Maglev System on the Island of Tenerife

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ABSTRACT: The Government of the Canary Island of Tenerife has initiated a feasibility study to build a maglev high speed system on the island. This paper discusses the results of the study aimed to investigate technical, operational and economic feasibility of a maglev route on the island.

1 INTRODUCTION

The Island of Tenerife in the Canaries, which belong to Spain, has an area of approximately 2,000 sq km and, with the volcano summit of Teide, a maximum altitude of 3,718 m. Just under a million people live on the Island of Tenerife, and it is visited by around five million tourists a year.

Transport on the island is provided mainly by cars and buses. Car density is at around 700 to 800 cars per 1,000 inhabitants. In the capital city of Santa Cruz, a tram has been operating on a roughly 16 km line since 2007/08. Peak holiday traffic is accommodated by a single motorway linking the northern and southern parts of the island. Around 45 % of the overall population live in the island's North. In contrast, a mere approx. 13.5 % of the population live in the tourist-oriented communities of the South, which is important with regard to employment. Passenger traffic to and from the Island of Tenerife is handled via two airports (North and South) lying about 65 km apart.

On the Island of Tenerife, planning studies have been carried out for railway routes for several years, both in the North and in the South of the island. Owing to its topological features (very severe gradients), railway planning on the Island so far has incorporated a total of 41 km of tunnels for a roughly 120 km railway route, i.e. 34 %.

In autumn 2010, the island's President arranged for the Maglev Tenerife Planning Consortium (PMT), consisting of Consulting Engineers Dipl.-Ing. H. Vössing Ltd. (IBV) and the Institute of Railway Engineering Ltd. (IFB), to examine the high-speed magnetic levitation railway as an alternative for a North-South link on Tenerife in a feasibility study.

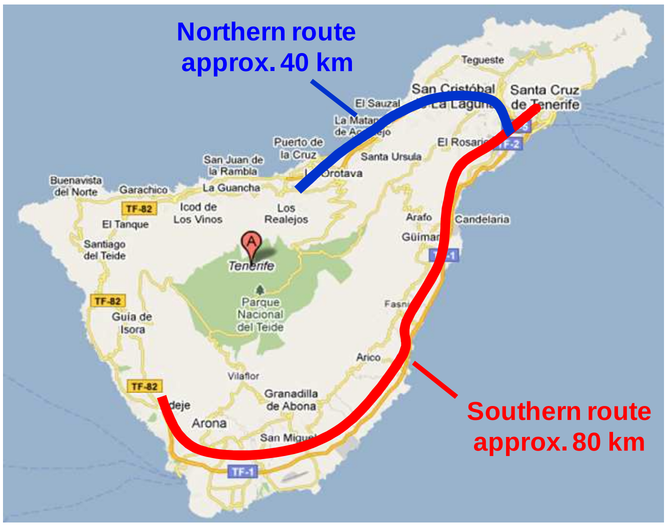

Figure 1, Island of Tenerife with route corridors

2 CONDITIONS AND REQUIREMENTS

The study was to demonstrate technical, operational and economic feasibility taking into consideration the project-specific requirements for the Northern and Southern routes. One essential requirement was that the cost of investment established for the total route of a preferred variant at a magnitude of around 3 billion EUR be demonstrable for a given operational load. In the main, this goal was to be achieved in contrast with wheel-to-rail studies by:

- a significant reduction in the share of tunnels,
- a greater combination of the guideway with the motorway,
- making use of the motorway's central reservation area wherever appropriate and
- minimising the entire area requirement for the guideway by taking advantage of the system-specific Transrapid route planning.

Since the Transrapid maglev has to accomplish the same transport role as the railway planned previously, the latest traffic volume data in the railway planning concepts was taken as a base.

Owing to the comparatively short time for processing, what are referred to as other costs, for example of stops, car-parks and entrances, workshops and storage sidings, were originally adopted from the planning concepts for railways. This data was checked for plausibility, and cost assumptions / optimisations deviating from it were stated.

A more in-depth handling of all thematic foci is to be carried out in a second examination phase.

3 RESULTS

3.1 Route and infrastructure

The overall route examined for the Transrapid maglev has a total length of approx. 120 km, with 13 stops in all; 5 intermediate stops each on the Northern and Southern routes and three termini: Los Realejos (end of Northern route), Las Americas / Costa Adeje (end of Southern route) and Santa Cruz (capital).
This route (Figure 2) links all the important centres of the island, especially the North with the South and both parts of the island with the capital of Santa Cruz as well as the two airports that are vital for the island. The route is to become an integral element of public transport on the island and will be integrated in the island's overall transport plan.

