The Underground Option for the New Railway Line between Turin and Caselle Airport in the Turin Urban Area

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ABSTRACT

The city of Turin is linked to the “Sandro Pertini” international airport, which is located near the town of Caselle, by railway line. Due to the construction of the Turin underground railway by-pass and the need to cross under the Dora Riparia river, it has proved necessary to build a new underground connection between the Caselle railway and the regional railway lines. This connection will be constructed inside the Rebaudengo station, where the new high speed railway line between Turin and Milan will also pass.

The stretch of the new railway line connection to the airport will be about 13 km long inside the Turin urban area. It will be constructed between the small town of Venaria Reale and the Rebaudengo station and will be made up of an underground section and a section on the surface. Four different alignments have been studied for the construction of this stretch and they have been compared on the basis of transport efficiency, technical construction difficulties, administrative aspects and environmental interferences. The feasibility studies for the described project are discussed in this paper and the reasons behind the choice of a specific alignment are presented.

1. INTRODUCTION

The “Sandro Pertini” Turin international airport in Caselle is connected to the city by roads and by a roughly 13 km long railway line which is part of the Turin-Ceres railway line.

This line starts from the Dora station in the city, where travellers can change onto the Turin-Milan line or onto urban transport on the surface.

The reorganisation project of the Turin railway junction includes the connection between the Turin-Caselle airport-Ceres line and the regional railway by-pass line along the Turin-Milan axis. This project offers the opportunity of associating a profound urban renewal to the modernisation and integration of the various transport networks that are involved in the project.

The significant element of the railway by-pass project is in fact that this stretch of railway will be placed underground and the number of tracks will be increased so that international connection trains, including high speed, national, regional and metropolitan trains, can converge on this axis so as to have the possibility of interchanges between the various levels of mobility on tracks, including metropolitan, along the central axis of the city.

The programme of the interventions at present under way as part of the construction of the railway by-pass has been drawn up to reach the following objectives:

- the insertion of the Turin metropolitan area into the European high speed railway network;
• the improvement in the quality of railway connections, at both a regional and international level;
• the construction of a new regional and metropolitan integrated public transport system.

As far as this choice is concerned, the Turin town-planning scheme drawn up in 1995 foresaw the covering of different stretches of the railway and the construction of a large avenue on the surface as part of plans to renew the vast abandoned industrial areas along the sides of the railway.

With the sinking and the general filling of the railway lines, urban territorial continuity will again be established and new public spaces will be recuperated that can be used in a variety of ways.

The total length of the Turin by-pass is about 12 km long. The project for the new railway interconnection project between the Caselle airport line and the railway by-pass is part of this programme: the two lines converge at the Dora station in Turin. The construction of the by-pass involves the lowering of the tracks to a maximum depth of about 18-19 m below ground level, passing under the Dora Riparia river with the construction of a four-track approximately 2 km long tunnel under the riverbed and the construction of a new railway station (Rebaudengo station) immediately after the tunnel, towards the East in the direction of Milan.

This interconnection should also be developed underground in order to join up with the regional tracks of the railway station in the new Rebaudengo station which will become the central point of passenger exchange between the railways and the urban transport services on the surface.

2. HYPOTHESES OF THE STUDIED ALIGNEMENT

2.1 Design constraints

The constraints involved in the development of the new design hypotheses should, for the Turin-Ceres line, take into account that:

a) the plani-altimetric alignment should have a slope that does not exceed 2.2% and a radius of curvature not below 200 m;
b) the inner section of the tunnel (for the underground stretches) should be 8.6 m wide and 5.7 m high;
c) the safety exits should be located each 250 m;
d) the branching of the Turin-Ceres line from the Italian Regional railway line should take place in a station which should have the possibility of guaranteeing, after the connection to the railway by-pass, a “third” manoeuvre/sidings track (such as the Rebaudengo station);
e) there should be the possibility of reusing, at least a part, of the already constructed structures and of avoiding destructive interference with the new structures;
f) interferences with the utility networks and already existing structures should be limited to a minimum;
g) the impact of work in the construction sites should be reduced to a minimum as far as urban mobility is concerned;
h) tree-lined areas should be protected whenever possible.

