at each stage, and how that information should be provided, including specific information for disabled passengers.

All rail industry staff need training – from the Board to the train cleaning crew. This report shows what the training should cover, in particular for:

- senior and middle management,
- design and development staff,
- front-line staff.

An effective way to instruct staff about the problems and barriers that disabled passengers encounter on their journey is to chart the journey a disabled passenger would make and to identify the barriers en route. In addition, staff need to be fully trained in health and safety issues relating to equipment used, and in the preferred way that disabled people wish to be assisted.

Just as the customer service qualities of job applicants are taken into account in staff recruitment, so attitudes towards disabled people should be considered. Recruiting the right staff to begin with will help ensure than any training provided is effective.

In the context of this study it has not been possible to do a comprehensive cost-benefit analysis, the reasons being that no single equation is possible because every railway in Europe has a different starting point. It may, however, be obvious that because an increase in accessibility results in an increase in the total quality of the rail service, such a service will attract more passengers and therefore generate more income for the transport operator.

The cost can be distinguished between the expenditure involved in making existing rolling stock accessible by retrofitting, and the cost of building new trains on the basis of an accessibility design. Generally, retrofitting is usually more expensive than building new trains, and the additional cost involved for new accessible rolling stock is considered to be relatively minor.

Experience with accessible bus transport in various countries has shown an increase in patronage of some 15%. Conclusions from a 1993 study undertaken in the Netherlands on the effects of accessibility showed that with a minimum scenario of accessibility improvements, the number of journeys by people aged 55+ in rail transport will increase by two additional trips per person per year.

From consideration of the general needs of the rising population of disabled and elderly people across Europe, and the guidance and examples given in this report, it is clear that increases in passenger numbers *can* therefore be achieved through making public transport accessible to disabled people. However, this requires much more than just providing boarding equipment for wheelchair users to get on a train.

What is required is a commitment to a two-fold strategy:

a) The removal of *all* barriers to travel by rail, for *all* members of society.
b) Positive marketing plans to promote rail travel, particularly targeted at individuals and groups who are inhibited by their disability from considering rail travel.

The potential demand can only be reached through a strategy of progressive removal of the barriers to travel affecting disabled and elderly people.

To turn the potential into real demand, railways must develop marketing strategies which segment the demand, identify the key user benefits and communicate with the target markets.

The railways of Europe have much to gain and little to lose from a planned approach to accessibility. Substantial market growth can be achieved, and the potential market for accessible rail travel is already at least 170 million people.

1. Introduction

This report is the output of a collaborative European project in which experts from seventeen countries and four international organisations took part. The participants represented railway operating and manufacturing industries, governments and academic experts in the field and representatives of disability organisations.

The purpose of the report is to provide guidance on best practice in meeting the needs of rail travellers with reduced mobility.The material in the report is drawn both from actual operating experience and from research in the participating countries and has been brought together by people with many years experience in the subject. The primary audience for this report is the rail industries and the public authorities responsible for transport.

The report states clearly that providing full accessibility is not only a necessity on social grounds, it is also both a necessity and an opportunity on economic and marketing grounds.

Disabled and older people represent a significant and growing part of Europe's populations whose desire to travel for business and for leisure represents a potential major new source of revenue for the railways. It is also important to recognise that making facilities and services better for disabled people makes them better for everyone.

The final target is clear and unambiguous: there must be full accessibility for disabled and elderly people to Europe's rail networks. Strategic guidance is given on how this might be achieved.

However, the report also recognises that the industry has, in many areas of Europe, a legacy of old stations, infrastructure and rolling stock and also heavy financial

burdens. As a result, a number of compromises and interim solutions are also demonstrated, which can provide substantial improvements in accessibility relatively quickly and at lower initial cost.

The guidance covers the needs of people with a wide range of impairments: physical, sensory and intellectual. Organisations of disabled people in the participating states have contributed their comments to the draft. The guidance does include a great deal of material specific to the needs of wheelchair users. This is not an indication that they are of greater importance – or indeed as numerous as people with other kinds of impairment. It is simply because in design and operational terms wheelchair users represent the biggest challenge for the industry.

The guidance is not intended to be a definitive text book on accessibility. Circumstances will vary and there is no substitute for involving disabled people at national or regional level in the development of specific projects. It will, however, we hope, stimulate fresh ideas and highlight key issues that will help those responsible for the future of Europe's railways to ensure that they are inclusive of the needs of all our citizens.

2. The case for accessible railways

This chapter summarises the key demographic details and social and legislative trends relating to Europe. These data indicate a substantial *potential* demand, of strategic importance.

2.1. Definition of disabled person

A disabled person is someone who encounters barriers in his or her environment, including transport, which prevents him or her from full and active participation as citizens. This could include people who have impairments, whether long-term or temporary, intellectual, emotional, sensory, communicative or physical, and these may be visible or hidden.

In the last decade many European countries have learned that disability is not only about wheelchair users and, more importantly, that some environments can cause disability in a broader range of the population.

Most people with visual impairments are not totally blind. They have residual vision and require strong colour contrast, adequate lighting, easy to find signs and large lettering to make best use of their vision. People who have speech impairments find it easier not to have to ask for information - and if they are also deaf they will not be able to hear audible announcements. Clarity of visual information helps everybody.

Not all people with hearing impairments are totally deaf. Many of them use hearing aids and require clarity of spoken announcements. A great number of passengers may have difficulty with loudspeaker announcements because of the noisy station environment (train passing along the platform, for example). Clearly spoken information with visual supports helps everyone.

Orientation problems are not only caused by intellectual impairments. Many passengers are strangers in the area or in the country. Many passengers do not know the language and they also need support in finding their way. Pictograms may solve some language problems. Other solutions are the design of stations, especially the physical layout. Too many tunnels and stairs and 180 degree turns will cause disorientation to many a passenger.

And too many shopping kiosks blocking the route may confuse even the most experienced passenger. Feeling lost in a strange station is not limited to passengers with intellectual impairments.

People are increasingly developing allergies, including asthma, and clean air and the use of non-allergenic materials is vital if they are to travel by train. Providing well defined areas of "clean air" is good for everyone.

People with mobility impairments include people walking with canes or crutches, as well as elderly people who walk slowly and cannot carry heavy luggage. They experience difficulties passing over high steps, walking along distances and even using escalators. Accessibility can also benefit a wider range of the population. People with reduced mobility include families with small children and a lot of luggage, including perhaps a pram or a push-chair. And everyone with a suitcase in each hand has difficulty entering a station if the door does not open automatically. It is therefore obvious that everyone will profit from level access and from the increase in comfort. Department stores have understood this for a long time.

And we can all expect to develop mobility, sight, hearing or even intellectual impairments, if we are looking forward to an old age. So the measures proposed in this report are of benefit to us all.

2.2. Numbers and scope of disabled and elderly people

- Disabled people represent around 13% of the population of Europe. This is approximately 63 million people.
- The range of disabilities includes:
  - people with mobility impairments (including wheelchair users and people unable to walk far, or at all)
  - sensory impaired people (including people who are totally blind or deaf)
  - people with learning difficulties
  - other forms of impairment, such as asthma or orientation problems.
- Disability increases with age; approximately two-thirds of disabled people are elderly.
- The share of the elderly in the total population of Europe is expected to rise from 21% now to around 31% by 2020, and to around 34% by 2050. Those aged 80+ are predicted to rise from 4% of today's population to some 10% by the year 2050. Thus, the elderly will be a larger part of the population - but with better health conditions than at present.
- When we also take account of accompanying persons and non- disabled people with temporary mobility restraints (such as young parents with baby buggies or with luggage) who would also benefit from accessible railways, we know that accessibility already affects 35-40% of the population (170 to 194 million people). This potential market for railways could rise to at least 200 million people by the year 2020.
- Without accessible policies, railways can therefore only target 60% of the population.

Figure 2.1. People with reduced mobility

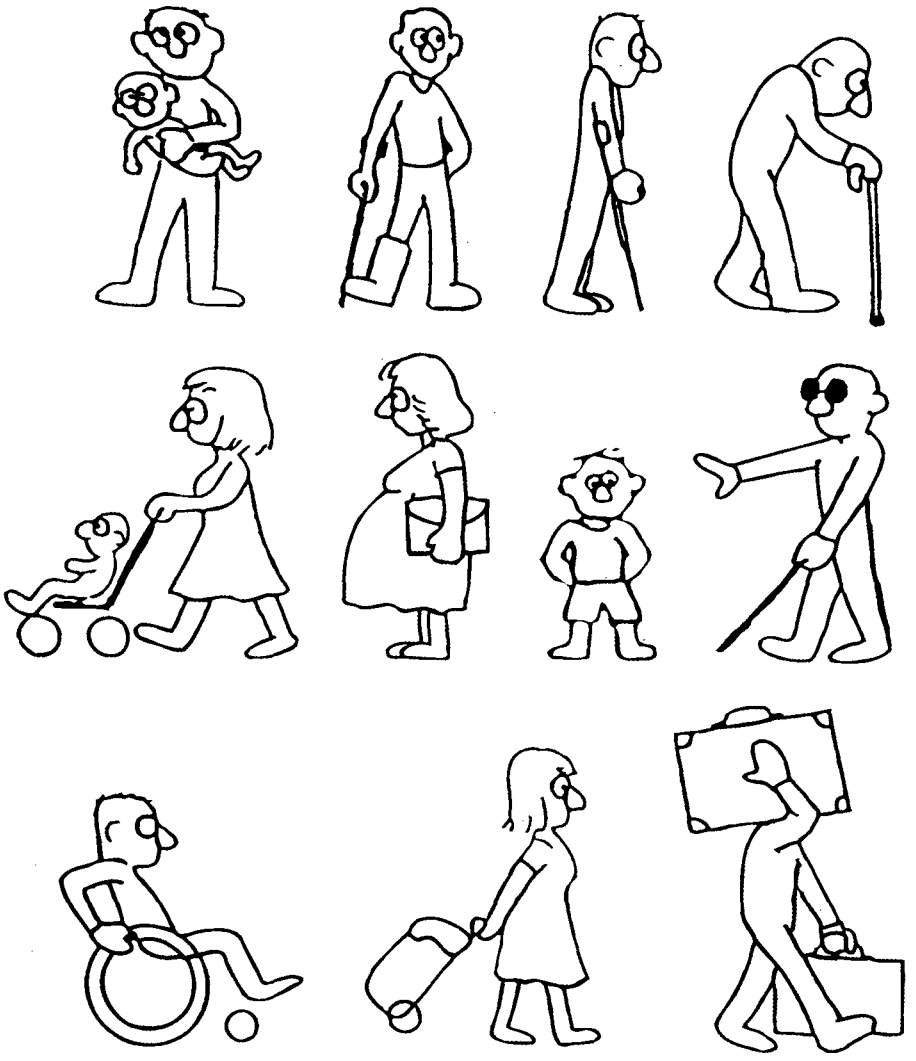
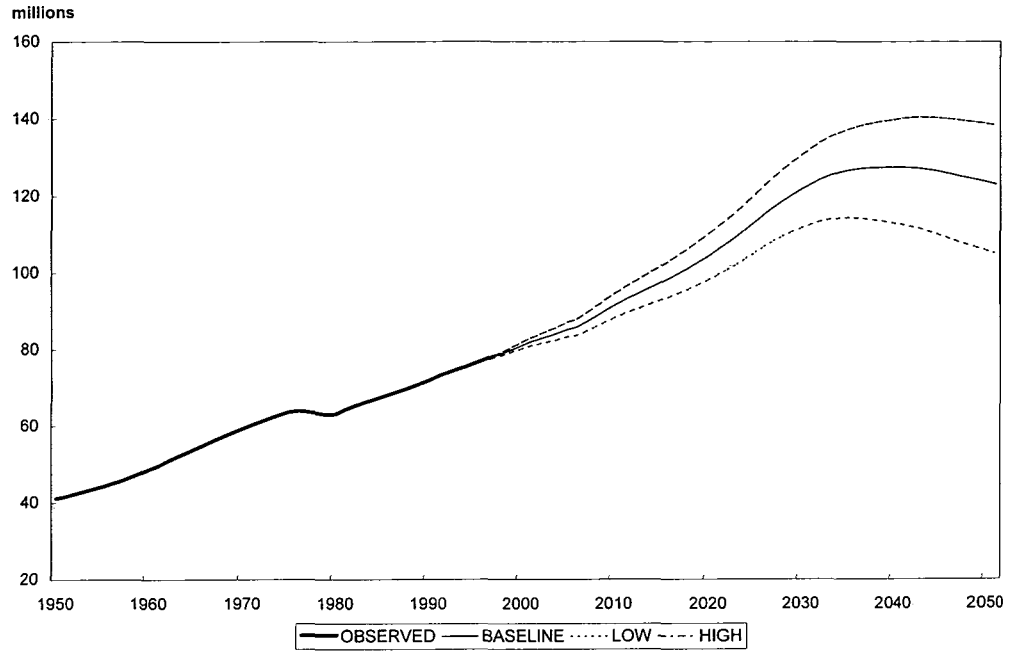


Figure 2.2. Population aged 60 and over - EUR 15



2.3. Social and legislative framework

There has been a progressive increase, over the past two decades, in the social awareness of the requirements of disabled people throughout Europe and in other parts of the world.

This progression has moved from, initially, making provision for disabled people on a welfare oriented basis, towards an increasing demand from disabled people to have equal access to all facilities as a matter of human rights.

All countries now increasingly recognise disabled people as an important part of the population, who are now demanding full integration into society, and full access to all forms of activity: education, employment, and social and leisure activities. It is also recognised that accessible transport is the key to making these facilities available; without the essential transport links, there is no access.

Now this social trend is being underpinned by human rights and anti-discrimination legislation. Reference is made to Resolution 48/96 of the United Nations containing Standard Rules on the Equalization of Opportunities for Persons with Disabilities (1994).

Examples of national legislation are:

- the Act on Facilities for the Disabled on Public Transport (1979) [Sweden]
- the Americans with Disabilities Act (1990)
- the Commonwealth Disability Discrimination Act (1992) [Australia]
- the Disability Discrimination Act (1995) [United Kingdom]

All of these make some provision for accessible transport.

Other countries are considering legislative frameworks along similar lines.

At the European Union level, various initiatives recognise the needs of disabled and elderly people. The principles have been particularly recognised in:

- The Commission Communication on Equality of Opportunity for People with Disabilities (1996).

  This sets out the European Community Disability Strategy and notes, *inter alia*, that many transport systems continue to be inaccessible or accessible only with difficulty and that the principle of "design for all" has cross-sector benefits.
- The Resolution of the Council and of the representatives of the governments of the Member States of the European Union meeting within the Council on Equality of Opportunity for People with Disabilities (1996).

  This underpins politically the principle of equality of opportunity in the development of comprehensive policies in the field of disability.

- The Resolution of the Council on Equal Employment Opportunities for People with Disabilities (1999).

  This calls on Member States of the European Union, within the framework of their national employment policies and in co-operation with the social partners and non-governmental organisations of disabled people, to place particular emphasis on the promotion of employment opportunities of people with disabilities.
- The European Union White Paper on European Social Policy (1994).

  This calls for EU-wide actions to meet the challenges of an ageing population.
- The European Union White Paper on the Common Transport Policy (1992).

  This calls for a Community action programme to include proposals for measures to improve accessibility for disabled people to all modes of transport.
- The Citizens' Network Green Paper of 1996 which stated that accessibility is a major criterion for quality of service.
- The European Union White Paper on a New Strategy for Revitalising the Community's Railways (1996).

These issues are again present in the Key Action on Sustainable Mobility and Intermodality of the Fifth RTD Framework Programme launched by the European Union.

As a result of all these social and legislative initiatives it will progressively become impossible for railways to resist this change. Indeed, given the large numbers of potential passengers involved, it is in the railways' interests to make positive developments to attract extra passengers.

2.4. Identifying the potential demand

A number of studies are being conducted at local level to quantify the actual increase in passengers which would

result if public transport were to become fully accessible to disabled people.

At this stage of development, some of the studies have related to other forms of public transport, but they are nevertheless indicative of positive trends in ridership.

Most of the studies to date have resulted in three clear findings:

a) There has been a discernible increase in the number of disabled passengers resulting from the provision of accessible vehicles.

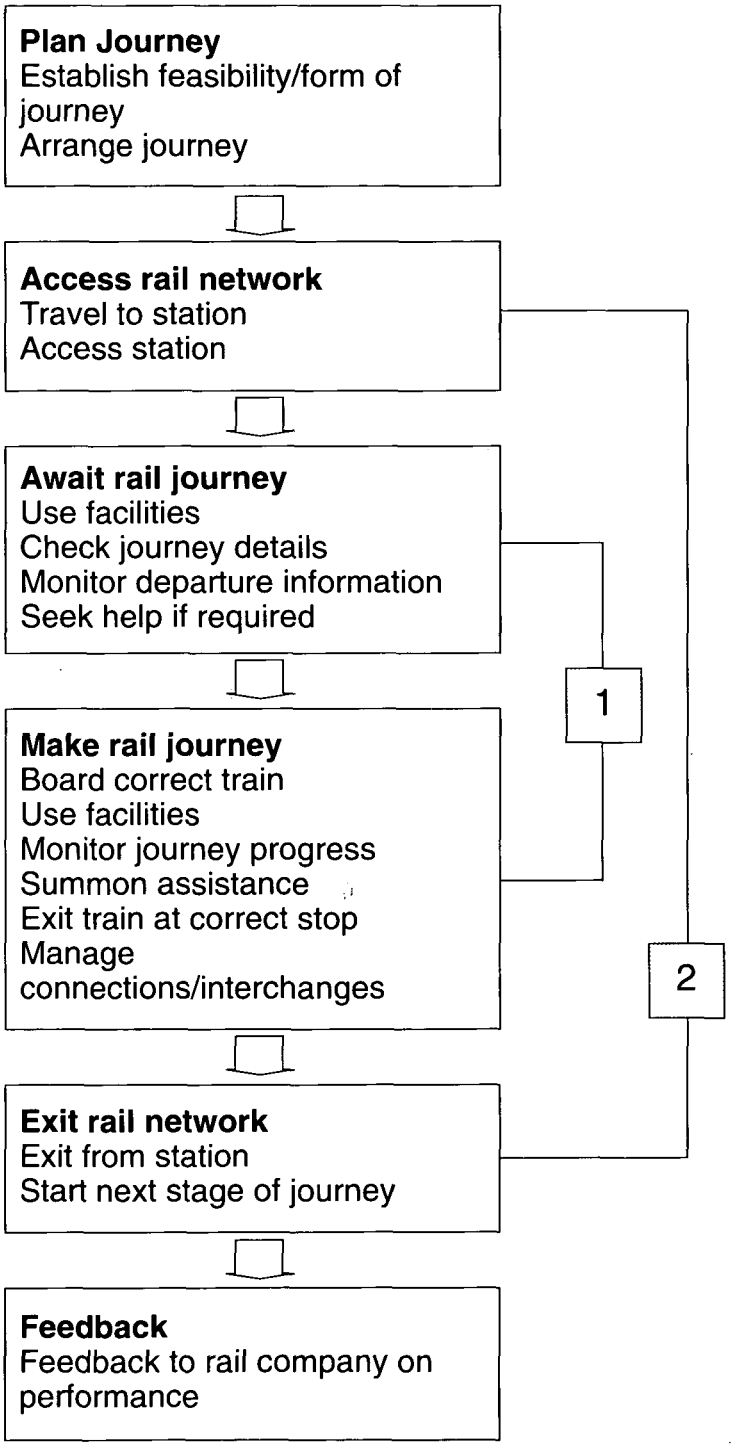
   This has not just been in relation to wheelchair users, where the previous situation was of low ridership due to vehicle design, but also among other people with mobility impairments and those with sensory impairments.

b) There has also been increased ridership of non-disabled people.

   This has included parents with baby buggies, passengers with heavy luggage and many other groups. This makes clear that improvements for disabled people also provide better access for all passengers.

c) By far the best results are obtained when *all* aspects of access are addressed. These include:
   - the rolling stock design and facilities
   - infrastructure, including station design and facilities
   - interoperability of the total system
   - intermodal transfers at stations and termini
   - information - often the key to success
   - staff involvement and training
   - as well as, of course, the surroundings of the stations, including the park and ride facilities and the distances within stations.

Figure 2.3: Main stages in a rail journey



2.5. Removal of barriers to travel

This work has been addressed in detail by several multi-national and multi-functional working groups within the study. The reports of these working groups, covering Rolling Stock Design, Stations, and Information and Training, follow in chapters 3 - 7. It is, nevertheless, important to state here the main barriers which particularly affect disabled and elderly people.

These include:

I. The physical barriers to rail travel
   Access to trains
   Access to stations and station facilities.

II. The financial barriers
   Is the journey affordable?
   Is the fare structure competitive?, etc.

III. The information barrier
   Is the information available?
   Is it comprehensible?, etc.

IV. The confidence barrier
   Can the total journey, there and back, be made with certainty?
   Will there be trained staff to help me when I need them?

V. The time barrier
   Can booking arrangements be made in time?
   Can the train be reached in time, with the help of staff, when needed?

These five elements, of which passengers' confidence is the most important, make up the concept of total accessibility, for all.

The chapters and case studies which follow make many recommendations for the removal of these barriers on all

these aspects. These recommendations are based on both research into the best ways to meet specific needs, and examples of good practice and design being operated in particular areas.

However, the role of governments, both national and European, is crucial to railway operation. Governments have the power to take political, legislative and financial initiatives. COST 335 commits participating countries to removal of barriers to rail travel for disabled people and the initiative offers real hope of government support.