In the context of working out the overall route, a total of six variants were examined. They differ from one another mainly in the way that route planning is conceived for the stops and the stops are linked to the route. While presenting initial project results, one variant was chosen as a preferred variant for the route as a whole and declared feasible and accomplishable from today's standpoint. The following describes this variant only. Moreover, this preferred variant takes all the boundary conditions (e.g. location of the stations) from the previous railway planning concepts into account.

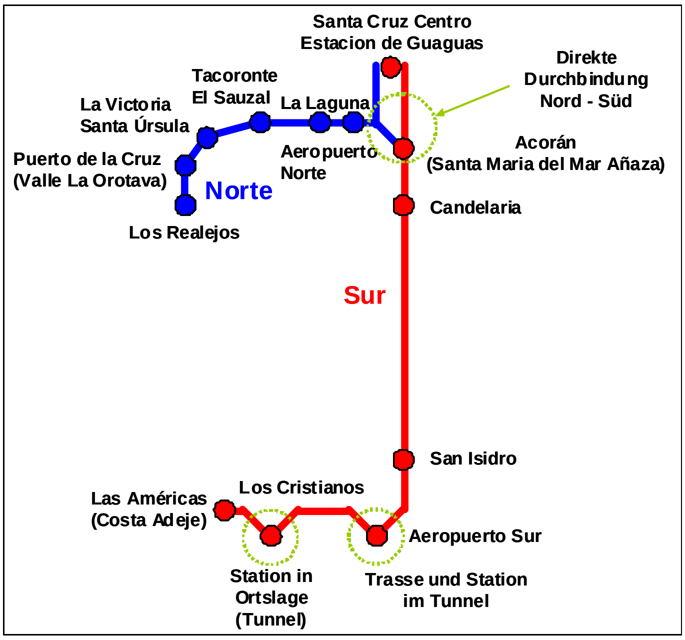

Figure 2, Northern and Southern line incl. stations, preferred variant

MAP: Direct North-South connection
Station situated in community (tunnel)
Route and station in tunnel

Table 1 shows the essential characteristic data of the preferred variant. Roughly half of the route has been designed double-track, with the other half single-track. What ought to be stressed here is the environmentally friendly route planning incorporating 57% (69 km) of the guideway being combined with the existing motorway and the comparatively low share of tunnels on the route of 14% (17 km), which considerably lowers costly construction risks.

For the entire route, 11 substations and 5 shunting operation areas (1 each at the termini of Las Americas and Los Realejos, and 2 at the terminus of Santa Cruz as well as 1 at the maintenance centre) are required.

Table 1, Characteristic values for the preferred variant

Characteristic data		Variant A5/B3
Route length		122 km
Com-prising	Double guideway (47 %)	57 km
	Single guideway (53 %)	65 km
	Alignment with motorway (57 %)	approx. 69 km
	Motorway central reservation (14 %)	17 km
	Number of planned crossover facilities	22
Track length		
Com-prising	elevated (59 %)	72 km
	at-grade (24.6 %)	30 km
	on bridges (2.4 %)	3 km
	in tunnel (14 %)	17 km
Number of stations		13
Technical and operating components (number)		
Route substations and propulsion areas		11
Shunting converters / shunting propulsion areas		5

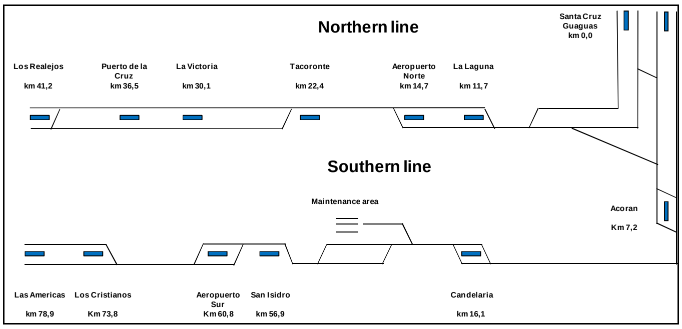

Figure 3, Track layout, preferred variant

3.2 *Operational concept*

The operational concept assumes a constant length of the high-speed maglev trains for the entire service period of 17 hours. Depending on the way the timetable is designed, the break in operation will last around 7 hours. The frequency of services is defined differently for the peak and off-peak service periods. In peak traffic time (2 hours) frequency is 15 min. A 30- or 60-minute frequency will be provided for the off-peak period (15 hours). Within the service period stated and the frequency of services defined, a total of 60 journeys (in both directions) are operated every day.

