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Security aspects of the new railway link with Brussels Airport

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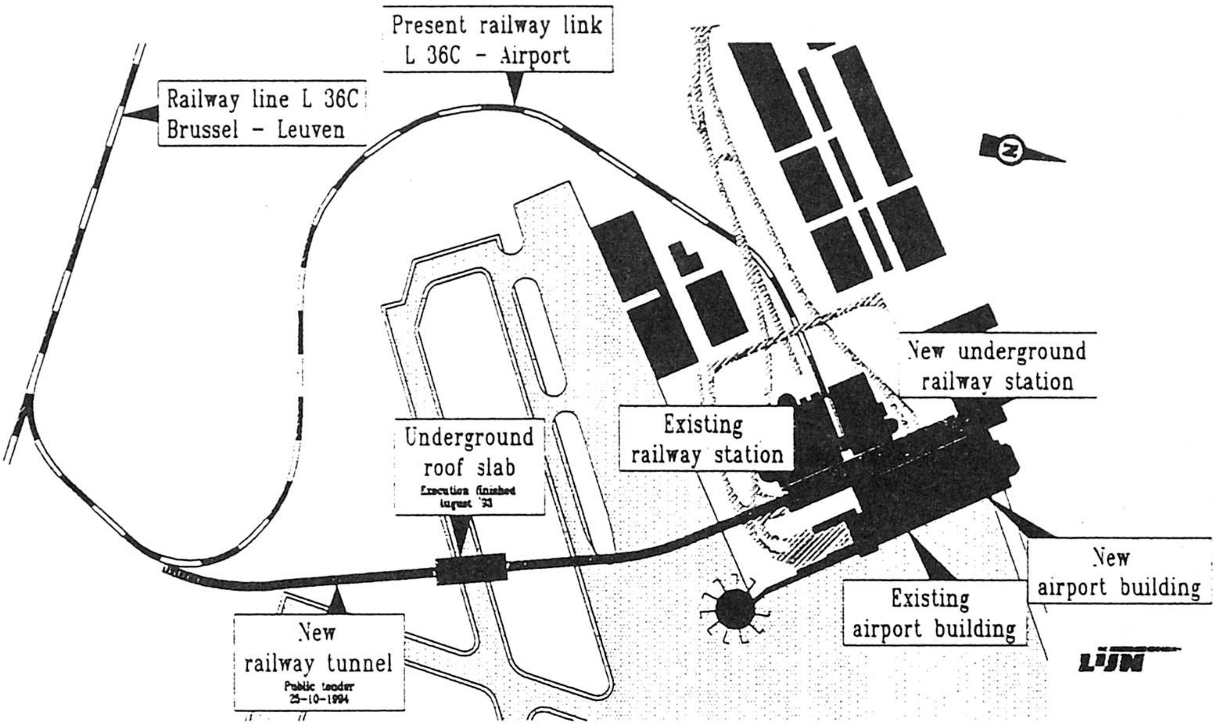
Etienne Hemerijckx is civil engineer (Leuven University 1973). After a successfull career of 17 years, he was in 1990 promoted to Head of Department of the Central Study Office of De Lijn, where he is charged with the follow-up of the general management of studies and execution of works for the advancement of the public transport in Flanders.

A recent railway project, managed by the "Centrale Studiedienst of De Lijn" advances the railway link of the NMBS (National Railway Company of Belgium) between the important Brussels - Leuven line and Brussels Airport. The project comprises the construction of a new railway station and a 1 km long tunnel under the airport installation, coupled with the architectural finishing, the electro-mechanical equipment, the track installation and the connection with the existing railway line. The execution of important works at and under the airport implies the observance of some security measures, providing a minimal hindrance of the airport services.

1. Project management Centrale Studiedienst De Lijn

The Centrale Studiedienst De Lijn provides for the project management of the construction of a railway station, the tunnelling works and the track installation.
Master builder is the Belgian Railway Company.
The Centrale Studiedienst De Lijn has a large experience with study and supervision on the main structure, the architectural finishing and the electro-mechanical equipping of underground infrastructures, especially for the Antwerp premetro.
In the past, many impressive underground techniques were studied and executed, such as a.o. the shield method, the pipe-jacking method, the freezing method, injection.



