

# THE URBAN TRANSPORTATION MONITOR

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## Selection of Maglev Questioned

*Expert Provides Reasons Why High Speed Rail Is a Better Choice*

Professor Vukan Vuchic provided *The Urban Transportation Monitor* with a document that he prepared last month on the decision by the U.S.DOT to select maglev as a High Speed Ground Transportation mode as well as to select the Washington D.C.-Baltimore corridor as one of two locations to develop pilot a project to test maglev technology.

The following is a summary of the main points of Dr. Vuchic's document: "*The Maglev Transportation System and the Baltimore-Washington Proposed Project: An Independent Expert Review.*"

One of the main goals of a rail system is to provide citizens with a viable alternative to air transport, and thus reduce the burden on airports and the highways people must drive to get to them. In France, the deployment of a 417-km (259 mile) line for the TGV between Paris and Lyon helped replace most of the air traffic between the two cities with train passengers. Planners of Germany's Intercity Express intend to develop a high speed rail system that offers twice the speed of car travel to stops within city centers rather than peripheral airport locations.

Vuchic assesses the current state of high speed rail (HSR) as favorable. Since the first HSR lines were built 36 years ago, they have provided safe, efficient travel. Many countries have expanded the service capacity of individual HSR lines by including them in

large networks of rail lines. Japan, in particular, has developed a network of lines totaling several thousand kilometers. The Tokyo-Osaka line is one of the busiest in the world, with 400,000 riders per day.

Arguments typically used to promote the creation of maglev lines usually emphasize that magnetic trains would be faster and more energy efficient than HSR. Vuchic's report seeks to demonstrate that these claims are not accurate.

His report raises several fundamental points. When considering speed, there are two distinct meanings to consider: first, the maximum experimental speed, which is the speed achieved under pre-set test conditions. This is different from the maximum operating speed, which is the speed the system is intended to reach under normal

operating conditions. The difference between the maximum experimental speed and the maximum operating speed can be significant, with the former being as much as 50-80% higher than the latter. Vuchic emphasizes the importance of using the corresponding speeds when comparing two systems.

The most significant advantage commonly ascribed to maglev—high speed—actually does not exist, because HSR has improved its operating speed over the last few decades to equal that of magnetically-levitated trains. Vuchic asserts that the touted speeds of maglev trains are misleading. While advocates contend that they can go much faster than HSR, Vuchic points out that this widespread belief is based on a comparison of the maximum *experimental*

speed of maglevs with the *operating* speeds of HSR.

According to Vuchic, without an advantage of speed, maglev does not offer a viable alternative to HSR. In fact, it has several drawbacks: it is costly, with higher investment and operating expenses, it consumes more energy, and it cannot operate on complex inter-

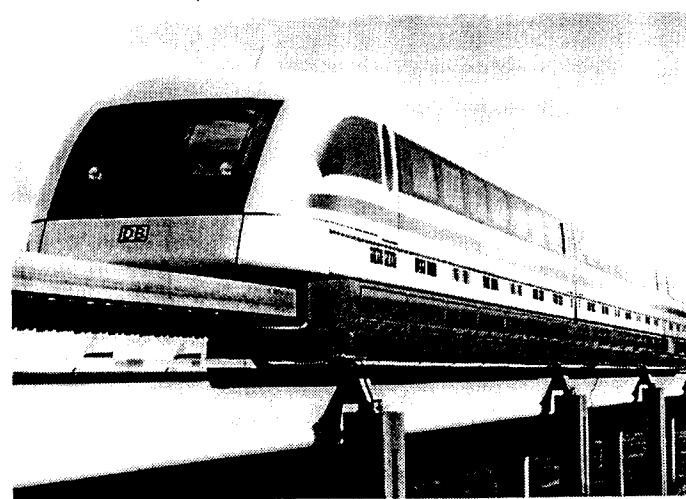
changes. Without the ability to join existing networks, maglevs cannot contribute to the growth of intermodal systems, which Vuchic identifies as the real trend of the future in transportation planning.