Since this route represents both a typical regional link and a link between two airports, standing passenger capacity can be fixed at 2 to 4 persons per qm, like in European regions/railway vehicles. If three persons per qm use the service, 125 spaces per section and 250 spaces per train (2-section vehicle) or 375 spaces (3-section vehicle) are possible.

Depending on the number of cars per train, 1,000 spaces (4 2-section trains) or 1,500 spaces (4 3-section trains) can be offered per hour and direction.

A total of 16 trains are required for the preferred variant discussed here. These include three trains as an operational reserve or as a maintenance reserve.

In regular service, an operational top speed of 270 km/h (Figure 4) is achieved on the Southern route, and 230 km/h on the Northern route. Since the guideway distance between stops on the Southern route is roughly 40 km (Figures 4 und 5), a significantly higher speed can be attained for demonstration purposes than in comparison to regular service speed. Higher speeds do not result in any operational advantage on the other route sections but cause significantly higher traction energy costs.

Using powerful, verified train journey and operation simulation programmes, vehicle turnover as well as essential vehicle dynamic and energy characteristic data of the system were calculated on the basis of route propulsion and vehicle data.

Calculated journey time (without timetable reserves) is 34 minutes on the Southern route and 26 minutes on the Northern route. Journey time on the overall North-South route with connecting (10 intermediate stops without the Santa Cruz station being served) is 56 minutes (Figure 6). Journey time as a direct link (express journey, without intermediate stops, 65 km) between the two Northern and Southern airports is 21minutes.

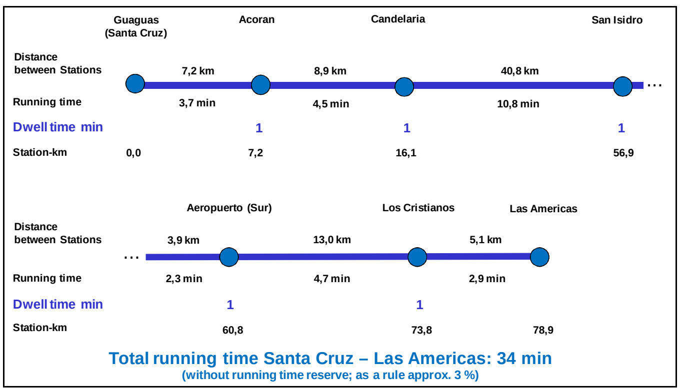

Figure 4, Southern line incl. stations, running and dwell time

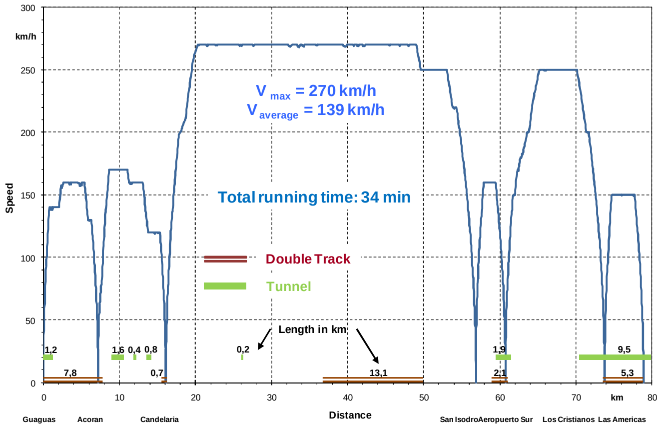

Figure 5, Speed profile Southern line, incl. double track, tunnel

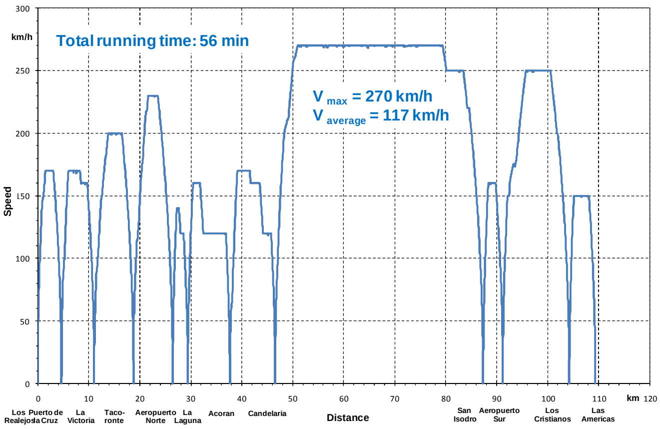

Figure 6, Speed profile, connection Northern-Southern Line

Vehicle turnover was calculated with operation simulation taking the operational requirements (timetable frequency, stopping / turning times at the stops) and systems engineering design (location of the propulsion areas and guideway crossover plant, time required to negotiate points) into account. With the results of the simulations, the turnover times of the vehicles and the required double-track guideway areas for trains passing each other in both directions were established (Figure 7). In addition, using timetable frequency and the calculated turnover times, the required vehicles fleet was determined depending on variants. Figure 7 shows an example of a timetable representation for 2 hours in the peak service period, with a frequency of 15 minutes.