2. Execution methods

2.1. Railway station

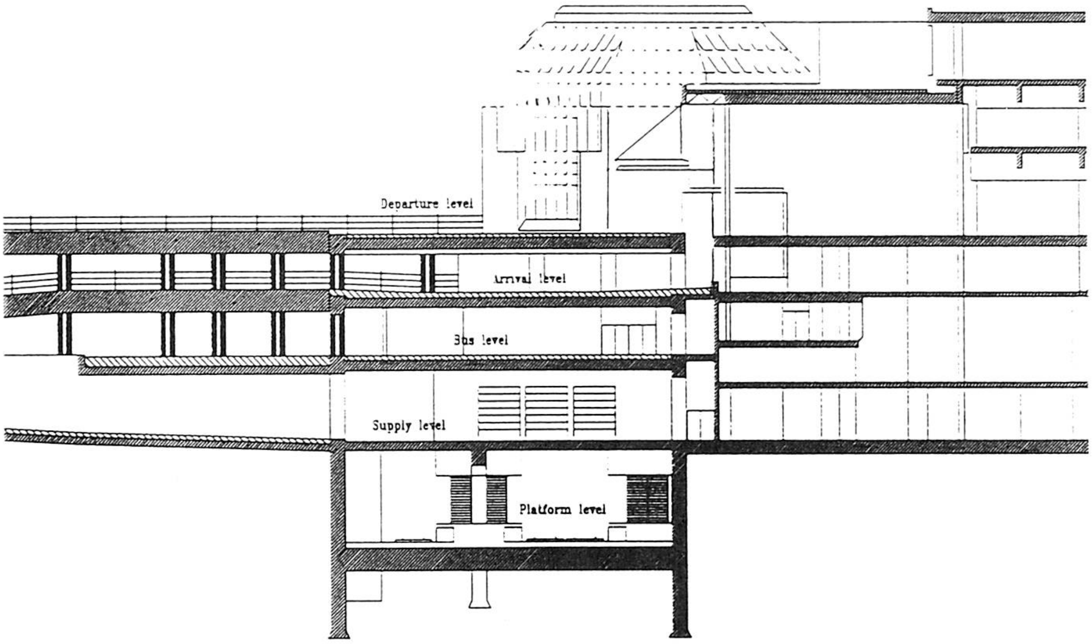
2.1.1. General concept

The station has 3 underground levels and has 2 flights of stairs, the one at the entrance and exit of the new airport building and the other at the entrance and exit of the old airport building.

- The lowest level has 3 tracks and platforms with a length of about 385 m and a width of about 4 m.

- The level on top of the lowest one (called supply level) stands for the connection between the platforms and the airport building and creates room for technical equipment that is necessary for the railway station operations.

- The 3rd underground level, that is situated straight under the street level (called bus level) provides for the train passengers flow from the platform to the airport and to the railway company ticket offices.
Moreover, it is possible to move in with technical and administration services, which are involved with the station services such as luggage treatment, telecommunication, sanitary, dressing room etc.