3. Rolling stock design

Passenger accessibility is a very important issue that needs to be addressed when designing rolling stock for rail systems. With regard to access to the train and to the facilities and services provided on the train, the key issues to be addressed are:

- Boarding/alighting through the doorway and the interface between platform and train floor;
- Circulation within the train;
- Seating and/or sleeping accommodation;
- Access to the facilities and services on the train (toilets, catering etc.);
- Provision of information (on board and outside the train).

Railway operators and rolling stock manufacturers must consider the needs of potential users and ensure that the train and the facilities and services provided on the train are accessible to all. This can only be achieved by basing rolling stock design on functional criteria obtained from the knowledge of human capabilities.

3.1. Requirements for passengers with reduced mobility

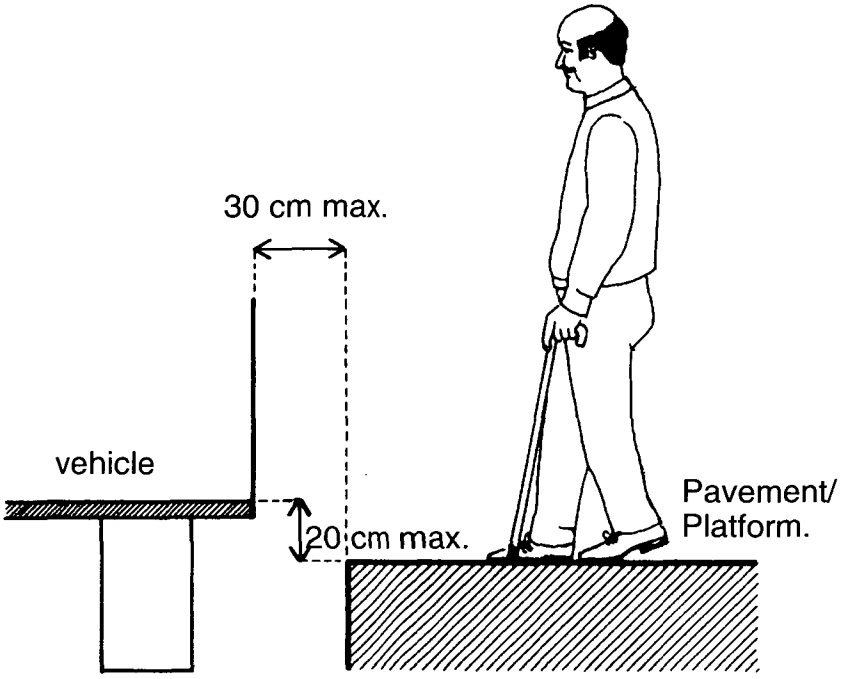
3.1.1. People with mobility impairments

People with mobility impairments most at risk when considering access to the train are those with walking difficulties and those with gripping problems resulting from impaired upper limbs, arthritis, small size etc.

Stepping over the gap between the platform edge and the first step in a coach doorway, and climbing any other steps is a difficult manoeuvre for people with walking difficulties, even if ergonomically designed handrails are provided. The maximum gap and step dimensions that can be tolerated

are shown on figure 3.1. Shorter gaps should be looked for, so that they require less effort and concentration.

Figure 3.1. Gap or step requirements for motor impaired people (source Oxley, 1985)



Access along a corridor, through a vestibule and interior door may require a wider throughway for people who have walking difficulties than for wheelchair users, especially for those with walking sticks or crutches. The preferred minimum width for a throughway would be 1 m. However, for circulation within the train the requirements for a wheelchair user should be manageable by other people with mobility impairments.

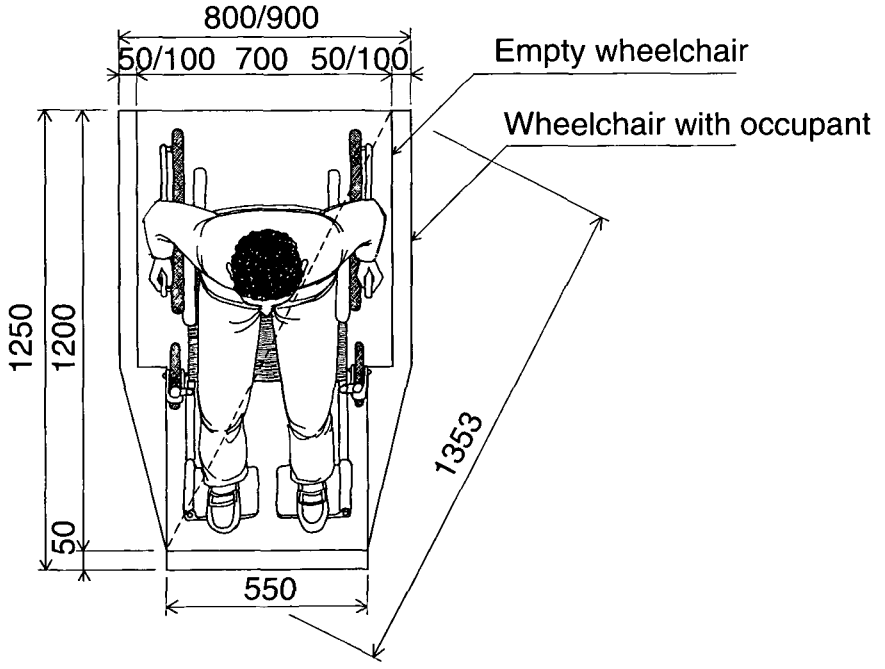
Handrails and handholds provide essential help at doorways into coaches and for circulation within the train, especially when the train is moving. In order to provide an efficient grip, attention should be paid to their position and shape. More details are given in the following sections.

Push buttons (call for stop, door opening, emergency etc.) should be designed and located for easy identification and operation.

3.1.2. Wheelchair Users

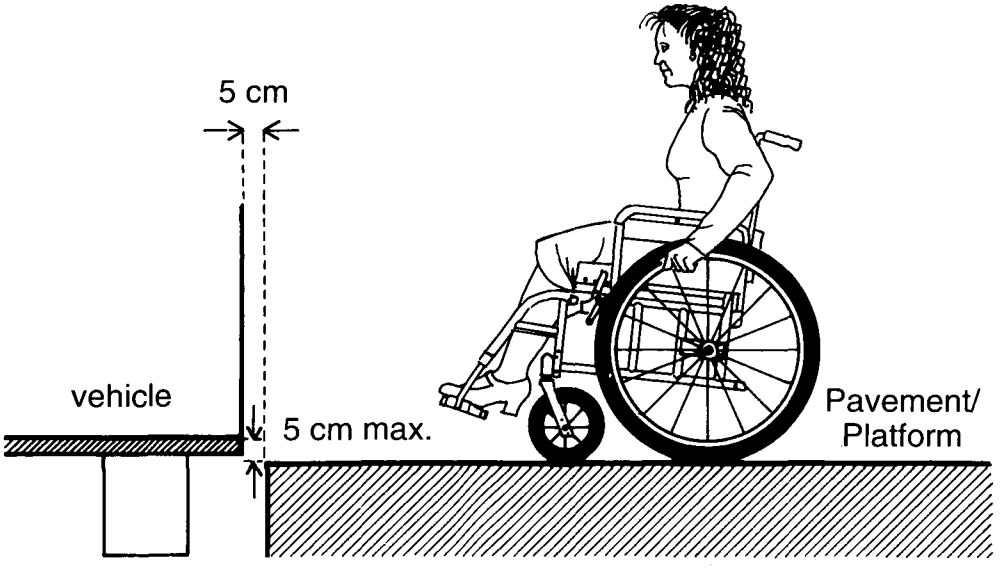
Wheelchair shapes and dimensions vary considerably. Manually operated wheelchairs are the most common in use, although electrically powered models are becoming more numerous in many European countries. For the practicability of access to trains, the minimum acceptable dimensions for an occupied wheelchair are derived from the unoccupied wheelchair dimensions in ISO Standard 7193 (figure 3.2), but take into account the heavier weight of electric wheelchairs (total load at least 300 kg).

Figure 3.2. Figure of wheelchair-measurements



Crossing a gap is the greatest difficulty for a wheelchair user, mainly due to the small front wheels. The maximum recommended gap dimensions are shown on figure 3.3.

Figure 3.3. Maximum gap dimensions for wheelchair users without assistance



Going up and down a ramp is another demanding manoeuvre for a wheelchair user without assistance. Useful information has been gathered from experience with access ramps in low-floor tramways and buses. Wheelchair users can cope with steeper gradients than for street infrastructure, provided that a handrail can be grasped in the doorway or corridor and that the upstands at both ends are minimal. However, the maximum gradient that can be managed is dependent on the length of the slope, the requirements for which are detailed in the following sections. It must be stressed that assistance may be needed to passengers using a manual wheelchair and having weak strength in their arms.

Passing along a corridor and through a doorway requires a clear width greater than the width of the occupied wheelchair to allow space for hands and elbows.

Access to the wheelchair space and to wheelchair accessible facilities (including the vestibule) may require

sufficient space to enable a wheelchair to be turned through 180°.

Push buttons should be reached, identified and operated easily.

Unobstructed clearance should be provided underneath a table or wash basin that is to be used by a wheelchair user.

Safety for wheelchair users during a train journey should be ensured at the same level as for other passengers. The wheelchair must be positioned facing or back to the direction of travel to maintain its stability. A restraining device for the wheelchair or for the occupant is not considered necessary for safety, as the dynamic forces in a train are lower than in road vehicles.

Access to catering services and other facilities: Where catering services and other facilities (telephone, fax machines) are available in the train, access to them should be provided by direct access to the appropriate area. Where it is not possible (existing or refurbished rolling stock) it must be provided by other means such as a trolley service or a special service upon request.

When toilets are fitted in a train, an accessible toilet must be provided adjacent to the wheelchair accessible area.

Further details are provided in the following sections.

3.1.3. Sight Impaired People

Blindness implies a total or near total loss of the ability to perceive form. Low vision implies an ability to utilise some aspects of visual perception, but with a greater dependency on information received from other sources.

To assist sight impaired people, highly visible and tactile indications should be used on or adjacent to all power-

operated controls throughout the train. The height of the tactile indications above the floor level should be consistent.

When designing on board and external information using pictograms and text, consideration should be given to:

- Colour and tonal contrast
- Colour/tonal combinations
- Intensity of light and luminance
- Legibility of text characters: type size (which depends on the viewing distance and angle), typeface style, contrast
- Glare and reflections.

3.1.4. Hearing Impaired People

Hearing impairment can affect the whole range or only part of the auditory spectrum which, for speech perception, the important region is between 250 and 4,000 Hz. Hard of hearing persons are those with mild to severe hearing loss but who can benefit from amplification.

Sound systems with loudspeakers should be designed with the aid of professional advice. Providing more loudspeakers allows for a reduction in volume without reducing penetration of the sound. Attention should be paid to the quality of recording devices when used.

Passengers who have hearing aids with "T" (telephone) switches can amplify sound via low-cost induction loop systems.

3.1.5. Safety issues

Safety and emergency situations need special consideration when disabled passengers are on board the train. For example, visually impaired people may not notice a flashing light, hearing impaired people will not hear train failure and emergency announcements, and people with

mobility impairments may need assistance in case of emergency evacuation of the coach.

- In the case of failures and emergencies, train staff must inform the passengers and give oral instructions. Recommendations for information systems appropriate for sight and hearing impaired people are described in the report. However, train staff must always make sure that the information has been received.
- Controls for assistance and emergency alarms are fitted in the coaches. Special control systems must be provided in the accessible toilet as well as in the designated area for wheelchair users. Recommendations on their appropriate location and design are given in this chapter.
- Disabled passengers may need special assistance for evacuation in case of emergency. Particularly difficult situations may be encountered if the train has to be evacuated to the ground level and even more so within a tunnel.
- Failure of mechanical or electrical systems may be encountered on a train during a journey. It is important that any special access equipment incorporates emergency means of deployment so that wheelchair users can be safely disembarked from the train.

Appropriate emergency procedures must be produced and approved and all the train staff and rescue teams must be trained in the use of the procedures.

It may be worth considering the procedures and special equipment in use with:

- Eurotunnel for the Shuttle,
- SLTC (Societe Lyonnaise de Transport en Commun) for the accessible underground line in Lyon (France).

3.2. Access to the train

3.2.1. General Remarks

Designing good access to the train provides advantages not only for disabled people but also for all other passengers and for the operator.

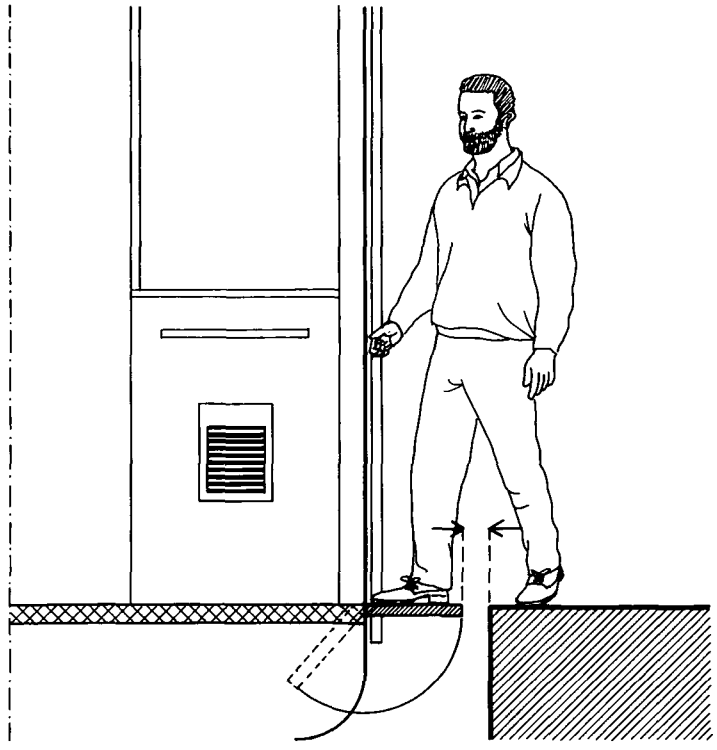
Good access benefits passengers because it is easier and safer to board and alight the train, and benefits the operator as it can reduce the stopping-time at stations.

Whereas underground and some suburban railways operate on dedicated infrastructure, most main line and long distance trains share the infrastructure with freight traffic, which puts constraints on their design. Steps and gaps are often difficult to avoid, which causes considerable problems to disabled people, especially to wheelchair users.

A real improvement in accessibility for all passengers can only occur if platform and coach-floor heights are at the same level (figure 3.4). Unfortunately to achieve this 'level access' on existing railways would mean in most instances new installations and/or new trains.

The requirements given below are for future main line trains operating over existing infrastructure. All new railway systems should comply with the optimum requirement for a level access between platforms and trains.

Figure 3.4. Level access for new railways



3.2.2. Access Doors

Train access doors must fulfil the following requirements:

- Contrasting colour and tone should be used for easy identification of the doors, steps and handrails.
- The entrance should be well illuminated.
- Access doors must be clearly identifiable by sight impaired people.

  Spaces between coaches should be distinctively different from access doors.
- Access doors must have an effective clear throughway of at least 800 mm. *The preferred minimum dimension is 850 mm.*
- Door opening and closing should preferably be automatic or remotely operated.

- Door operation, if not automatic, should be by means of simple control devices (push-buttons, levers etc.) in contrasting colour and tone to the background (red should not be used as this is associated with stop or danger). Control devices should be operable with the palm of the hand and must not require a force greater than 10N to operate. The highest point of any control device must be at a maximum of 1300 mm above the floor, *although 1200 mm is preferred.*
- Control devices should be illuminated for easy identification and have tactile indicators in a contrasting colour on or adjacent to them.
- A system to lock the doors automatically while the train is in motion must be provided. Also, the system must only enable doors on the platform side of the train to be opened when standing in a station.
- An audible signal and a visual signal (flashing light etc.) should be provided both inside and outside the coach as a warning that the doors are about to close.

3.2.3. Steps, Handrails and Handles

Train access doorways must fulfil the following requirements:

- The vertical gap between the platform and the bottom step, and the height of each step, when there are more than one, must not be greater than 200 mm.
- Steps should have an effective tread depth of 280 mm and must not be less than 200 mm.
- Overhanging step nosings should be avoided.
- A horizontal gap should not exceed 300 mm.
- Doorways with more than one entrance step must be provided with non-slip handrails on both sides of the doorway, fitted internally as close as practicable to the coach outer wall. *100 mm is the preferred maximum distance.* They must reach to a height of between 800

mm and 900 mm above the bottom step and must be parallel with the line of the step nosings (see figures 3.5, 3.6, 3.7). A vertical handrail must also be provided for motor impaired people when stepping on and off the train (see figure 3.5).

- Doorways with only one entrance step must be provided with vertical, non-slip handrails on both sides of the doorway, fitted internally as close as practicable to the coach outer wall. They must extend from 700 mm to 1200 mm above the threshold of the first step.
- All handrails must be round in section with a diameter of between 30 and 35 mm and must have a clearance of at least 45 mm to any adjacent surface for easy grasping. Also, they must be in a contrasting colour to the background surface for easy identification.

Figure 3.5. Steps, handrails and handholds

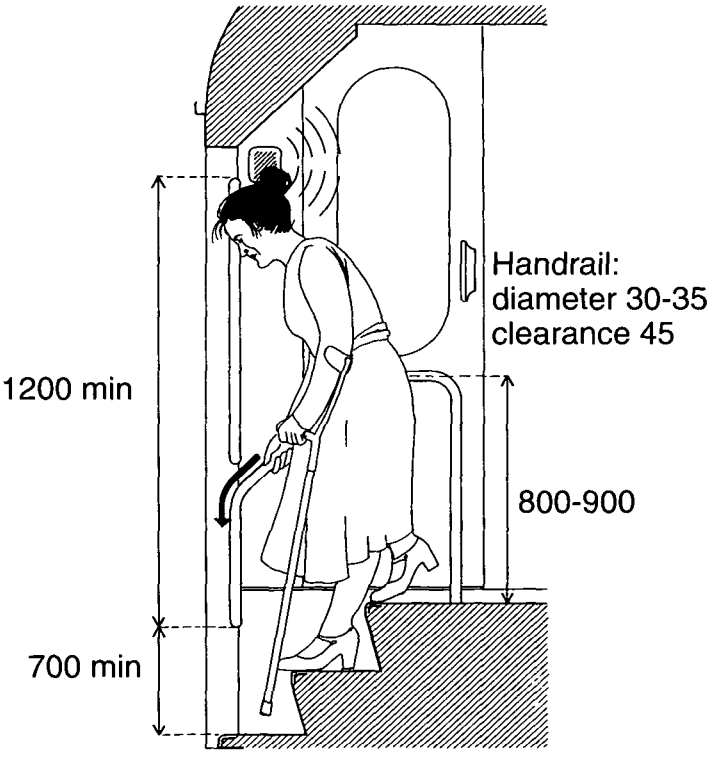


Figure 3.6. Steps, handrails and handholds

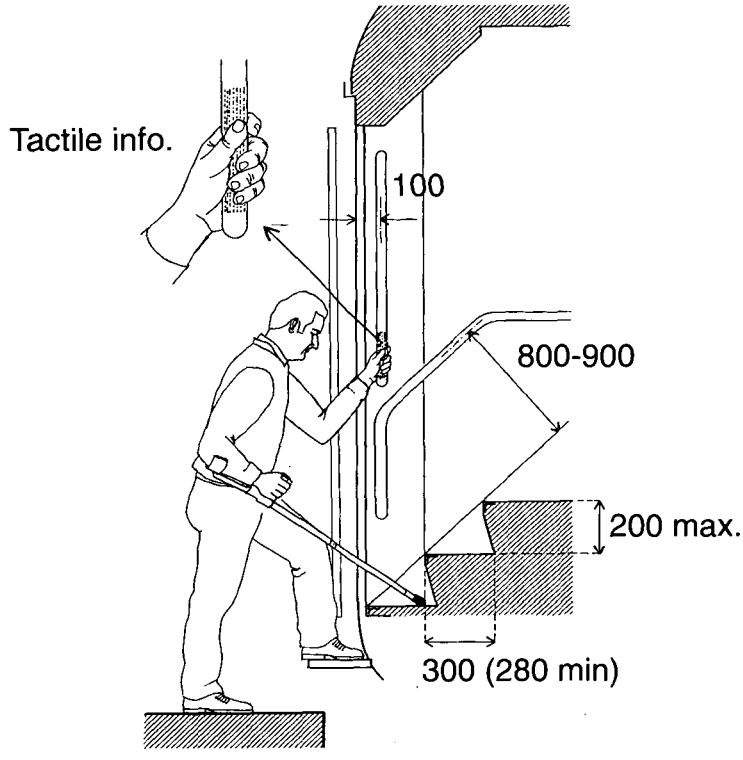
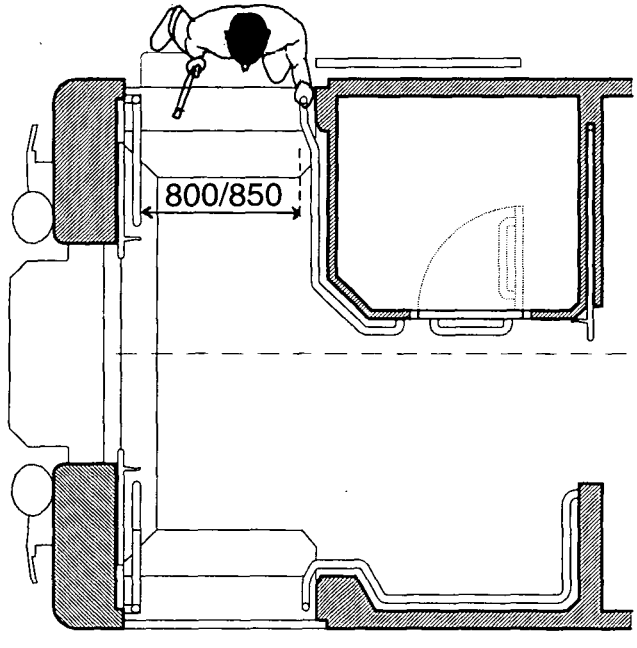