2.2 Studied alternatives

Four alternative hypotheses of the alignment were taken into consideration in the study developed over the year 2005 (Fig. 1). The consequent abandonment of the two different stretches of the line from Dora towards Venaria (where is located a magnificent royal palace) would make it possible to construct a new tramline connection which would go from the centre of Turin to the Venaria railway station, and would in part make use of the abandoned railway and in part make it necessary to create an ex novo tramline running along beside the railway line almost to the Venaria station. A tramline of this type would surely offer an important advantage both from the purely transport point of view but also from that of a tourist and cultural point of view. The important characteristics of the four solutions are presented in the following four sections together with the relative positive and negative points.
2.2.1 Solution 1: BASSE DI STURA

Length: 7900 m

Would break off from the present alignment at the Venaria cemetery and join the by-pass in correspondence to the future Rebaudegno station. The alignment, prevalently on the surface, would cross the Basse di Stura waste disposal site, a future park. An underground tunnel would be used to cross Corso Grosseto. Some works of art are foreseen: 2 bridges over the Stura, a viaduct to cross the waste site, a viaduct to cross the northern ring road and a stretch of tunnel to resolve the complex problem of crossing Corso Grosseto. A station could be foreseen in the waste disposal site which could start functioning when this area becomes a park and it could furthermore function as an interchange station with a car park below the Borgaro interchange on the northern ring road. With this solution, however, the transport services would be lost for a large urban area, between Venaria and Torino but these could be integrated with a new tram service.

Critical points
Environmental problems:
- increase in the area of ground already compromised by the ring road and the future AC;
- transit in a planned park;
- close presence of a high risk factory (Rockwell Italia) on the south of the Stura stream.

Administrative problems:
- the waste disposal site is authorised to function until 2009, but it is not unlikely that works could start before 2010, when a new incinerator will be activated;
- a preponderant part of the alignment is conditioned by expropriations;
- necessity of urban variations and verifications with the basin authorities.

Technical problems:
- crossing of the waste disposal area by viaducts;
• 2 bridges over the Stura river of which the bridge close to the ring road is of greater technical difficulty due to the extension of the floodable area.

Transport problems
• the Madonna di Campagna and Rigola stations would be abandoned.

Positive points:
• availability of space which would make it possible to cross the secondary roads, with the exception of the ring road and the Caselle highway, and allow opportune road deviations to be made for the sites without serious consequences on the traffic;
• availability of the present railway track from the Dora station to the ring road which could be used for other transport systems;
• a station could be constructed along the alignment with an interchange car park in the future Basse di Stura Park, located close to the ring road interchange.

<table>
<thead>
<tr>
<th>Travelling time</th>
<th>Costs (€ x 1000)</th>
<th>Construction times</th>
</tr>
</thead>
<tbody>
<tr>
<td>10’</td>
<td>150,682</td>
<td>39 months</td>
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</table>

2.2.2 Solution 2: VIA VERONESE

Length of new alignment: 3600 m

Would break off from the present alignment close to Via Druento (PK 0) towards East in an underground tunnel and join the by-pass in correspondence to the future Rebaudengo station, basically maintaining the same transport service as the present line. The new underground tunnel would be about 3600 m long and it would not have to pass under rivers or their floodable areas, railways or important roads, with the exception of the Corso Grosseto underpass.

Critical points
Environmental problems:
• interference with the Piazza Stampalia garden;
• disturbance to road transport due to the crossing of Via Lanzo, the airport road and Corso Grosseto (which could be eliminated using blind hole technology).

Administrative problems:
• areas to be expropriated.

Technical problems:
• maintaining the railway connection with the GTT depot in Venaria;
• displacement of the utilities.