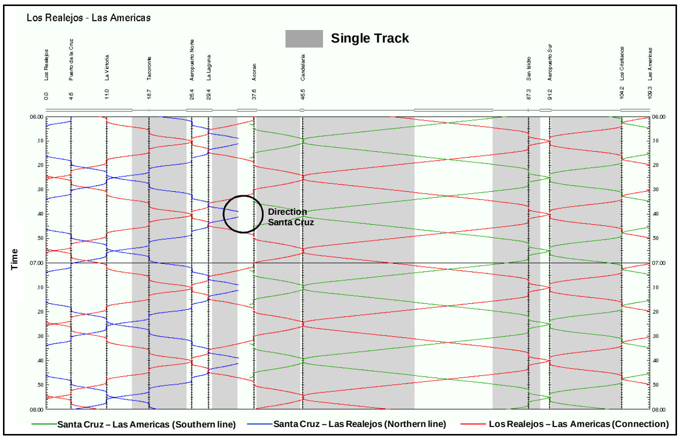

Figure 7, Graphical timetable total line

4 COSTS

4.1 Investments

The investment cost of the infrastructure and the vehicles was established by the Planning Consortium on the basis of several years of experience with planning and project costing of railway and maglev projects.

What are referred to as “other costs”, e.g. of stops, car-parks and entrances, workshops, observing health and safety regulations, maintaining rights of way, imponderabilities, etc., were initially adopted from the INECO railway studies in this first examination phase.

In the context of the feasibility study, 6 route variants with three operational concepts were examined. Total investment is between 3 and 3.55 billion EUR. In Phase II, optimisation potentials in route planning, in the operational concept and in efficiency (income and expenditure, i.e. returns, operating costs) will be examined.

4.2 Operating costs

In the main, establishing the operative overheads was based on the forecast volume of passengers, the operational concept chosen (peak service period 15-minute frequency, off-peak service period 30/60 minute frequency) and, derived from this, the technical design of the subsystems, such as permanent way/points, propulsion/power supply, control/safety and communications engineering as well as vehicles.

The operational overheads consist of the direct cost items for maintenance (materials and staff), for energy (traction and ancillary energy demand) as well as for staff (operational management, cleaning). The estimates for maintenance and operational management costs are based on experience values. Traction energy demand was determined via simulation on the basis of the operating programme and timetable for the overall route on hand (North, South and connecting services).

Taking German price levels as a base, depending on vehicle configuration (number of sections per train), operating costs are at between 50 and 55 million EUR a year. Considering the country and Island specific cost level, approx. 20% lower operating costs can be reckoned with.

5 CONCLUSIONS

The results of the Feasibility Study Maglev Tenerife (Phase 1) show that, taking into account the project specific requirements regarding route planning, the operational concept, transport capacity and the environmental aspects, the Transrapid maglev can perform its transport role in a fast and comfortable manner on Tenerife.

Overall investment for the maglev route can be demonstrated to lie within the magnitude of around 3 billion EUR. For this purpose, a total of six route variants with three operational concepts were examined. The investment costs of these variants are between 3 and 3.5 billion EUR.

German cost levels were taken as a base for the cost calculations performed; country and Island specific cost reduction potentials have not been considered yet.

In the first phase of the Feasibility Study Maglev Tenerife (examination period of approx. just three months), no in-depth optimisations could be achieved in route planning, in further reductions in risky tunnel shares, in the operating programme or in technical and operational system design. This is what Phase 2 will be made use of for. Experience has shown that here, further cost reductions of 5 to 10 % can be reckoned with.

6 REFERENCES

Kühr H.-T., Mnich P., Richter F., Fritz E., and others “Feasibility Study Maglev Tenerife Phase 1” Documentation, Berlin/Düsseldorf, Germany, February 28, 2011.

INECO Studies: Northern and Southern Line wheel-to-rail Tenerife, November 2009, March 2009 and further supplements 2010.