Figure 3.7. Steps, handrails and handholds



3.2.4. Special access requirements

To allow a person in a wheelchair to board and alight the train without additional help, the horizontal and vertical gaps between the platform and the train floor must *not be greater than 50 mm* (figures 3.8, 3.9)

Figure 3.8. Wheelchair users' abilities to pass over horizontal and vertical gaps

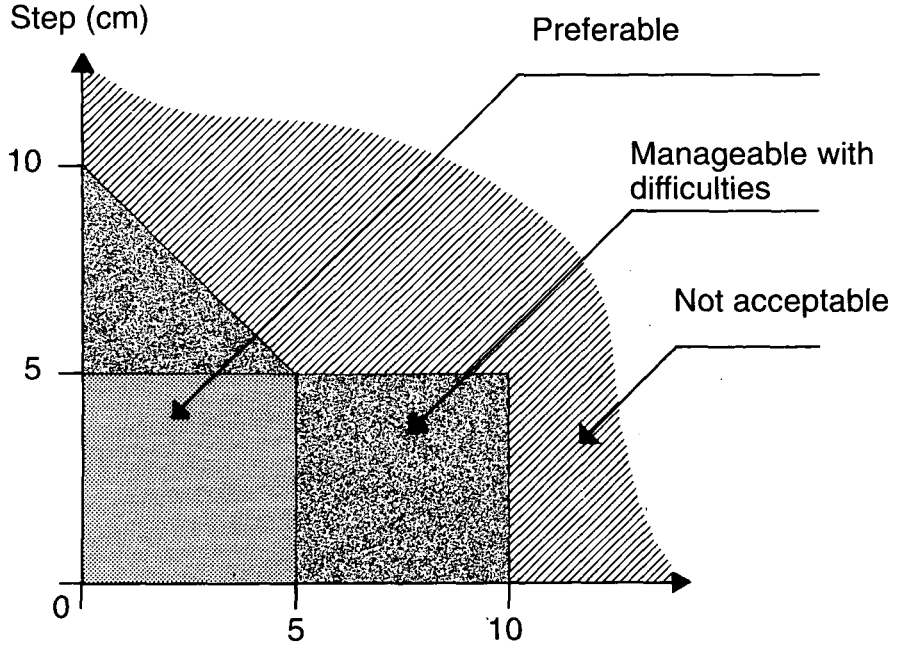
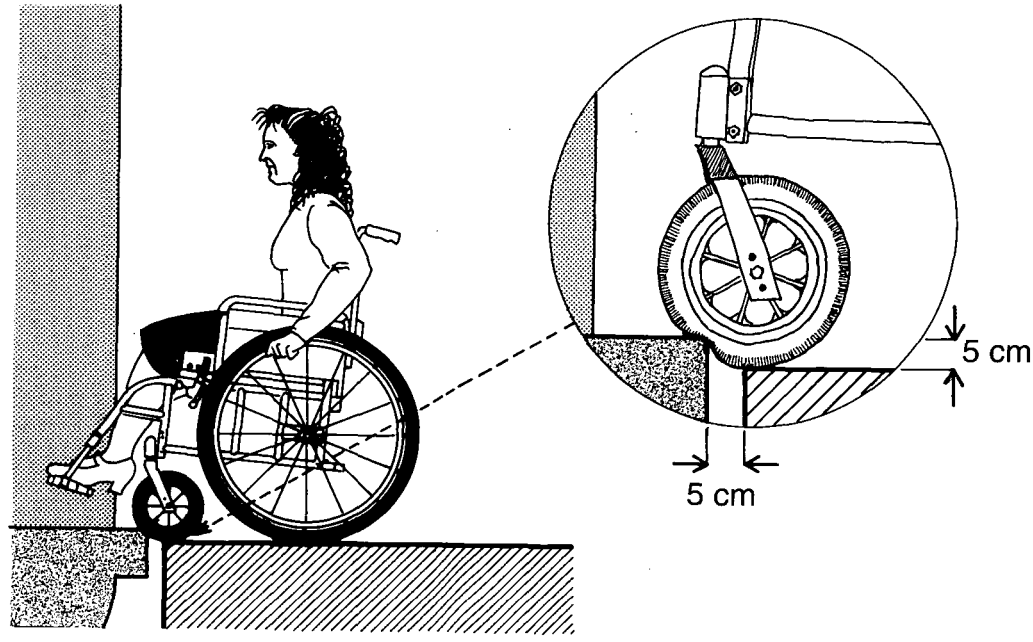
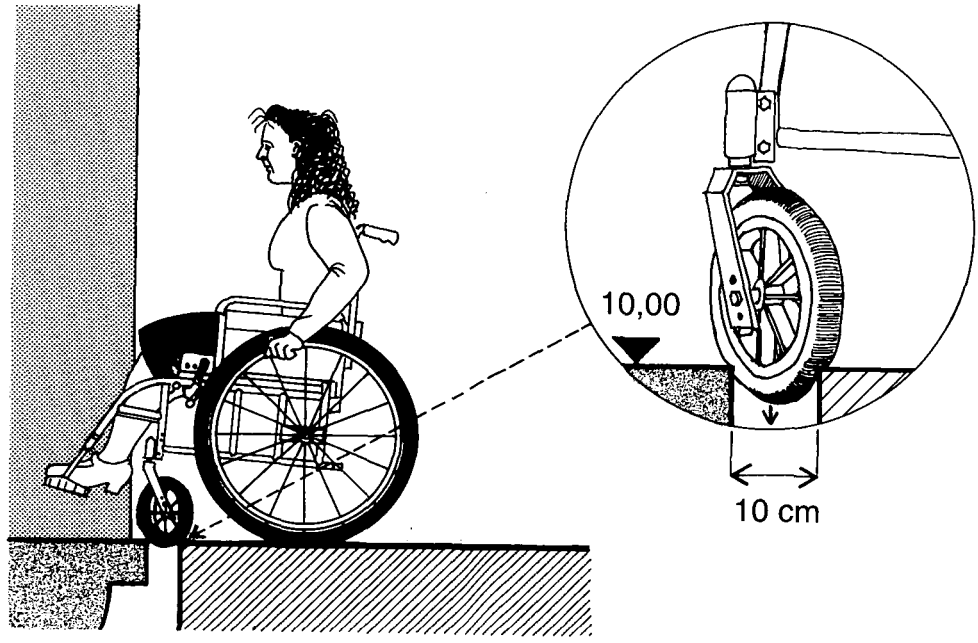


Figure 3.9. Recommended horizontal and vertical gaps for wheelchair users





Greater gaps in existing railway systems must be bridged with special devices. Several alternatives may be considered allowing, among other things for operating constraints, to ensure accessibility of the coaches fitted out to accommodate passengers in wheelchairs namely and those with severe mobility impairments:

- Access or bridging ramp: a ramp either manually put into place by staff or deployable by mechanical means and operated by staff or passenger.
- Bridging plate: a fully automatic device, integrated in the coach floor which ensures step-free access when the gap is small.
- Platform lift, operated by station staff to overcome a significant height,
- On board lift, integrated in the doorway and operated by train staff to overcome a significant height.
- Partially raised platform, located where the accessible coach door(s) stands at stop.

This issue is developed in chapter 4.

3.3. Circulation within the train

3.3.1. General remarks

Relevant facilities and installations, priority seating for use by disabled people, luggage stacks for passengers boarding with luggage, prams etc. should be accessible to all passengers. In order that disabled people should not have to walk any distance through the train, they should be situated near to the entrance doorways. Internal doorways designated for wheelchair access must provide sufficient throughway and space for necessary manoeuvres (see paragraphs 3.3.3 and 3.3.4).

An ideal solution is to locate the service facilities and installations (for example restaurant, catering) in one or two

coaches in the middle of the train. Where catering and other services are not accessible to disabled passengers, they must be provided by alternative means, such as a trolley service or a special service, upon request.

Steps and stairs are an obstacle for disabled passengers. There should be no steps inside the coach between the doorway and any area designated for the use of disabled passengers.

3.3.2. General design criteria

- All public areas should be evenly lit to enable passengers to safely manoeuvre through the train. High lighting levels alone will not necessarily result in good visibility. To ensure good visibility, harmony between the following factors is required:
  the lighting level.
  the light reflectance (or luminance).
  the colours of objects and surrounding area.
  the contrast between the object and surrounding area.

Further information is given in tables 3.1 and 3.2.

- Contrasting colour and tone should be used for easy identification of the doors, steps and grab handles.
- Shiny surfaces should not be used for interior vertical partitions.
  Where transparent panels such as glass are used, other than for coach windows, they should be clearly identified by a band of colour or other highly visible means.
- All floor surfaces should be skid resistant in all weather conditions.
- The entrance vestibule should contrast in colour and tone with other passenger areas by any means of differentiation (e.g. the floor surface).

- A strip of floor surface, of contrasting colour and tone, should be provided within 100 mm of the edge of the door sill. The strip should extend the full width of the external doorway to a depth of at least 80 mm.
- In order to enable people with mobility impairments to circulate safely, regularly spaced handrails and handholds should be provided throughout the train including passenger saloons, corridors, vestibules and inter-coach gangways.
- All handrails and handholds must be in a contrasting colour with the background.
- Sharp corners, edges and overhanging features should be avoided or must be very clearly identified.

3.3.3. Interior doors

- Interior doors should open automatically or semi-automatically and must remain open long enough to enable disabled people and passengers with heavy luggage to pass through safely.
- Door opening, if not automatic, should be by means of a simple control device (push-button, lever etc.) in contrasting colour and tone to the background (red should not be used as this is associated with stop or danger). The control device should be operable with the palm of the hand and must not require a force greater than 10N to operate. The highest point of the control device must be at a maximum of 1300 mm above the floor, although 1200 mm is preferred.
- Interior doors providing access to the priority seats and to luggage storage should have a minimum clear throughway of 800 mm. For interior doors providing access for wheelchairs, the preferred minimum clear throughway is 850 mm.
- Doors incorporating glass or any other transparent material should be highlighted with clearly visible

features (such as coloured strips) at eye level (about 1500 mm) and preferably at lower eye level (about 900 mm) for children, small passengers and wheelchair users.

3.3.4. Corridors and vestibules

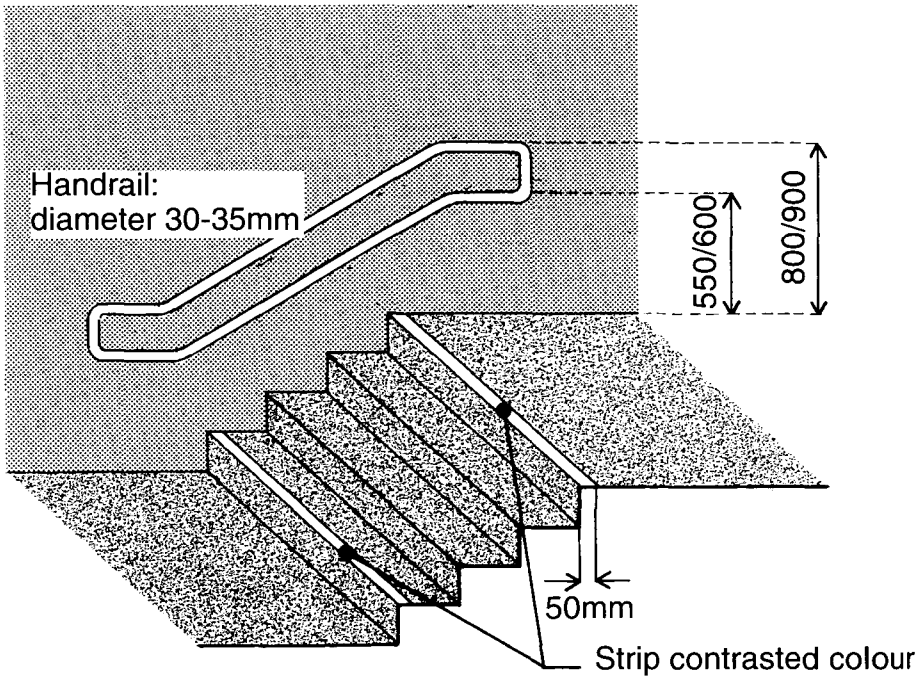
- Aisles and corridors for the use of disabled people should be at least 800 mm wide. *Where access for wheelchairs is required, the preferred width is 900 mm.*

- Sufficient space should be provided to enable a wheelchair to turn through 180. Space to enable a three-point turn is acceptable, although *a turning circle of 1500 mm diameter is preferred.*

3.3.5. Steps and stairs

- Where steps are unavoidable, each step should have a maximum height of 200 mm and a minimum depth of 280 mm. *The preferred depth is 330 mm.* Overhanging step nosing should be avoided.
- Staircases (2 or more steps) must be provided with two parallel non-slip handrails on both sides, installed at heights of 550-600 mm and 800-900 mm relative to the bottom step and must be parallel with the line of the step nosing. The handrails should extend beyond the first and last steps (figure 3.10). If a handrail is curved, the radius to the inside face of the curve should be a minimum of 50 mm.
- As a minimum, the edges of the first and last steps must be indicated by a strip of contrasting colour and tone of at least 50 mm breadth extending the full width of the steps on both the front and the top surfaces of the step nosing.

Figure 3.10. Stairs and handrails



3.3.6. Handrails and Handholds

- All handrails must be round in section with a diameter of between 30 and 35 mm and must have a clearance of at least 45 mm to any adjacent surface for easy grasping. Also, they must be in a contrasting colour to the background surface for easy identification.
- Handrails curved along their usable length must have a minimum inside radius of 50 mm.
- Handholds or vertical handrails and/or oblique handholds on the backs of aisle-side seats should be provided at regular intervals to aid safe circulation through the coach.
- Handholds must be positioned at between 800 and 1000 mm above the floor.
- All handrails and handholds must be structurally sound.

3.3.7. Interior Ramps

Where ramps are unavoidable, the following gradients are considered acceptable because of the limited space inside railway coaches.

ramp length	ramp slope
>1000mm	max. 8%
600-1000mm	max. 13%

A steeper slope up to 18% for a maximum length of 600 mm is acceptable only *for existing or refurbished coaches.*

Handrails shall be provided in accordance with the specifications above (paragraph 3.3.6).

3.4. Accommodation during the journey

3.4.1. General remarks

This section considers the accommodation requirements for disabled passengers so as to ensure that their journey can be made as easily and as comfortably as possible.

Some seating must be identified as Priority Seating. These seats provide easy and unhindered access for disabled passengers who want or need to use them. Identification of these seats makes it easier for disabled passengers to claim them.

This section also concentrates on the requirements for wheelchair accomodation within the designated coaches. It is important that access between the wheelchair accessible doorway and the saloon can be achieved easily and in a forward direction.

Although not specifically referred to in this section, any other features requiring passenger interface that may be provided within the priority seat area and the wheelchair

designated space, such as lighting controls, should be within easy reach from the seated position.

As operators are not all starting from the same point, the number of priority seats and wheelchair spaces provided per train set has to be a matter of local determination. The following principles are recommended:

- A minimum of 10% of seats or a minimum of 8 seats on each coach should be designed and designated as priority seats for use by disabled people.
- Every train set, new or refurbished, must have a wheelchair space.
- It is a matter of equality of opportunity to travel that wheelchair spaces be provided in every separate class of accommodation which is available to able bodied passengers.
- It is much better to provide at least two wheelchair spaces together; because wheelchair users may be travelling together.
- It is not necessary to equip every coach in a train set. However, long train sets should have more than the minimum number of wheelchair spaces and priority seats.

3.4.2. Priority seats

General specifications for all priority seats:

- Each priority seat shall be clearly identified by a notice with a strict obligation to give up the seat to a person who needs it. The notice shall be positioned on or adjacent to the relevant seats. The universal wheelchair symbol is not appropriate to be included in this notice, nor is any symbol that conveys illness.
- A minimum of 10% of seats on each coach should be designated as priority seats for use by disabled people.

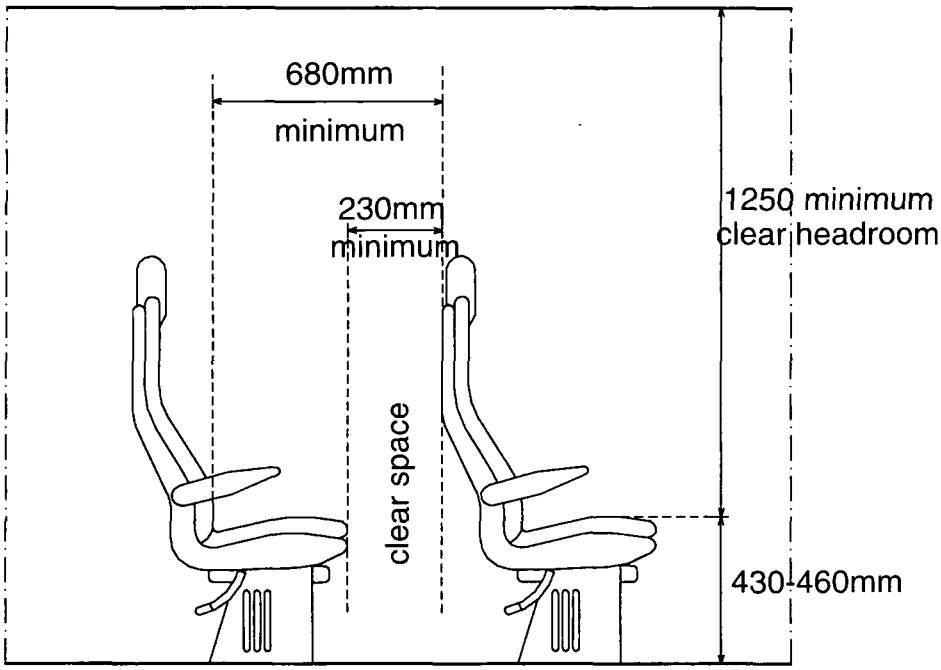
- The priority seats should be located immediately adjacent to the entrance vestibule and, in the case of double-deck coaches, some of the priority seats must be on the entrance level.
- The seat cushion for each priority seat must be at least 450 mm wide.
- To improve the ease of standing from the seated position, the top of each seat cushion must be between 430 mm and 460 mm above floor level at the front edge of the seat. The clear headroom above each seat must be at least 1250 mm from the top of the seat cushion.
- Seating that is provided specifically for wheelchair users to transfer into should have the seat cushion at 450 mm above floor level at the front edge of the seat.
- Priority seats must be equipped with movable armrests that should move to the extent required to enable unrestricted access to the seat or to any adjacent priority seat.
- Priority seats must not be capable of being tipped-up to create space for a wheelchair or for luggage storage.
- Where practicable, all priority seats should have a clear space underneath for an assistance dog. A minimum of two priority seats per coach must have a clear space beneath.
- Priority seats should be provided, wherever possible, in a mix of uni-directional seats and facing seats so there is a choice for individuals or for groups of people travelling together. The provision of facing seats is particularly important to speech impaired and to hearing impaired persons.

3.4.3 Uni-directional seats

- Where uni-directional seats are provided, there must be adequate clearance in front of each seat so as to ensure ease of access. As shown on figure 3.11, there must be

a minimum distance between the front surface of the seat back and the vertical plane through the rearmost part of the seat in front of at least 680 mm. There must also be a minimum clear distance between the front edge of the seat cushion and the same vertical plane for the seat in front of at least 230 mm.