HSR trains have the added advantage of having simpler switches than maglev's, allowing HSR to switch along interchanges easily. Maglev must use complicated switches, discouraging planners from considering using maglev on interconnected networks. Furthermore, maglev requires the construction of an entirely new infrastructure, whereas HSR can be built along existing rail lines.

Vuchic asserts that HSR also provides a more comfortable ride than maglev, with less noise and fewer bumps.

No matter what alignment planners might choose for maglev, grade, aerial, or tunnel, studies indicate that the cost would be 10 to 20% higher than HSR. It would require new infrastructure, a particularly costly expense in downtown areas like Baltimore. While maglev might be free of the wheel resistance of HSR, its magnetic levitation would require constant use of energy which would likely surpass the energy HSR needs to overcome wheel resistance during operation.

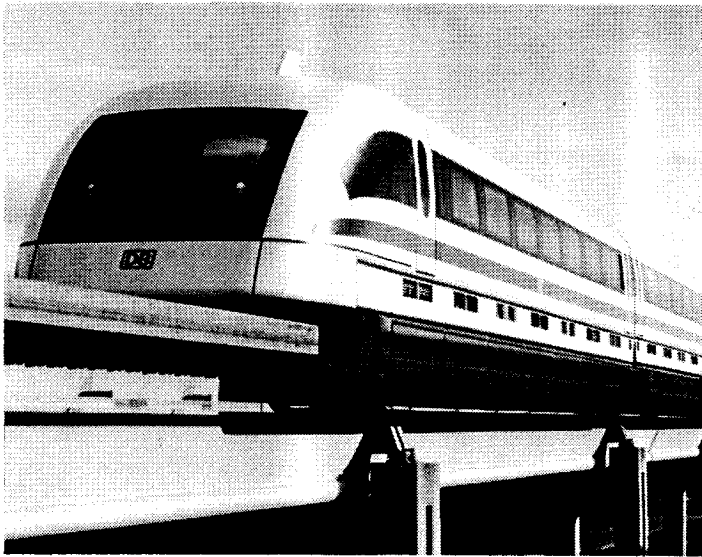
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*The German Transrapid maglev. (Photo: Transrapid)*

# Maglev vs. High Speed Rail: The Debate

In its February 16, 2001 issue *The Urban Transportation Monitor* published a summary of Professor Vukan Vuchic's critical review of the decision by the U.S. Department of Transportation to select maglev as a High Speed Ground Transportation mode as well as to select the Washington D.C.-Baltimore corridor as one of two locations to develop a pilot project to test maglev technology. Phyllis M. Wilkins, Executive Director of Maglev Maryland, in conjunction with the Maryland Mass Transportation Administration, prepared a response to Dr. Vuchic's article. *The Urban Transportation Monitor* asked Dr. Vuchic to provide a rebuttal. Ms. Wilkins' response and Dr. Vuchic's rebuttal appear below.



*The German Transrapid maglev. (Photo: Transrapid.)*

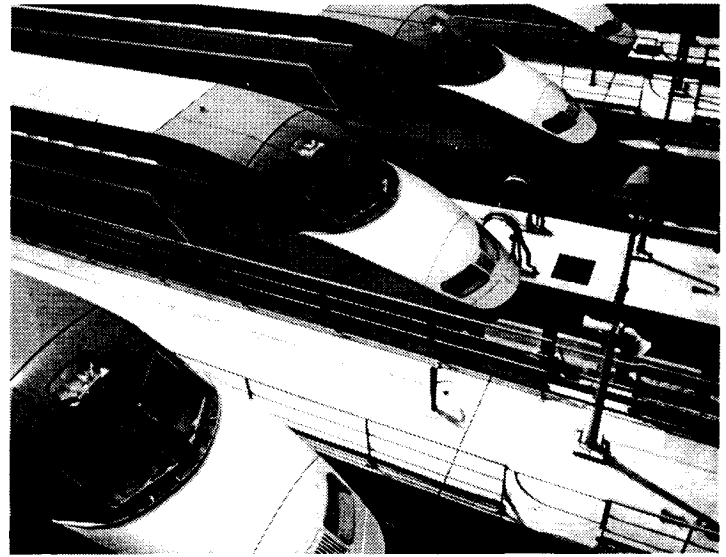
## Phyllis Wilkins' Response

I am writing to respond to the article questioning the selection of Maglev prompted by Dr. Vuchic's paper. Dr. Vuchic has widely circulated this paper which contains some statements that many feel are erroneous or not fully substantiated. I would like to provide you with abbreviated responses to some of his points. Maryland Mass Transportation Administration (MTA), which is managing the Baltimore-Washington Maglev project, has prepared responses to his entire paper.