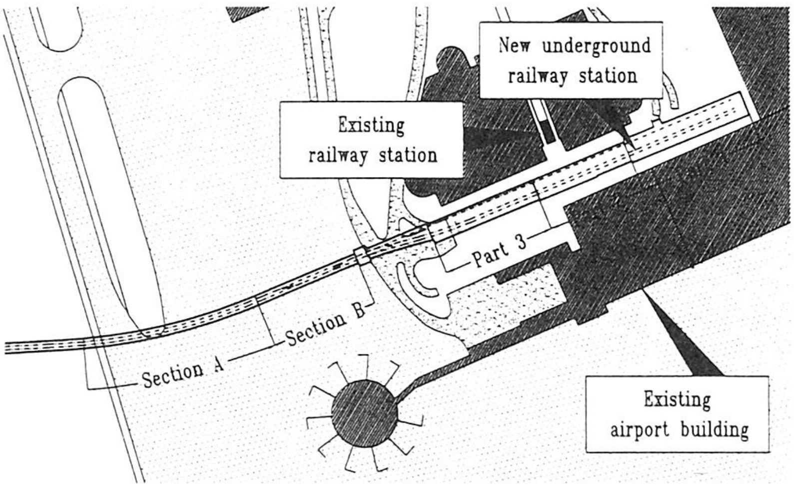


One flight of stairs is situated in the immediate neighbourhood of the new airport building, where all the passengers will have to leave the airport and where the international passengers will have to pass the customs.
The other flight of stairs is situated at the present railway station which is already linked up at the moment with the present airport building.
The new station maintains this connection.

After the new airport building is operative, the older one will be entirely adapted and renovated. Both flights of stairs are connected with each other as well through the platform level, the bus level b.m.o. a corridor neighbouring the above mentioned technical and administration rooms, as via the arrival hall of the airport building.

2.1.2. Execution methods

The execution of the railway station can be splitted up into 3 parts.

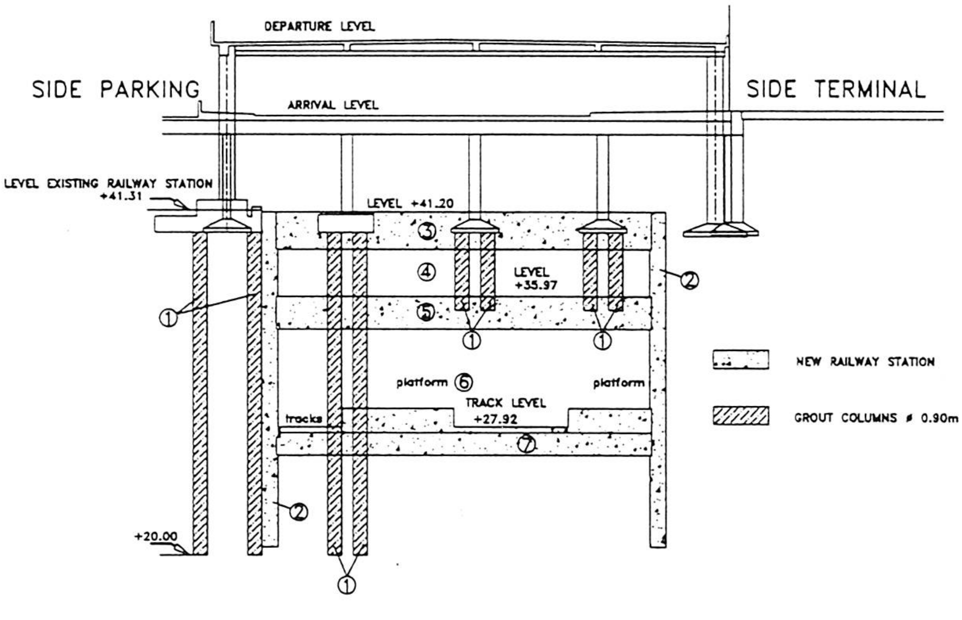


Part 1

This 145 m long section comprises the flight of stairs at the new airport building with which it was simultaneously executed. Because of its implantation, it was possible to construct it according to a classical method. The exterior walls were executed as slurry walls and the roof slab was concreted at the bare ground. The further excavation under the roof slab was executed from top to bottom, respectively concreting the intermediate and bottom slab.

Part 2

This 110 m long section is situated at the existing railway station, heading the old airport building. It comprises the construction of a flight of stairs situated at the entrance and exit of the old airport building.
The difficult situation, between the parking building and the airport complex on the one hand and the presence of the esplanade (departure level), which has restrictions in height during the execution, asked for a lot of consideration when determining the execution method.
A first thought was to demolish the entire part of the existing station that should be crossed. Because of the presence of a lot of public utility pipes, which were a must for the airport operations, this solution was too expensive and technically not favourable.
Consequently, the study was adapted in such a way that the pipes, the roof and the columns of the existing railway station could be maintained. The columns and the roof are caught up in the new intermediate slab, but are to be supported in a provisional phase with help of V.H.P.-grout piles.