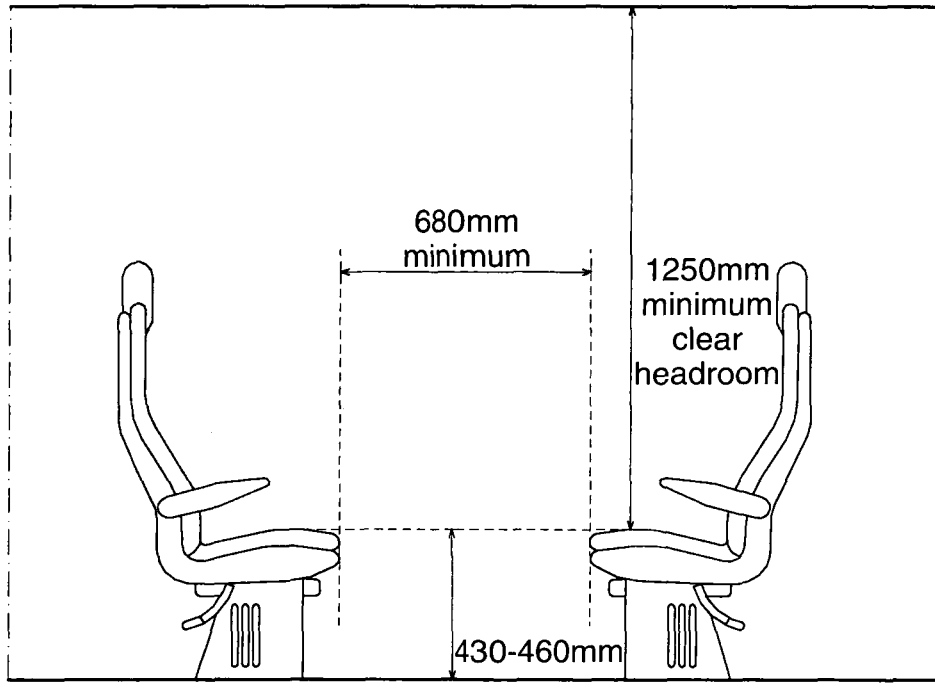
Figure 3.11. Uni-directional seats



3.4.4 Facing seats

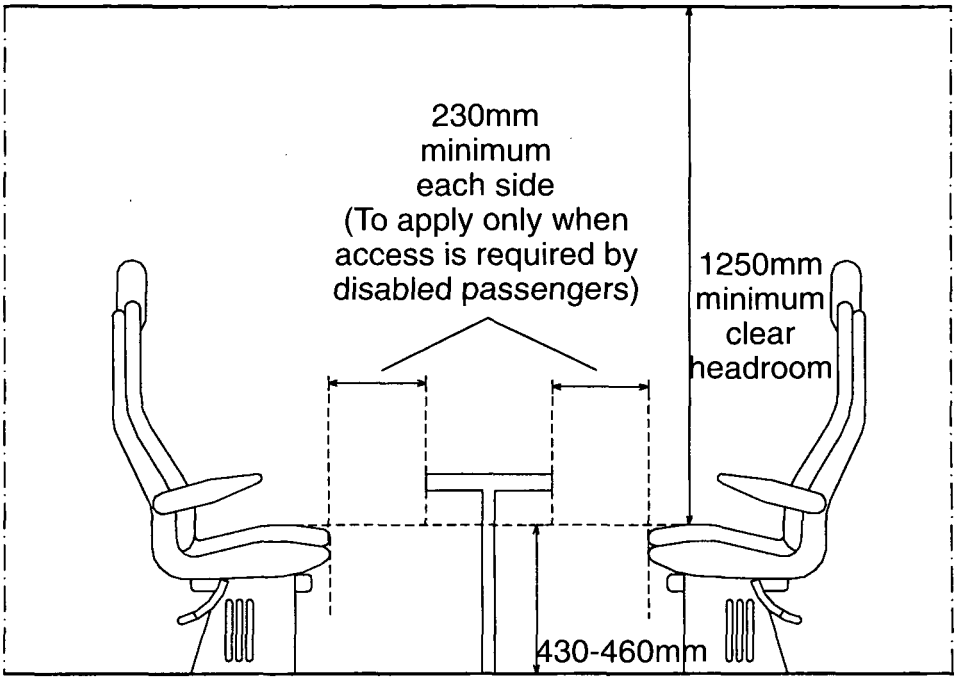
- Where facing seats are provided the distance between the front edges of the seat cushions must be a minimum of 600 mm (figure 3.12).

Figure 3.12. Facing seats



- Where facing seats are equipped with a table, there must be adequate clearance between the front of each seat and the edge of the table so as to ensure ease of access. There must be a minimum clear horizontal distance between the front edge of the seat cushion and the leading edge of the table horizontal of at least 230 mm (Fig. 3.13).

Figure 3.13. Facing seats with table



3.4.5. Reserved space for wheelchair users

Specifications for the Designated Space

- A clear space for a wheelchair, called here the designated space, must be provided in a passenger area immediately adjacent to a wheelchair accessible doorway.
- The space or spaces must be clearly identified by the International Symbol of Access (the wheelchair symbol).
- Sufficient space must be provided to enable a person in a wheelchair to manoeuvre between the accessible doorway and the designated space including space to enable a 180° turn.
- The minimum clear area for a designated space must be 1300 mm in the longitudinal plane of the coach by 750 mm in the transverse plane. *The preferred dimension is 1400 x 800 mm.*

- To maximise seating capacity within the coach it is permissible to provide tip-up or fold-up seats in the designated space provided that the above clear space is maintained.
- There must be no obstruction of the designated space between the floor and the ceiling of the coach other than an overhead luggage rack, a horizontal handrail attached to the wall or ceiling of the coach or a table in accordance with recommendations below.
- No features or fittings for the use of other passengers (magazine racks etc.) must be provided within the designated space.
- To ensure stability of the wheelchair under all operational conditions the designated space must be designed for the wheelchair to be positioned either facing or back to the direction of travel.
- There must be a structure or other acceptable fitting at one end of the space at least, that must have a minimum width of 700 mm, measured at floor level, and have a height capable of preventing a wheelchair which has been positioned with its back against the structure or fitting, from tipping over backwards.
- Wheelchair restraint systems are not generally required. However, where a restraint system is provided it should be easily operated by a wheelchair occupant, it should not cause an obstruction to access and egress and it should not represent a hazard to other passengers.
- A horizontal handrail should be provided on the side wall of the coach in the designated area. The handrail shall have a slip-resistant surface and must colour contrast with the side wall of the coach. The handrail should be at a height of between 700 and 800 mm above the floor, should be round in section with a diameter of between 30 and 35 mm and have a minimum clearance of 45 mm to the adjacent surface.

- Associated seating should be provided adjacent to the designated space for the use of accompanying passengers.
- Where tables are provided in the passenger area, the designated space must be provided with a table giving an unobstructed clearance of 720 mm between the underside of the table and the floor. The table may be fixed or designed to be hinged or folded away, but it must not obstruct wheelchair access into and out off the designated space. Any table designed to be hinged or folded away must be capable of being easily operated by a person in a wheelchair.
- For those passengers who prefer to transfer out of their wheelchairs, a stowage space, which can accommodate a folded wheelchair, should be provided adjacent to the designated priority seat.

3.4.6 Emergency Alarm

- An emergency alarm must be fitted in the designated space within easy reach of a passenger in a wheelchair. The alarm control must be operable by palm or any part of the hand press and must not require a force exceeding 10N to be operated.

- The alarm must sound a warning that will be heard by a member of the train staff who can take the necessary action. An intercom system is acceptable but other voice systems should not be used. A visual and audible indication that the alarm system is working should be provided adjacent to the designated space.

- The alarm device may be designed to be activated only when a person in a wheelchair is in the designated space.

3.5 Service Facilities

3.5.1. General remarks

On board facilities and services should be accessible to all passengers.

Where this is not possible, alternative means must be provided to ensure that disabled passengers get equivalent amenities as all other passengers.

3.5.2. Toilet specifications

General specifications for all toilets

- The centre of any door handle, lock or door control device on the exterior or interior of the toilet compartment must be located at a minimum of 800 mm and a maximum of 1200 mm above the floor.
  They must be of a suitable size and form to enable easy operation.
- Any door control device, and other equipment inside the toilet compartment must require a force of not greater than 10N to operate.
- Any control device, including flushing system, should be provided in a contrasting colour and/or tone to the background surface, and should be identifiable by touch. Clear, precise information for the operation of any control device must also be provided, making use of pictograms.
- Fixed vertical and/or horizontal handrails should be provided adjacent to the toilet pan and the wash basin. Handrails must be round in section with an outside diameter of 30 mm to 35 mm, and must have a minimum clear distance of 45 mm to any adjacent surface. If a handrail is curved, the radius to the inside face of the curve should be a minimum of 50 mm.
- The toilet seat and lid, and any handrails should be in a contrasting colour and/or tone to the surroundings.

- The flooring in the toilet compartment and in the adjacent vestibule area should have a smooth, skid resistant surface, even when wet.
- The locking mechanism must be clear and unambiguous.

Wheelchair Accessible Toilet

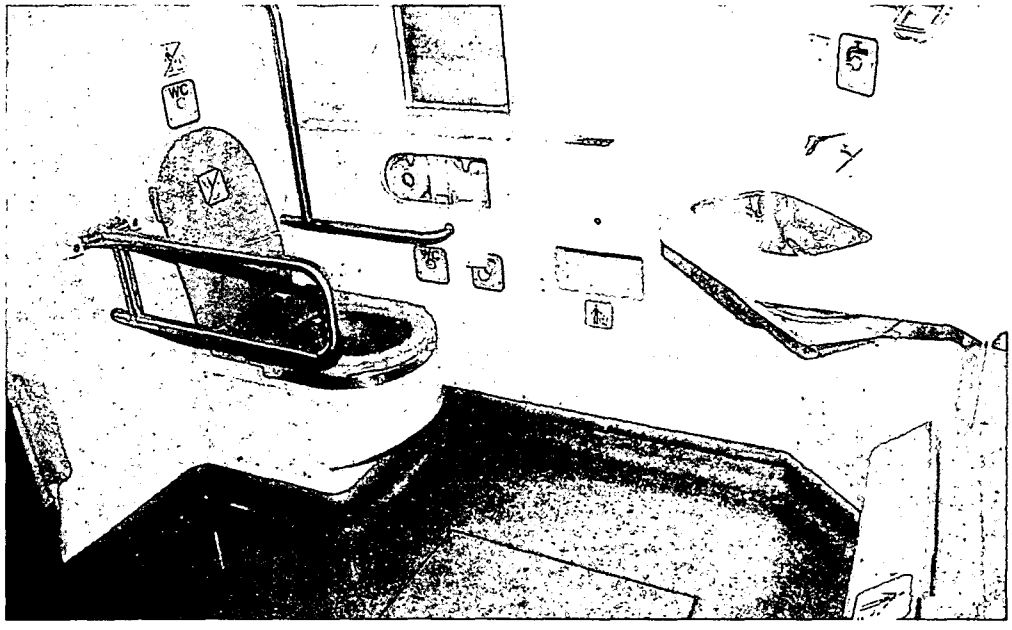
In addition to the general requirements above, a wheelchair accessible toilet must incorporate the following requirements:

- The toilet access door must provide a minimum clear throughway of 800 mm. *A power operated sliding door is preferred.* The exterior of the door must be marked with the International Symbol of Access.
- There must be sufficient space inside the toilet compartment to enable a wheelchair to be manoeuvred to a position adjacent to the toilet seat and, where practicable, to the front of the toilet seat. This will ensure access to the toilet for a large majority of wheelchair users.
- A horizontal handrail that complies with the dimensional requirements in the clause above must be provided at each side of the toilet seat. The handrail on the wheelchair accessible side must be hinged in such a way so as to enable an unobstructed transfer for the wheelchair user to and from the toilet seat.
- The front of the toilet seat should be at a minimum distance of 700 mm in front of the back bulkhead to enable a wheelchair to be suitably positioned for lateral transfer.
- The surface of the toilet seat, when lowered should be at a height of 475 mm to 485 mm above the floor level.
- All amenities (wash basin, soap dispenser, toilet paper etc.) should be readily accessible to a wheelchair user.
- The toilet compartment must be fitted with a minimum of two emergency alarm devices. One must be positioned

at not more than 400 mm above the floor and the other at between 800 mm and 1200 mm above the floor. The alarm devices must be operable by the palm of a person's hand and must not require a force exceeding 10N to operate.

- The alarm must sound a warning that will be heard by a member of the train staff who can take the necessary action. An intercom system is acceptable but other voice systems should not be used. A visual and audible indication that the alarm system is working should be provided within the toilet.

Figure 3.14. Example of Wheelchair Accessible Toilet

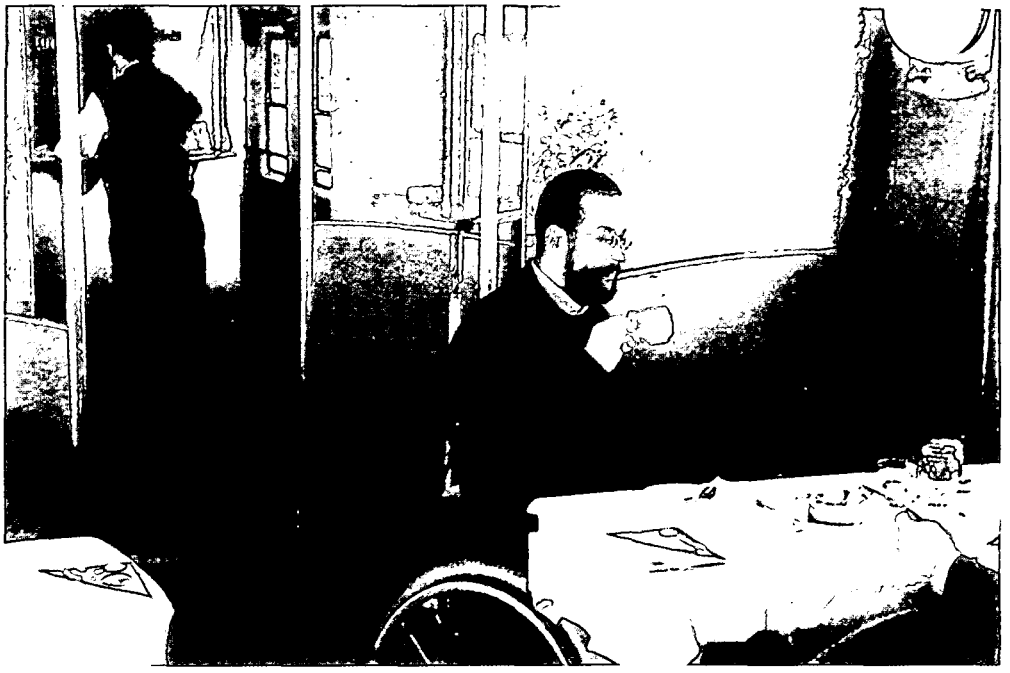


3.5.3. Catering facilities

- Access to all catering facilities should be provided for wheelchair users and mobility impaired people. Where this is not possible because of gangway restrictions in existing or refurbished coaches, location on the upper deck of a double-deck coach etc., an at-seat service or trolley service must be offered.

- Where a restaurant coach is accessible to wheelchairs, it should have a minimum of two suitable table places, one in the non-smoking and one in the smoking zone (where applicable). There should be an unobstructed clearance of at least 680 mm between the underside of the table and the floor. *720 mm is preferred.* There should also be at least one seat at these tables for an accompanying person.
- Where practicable, there should be a clear space underneath some of the seats in the restaurant coach for an assistance dog.
- Where provided, the menu and price list shall be clearly displayed and easily legible (large characters, contrasting colours etc.). One menu should be available in Braille on request from the catering staff.
- Automatic vending machines should have controls not higher than 1300 mm from the floor. *1200 mm is preferred.*

Figure 3.15. Wheelchair in a dining car



3.5.4. Communication facilities

Where a train provides facilities for communication such as telephone, facsimile machines etc., the following requirements are recommended:

- At least one of each type of device must be accessible to wheelchair users.
- The top of any part of a device that has to be reached by the user should be at a minimum of 800 mm and a maximum of 1200 mm above the floor level.
- At least one telephone should include an induction loop system. It must be identified with the appropriate international symbol.

An alternative solution for wheelchair users and people with walking difficulties would be to provide mobile facilities available on request from the train staff.

3.5.5. Sleeping facilities

Where a train provides sleeping facilities, the following requirements should be included:

- A minimum service of one compartment on each coach should be designed especially for people with walking difficulties that can be booked in advance.
- A minimum of one sleeping compartment should be accessible to wheelchair users and must be suitably equiped to enable transfer between the wheelchair and the berth. This compartment must provide for access to a toilet (figure 3.15). It must be identified with the International Symbol of Access.
- Access requirements to special compartments must be in accordance with section 3.3, Circulation within the train.
- Each special compartment must be fitted with a minimum of two emergency alarm devices. One must be

positioned at not more than 400 mm above the floor and the other must be accessible from the berth. The alarm devices must be operable by the palm of a person's hand and must not require a force exceeding 10N to operate. The alarm must sound a warning that will be heard by a member of the train staff who can take the necessary action. An intercom system is acceptable but other voice systems should not be used. A visual and audible indication that the alarm system is working should be provided.

Figure 3.16. Example of a sleeping compartment for disabled passengers

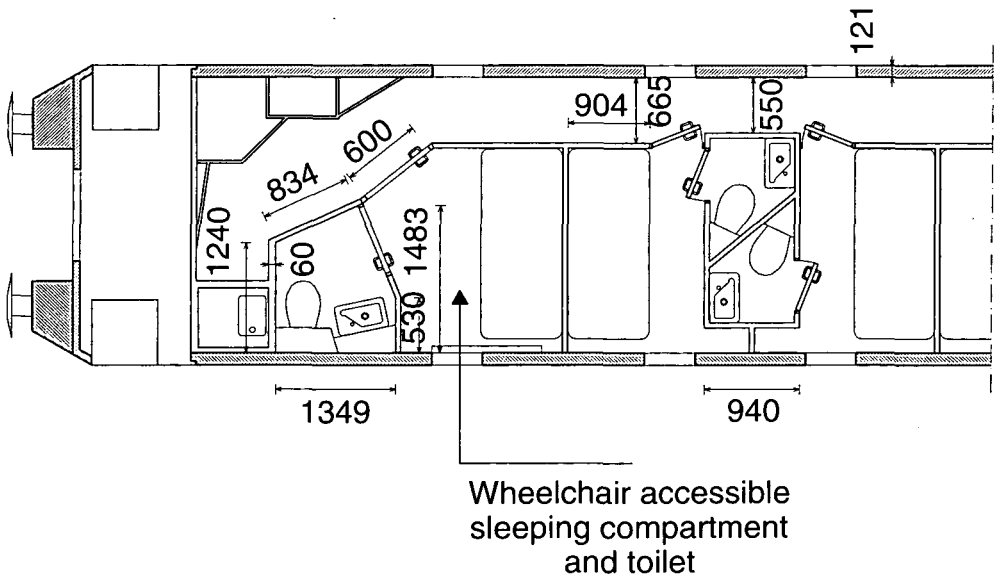
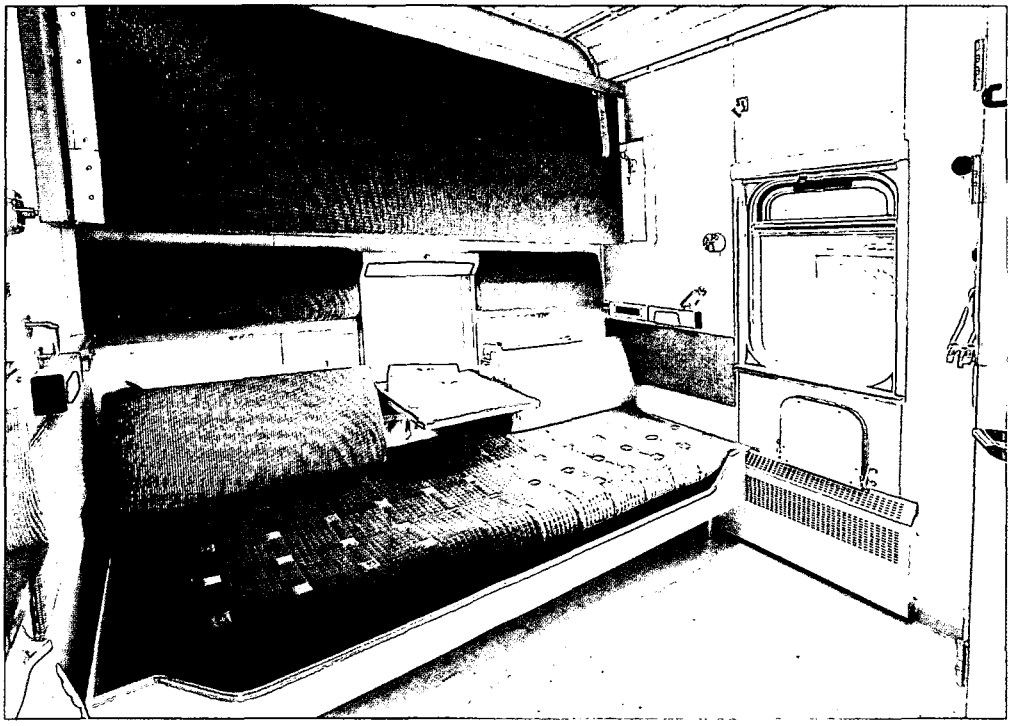


Figure 3.16.2. Example of a sleeping compartment for disabled passengers



3.6 Information

3.6.1. General statement

Good information on the exterior and interior of the train provides a comfort to all passengers with respect to their journey and helps avoid any anxiety they may have about their final destination.

Receiving audible information may be difficult or even impossible for hearing-impaired people and similarly, visual information to sight-impaired people. Therefore, it is important that information is provided through both audio and visual messages as far as possible.

Visual information is commonly displayed by means of new technologies (LED or LCD displays and video screens). The displays should be located so as to be clearly readable by all passengers under all lighting conditions, by day and by night (see table 3.1). Dynamic signs provide variable (real time) messages. Their speed of change should not be too fast; a line of text should be displayed for at least ten seconds.

To improve legibility, a mixture of upper and lower case lettering (initial capital followed by lower case) should be used. The use of serif typefaces should be avoided. Helvetica, Rail Alphabet, Frutiger and Airport typefaces, or equivalent, are recommended (see table 3.2).

For audio displays, attention should be paid to the quality of loudspeakers and recording systems (when used).

3.6.2. Information on the exterior

- The International Symbol of Access must identify the coach(es) fully accessible for all. Where special facilities are provided on any other coach, they must be identified

by appropriate pictograms, so they can be easily located from the station platform.

- The train destination must be displayed very legibly on the sides of the coaches and/or on the front of the train.
- When located on the front of the train, characters should be in letters at least 125 mm high for upper case and have a high contrast and tone with their background. At present this is best met by the use of bright yellow numerals and letters on a black background.

3.6.3. On board information

- Announcement of station stops should be made through both visual and audio means. The information must be given well in advance to enable passengers to prepare for alighting.
- A map of the nation wide network, showing distances and borders, should be displayed inside the coaches of main line trains. A map of the network of the region concerned should be displayed inside regional trains.
- Passenger information notices should be suitably located and easily readable. Text and/or pictograms should be in a contrasting colour and tone to the background.
- If on board information is provided on paper stickers the text should be in black lettering on a white or yellow background and should be easily readable.
- Where toilets are provided, their location should be indicated in the passenger saloons by means of sufficiently large pictograms. A luminous "toilet occupied" indicator should be provided that is visible to most seated passengers.
- The electro-acoustic chain should ensure a frequency range between 100Hz to 4000/6000Hz. The dynamics should prevent the signal from reaching saturation levels.