I would like to preface my response with the fact that as the Secretary of the High Speed Ground Transportation Association, I am a proponent of both high-speed rail and Maglev and actively lobby for both modes. However, as the Executive Director of Maglev Maryland, I would like to make the point that Maglev is part of the future of the transportation system of this country and is being supported by the federal government's Maglev Deployment Program. The government has recognized that the continuing growth of congestion on the ground and in the air can only be addressed by the introduction of an additional mode of ground transportation with capabilities that far exceed existing high-speed rail. Many believe that the introduction of Maglev will also benefit high-speed rail by making more funds available to increase speed in different corridors. A successful Maglev project will help create a demand for higher speed for rail across the board.

The central thesis of his paper ignores the fact that the two projects are competing for funds only available for Maglev De-

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*European TGV high speed rail.*

## Vukan Vuchic's Rebuttal

### Clarifying the concepts for a correct comparison of high speed ground transportation modes

I welcome Ms. Wilkins' response to my report on the comparison of Maglev and High Speed Rail (HSR), and my evaluation of the proposed Baltimore-Washington (B-W) Maglev project. Any project of this scale requires professional discussion to clear up many issues that are raised and to correct often confused concepts and often biased claims by various interested parties and sensational reports. Here is my condensed answer to the major criticisms of my report by Ms. Wilkins, as well as some additional clarifications about High Speed Ground Transportation (HSGT) modes.

My research of the Maglev system and DOT's program to promote it finds that the comparison of Maglev with Accelarail (existing rail systems upgraded to high speed operation, i.e., over 200 km/h) and new High Speed Rail (HSR) is biased because it overestimates Maglev's advantages, downplays or ignores its disadvantages, and uses many hypothetical situations for Maglev to compare it with HSR in real world conditions--a patently incorrect comparison. Actually, over several recent decades we have had numerous attempts to "solve" transportation problems of existing systems created by organizational and policy deficiencies by applying different technological solutions, conceived for ideal organizational and policy situations. It is therefore important to compare different transportation systems under comparable and

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ployment. Further, it should be noted that the enabling legislation for the Maglev Deployment Program requires a public/private partnership to pay for the entire project costs. In the case of the Baltimore-Washington Maglev project, it is estimated that the cost to be borne by the private sector will exceed the investment by the public sector. I would refer you to an article in the February 26, 2001 issue of *The Bond Buyer* regarding the Maglev competition as an example that the interest across the country in this program is very active and that the financial community is taking it seriously.

*Dr. Vuchic asserts that the speed ascribed to Maglev is not proven but only experimental.*

A total of approximately 750,000 km (470,000 miles) of running operation has been achieved since the German Transrapid test track facility opened in 1984. Approximately 330,000 passengers have ridden the Transrapid since visitor operations officially began in 1992. On the twenty-mile test track they routinely achieve top speeds of 250 to 280 miles per hour. These routine results take it out of the realm of experimental.

*Dr. Vuchic argues that high-speed rail has a major advantage over Maglev with respect to compatibility with extensive existing rail networks.*

It is true that the Maglev train can operate only along a dedicated and specially designed Maglev guideway and thus cannot operate over existing rail tracks. This is not the disadvantage commonly assumed. The use of a dedicated guideway allows optimized Maglev operation--from design, operation, and maintenance aspects. True high-speed rail operation is only economically justifiable when dedicated rail lines are designed, built, and maintained. Upgrading of existing lines and mixing of traffic (high and medium speed passenger traffic and/or freight traffic) compromises operation (very different train speeds) and makes maintenance very expensive (to maintain the high requirements for high speed rail).