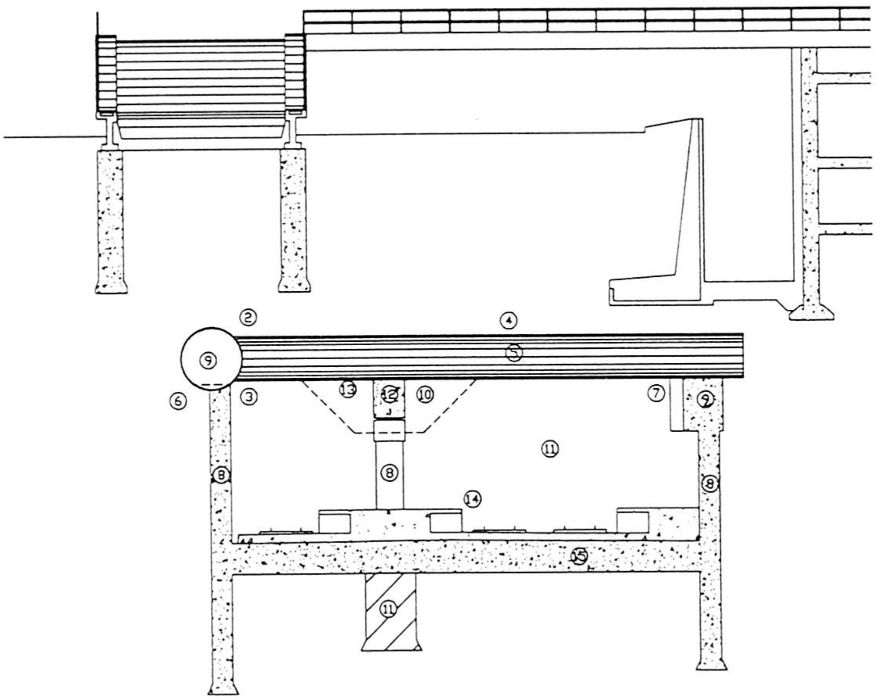


1. Execution of V.H.P.-columns after the boring of pits throughout the existing foundation soles.
2. Execution of the walls in sheeted trench.
3. Execution up to bottom side intermediate slab bus level and concreting of the slab and the anchoring of the foundation soles.
4. Excavation under the slab at bus level and the demolition of the grout piles.
5. Reinforcing and concreting of the intermediate slab at the supply level.
6. Excavation of the bottom slab.
7. Execution of bottom slab and platforms.

Part 3

This 130 m long part is constructed simultaneously with the tunnel under the airport and is used as track level. In order to minimise the disturbance at the airport, the following execution method was chosen:

From a work site situated at the border line land-airside, a longitudinal tube with a large diameter (Ø 3 m) is jacked in the direction of the second part of the station. This tube is used as working gallery from where transversal tubes with a smaller diameter (Ø 2,1 m) are jacked and forming the roof slab once the tubes are reinforced and concreted.
Out of the working gallery (tube Ø 3 m), also the side wall is executed in sheeted trenches.
The other side wall and the intermediate column is excavated in sheeted trenches out from the galleries under the roof slab.
After the roof, the walls and the mid columns are realised, the bottom slab and the platforms can be concreted.



Working method 1 longitudinal and transverse tubes

1. *Realisation of the construction shaft at the border line landside-airside*
2. *Jacking of the longitudinal metal tube Ø 2960*
3. *Realisation of the working slab in the tube*
4. *Jacking of transverse concrete tubes Ø 1900-2100*
5. *Reinforcing and concreting of transverse tubes*
6. *Demolition of a part of the longitudinal tube*
7. *Construction of a gallery under the transversal tubes*
8. *Construction and concreting of the sheeted trenches*
9. *Reinforcing and concreting of the longitudinal tube and construction of sheeted trenches*
10. *Restricted excavation under the transversal tubes*
11. *Construction of sheeted pits and columns*
12. *Construction of longitudinal beam under the transversal tubes*
13. *Installation of flat jacks*
14. *Excavation up to bottom side of the bottom slab*
15. *Execution of the working floor and bottom slab in parts*
16. *Final joint between the tubes*

2.2. Railway tunnel

2.2.1. General problematic of the works under the airport

The execution of important works at and under the airport implies undoubtedly the taking of some security measures.