3.7. Case studies

Railway operators and train manufacturers have recently committed themselves to develop new designs for passenger coaches which facilitate access to disabled people or even provide full accessibility to all (including access for wheelchair users). Owing to the differences between platform heights of each country or region, examples of level access (with an automatic bridging plate) or step free access (with an access ramp) are described in the following case study sheets as well as examples of interior fittings.

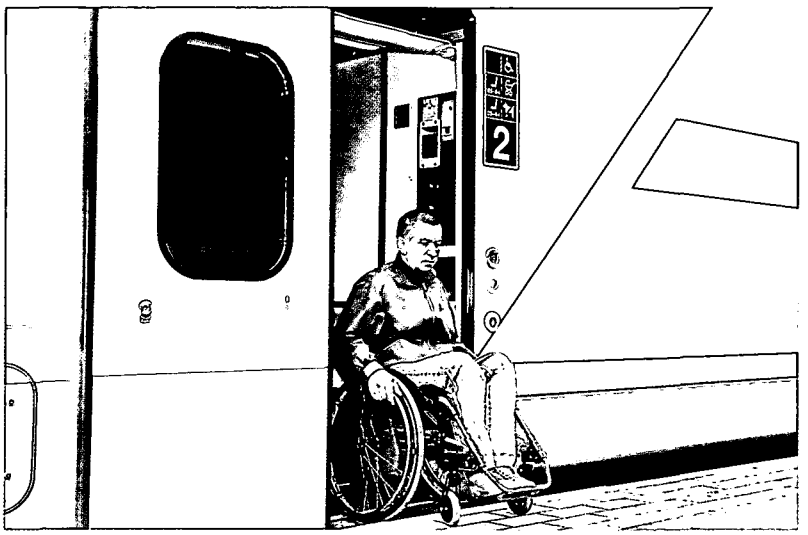
3.7.1. Long distance trains

The first case study is the double deck coach ordered by VR in Finland. It is inserted in IC train sets to provide one accessible coach.

The second case study is the feasibility study of medium height ('midfloor') coaches for IC trains.

These examples show, together with the one of the TGV Duplex train operated by SNCF in France, that it is technically easier to make accessible double-deck coaches rather than standard coaches. This is due to bogie height constraints. The Talgo train design showed the way towards lower floor levels for long distance trains.

Case study 1: Intercity service coach, type Eds, for VR



Step-free entrance of the double-deck coach.

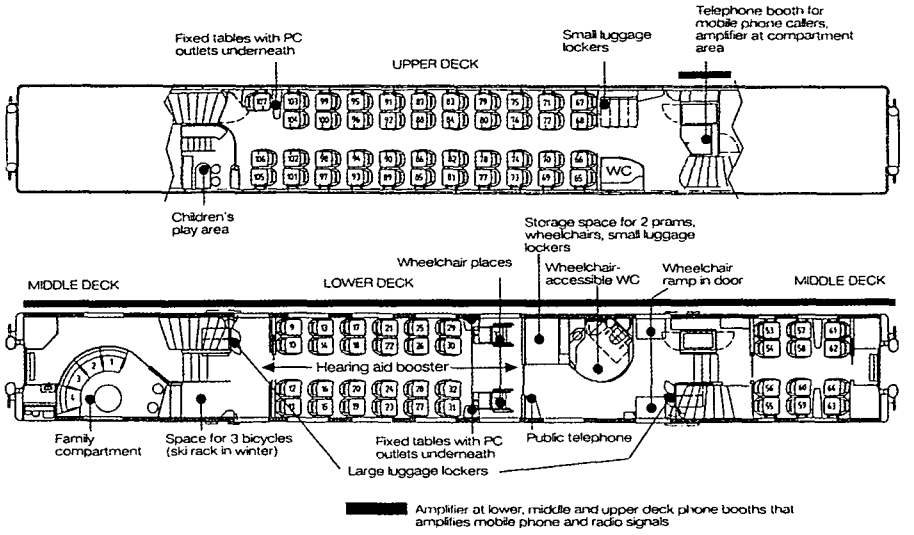
Features: New 2nd class coach with wide range of services for IC-trains. Total seating capacity, 85 passengers.

Entrance:

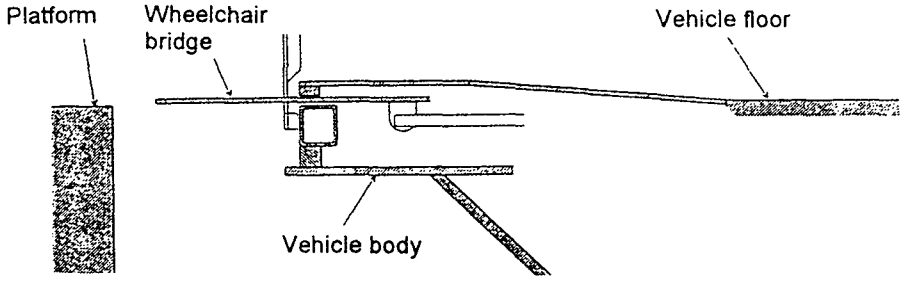
- Height of platform, entrance and lower deck, 550 mm from top of rail
- Passenger operated bridging ramp at entrance doors.
- Removable folding wheelchair ramp, operated by train crew, for earlier platform height of 265 mm.

Lower deck:

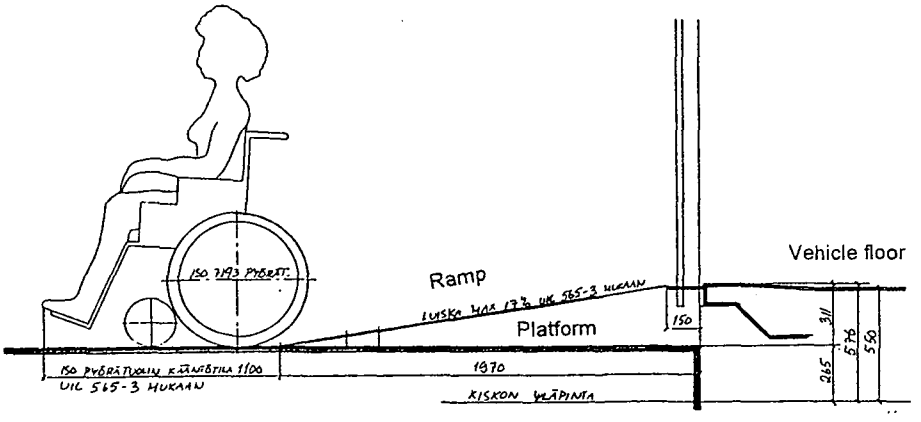
- Space for two wheelchairs in compartment.
- Wheelchair accessible toilet.
- Large luggage lockers near doors, small luggage lockers on both decks.
- Storage space for two prams or wheelchairs.
- Space for 3 bicycles / ski rack in winter.
- Hearing aid booster in passenger compartment.
- Public telephone, accessible for wheelchair passengers.



Layout of double-deck Eds coach



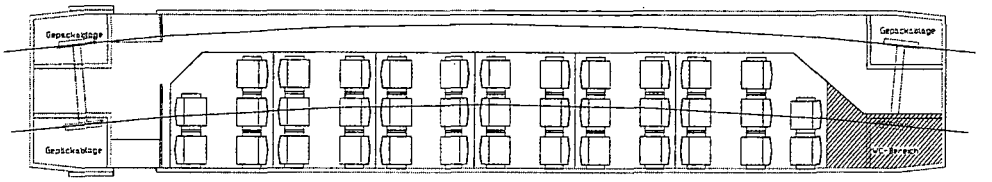
Wheelchair bridge structure. Maximum gap between bridge and platform, 50mm. Platform height, 550mm.



Operating principle of removable ramp for 265mm high platforms, which will be built to a 550mm height by year 2006.

Case study 2: New Generation of Main-line Passenger Trains

Item: Feasibility Study of the construction of new Middle-Floor passenger trains (by order of the UIC Sub-Commission Passenger Vehicles)



Articulated set of coaches, proposal of interior decoration (1st class)

Study by: Prof. Dr. M. Hecht, TU Berlin, Institut für Strassen und Schienenverkehr and Dipl. Ing. J. Wichser ETH Zürich, Intitut für Verkehrsplanung und Transporttechnik studied the feasibility of construction and operation of Midfloor-InterCity-coaches by order of the UIC, co-financed by the Swiss ministry of education and science.

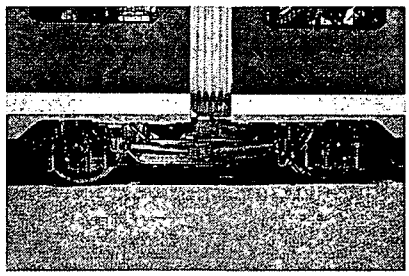
Results: It is possible to build coaches with an entrance level of 600/800mm and a floor level of 660/800mm. Therefore the entrance of the level from platform heights of 550/760mm can be offered to passengers.

Coaches can be constructed for a maximum speed of 200 km/h. Articulated trains featuring Jacobs-Bogies with special brake constructions and configurations (additional electromagnetic rail brakes and eddy-current brakes) could circulate with speeds over 200 km/h for scheduled train operations as well.

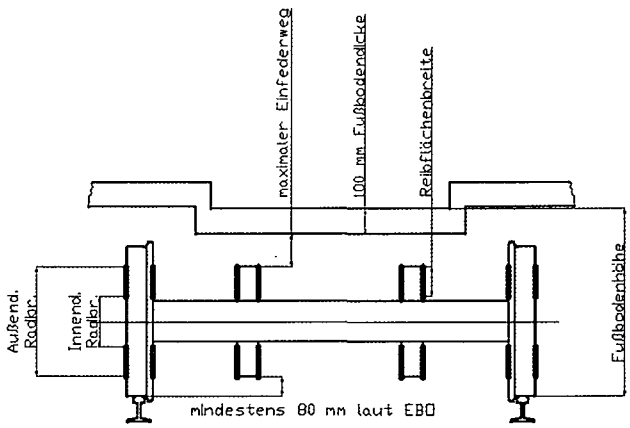
It should be possible to built tilting trains with reduced floor level.

Problems: The condition of the special floor level doesn't allow to couple those coaches with standard rolling-stock. So there is a need to compose complete trains or wagon-groups, coupled with standard rolling stock via special constructed and equipped so called transition-coaches at the end of the train or waggon group.

Generally the use of wheels with an diameter smaller than 920mm is necessary. A wheel-diameter of 760mm for articulated train is also needed.
Smaller brake-discs have a sufficient braking power to stop a train at the same way than ordinary trains do.



Bougie Jacobs Key Element of the articulated set of coaches (new Class 424, DB AG)



Wheel and floor level at Jacobs-bougie

3.7.2. Regional trains

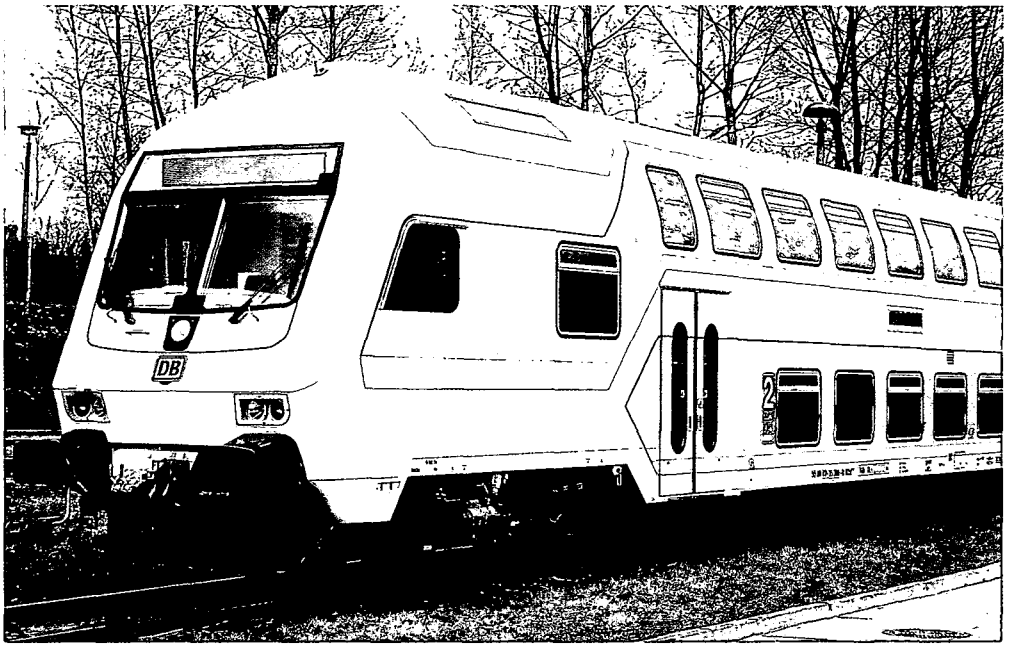
New commuter or regional trains are designed with either standard or double- deck coaches. The case studies illustrate the provision of:

- Access ramp that fits one platform height (on the double deck coach for DB AG in Bremen-Germany).
- Access ramp that can fit three different platform heights (one the new DAB 764 double-deck coach operated by DB AG in Germany.
- Retractable step to be used in case of low platform height, wheelchair space and accessible toilet (on the 'midfloor' coach TER 72500 operated by SNCF in France.
- On board lifts for 'midfloor' coaches that can fit various platform heights (Region shuttle and ET-425-426 EMU commuter operated by DB AG in Germany.

Two other case studies are at a prototype stage and illustrate:

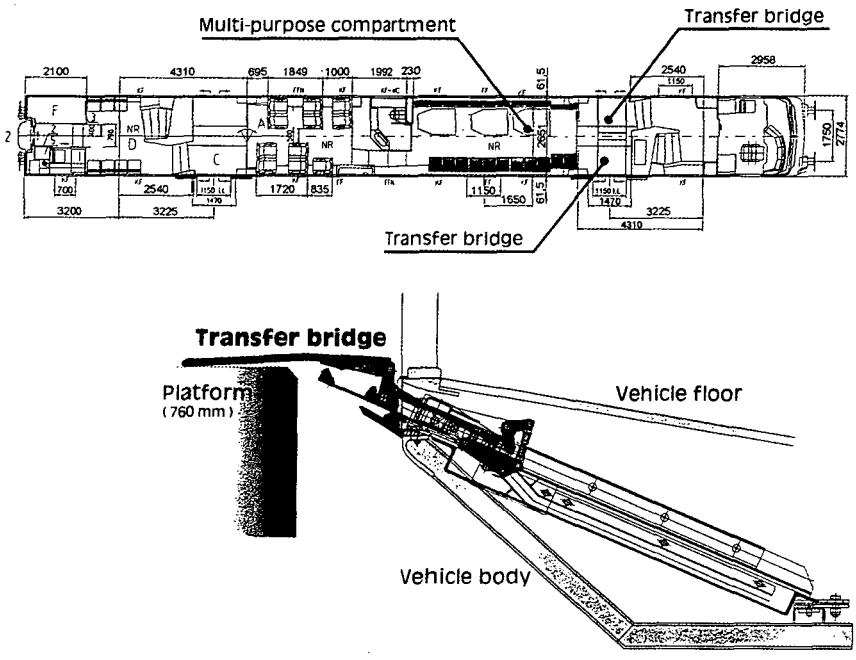
- Interior lifting platform in the Crusaris Regina from Adtranz.
- Access ramp which would be automatically deployed and would fit platform heights from 250 mm to 700 mm and floor heights upto 1150 mm, to be operated by NSB in Norway.

Case study 3: Double-deck driving trailer DBbzf 761 (Bremen) for DB AG



Double-deck driving trailer, type DBbzf 761 (Bremen)

Features:
- Train set serving suburban and regional railway lines
- Height of platform/entrance 760 mm above rail surface
- Transfer bridge
  operating time approx. 5 sec.
  operated by staff, operation by passenger possible if required
  width 970 mm
  length 366 mm
  max. wheelchair weight 300 kg
  max. wheelchair length 1420 mm
- Multi-purpose compartment fully accessible to wheelchair space for 3 wheelchairs
  toilet accessible to wheelchairs
  31 foldable seats



Transfer bridge and multi-purpose compartment

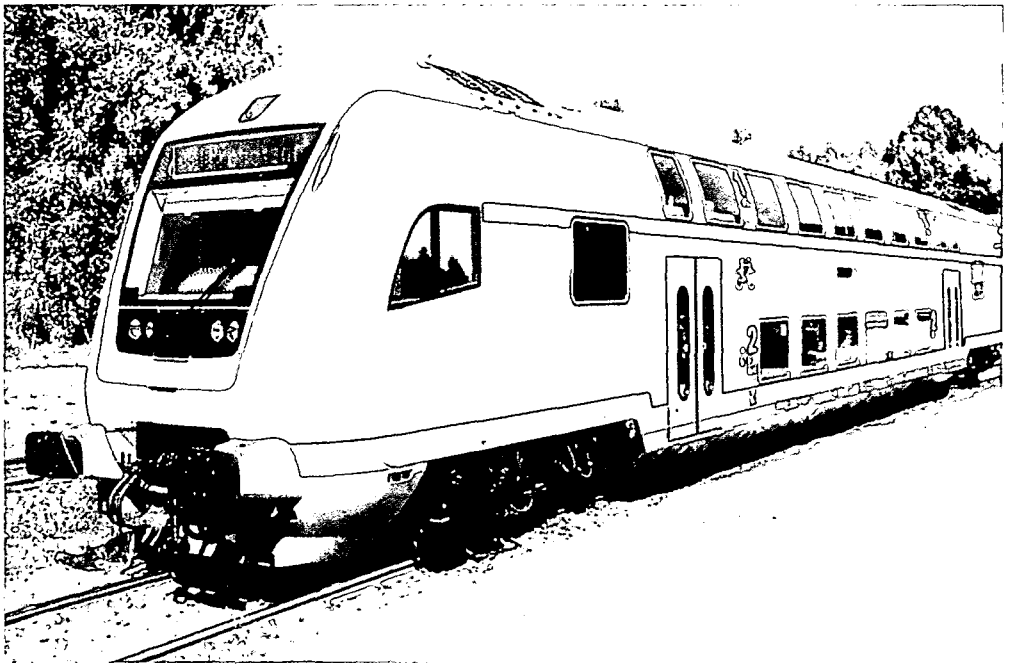
Costs:

- Double-deck driving trailer: approx. DM2.6m
- Train set of 5 coaches (without locomotive): approx. DM9.6m
- Extra cost of DM0.3m per driving trailer for redesign and installation of equipment for wheelchairs
  = approx. 10% of vehicle price
  = approx. 3% of train set price.