Using existing tracks combined with newly built high-speed lines is not necessarily a benefit, because even short sections on existing low speed tracks reduce the average speed significantly. In France, where most of the TGV service is done on new tracks, the average speed is in the range of 200 km/h. In Germany where the new tracks are rare, the average speed of the ICE is in the range of 150 km/h. It is really doubtful if it makes economic sense to let trains capable of an average speed of 300 km/h run at these low speeds.

While the ability to use existing rail rights of way is viewed by Dr. Vuchic as an advantage of High Speed Rail, the fact of the matter is that in many urban corridors (North East Corridor, Chicago-Milwaukee, Los Angeles-San Diego) the existing rail lines are at capacity and building new lines is as difficult as building new highways. In these corridors Maglev offers considerable advantages in that it is an elevated system with small footprints that can be threaded along existing rail, highway and power line rights of way in a far less obtrusive manner. Furthermore, Maglev's com-

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**realistic real world conditions.**

To be feasible for introduction, any new technological system has to meet two criteria. First, it must be physically/economically feasible; and second, it must have a "performance/cost package" superior to such "packages" of existing systems. Let us examine Maglev.

My report clearly states that Transrapid Maglev has been proven to be physically feasible and successful in operation. I do challenge the claims that Maglev has such a huge superiority over HSR as it is claimed. For example, Transrapid's often mentioned capabilities of 300-400 mph would be more correct if these figures were expressed in km/h (Transrapid's maximum speed has been 436 km/h or 272 mph; it routinely exceeds 400 km/h or 250 mph [but not 280 mph] on the test track in Emsland, Germany). HSR running at 300 and tested at 350 km/h is not much inferior in travel time, especially if these speeds are not reached for long periods of time.

Transrapid is superior to HSR in acceleration capability, although not as much as its promoters claim and show on diagrams in Maglev system brochures because acceleration at low speeds is limited by passenger comfort (not by rail adhesion), and at high speeds by the economics of energy consumption.

I also challenge as incorrect comparisons of experimental results of Maglev with those of HSR achieved in regular operations. It is true that Transrapid has carried over 300,000 passengers on its 32-km long test guideway in Emsland, Germany. But that experience can not be compared with HSR if one bears in mind that a single HSR line, **Tokyo-Osaka, has carried more than 300,000 passengers per day for several decades, with average trip length of over 200 km.** The intention of DOT to test Maglev is therefore correct, but the question is where and how such a demonstration will provide the needed information.

Ms. Wilkins' claim that the fact that thousands of people visit Emsland to ride Maglev trains is by no means a proof of this mode's extreme popularity. Monorails are always popular in amusement parks and they have enjoyed an aura of "future system for cities" for about 40 years, yet technical studies have consistently proven them inferior to rail transit. Popularity of prototype lines and exotic new modes is no proof of their permanent attraction of passengers.

For clarity of concepts, in selecting High Speed Ground Transportation (HSGT) modes, one has to distinguish **two comparisons**. First, **operation on fully separated guideways vs. operation on exclusive as well as on existing guideways** (i.e., rail lines with the same gauge). And second, **if the fully separated right-of-way is adopted, which technology should be used**. This is where Maglev and HSR should be compared with respect to their technical/operational characteristics.

Presentation of Maglev and its comparison with rail often implies an incorrect image. Maglev is presented, correctly, operating on exclusive rights-of-way only. HSR, such as the French TGV and German ICE, are claimed to be inferior to Maglev because they can and do share railway tracks in terminal areas. Actually, HSR can, of course, be built on exclusive lines only like

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mercial speed is much higher than high speed rail and as such represents the next step after high-speed rail.

Given the scenario as proposed by Amtrak, in which the Eastern Seaboard would operate with three levels of rail service (Maglev connecting major center cities and adjacent airports, Acela connecting major and intermediate cities, and commuter rail connecting center cities with suburban locations) extensions from the Eastern Seaboard corridor to other locations could be provided by the second and third level services. Ultimately, it is hoped that the nation will see the development of a broad and comprehensive Maglev network by the second half of the 21<sup>st</sup> century after service on the Eastern Seaboard Corridor has proven Maglev to be a successful technology and has effectively relieved congestion along the highways and airports serving this corridor.