The study has to take into consideration in the first place a minimal hindrance of the airport services. On the other hand, construction costs may not be too high because of this particular reason. A solution which is as technical as economical justified, but also acceptable for the airport services should be found.

For these reasons a part of the roof slab of the tunnel at the height of the runway 07.R was preliminary executed. Initially was chosen for the entire underground pipe jacking method. Further studies and discussions with the airport management lead to a more economical but technical solution. The runway 07.R should be shortened during one month and the roof slab (over a length of 157 m) at this runway could be executed with the cut-and-cover-method.

As August is the month with the less nebulosity, the airport management admitted the interruption only in this month. The runway 07.R is the only one which can be used to land in case of mist as it is equipped with an instrument landing system (ILS).

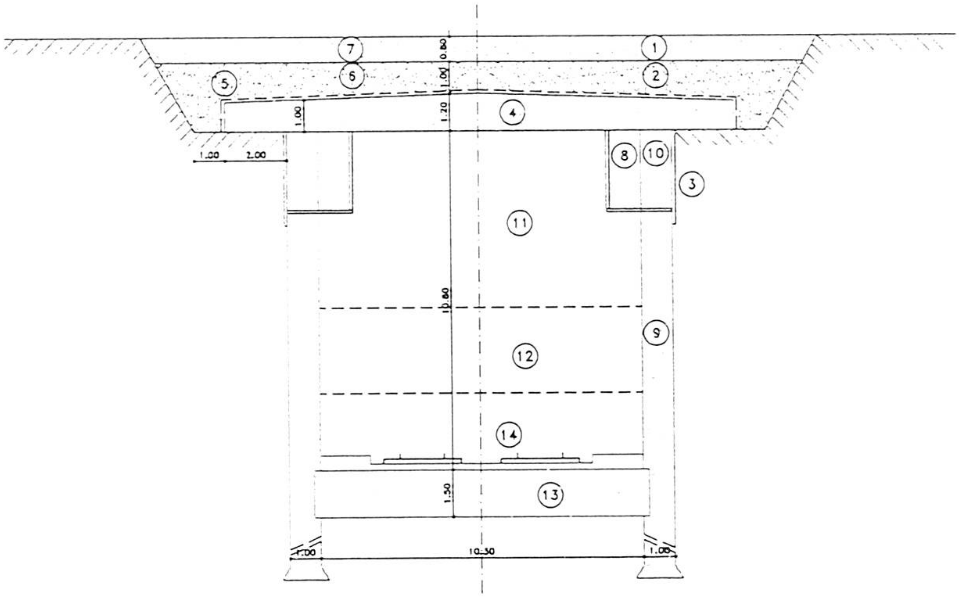
The construction methods were strongly influenced by the security directions of the airport.
- The necessary safety distances versus the air traffic (safety distances which are on their turn dependent of the weather circumstances and visibility limits) should be taken into account.
- Machines and tools can only be used respecting the valid height restrictions.
- Machines, portable phones etc. may not disturb radar and control tower.
- The necessary measures should be taken to protect the workers and the materials against the blast-effect, this is the enormous air displacement caused by the take-off of the planes.

Next to these technical elements a number of administration directions have to be taken into consideration.
- All the persons and vehicles passing the airside area have to possess a valid entrance identification.
- Each passage landside-airside is checked by watchmen in guardhouses.
- All vehicles entering the airport have to obey the own specific traffic reglementations and have to be ensured with a minimum amount of 100 million B.F. for claims as a result of fire or explosions.
- For the execution of the works, an insurance covering all worksite risks up to an amount of 20 milliard B.F. for damage at planes and passengers needs to be settled.

Another aspect of the problematic is comprised in the administrative treatment of the files. Special attention has to be paid to a good timing with reference to approbations and starting dates according to the admitted working periods defined by the airport management.