Remarks:

- Transfer bridge requires same height of platform and coach entrance
- The next generation of the driving trailer will have two different entrance heights of 600 mm and 760 mm to serve both 760 mm and 550 mm high platforms. To reach the suitable entrance, the wheelchair user will be able to circulate inside the vehicle between the two entrance areas
- Manufacturer of vehicle: Bombardier Transportation, DWA Görlitz

Case study 4: Double-deck driving trailer accessible to wheelchair users, type DABpbzf 764, for DB AG manufactured by Bombardier Transportation, DWA Görlitz



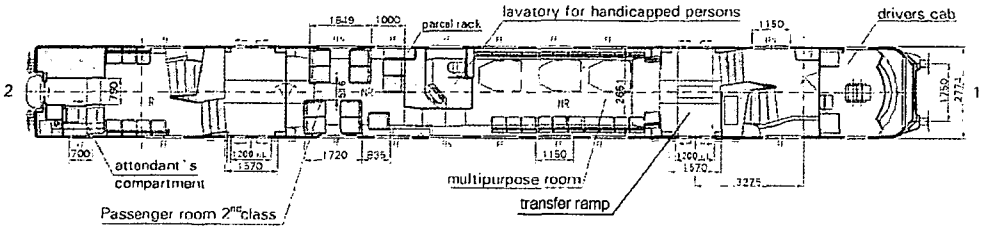
Double-deck driving trailer, type DABpbzf 764

Features:
- 1st an 2nd class-trainset serving suburban and regional railway lines
- The seating capacity of the driving trailer is 79 passengers (38 passengers 1st class)

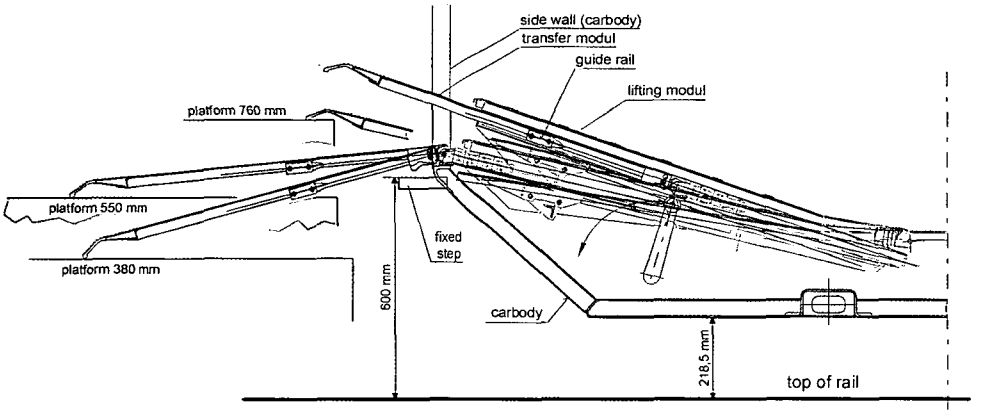
Entrance:
- Entry height: 600 mm from top of rail,
- Transfer ramp for wheelchairs operated by train crew for platform heights from 380 mm to 760 mm above rail surface
- Usable for wheelchairs with UIC dimensions, max. wheelchair weight: 350 kg

Lower deck:
- Multi purpose compartment fully accessible to wheelchairs

- Space for at least 3 wheelchairs
- Toilet accessible to wheelchairs
- Space for 6 bicycles or other large pieces of luggage
- Call-button for disabled people inside and outside
- 23 foldable seats



Lower deck of the double-deck driving trailer



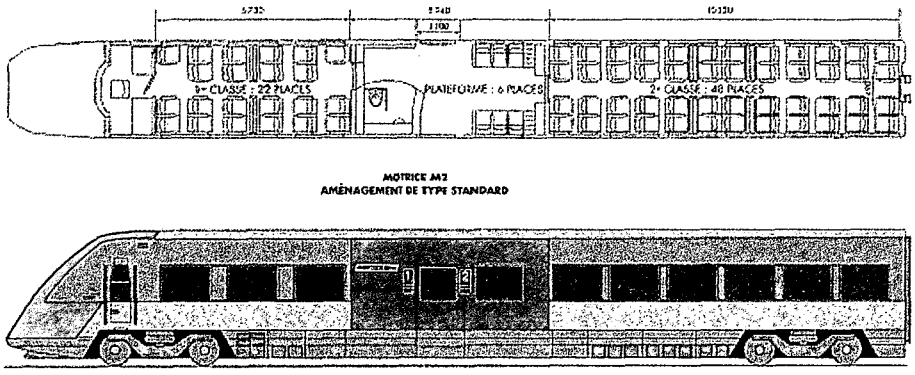
Operating principle of transfer ramp for different platform heights

Case study 5: XTER 72500 - Diesel Multiple Unit (DMU)

Two or three cars train set serving SNCF suburban and regional railway lines

Ease of Access

- Accessibility for mobility impaired passengers and prams.
- Through a wide single leaf door located in the middle of the coach: free width 1100mm
- Semi automatic opening by push buttons from inside and outside
- Access door fitted with a moveable step device
- Vestibule with low floor level: 860mm above rail surface
- From platform height of 550mm:
  - horizontal gap with step device: 50mm in straight line
  - vertical gap with step device: 85mm



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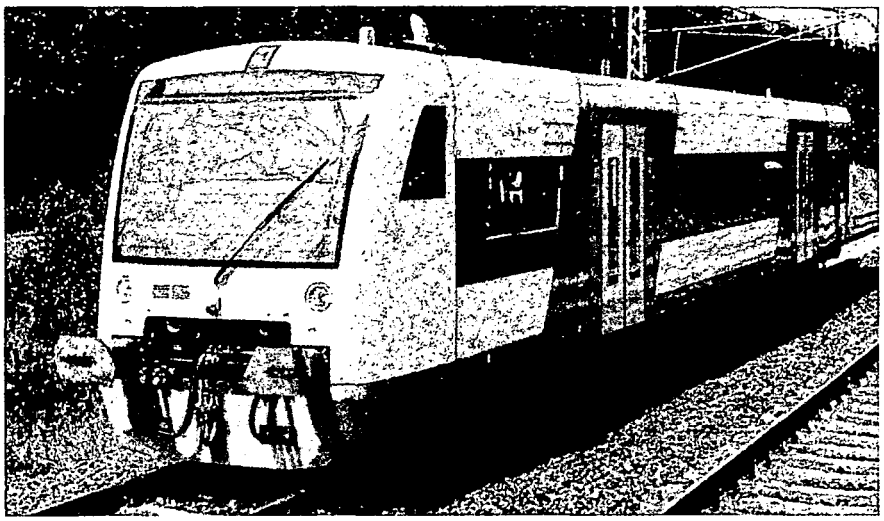
Vestibule Equipped with

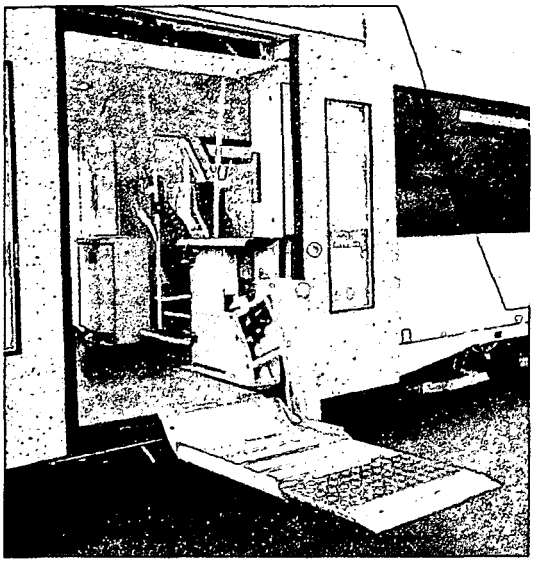
- Locations with tip-up seats foreseen to accommodate wheelchair users
- Toilet module accessible for wheelchair users

Case study 6: Regio Shuttle



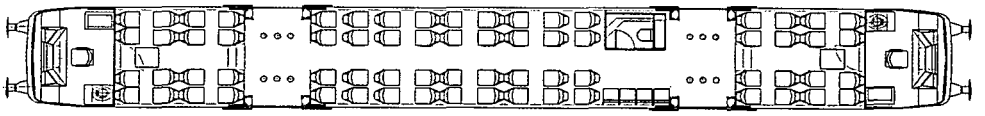
Features: Regio-Shuttle has attracted many customers around Germany since its introduction in 1996. More than 100 vehicles have been ordered by some ten different customers.
Regio-Shuttle has the highest low floor portion among the diesel railcars for 70-80 seated passengers which fulfils the UIC buffer load requirements of 1500 kN. The location of the diesel engines and the drive unit below the driver's cab outside the bogies offers the opportunity to use all the space between the bogies for a 600 mm low floor area, with 760 mm optional.
The passenger area above the bogies have a floor height of 1000 mm.

Lift for Disabled Passengers



- For adaptation to different platform heights
- load capacity 300 kg
- platform dimensions: 1200 x 740 mm
- Time for loading/unloading about 2 min each time
- not usable without outside help (handling by railway staff only)
- design according to DIN 32 983

Layout of vehicle

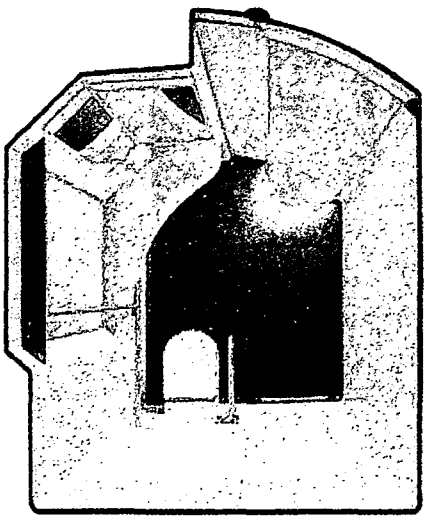


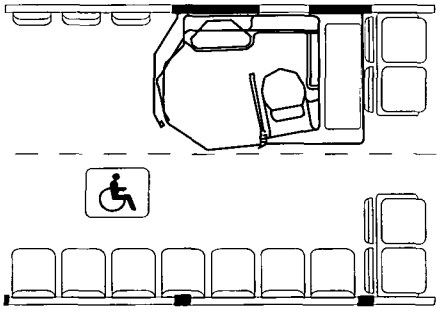
Seating capacity:	Seats	72
	Tip-up seats	4
	Area for e.g. bicycles	4
	Fastening Belts	3

Multi Purpose Compartment (MPC)

- Wayfinding sign to MPC on outside of coach (see that entrance/lift and MPC are close together)
- sufficient space for wheelchair turning
- fastening belts for wheel-chair (between folding seats)
- push button for wheelchair user "Stop at next station"

Lavatory for disabled passengers

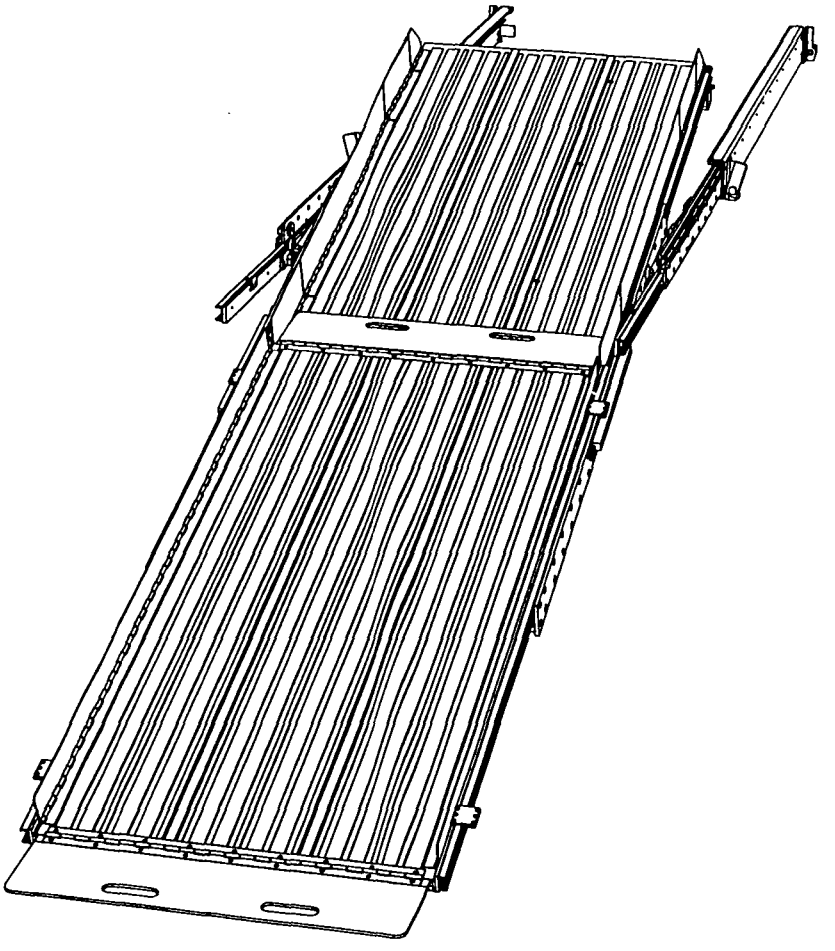




- usable without outside help
- electrically-driven sliding door
- place for wheelchair turning
- design in accordance with UIC 565-3, DIN 18022, DIN 18025

Case study 7: Access Ramp for Type 73 (new Express Trains) NSB / The Norwegian State Railways

Specifications: Tilting train sets of 4 coaches (without locomotive), manufactured by ADTranz Norway. First 3 sets in operation from November 1999.
One coach modified for wheelchair users, with access ramp to board and alight the train. Ramp is delivered as a compact cassette, integrated in the floor of the entrance area, containing frame, telescopic arms and the ramp.



Operational area: From platform 250 - 700mm ToR to floor 1150 mm

Operation time: Max. 45 seconds

Capacity: 450 kg

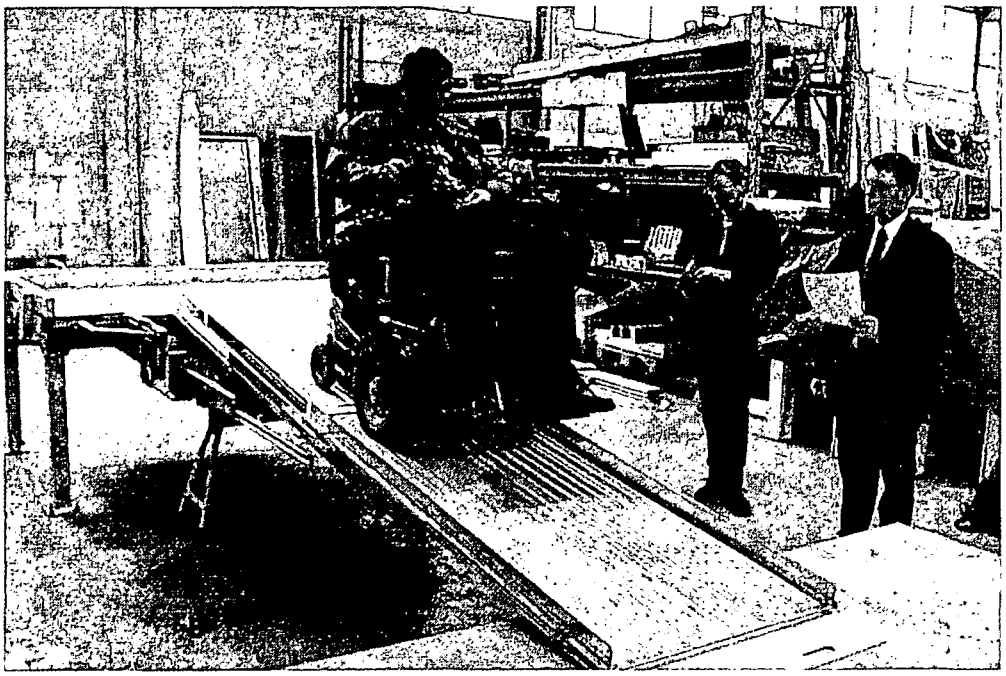
Operation: Preparations/parking: By staff only, 1 person, max. operating load 450 kg, Self-supporting access by low angle, otherwise need for assistance.

Dimensions: Ramp: 800 x 3336mm, cassette: 1000 x 1750 x 112 mm

Security: Electronic device activated in driver's cabin while in use

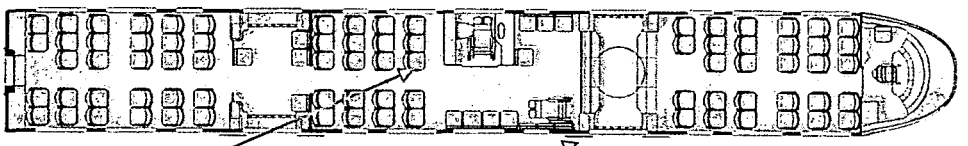
Work conditions: Snow, ice, water, sand.

Propotype testing



Case study 8: CRUSARIS Regina

Wheelchair user prepared - wheelchair lift is standard

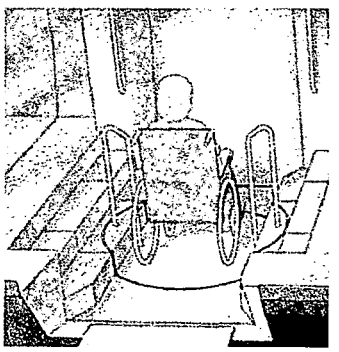


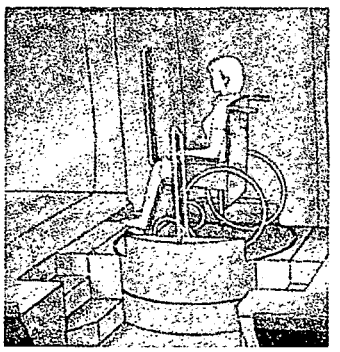
Spacious wheelchair accessible toilet

The train is equipped with a spacious wheelchair accessible toilet near the wheelchair lift and a flexible area especially designed for passengers with wheelchairs or prams

Internal wheelchair lift

Entrance at platform height and a internal wheelchair lift that can be used from the wheelchair make Regina easily accessible for wheelchair users. The wheelchair lift can be found in all the train sets





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Weidmann. Transporttechnik der Fussgänger, IVT Bericht 90, 1992

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Table 3.1: Recommendations for the use of contrast, brightness, colour and shape for information matters

(source: Verbesserung von visuellen Information im öffentlichen Raum. Bundesministerium für Gesundheit)

Priority	Value for contrasts	Colour combinations (light on dark)	Value of light density
1 – Warning	$0.83 < K \leq 0.99$ optimum contrast	Blue on green ° Yellow on lilac Green on blue Black on white White on red	300 cd/m² up to 500 cd/m² on signs and markings surfaces Emergency lighting: >500 cd/m
2 – Decision	$0.5 < K \leq 0.83$	Yellow on green Black on neutral*° White on blue White on green	30 cd/m² up to 299 cd/m² in weak room lighting up to well lit shop rooms
3 – Guiding	$0.28 < K \leq 0.50$	Blue on neutral° Yellow on grey Green on neutral Red on neutral Black on green°	3 cd/m² up to 29 cd/m² as in dim street lighting

° exception: black on light

* neutral = black or white or grey

Table 3.2: Recommendations for height of characters for information matters

(source: Verbesserung von visuellen Information im öffentlichen Raum, Bundesministerium für Gesundheit)

	Reading distance			
Priority	**30 m**	**10 m**	**1 m**	**0.25 m**
1 – Warning	1040 mm	350 mm	35 mm	9 mm
2 – Decision	520 mm	170 mm	18 mm	4 mm
3 – Guiding	420 mm	140 mm	14 mm	3 mm

4. Bridging the gap from platform to train

4.1. Preamble

Boarding and alighting a train usually means that passengers have to get through the door and negotiate a few steps, as only in recent years some new trains began to offer level access between the platform and the train floor at the entrance door.

Steps and gaps are a real barrier to people in wheelchairs and even to people with severe walking difficulties. The functional capabilities for passing over the gap between the platform (or pavement) and the vehicle floor have been investigated. Laboratory tests were performed in France, Germany and Great Britain by mobility impaired people and wheelchair users who were used to moving around in the city and reaching the train station.

The requirements were determined as follows:

- The horizontal and vertical gaps shall be not greater than 100 mm (*50 mm is preferred*) and 50 mm respectively for people in wheelchairs (see Chapter 3).

- The horizontal gap shall be not greater than 300 mm for people with severe walking difficulties.

Where level access cannot be achieved, technical and operational solutions for boarding/alighting are being used in order to overcome the steps and gaps.

It is quite clear that the use of such boarding aid devices is a burden both for the passenger and for the railway (and station) operator. Therefore, it is important that the right choice is made after considering all the factors that may affect the safe and effective operation of the system.

4.2 Factors for boarding aid choice

The ideal system does not exist. In fact, the choice of the best solutions depends on the kind of train traffic (from the commuter train with short dwell times at the station to the long-distance train), operational, technical and economic factors.

4.2.1. Technical aspects

Space available on the platform: the platform width as well as the presence of obstacles on the platform (staircase, furniture, poles, kiosks etc.) may prevent the boarding aid from being deployed or from being positioned where required. Another factor which has to be considered is the crowd on the platform which may be an obstacle to deploying a boarding aid or for a platform based device which has to be transported from the storage area to the coach door.

Reliability of the boarding aid must be ensured. This means that any mechanical and electrical components must be designed taking into account the environmental conditions likely to be encountered in service, dust and objects which may cause damage to the device. Vandalism is a concern of operating companies, more and more of whom are installing securement systems in the stowage area. The UIC-report (Mobility for All - The missing millions, 1996) indicated that on-board devices then in use were more complex and therefore were more prone to problems that were likely to cause train delays.

Safety of operation is a crucial issue both for the passenger and for the operating staff where present. Currently the deployment of a boarding aid, whether on the platform or on board, requires staff supervision. In case of an on-board lift, it may also be necessary to install visual

and audible warning signals especially if the staff member deploying the device does not have a full view of the operation.

The design of the boarding aid must take into account the possibility of a wheelchair, and in particular a high-powered electric wheelchair, accidently overriding the raised edges of a ramp or lift platform.

A powered boarding aid must incorporate an emergency method of deployment and operation with a wheelchair occupant in case of power failure.

Availability of the boarding aid when and where it is needed will help reduce the stress level of the passenger and improve working conditions for the staff. An on-board boarding aid can be considered as always available, provided that the train staff are about when passengers require assistance. With regard to a platform based boarding aid, the staff must be aware of its location and must return it after use. A secure stowage area would ensure greater efficiency as staff would know where to find it and it would also avoid the risk of damage (possibly from dust and dirt) and vandalism.

Flexibility in traffic management : train operators should consider the allocation of station platforms for their devices. Generally it has been considered too difficult to restrict boarding aids to a few platforms as trains are frequently routed into any available platform. Another problem is the common use of tracks for freight as well as for passenger trains. The gauging constraints of freight trains often mean that the gap between the platform and the rolling stock has to be wider than would normally be required. Giving consideration to the separation of passenger trains and freight trains through stations would help overcome this problem.

4.2.2. Human factors

Dignity of the passenger must be guaranteed. Examples that clearly not acceptable are the use of a luggage carts and the manual transfer of a person. In any case this is prohibited under EC legislation (Manual Handling of Loads Directive 90/269/EEC of 29 May 1990). Moreover, representatives of disabled people prefer on-board devices as their use is more discreet.

Ergonomics, comfort and safety: Good ergonomic design of a boarding aid will reduce the risk of harm or injury to the staff member operating the device. It is also more likely to reduce the temptation of some staff not to use the device and to transfer the passenger by hand, a practice that puts the passenger at considerable risk. The smooth operation of a powered lift is essential and the slope of a ramp should not be too steep.

Availability of staff has to be guaranteed to assist with passengers who have booked in advance. Passengers in some countries are experiencing problems with the non-availability of staff.

Staff training will ensure an efficient use of the boarding aid and guarantee a safe quality service.

Independent boarding for disabled people should be the aim wherever possible. Initially it should be aimed at suburban and regional trains for which passengers do not usually reserve their seat in advance.

4.2.3. Economic aspects

Investment cost depends on the number of train coaches and/or the number of station platforms to be equipped. On board devices must be provided on each side of the accessible coach as the platform may be on either side.

Operational cost includes:

-maintenance of boarding aid devices(increased time for trains out of service and staff cost);
-staff time to deploy the devices;
-increased dwell time at stations for the deployment of boarding aid devices;

Operational cost for the last two parameters is considered to be lower for on board devices even though deployment time is directly linked to the height of the vertical gap. However, on board devices are more complex and at present may be more prone to failures and require more frequent maintenance.