*Dr. Vuchic claims that HSR is a more comfortable ride than Maglev with less noise and fewer bumps.*

The Transrapid Vehicle TR08 is the vehicle that was designed for commercial operation on the Berlin to Hamburg line. Maglev speed is constrained by passenger comfort and because the vehicle floats contact free above the guideway, the ride is very smooth and comfortable. This vehicle has received Final Type Approval by the German Government for commercial passenger operations. This vehicle has undergone several improvements over the TR07 test vehicle that will contribute to improved noise profile, including improved aerodynamics. As part of their certification process, Transrapid has done extensive noise testing and can demonstrate that at comparable speeds the vehicle produces much lower dB levels than a freight train, light rail, intercity train or HSR. At a top speed of 500 km/h that is 200 km/h higher than the top speed of HSR, its noise level is still significantly lower. It should be further noted that the top speed for Maglev is unattainable for HSR. (See the table below prepared by Transrapid as a result of government testing.)

### Noise Levels: Maglev vs. High Speed Rail

Speed	Noise Level: Maglev	Noise Level: HSR
200 km/hr	71-75 dB(A)	84-90 dB(A)
300 km/hr	77-82 dB(A)	90-99 dB(A)

*Dr. Vuchic also questions the statement that Maglev operating costs are low because of the absence of physical contact between vehicle and guideway. This is questioned because of the extreme precision the guideway must have to maintain the small clearance of 10 mm. The operating costs are not a function of the gap requirements. The lack of contact reduces maintenance costs by eliminating physical wear that is common to wheel-on-rail systems. It should also be noted there the loads are distributed along the length of the vehicle compared with the heavy point loads of conventional steel wheel systems. Operating costs are calculated based on the schedule of operation, the headways, frequency of operations, energy consumption, and related labor costs*

The fact that the guideway of the Transrapid has to be precise

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Maglev (Shinkansen was forced to do that due to the narrow gauge of Japanese Railways). However, extensive studies in each country have found that the advantages of much lower investment costs, shorter construction time and lower environmental impacts of partially sharing tracks and stations far outweigh the disadvantages of additional travel times in terminal areas. Provision of no-transfer service to cities not yet connected by HSR tracks, such as Geneva and Hamburg, represent another significant advantage.

Therefore, **Maglev does not have an advantage of not sharing tracks; rather, it has a major disadvantage that it does not have that option**, so that its construction in the same corridor would involve higher investment, more years and greater obstacles in obtaining such rights-of-way than an HSR system would have. Maglev also must have its own new stations and yards. This feature limits Maglev to operation on its guideways only, requiring transfers to any other line, adding to total passenger travel times.

Further, Maglev is always shown as superior to HSR because it, supposedly, runs on elevated guideways. Actually, HSR also can, and in many cases does, run on elevated guideways, with the same advantages (although with a larger "footprint"), as well as disadvantages—much higher cost than at-grade tracks and inability to use such alignment in most urban areas. When the alignment can not be aerial, Maglev would have to use the tunnel as the HSR does, and require a greater profile at that. Thus again, **HSR is not inferior to Maglev because it mostly runs at ground level. Rather, it is superior because it has more options: it can use the same alignment as Maglev, as well as lower-cost ones.**

While Maglev systems were very shaky and noisy at different stages of development, Transrapid 8 has demonstrated lower noise than HSR. With respect to the riding comfort, HSR is so perfect, that other modes can at best match it.

With respect to maintenance, it is correct that it is of a very different nature on Maglev from that on HSR. Rail does have contact wear which Maglev does not, but it is not correct that Maglev guideways once built will remain in perfect condition forever, regardless of use. It will still carry dynamic loads that may lead to settlements—which occur on any concrete structure. Rail vehicles can absorb certain alignment imprecisions through their multiple truck suspensions; any column settlements on Maglev will be much more complicated and costly to correct.

How frequent and serious these corrections would be can be known only after more extensive real-world operations.

Yes, extensive estimates of maintenance and other costs were made for the Berlin-Hamburg project, and they were taken into account when the two alternatives were compared and the decision to cancel the Maglev project and proceed with HSR was made.

An updated comprehensive comparison of major features of Maglev and HSR is presented in the table on page 11.