2.2.2. Execution methods

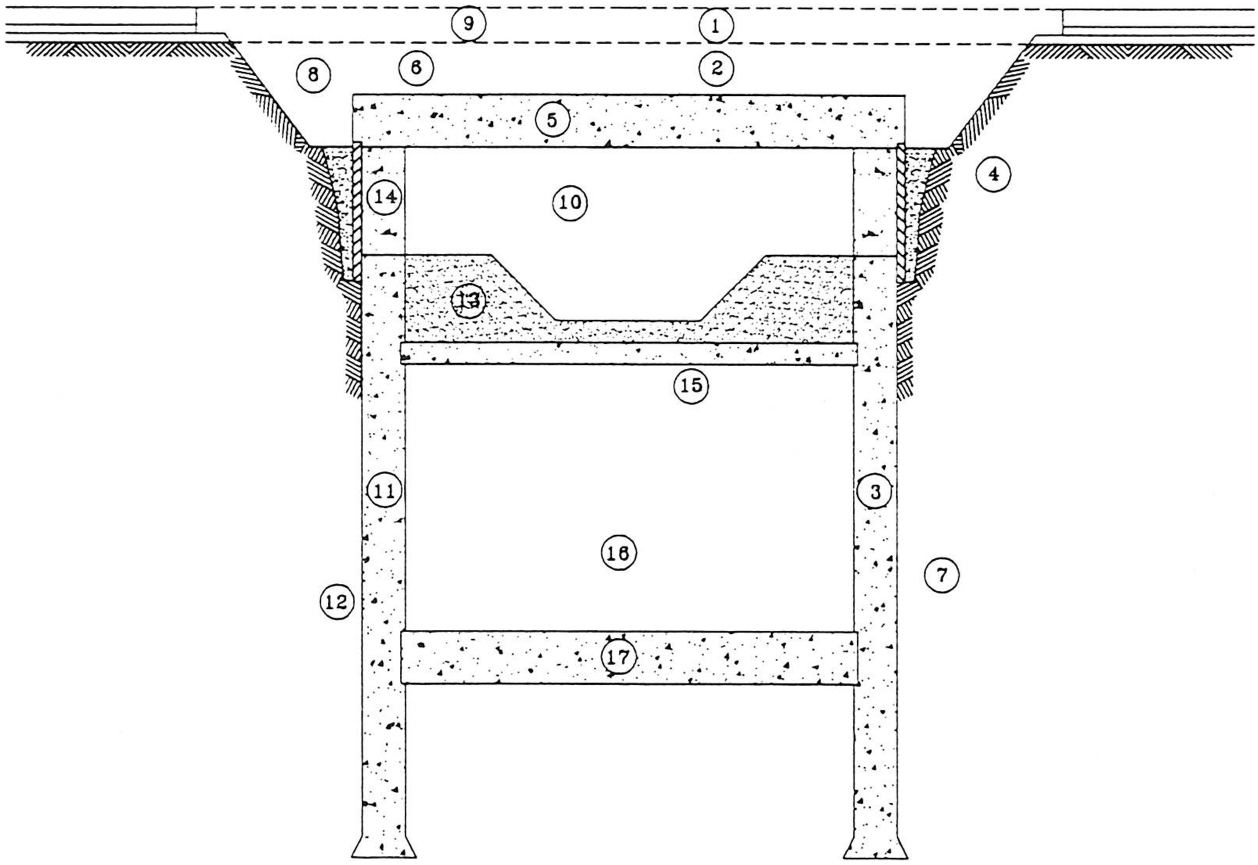
Roofslab 07.R
Based on the above mentioned problematic the following execution methods were chosen as possible solutions. If possible, a classic construction of the tunnel with the cut-and-cover-method was restrained.
In the area of the roof slab that is already executed, two longitudinal galleries are excavated from where the sheeted trenches are executed. After reinforcing and concreting of the sheeted trenches, they are concreted up to the bottom side of the roof slab.
Sequently the excavation can start from top to bottom.
The bottom slab can be reinforced and concreted.