4.3. Analysis of pros and cons of boarding aids

A survey of European railway operators involved in the COST335 action has been carried out to provide information on station and train parameters, the types of boarding aids used, numbers in use, frequency of use, the opinion of disabled passengers and their future strategies. Fourteen countries responded, the results of which are summarised in table 4.1.

It should be noted that in each country the questionnaire was answered by the railway network operator except for the United Kingdom, which was answered by Railtrack, the company responsible for the stations and track infrastructure since privatisation of the railway network. Also, the contact at Railtrack is a disabled person in a wheelchair and therefore in a better position to express the views of the people directly concerned.

Table 4.1

Boarding Aids in European Countries (1)

Country	Austria	Switzerland	France	Germany	Finland
Boarding Aids used	Platform lift	Platform lift	Platform lift Platform ramp Lift on TGV duplex	Platform lift On board lift Bridging ramp	On board lift On board bridge
Platform height-mm	550, 380 and less	550, 350	550, 350 900 (IdF region)	380, 550, 760, 900	265, 550
Floor height-mm	n/a	1160	900, ~950, 1190	600, 800, 1100	~550, 1200
N° stations equipped	n/a	150	200 (platform lifts)	385	0
N° Boarding Aids	100	250	220 platform lifts	580 lifts 30 ramps	100% Pendolino trains 10% main line fast trains 100% main line IC trains (1999)
Reasons for choice	n/a	Simplicity Low cost Only one staff	Easy to handle Fit various gaps	Easy to handle Low cost	Staff onboard
Boarding Aid price-Euro	4 400	4 900	4 100 manual lift 5 400 electrical lift	4 100 ~20.000 (lift/door)	4 400 (autom. bridge) 17.000-25.600 (lift / door)

Country	Austria	Switzerland	France	Germany	Finland
N° staff	1	1	1 or 2	1	1 for lift 0 for bridge (IC train)
Staff training	Yes	Yes	Yes	Yes	Yes, mostly
Manoeuvre time	A few minutes	Preparation not needed	~3 min	1 min	1,5 - 2 min (lift) 10-15 s (bridge)
N° use/day	n/a	15- 20 (main station) 2-5 (small stat.)	n/a	10/day to 1/ fortnight	n/a
Passenger opinion	Satisfied	Satisfied	Satisfied	Satisfied, mostly	Satisfied
Criticisms	n/a	None	Dirt/ Damage	n/a	n/a
Long term strategy	None	No change	Level access	Level-access + bridge plate for S train	level access

Table 4.1 (cont'd)

Boarding Aids in European Countries (2)

Country	Netherlands	Luxembourg	Denmark	Great-Britain	Sweden
Boarding Aid used	Platform ramp	Portable ramp	Platform lift Platform ramp	Platform ramp Onboard ramp	On-board lift Platform lifts (few)
Platform height-mm	760, 840 (new)	n/a	550	915	580 (all new stations) 730 (few suburban syst.)
Floor height-mm	1160, 1320	n/a	900-950	n/a	1150
N° stations equipped	150	1	30	n/a	few
N° Boarding Aids	327	1 (prototype)	50	n/a	160 (80 trains) 60 platform lifts
Reasons for choice	Small gaps, low cost, fits 2 platform heights	Easy to handle, fits various gaps, transportable in train	Best solution	Low cost, low maintenance	Few or no staff in small stations
Boarding Aid price-Euro	2 300	-	8 100	500	6 450 (12 900/train)
N° staff	n/a	Onboard staff	1	1	On-board staff
Staff training	Yes	-	Yes	n/a	Yes
Manoeuvre time	3-5 mins	3-5 min	2-3 min	n/a	1- 2 min
N° use/day	200/day	4-5 /week	n/a	Frequent	50/day

Country	Netherlands	Luxembourg	Denmark	Great-Britain	Sweden
Passenger opinion	n/a	Satisfied, easy, quick	Satisfied, would prefer self-sufficiency	Satisfied, but ramp too steep, not always available	Satisfied, would like self-sufficiency,
Criticisms	Staff required	n/a	n/a	Ramp weight (lighter new design), lack of safety	Platform lifts require extra work
Long term strategy	Minimise the height difference	More ramps (6)	Self operated ramp Level access for S-train	Level access	Level entrance for new train system

table 1 (cont'd)

Boarding Aids in European Countries (3)

Country	Hungary	Italy	Norway	Spain
Boarding Aids used	Platform lift	Platform lift	Platform lift Onboard lift (regional) Onboard ramp (manual)	Platform lift, Onboard lift (commuter)
Platform height-mm	300	250 to 550	700-570-350 and less	550 (main), 280, 700, 900 650 (high speed train) 680 (commuter)

Country	Hungary	Italy	Norway	Spain
Floor height-mm	1 100	500 to 1100	1320-1150-920-750	650 (Talgo), 850, 950 (high speed)
N° stations equipped	30	75	5 (1 lift/station)	60 (main)
N° Boarding Aids	33	110	16+22 onboard lifts 36x2 onboard ramps	120 platform lifts
Reasons for choice	**Safe, cheap, simple use**	Agreement with some disabled representatives	Operation safety Few crew in stations	Easy, cheap
Boarding Aid price-Euro	2 600	12 000	n/a	7 180
N° staff	1	2	1 (lift or ramp)	1
Staff training	Yes	Yes	Yes	Yes
Manoeuvre time	25- 30 s	2-3 min	2-3 min (lift) < 1 min (ramp)	1-2 min
N° use/day		~500/week	n/a	60 (high speed st.) 30 (main st.)
Passenger opinion	Satisfied	Yes, would prefer self-sufficiency	Satisfied, would prefer self-suffiency	Very satisfied
Criticisms	all coaches not adequate	Battery charging of electr. Model	Lifts too narrow, Long to operate	n/a
Long term strategy	No change	Test onboard lift, +continue use of platform lift	Platform height 570, 700 for commuter, Level access	continuation

Examples of Boarding Aids in use in Europe are shown on:

Figure 4.1. Platform ramp - Intercity train – UK

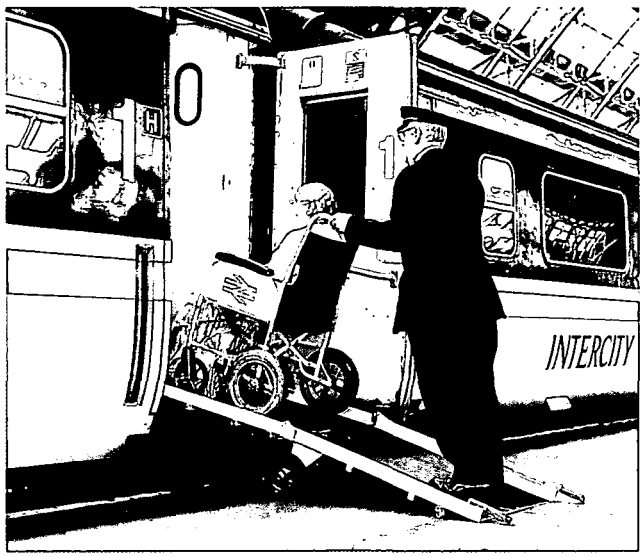


Figure 4.2. Platform ramp – NS railways – NL

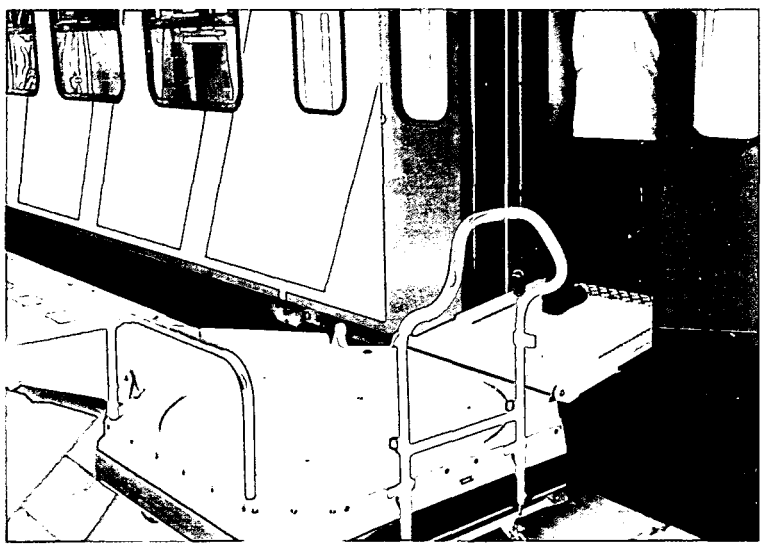


Figure 4.3. Onboard lift – SJ X2000 train – SE

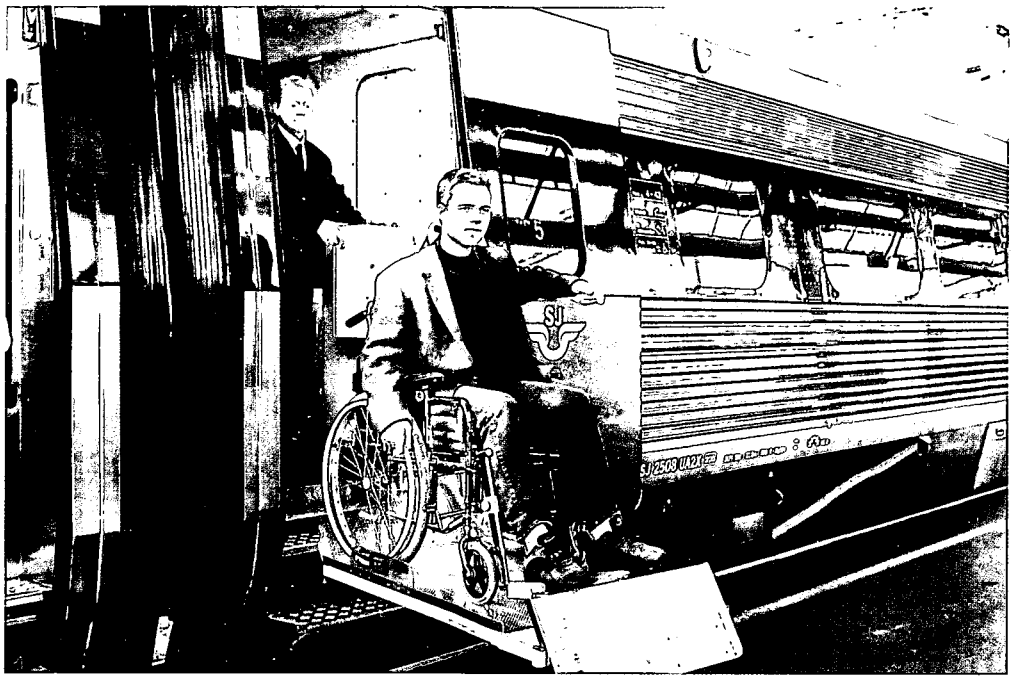


Figure 4.4. Platform lift – SNCF railways – FR

Figure 4.5. Bridging ramp – DB railways - DE

Figure 4.6. Access ramp – Double deck coach DB railways – DE

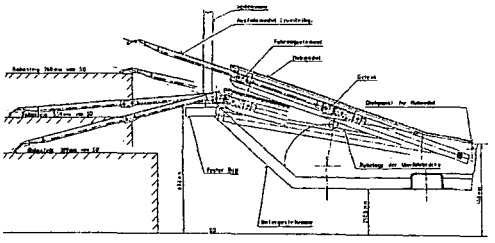
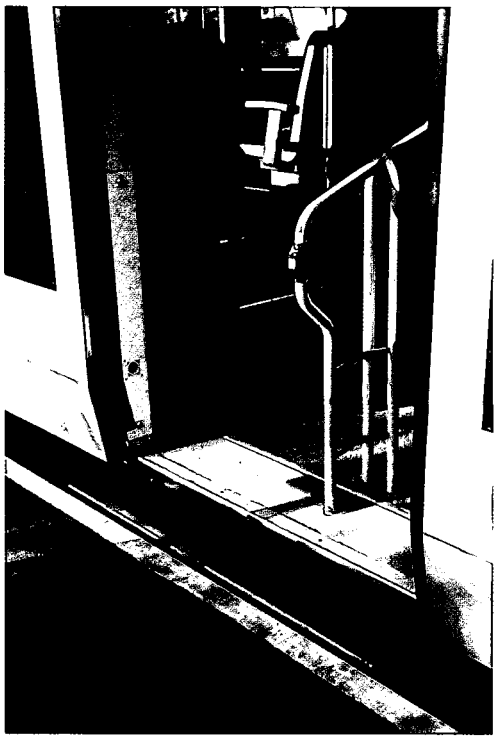


Figure 4.7. Partially raised platform – RBS railways, Bern – CH

Raised platform (32 cm)



Bridging plate

Entrance with one step at low platform (18 cm)

The results of the survey clearly show the difference in platform heights between countries and even within a country. It is interesting to note that several operators have decided to harmonise their platform heights and to provide level access with their new rolling stock, at least for commuter or regional trains.

The variation in cost for boarding aids of a similar type can be explained by the level of automation and the height span to which they are required to operate.

From the above analysis completed by a literature review, an evaluation of lifting devices against access ramps has been made highlighting the differences between platform based and on board devices. The evaluation is summarised in table 2 and table 3. The summaries are only general statements and do not reflect the differences between boarding aid and operating conditions for each country.

table 4.2

EVALUATION SHEET / LIFTING DEVICES

PARAMETERS	PLATFORM LIFT	ON-BOARD LIFT
TECHNICAL		
Area on platform	quite large for operation, storage, movement	smaller, predictable
Reliability	good provided steady maintenance and adequate storage	higher level needed to avoid disturbance of train operation
Safety	staff involvement	staff involvement + visual and audible signal during operation
Storage	on platform, sheltered, protected from vandalism	integrated in the train
Availability	depending on storage location	always, provided communication between on-board staff and PRM
HUMAN FACTORS		
Staff availability	1 or 2 persons from station staff	1 person from onboard staff
Staff training	needed	needed
Comfort – safety	work load in case of manual device ; possible jerks during lift operation	lower work load (powered device), smaller area for the wheelchair
Passenger dignity	lack of discretion	more discreet
Self sufficiency, prebooking	not self-sufficient, prebooking required 1/2h to 48 h in advance	prebooking required but shorter times allowed (communication with on-board staff)

PARAMETERS	PLATFORM LIFT	ON-BOARD LIFT
ECONOMICAL		
Investment	connected with number of station platforms from 1/station to 1/platform	connected with number of trains 2 devices/train (1 on each side)
Working time	longer operation (movement on platform, within station)	shorter - staff on-board.
Manoeuvre time	longer, 2 to 5 minutes, depends on platform clutter and staff skill	shorter : 1 _ to 2 minutes
Maintenance	depends on storage conditions	more limited

Table 4.3

EVALUATION SHEET / RAMPS

PARAMETERS	PLATFORM RAMP	ON-BOARD RAMP
TECHNICAL PARAMETER		
Area on platform	quite large for storage, movement and operation	smaller and predictable
Reliability	good with steady maintenance and adequate storage	good
Safety	staff involvement	staff involvement or visual and audible signals during operations (powered ramp)
Storage	on platform, sheltered, protected from vandalism	on board
Availability	depending on storage location	always, provided communication between on-board staff and PRM (manual ramp)
HUMAN FACTORS		
Staff availability	1 or 2 persons from station staff	1 person (on-board staff)
Staff training	needed	needed
Comfort – safety	work load and risks on steep slopes	less steep slopes but risks due to smaller width
Passenger dignity	lack of discretion	more discreet
Self sufficiency, prebooking	not self-sufficient, prebooking required 1/2h to 48 h before travel	prebooking required if manual ramp shorter times admitted (staff on-board)

PARAMETERS	PLATFORM RAMP	ON-BOARD RAMP
ECONOMICAL FACTORS		
Investment	connected with number of station platforms from 1/station to 1/platform	connected with number of trains 2 ramps per train (1 on each side)
Working time	longer operation (movement on platform, within station)	shorter - staff on-board.
Manoeuvre time	longer, 2 to 5 minutes, depends on platform clutter and staff skill	shorter : 1 _ to 2 minutes
Maintenance	limited, depending on storage condition	much limited

4.4. Recommendations

Boarding aids must be considered as a temporary measure to overcome gaps and steps between station platforms and trains.

A real improvement of accessibility to trains for all passengers can only be made when station platforms and coach-floor heights are at the same level and the horizontal gap (if greater than 50 mm) is filled by a bridging plate.

In the long term, the aim for total accessibility can only be achieved by means of level/step-free access to all facilities within the train.

The technical means to achieve this within a totally self-contained railway system is a matter for local decision, however,

where interoperability is a factor (including international services), a common European standard on station platform height is necessary.

Based on known rolling stock technology, it must be acknowledged that the coach floor cannot be lowered to any great extent as future developments tend towards higher running speeds. On the other hand, it is more feasible to raise a station platform rather than lower it. Therefore,

the recommendation is that platform heights should not be less than 760 mm above rail level.

For cross border operations, bilateral agreements should include consideration of the aim for level access across the service.

An intermediate step towards full accessibility should be to provide at least one coach with step free access in each train set.

During the transition period when boarding aids are necessary, the analysis in the above sections has highlighted the following:

- Operating companies must be careful when choosing their boarding aids in order to be consistent with their long-term strategy concerning availability of staff at stations.
- An important aim for the near future should be to get boarding aids safely automated so that wheelchair users and persons with walking difficulties can be independent when travelling by train.
- When a member of staff is needed to operate a boarding aid, a programme of training and refresher courses must be put in place, to include disability awareness, so that quality of service and passenger dignity be maintained at a high level.
- An access ramp is a simpler and less expensive solution than a lift if boarding and alighting can be achieved perpendicular to the doorway. However, vertical gaps should not be higher than 130 mm for independent access (ramp slope manageable by the passenger), or 180 to 250 mm for assisted access (ramp slope being manageable by the assistant).
- Partially raised platforms would be a less expensive solution, but allow less flexibility for train operation. It may be more difficult to implement such a solution in stations where trains with different gauges pass along the platform. It is certainly worth considering this solution for commuter trains operating with short stopping times.
- Platforms along curved tracks set a problem for bridging plates. An access ramp may be a more reliable solution

because it is folded out over the platform and can fill horizontal gaps of varied dimensions.

- Liability issues must be carefully investigated if a fully automatic boarding aid is to be implemented.
- Responsibility for the service and its safety must be clearly identified between the railway operator and the station operator where they are different companies.

4.5. Technical specifications

4.5.1. General specifications

- The boarding aid must accommodate the wheelchair whose dimensions are as specified in the ISO 7167 Standard with an occupant and withstand a weight of at least 300 kg.
- When staff manually operate the device, it must be ergonomically designed for safety and must require minimum effort.
- When the device is operated remotely by train staff, by the passenger or fully automatic, in conjunction with door opening/closing, it must incorporate safety features that provide visual and audible warning and prevent feet being caught between the platform and its moving parts.
- If powered, the boarding aid must incorporate an emergency method of deployment and operation with an occupant, in case of power failure.

  Such a method must be capable of being operated in a non-hazardous manner for the occupant or the operator.
- The international symbol for access should identify the location of entrance doors appropriate for access with the boarding aid and be readily visible.

4.5.2. Access ramp

An access or bridging ramp may be:

- Positioned manually by staff whether stored on the platform or on board (fig. 4.1).
- Or be deployed by mechanical means, operated by staff or by the passenger - see general specifications above (fig 4.6).
- The slope should be not more than 8% for a ramp longer than 1000 mm, 13% for a length between 600 mm and 1000 mm. If the length is less than 600 mm, a maximum slope of 18% may require assistance to the passenger.
- The effective width must be at least 760 mm. If the plate is less than 900 mm wide, it must have raised edges on both sides.
- The surface must be slip-resistant.
- The upstands at both ends must be bevelled, must not be higher than 20 mm and must have contrasting hazard warnings.
- The access ramp, if manual, must be securely fixed to the train coach when in use.

4.5.3. Integrated bridging plate

The bridging plate is a device integrated into the coach floor, fully automatic and activated in conjunction with the door opening/closing (see general specifications above). It should extend only a sufficiently *short* distance to fill the gap between the platform edge and the floor sill to ensure step free access (fig. 4.5).

- The effective width must be at least 900 mm or be as large as the doorway width (if smaller than 900 mm).
- The slope may be as steep as 18% because its length is less than 600 mm.
- The upstands at both ends must be bevelled, must not be higher than 20 mm and must have horizontal hazard warnings.
- It if remains horizontal (without support on the station platform), the horizontal and vertical gaps between the

plate and platform edges must not be greater than 50 mm (fig. 4.7).

4.5.4. Platform lift, on board lift

The platform lift is a device which can be moved, stored on the platform and must be operated by the station staff (fig 4.4).

The on-board lift is a device integrated into the doorway of the coach that must be deployed by the train staff. (fig. 4.3)

- The system must be able to overcome the maximum height difference between the coach floor and the platform where operated.
- The lift platform's effective width must be at least 760 mm.
- The lift platform must be unobstructed and must be slip resistant.
- The lift platform must have raised edges and two strong barriers, 100 mm hight above the surface of the plate to prevent an electric powered wheelchair from overriding the edge.
- The lift platform must be equipped with a handrail on one side, 750 to 900 mm high, for use by the person standing or in a wheelchair. If ramped at one end, a slope steeper than 13% may require help from the staff for a manual wheelchair.
- The upstands at both ends must be bevelled. If they are higher than 20 mm, help from the staff may be required.