Now let me address Ms. Wilkins' claim that my report is "theoretical" and "anecdotal" by referring to the MTA report's findings and claims which have led me to be critical about that project.

1. According to the projected travel diagram for the B-W Maglev

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has nothing to do with its maintenance costs. Once the guideway is mounted it will stay in place due to the non-contact operation without any wear and tear. Looking at high-speed rail, the situation is different: the precision has to be at least the same as for Maglev because there the "gap" is zero. In addition, there is daily wear and tear, meaning the tracks have to be adjusted regularly and the rails and the ballast have to be replaced every ten years.

During the German Berlin-Hamburg Project, operating and maintenance costs were closely scrutinized, documented, and ultimately agreed to by Deutsche Bahn. These costs formed the basis for the public-private financing concept and also for the construction contracts that were negotiated for the project. A demonstration project between Baltimore and Washington will conclusively establish Maglev operating costs.

We have found that one of the problems with Dr. Vuchic's paper is that he has examined maglev from a theoretical point of view and has used third person anecdotal remarks as a basis for his criticism. Maryland Mass Transit Administration has spent over two years working with a technical team to understand the technology from many aspects. They also took the time to travel to Germany to tour the test track, ride on the vehicle, examine the technology and question the technical staff at Transrapid. They now have first hand knowledge as a basis for their evaluation. I hope that this answers some of the questions raised by Dr. Vuchic.

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line, trains will travel at the maximum design speed of 380 km/h for only about 2.5 minutes. How can such a line then prove Maglev's capability of high speed for sustained longer distances? How can its experience with energy consumption and operating costs be valid?

2. Accepting for a moment the questionable assumption that the B-W is intended to be the first section of the Charlotte-Boston corridor, should one design both terminals of this line in the positions that would be extremely costly if not impossible to extend (imagine connecting the elevated Maglev guideways in Union Station into a tunnel going under the Capitol plaza and buildings!)?

3. Trains approaching stub-end terminals cannot use the maximum speed profiles because the risk of accident due to any deviation in the braking control system is unacceptable. **The B-W line will have two or possibly three stub-end terminals, degrading the line's average travel speed.**

4. Based on theoretical modeling, MTA's report projects a daily ridership on the line of 35,400 passengers. The fact that today daily ridership on that section is about 600 on Amtrak and 4,200 on MARC, **MTA's projection for Maglev appears extremely unrealistic** regardless of which model was used for its computations. Models projecting huge volume and profits from freight similarly lack any realistic validity.

5. Further comparison of theory and practice: in theory Maglev is claimed to have a great superiority over rail in speed and acceleration. **On the B-W line Maglev is scheduled to operate at an average speed of 183 km/h.** For comparison, Japanese Shinkansen operates on a line with similar length at 209 km/h, and French TGV Atlantique operates on a longer line at 224 km/h.

In closing, I am not denying the desirability of developing a demonstration project for the Maglev system, because of several advantageous features of this technology for HSGT. However, the demonstration project should be designed so that it can show the high speed capabilities on a considerable distance, where there is high ridership and presently no high-quality public transportation service. Los Angeles-Las Vegas would probably come closest to these requirements. The Baltimore-Washington project does not meet these requirements, so that it would probably not yield the results that would prove the major unknowns about the Maglev system.

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## Comparison of Maglev and HSR Technologies in Critical Systems Characteristics, by Prof. Vuchic

System Features	Maglev	HSR
Maximum speeds	420-450 km/h (261-280 mph)	300-350 km/h (186-217 mph)
Acceleration rates	Higher at upper speed range	
Intermodal capabilities/ Network aspects	None/Single lines	Excellent/Extensive Networks
Compatibility with built-up areas	New elevated guideways, tunnels and stations needed	New lines with existing lines and stations can be used
Impacts on surrounding areas	Lower noise and vibration	Tracks mostly at grade
System image/Passenger attraction	Excellent, plus initial innovation interest	Excellent/Superior network accessibility
Investment costs	\$12-55 million/km (\$19-88 million/mile)	\$6-25 million/km (\$10-40 million/mile)
Energy consumption	Higher than HSR	
Riding comfort		Superior