Transport problems:
• the Madonna di Campagna and Rigola stations would be abandoned and substituted with a new one close to Via Druento;

Positive points:
• the disturbances due to the work sites would prevalently be concentrated on Via Veronese, which has limited vehicle traffic and limited presence of residential areas;
• the construction works for the tunnel would not interfere with the water table;
• availability of the present railway track from the Dora station to Via Druento which could be used for other forms of transport;
• would not leave any evident permanent signs on the territory, but would represent a partial restraint on the future edification of the Ex Veglio area;
• opportunity of creating an intermediate station in Via Veronese at the service of the work installations (consequent removal of line 21 which is specifically used to service this area but is hardly used).

<table>
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<tr>
<th>Travelling time</th>
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<tr>
<td>8’</td>
<td>135,556</td>
<td>36 months</td>
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2.2.3 Solution 3: BASSE DI STURA (Borgaro)

Length: 7250 m

Would break off close to the Strada del Francese industrial installation before the bend that leads to the bridge over the Stura river and continue in a south-east direction on the surface. Would coincide with alignment 1, starting from PK 3400.

Critical points

Environmental problems:
- the new airport road layout on two levels means the railway alignment would have to adapt;
- it follows that, starting from the area of the aqueduct wells to the point where it joins with solution 1, the alignment could not be on the surface due to the numerous interferences that have to be overcome;
- the line would divide the green area of the Chico Mendes Park and condition the upgrading of the “Green Ring Road”.

Administrative problems:
- the waste disposal site is authorised to work until 2009, but is not unlikely that work could start before 2010, when the new incinerator will be activated;
- preponderant parts of the alignment conditioned by expropriations;
- the necessity of urban variations which would need to be verified with the basin authorities (the alignment is not compatible with the indications stipulated in the Basse di Stura Area Plan).

Technical problems:
- the alignment in the aqueduct well area would have to pass along a viaduct until it joins up with solution 1 because of the numerous interferences that have to be overcome including the new layout of the airport road on two levels.

Transport problems:
- the connection between Venaria and Turin would be withdrawn (which could be substituted with TPL) as would the connection between Venaria and the airport and Ciriè where there is a hospital and high schools (a connection that is not easy to substitute);
- the Madonna di Campagna, Rigola and Venaria stations would be abandoned;
- it would be necessary to create an alternative transport system (tram or metro) to connect Venaria to Turin and this involves further costs that still have to be defined;

Positive points:
- availability of space, which makes it possible to cross the secondary roads, with the exception of the ring road, the Caselle highway and the airport road and to foresee opportune road deviations for the work sites without important consequences on the traffic;
- availability of the present railway track from the Dora station to the ring road for possible reuse for other transport systems;
- a station could be constructed along the alignment with an interchange car park in the future Basse di Stura Park located close to the ring road interchange.

<table>
<thead>
<tr>
<th>Travelling time</th>
<th>Costs (€ x 1000)</th>
<th>Construction times</th>
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<tbody>
<tr>
<td>7’</td>
<td>148,260</td>
<td>39 months</td>
</tr>
</tbody>
</table>

2.2.4 Solution 4: CORSO GROSSETO

Length of the new alignment: 265 m

- Would break off from the present alignment in correspondence to Corso Grosseto (Fig.2) towards the east in an underground tunnel and join the by-pass in correspondence to the future Rebaudengo station. Like solution 2, this would all be in an underground tunnel without
having to cross rivers, railway lines or important roads, with the exception of Corso Grosseto. It would instead be necessary to demolish the Corso Potenza – Corso Grosseto road passover and then reconstruct an alternative crossroads structure.

Fig. 2. Corso Grosseto panoramic view.

Critical points
Environmental problems:
- management of the traffic (66,000 vehicles/day) at the ends of the section in Corso Grosseto (Largo Grosseto connecting with the Caselle highway) with interruption of service traffic;
- removal of the trees north of the Ala di Stura/Caselle highway junction section;
- setting up work sites in a densely populated area with a concentration of trade activities in the western part;
- the construction of a Potenza/Grosseto underpass for the new road organisation of the junction would be conditioned by the new railway alignment and would need to be sunk to a depth of –12 m. The already existing old flyover structures will be eliminated (Fig. 3).