4.5.5. Partially raised platform

This solution is a means for achieving level or step free access but is only feasible for railway systems and networks which can ensure that the accessible door of every train set stops adjacent to the raised section. The

design must be compatible with the gauge of the trains likely to pass through the platform (fig 4.7).

- Its width (perpendicular to the platform) shall be at least 2200 mm and be consistent with the length of the train's access ramp or bridging plate, if any). *The full width of the platform is preferred.*
- If the raised platform is shorter than the platform width, its extremity opposite to the track must either join the existing platform with a gentle slope or be marked with a painted edge of contrasting colour and tone. If such a step (opposite to the track) is higher than 210 mm, it must be equipped with two handrails located at 700 and 900 mm (+/- 50 mm) above the ground, structurally sound enough to prevent a person falling (fig. 4.7).
- The slopes leading to the raised part must be consistent with the recommendations for stations (see chapter 5). *5% is the preferred slope.*
- The international symbol for access should identify the location of the raised area.

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5. Railway Stations – design for all

5.1. Preamble

In many ways access to rail travel for many people depends on the layout and facilities at railway stations and how well these are maintained. The report sets out to demonstrate this to planners and transport professionals. Many barriers to rail travel occur at transport interchanges. All rail journeys start and end at rail stations. Therefore it is clear that measures taken to improve access at rail stations are extremely important to the overall journey.

The work in this chapter overlaps with chapter 4 in relation to access between the platform and the train. Easy access from platform to train is essential to the train journey. Without it, all other access improvements become redundant.

It also overlaps with chapters 6 and 7. If people are to travel by train, they must have information. Information is of utmost importance before and during the journey, and much of this information must be provided at the station. Thus signage and other means of providing information at stations must be located in the right places.

Making rail travel accessible to disabled people will increase the overall quality of railway travel. Inclusive design - design for all passengers - will both improve the station facilities, and be more cost-effective. Increased quality will increase the number of passengers using rail transport, just because they find railways easier to use. The distinction between the needs of disabled passengers, and those of non-disabled passengers is difficult to determine. Many people will find it more comfortable to go by train, once the rail system is made accessible. This increase in

the overall number of passengers makes investment in improved facilities financially worthwhile.

5.2. The Stations Handbook

A design handbook for accessible stations has been produced in parallel.[1]

The intention was to create a user-friendly handbook with examples of existing best practice for those responsible for planning and developing both existing and new stations. These recommendations are not intended to be prescriptive, or to limit innovation. And the drawings provided in the handbook are examples only and are not intended to illustrate the perfect solution.

For the Stations Handbook, certain general features of station design such as visibility, design of steps and ramps are identified, and the design principles to apply to these features are outlined. Then the journey of a passenger through the station is followed, outlining the principles for each specific station feature encountered on the journey.

In this report the thinking behind the good practice recommend is described, and some of the specific design recommendations are highlighted.

5.3. Railway stations as part of the travel chain

The railway station is an important part of the travel chain. The station, as a link in that chain, must fit with the other links (i.e. means of arrival and departure, and access to suitable rolling stock). This requires good intermodal

[1] You can find out where to get the Stations Handbook on the Internet at www.cordis.lu/cost-transport/home.html. An extract of the Handbook is included in subchapter 5.8 (Dahl charts).

connections that are integral to the overall station design, accessible, and clearly signed.

Good intermodal links will require proactive and co-operative relationships between local transport planners and operators. A good example of transport links is the train-taxi, already available some European countries. The taxi will be booked, at a set rate, for the passenger's ongoing journey. Pedestrians, cyclists and private car owners must not be forgotten in the development of intermodal connections, and safe walking and cycling routes and good parking facilities - with plenty of designated parking for disabled drivers and passengers close to the station entrance - are essential.

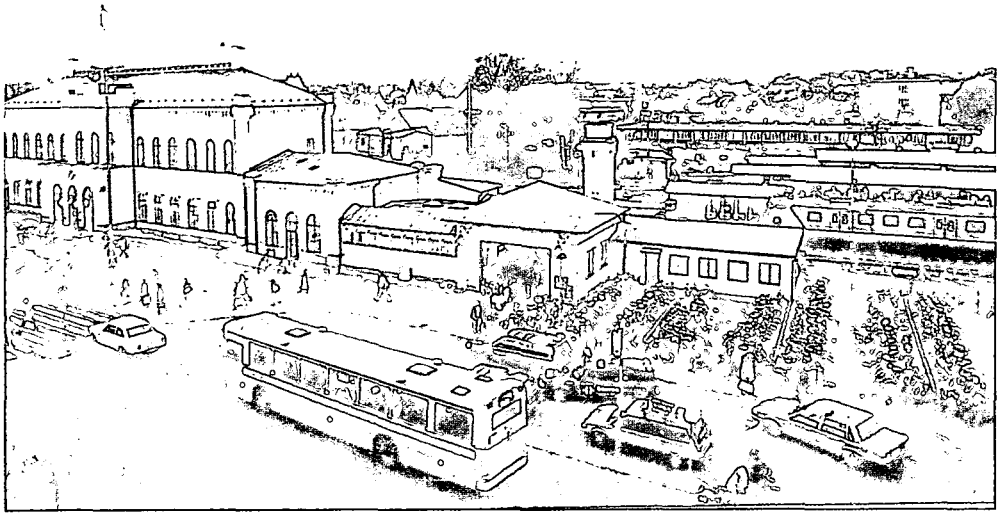


Photo 5.1 Hässleholm Station (Sweden)

Individual companies in the rail industry do not always have full control over the station and its environment. Parts of the environment may be under the control of local government authorities, local businesses or other rail companies. It is important, if we are to achieve full access for disabled people to the rail network in Europe, for the whole industry to work in partnership, inside and outside the industry, in

order that no link in the travel chain is broken. If, for instance, the local government authority owns the station forecourt, and retains a steep flight of steps up to the station entrance, many disabled people will face an impossible barrier to overcome. The station owner must exert influence over local government to ensure that this barrier is removed.

5.4. Some broad design principles

Good, accessible station design always has the function of the station as its primary consideration. Stations are places where passengers board and alight from trains. Travel operations, such as finding information about train arrivals and departures, buying tickets, and waiting for trains in reasonable comfort, should be the first priority. Of secondary importance are the commercial facilities, such as advertising, retail outlets and so on. These can enhance the experience of rail travel for passengers, but only if they do not create additional stress on the journey by getting in the passengers' way.

Other broad considerations include:

- Ease of passage from one part of the station to another:
  - Doors should open automatically so that passengers do not need strength or luggage free hands to open doors while keeping the station environment weather-proof.
  - Ticket control barriers should be avoided where possible, as they create a psychological and a physical barrier to the free flow of passengers.
  - Passageways should be wide.

- Distances between station facilities should be short:
  - Signs including distance measurements where distances are longer can help people with walking difficulties to plan and manage their station visit.

- Lifts are to be preferred to long ramps as these shorten the distance to cover, and the time needed.
- Plenty of seating should be provided to enable people to rest frequently.

• Assistance should be available for those who need it
- Assistance provided should be discreet, but readily available.
- All assistance staff should be trained in effective customer care, including disability awareness.

- If staff is not available, then assistance should be provided in another way. In some countries, local authority staff, taxi drivers and others are contracted to supply assistance at stations when it is needed.

Photo 5.2 Graz Station (Austria)

For more about information and staff training see chapters 6 and 7 in this report.

5.5. General elements of design

These elements are general, because they occur throughout the whole station experience, and form part of many other station features. For instance, the floor surface is part of the ticket office, but also of the station concourse, the toilet, the platforms etc. The later descriptions, here and in the Stations Handbook, of good design for specific station features, such as ticket offices, assume an understanding of appropriate floor surfaces, as well as the other general elements.

5.5.1. Circulation

Circulation is about the free movement of passengers through the station area. Some of the issues considered here are:

- **The layout of the station**
  Good use of space is important in designing a station – providing enough room for passengers to gather at specific points (such as in front of the departure boards) whilst ensuring that disabled passengers, those with prams and heavy luggage, can manoeuvre without endangering themselves or others.

  Station layout should be logical as this will assist all passengers, but especially people with visual and cognitive impairments. Main facilities should be located in step-by-step progression, with each facility visible from the previous one. For example, the ticket office should be visible from the station entrance. Secondary facilities (such as shops) should not intrude into the main circulation space.

  Information signs need to be logically positioned - at the point at which passengers will need the information. Information and advertising should be kept well apart.

Information desks should be positioned in the middle of the main hall, whereas travel centres and information giving more detailed assistance may be positioned around the main hall, easily visible from the information desk (i.e. easy to point out). Lifts and ramps to other levels should also be visible from the centre of the main hall, preferably in the same direction as the facilities they are leading to. Doors should without exception be glazed to enable people to see what is beyond them.

- **Floor surfaces, distances and turning circles**

  Floor surfaces must be slip resistant in all the local weather conditions.

  Turning circles for wheelchair users need to be a minimum of 1500 mm diameter, with a recommended diameter of 1600 mm.

  Walking distances should be taken into account, and station facilities – particularly those essential to travel such as the ticket office – must not be placed too far apart. Where greater walking distances cannot be avoided, as in large stations, an electric buggy may be provided for the carriage of passengers. If buggies are provided, staff needs to be aware of this and offer the facility to those who need it.

- **Accessing other levels**

  Stair design needs to take the needs of people with walking difficulties and people with visual impairments into account. The tread must be wide enough to support the foot, and the stair nosings should be contrasted, at the very least on each first step, to be easily seen by those with visual impairments. Open treads are not recommended as they cause a trip hazard.

The underneath of the stairs should always be closed so that people withvisual impairments, especially, are not in danger of colliding with the underside of the steps.

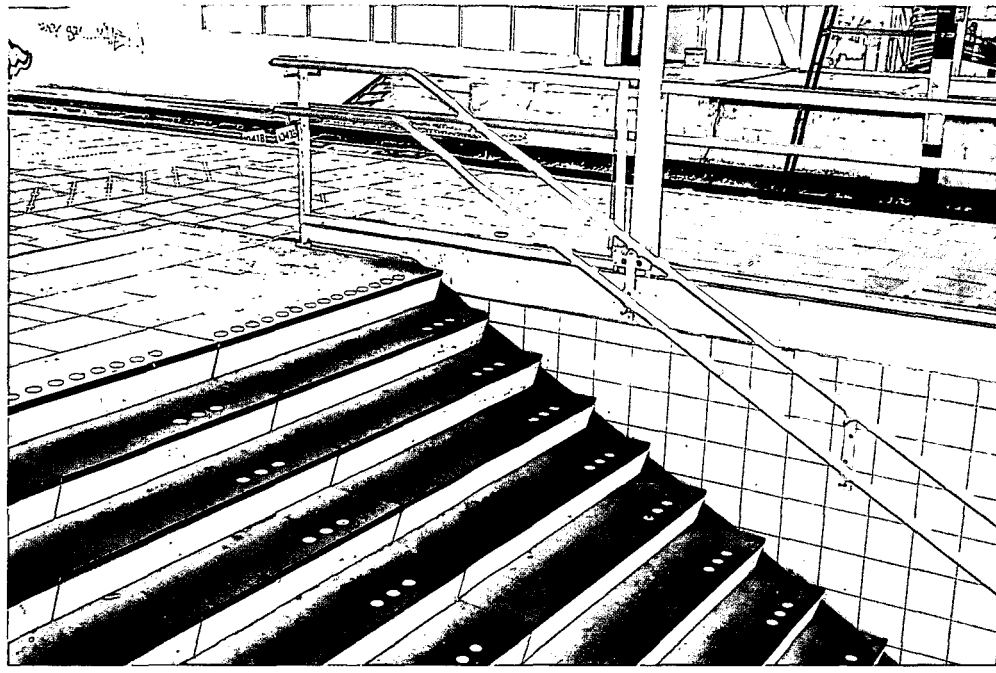


Photo 5.3 Leiden Station (Netherlands)

A rolling conveyor belt up the side of a flight of stairs can assist people carrying luggage, but the speed should be appropriate for people with walking difficulties. It should be installed so that it does not impede those using the handrails or cause a hazard for people with visual impairments.

A handrail is essential, and although stainless steel is good for vandal resistance and ease of maintenance, it is almost or totally invisible to people with visual impairments, and colour contrast is essential. Coloured coatings for stainless steel are available and can be used if stainless steel is the preferred material.

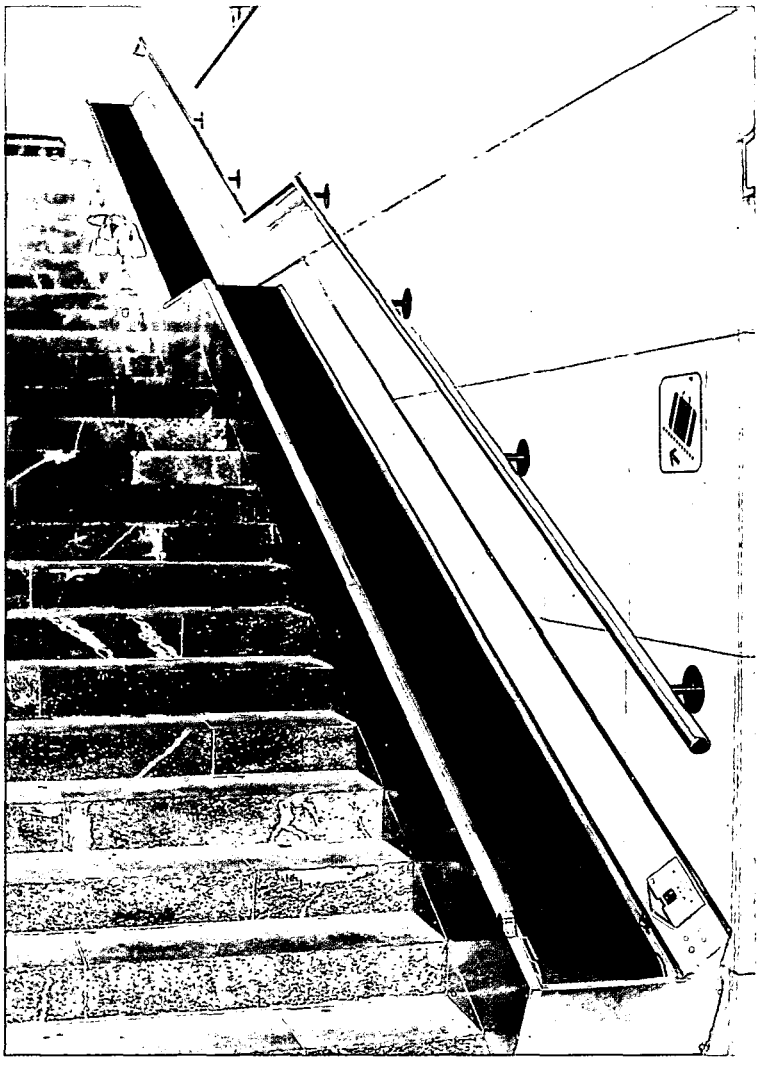


Photo 5.4 Ljubljana Station (Slovenia) - luggage conveyor belt

Some form of step free access (ramped travelators or lifts) must be available for wheelchair users and assistance dog users. Escalators are useful for people who have difficulty with steps or walking, but are of little use to those with wheelchairs or dogs.

A choice of means of changing floor level should be provided, but is especially necessary for people who, for example, experience claustrophobia in lifts but have difficulty climbing stairs.

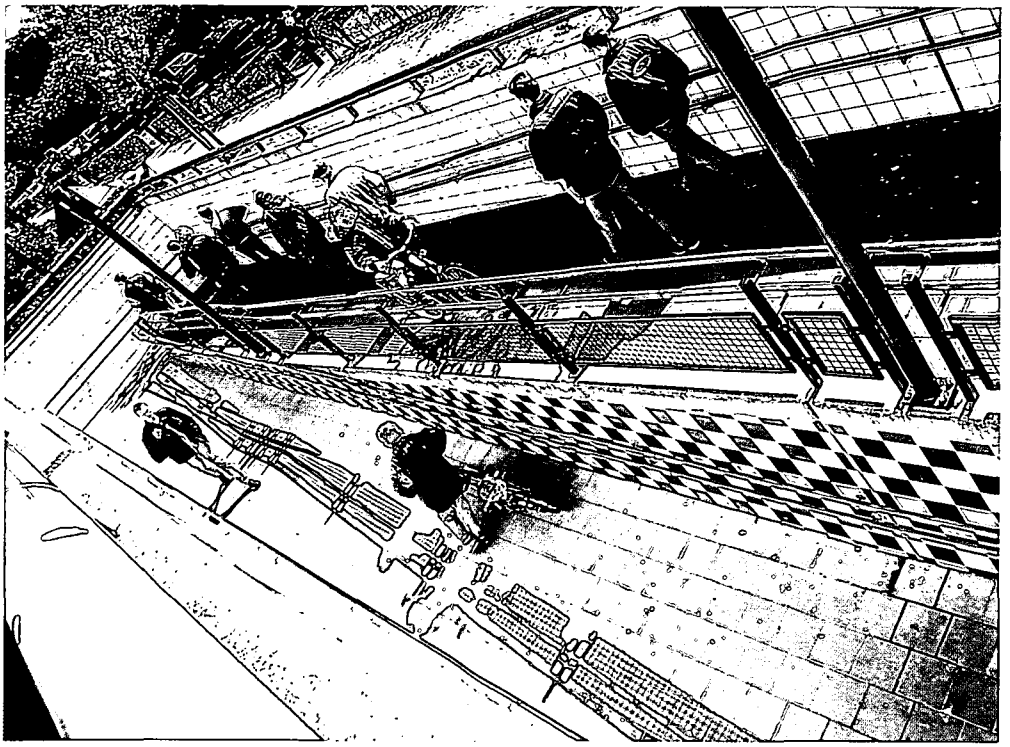


Photo 5.5 Utrecht Overvecht (Netherlands) - ramp

Long ramps should be avoided, or the additional option of a lift provided. Many people with walking difficulties find ramps difficult to negotiate. The longer the ramp, the gentler the gradient should be, and the more resting places should be provided. Ramps should never be longer than 132m, best length not longer than 50m, with a gradient of 6% maximum.

Platform stair lifts are not recommended for use in a station, as they are more suited to domestic use. Vertical open platform lifts can be used for short rises (about a metre), and should include a folding seat for ambulant disabled and elderly people.

Photo 5.6 Leon Station (Spain) - open lift

Closed lifts are best made from glass, as this reduces the risk of claustrophobia, increases security for the passengers in the lift and reduces the likelihood that people will use the lift as a toilet. However, the glass should be well marked so that it does not present an additional hazard to visually impaired people.

It is important that choice is available to passengers for as much of the time as possible, therefore it is recommended

that routine maintenance is carried out frequently, and at night when the station is less busy.

Some form of communication aid should be provided in lifts and on escalators, especially at small unstaffed stations, so that people can call for assistance in an emergency. And at unstaffed stations, a maintenance contract needs to be in place so that passengers are not left stranded for more than an hour at most. Madrid Chamartin station, for example, has a contract with the escalator supplier which requires an engineer to arrive within 10 minutes of being called.

Photo 5.7 Chamartin Station (Spain)

5.5.2. Visibility

- **Lighting**
  It is essential to ensure long lines of sight in a station so that passengers can "see and be seen". Good lighting is important for way finding, and reading information provided. It is also important for security – often of great

concern to disabled passengers who are unable to move as quickly as others can. The lighting level should be adapted to the surroundings. Lighting should be even throughout the station area, except at entrances and on stairs, where a slightly increased lighting level is needed. It is important to use lighting and materials in a way that avoids reflection, glare, or alternate patches of light and dark. It may be necessary to regulate the amount of natural sunlight that enters the station area in order to avoid glare and reflection.

- **Contrast**
  Colour and contrast can be used to direct passengers around the station (for example, the route to and from platforms marked on the floor in one colour). It is of great importance to people with low vision, to mark obstacles, and identify surroundings and facilities. For example, good contrast between walls, floor and ceiling enable visually impaired people to get the measure of their environment.

5.5.3. Environment

- **Clean air**
  People these days are becoming more environmentally aware, and more concerned about clean air in public places. This is not just a 'green' issue - increasing numbers of people have allergies, currently 4% of the population, and are unable to breathe in areas that are contaminated by smoke, dirt or animal hair. If the railways are to attract more passengers, the access needs of this group of people must be taken into account.

  The minimum requirement is for non-smoking areas - although it is better to have limited areas for smoking, with the main part of the station non-smoking. Animals,

such as dogs, should also be restricted, although the needs of assistance dog users should be balanced with the needs of those with allergies. Adequate provision needs to be made so that both groups of people can receive equal service in the station, without discrimination or discomfort.

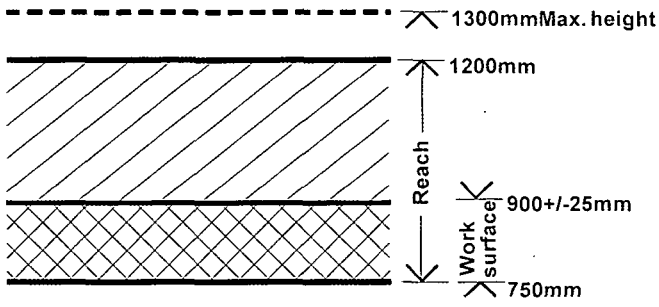
Smoking is also a fire-hazard, and in some places it is safer to ban smoking altogether.

Disabled passengers may well be more affected by a dirty environment, for example, toilets, or on floors. People with walking difficulties may slip on wet or dirty floors more easily than non-disabled people. And disabled people using toilets have to touch their surroundings more than non-disabled people, and are therefore more inconvenienced by unhygienic toilets.

Figure 5.1. Dimensions

Heights

Accessible objects and work surfaces



Widths