The design solution foresees the formation of a two-level roundabout for road traffic, with vegetation along the containment slope and in the central nucleus. Furthermore, the road system would be distanced from the buildings, thus allowing large areas to be left free for pedestrians. The higher level (+≈ 6-7 from the ground level) would be used for the Grosseto/Ferrara/Potenza road axes while the lower would be used for the Venaria, Stampini, Borgaro, Stradella and Lombardia roads (Fig. 4).

Administrative problems:
- there would be no particular problems of an administrative type.

Technical problems:
- demolition of the road junction;
- displacement of the utilities;
- tangent to the buildings in the two sections at the ends of Corso Grosseto.

Transport problems:
- the position of the new Grosseto station is not indicated (it is possible to position this station close to Largo Grosseto using blind hole technology).
Fig. 3. Flyover C. Potenza-C. Grosseto to be eliminated.

Fig. 4. Two-level roundabouts for road traffic under passed by the new railway alignment Corso Grosseto.

**Positive points:**
- the tunnel construction works would not interfere with the water table;
- availability of the present railway track from the Dora station to the Madonna di Campagna station which could be reused for other transport systems;
- conservation of a station in the Madonna di Campagna area;
- would not leave any evident permanent signs on the territory and its construction would allow the Grosseto junction to be upgraded;
- no railway station would be abandoned;
- opportunity of using the Madonna di Campagna station as a tram stop.
The two basic solutions that have been proposed, underground and on the surface, are not so different as far as the costs and construction times are concerned, but one is almost double the length of the other. The greater length does not, however, have an important effect on the costs and construction times, thanks to the lower degree of difficulty in construction.

Both solutions foresee the possibility of installing new service points: solutions 1 and 3 in fact foresee the possibility of constructing a station in correspondence to what one day would become the “Basse di Stura Park”, with a car park for ring road use, while solution 2 foresees the possibility of a new station in Via Paolo Veronese in correspondence to the State Finance Offices, that is, in a promising area of development. This latter station was not considered in the presented economic estimation. Solution 4 would require a new station, “Grosseto”, which would substitute the abandoned “Madonna di Campagna” station.

The construction of the new infrastructure would impose new constraints on the territory, which would be particularly relevant in the case of solutions 1 and 3 as it would be necessary to construct new bridges over the Stura river as well as road passovers over the ring road and over the local roads. It was considered useful to compare the travelling times of the various alignments proposed in this study and in the previous ones. In order to make this comparison, the length of the routes between the entrance point in the Rebaudengo station and one point along the line that corresponds to the furthest breaking off point from the Rebaudengo station (that of solution 1) were calculated for all the solutions. The results are reported in the following Table 1.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Length (km)</th>
<th>Travelling time (minutes)</th>
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<tbody>
<tr>
<td>1. Basse di Stura</td>
<td>3650</td>
<td>10</td>
</tr>
<tr>
<td>2. Via Veronese</td>
<td>8150</td>
<td>8</td>
</tr>
<tr>
<td>3. Borgaro</td>
<td>7250</td>
<td>7</td>
</tr>
<tr>
<td>4. Corso Grosseto</td>
<td>8200</td>
<td>8</td>
</tr>
</tbody>
</table>

The travelling times therefore do not make the solutions different to any great extent.

In conclusion the city of Turin has decided on solution 4, along Corso Grosseto, which is currently at the design stage for the construction call-to-tender.

This choice was determined by the fact that: the transport services in this part of the city will not be changed to any extent; Corso Grosseto is a very wide avenue that will be able to house the new structure without damage to the trees and without causing serious problems for the traffic on the surface; the opportunity to eliminate the flyover at the Corso Potenza – Corso Grosseto crossroads and to substitute it with a low structure which will fit better into the local urban context without loosing its functionality.