1. Demolition hardening runway 07.R	*10. Sheeted wall*
2. Slope excavations up to bottomside roof slab	*11. Excavation under the roof slab and demolition of the sheet pilling of the gallery*
3. Drive in of sheet piles to 0,5 m under the gallery	*12. Excavation in restricted length up to bottom side bottom slab*
4. Working floor, reinforcement and concreting of the roof slab	*13. Working floor, reinforcement and concreting of bottom slab*
5. Watertight coat and protective concrete	*14. Foot paths, track installation and electro-mechanical equipment*
6. Refilling with soil	
7. Repair of the runway 07.R	
8. Execution of galleries under the roof slab	
9. Execution, reinforced concrete-sheeted trenches	

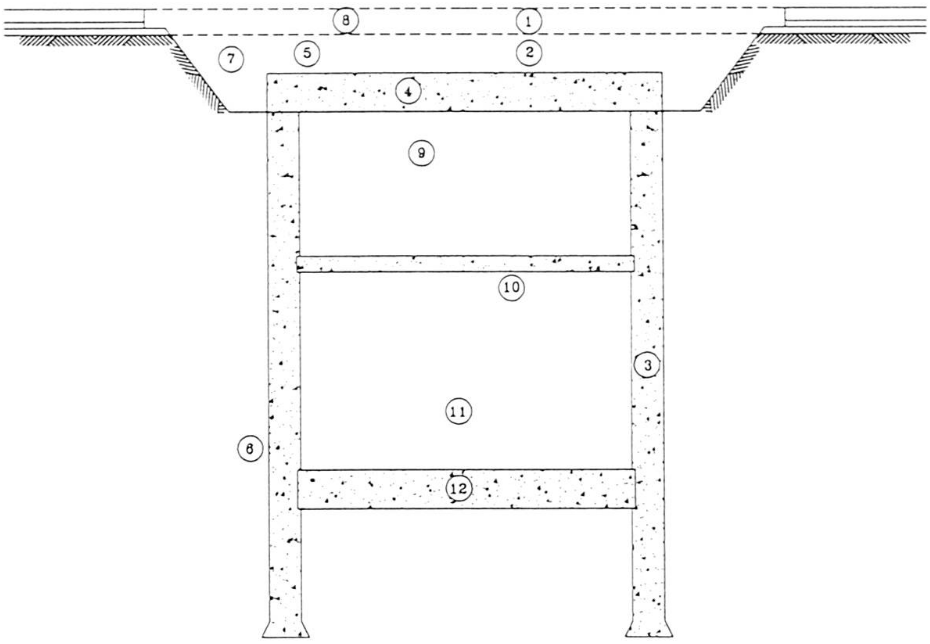
Tunnel at the standing places - Section A and B
As the standing places were out of order during 3 months (August, September and October 1995) the most economical solution was obvious.
This solution can be compared with the one that was applied for the execution of the roof slab under the runway 07.R in August '93 (although the longer distance ± 330 m and the necessity to maintain the air traffic in several phases). Because of the gained experience with the roof slab in 1993, this method was still refined.

Section A



1. Demolition hardening platform *2. Excavation up to bottom side of roof slab* *3. Construction of primary sheeted trenches (1 to 2 = 50 %)* *4. Concrete slab, to be placed at 20 cm behind the primary sheeted trench and filling up with sand cement* *5. Working floor, reinforcing and concreting of roof slab* *6. Watertight coat and protective concrete* *7. Injection of primary sheeted trenches* *8. Refilling with sand cement*	*9. Repair of platform and ground surface* *10. Excavation of dumpling 1st phase* *11. Secondary sheeted trenches out from dumpling 1st phase (1 to 2 = 50 %)* *12. Injection secondary sheeted trenches* *13. Excavation of dumpling 2nd phase up to the intermediate slab* *14. Connection secondary sheeted wall - roof slab* *15. Reinforcing and concreting of the intermediate slab* *16. Excavation of dumpling up to bottom slab* *17. Working floor, reinforcing and concreting of the bottom slab*

Section B



1. Demolition hardening platform *2. Excavation up to bottom side roof slab* *3. Construction of sheeted trenches* *4. Working floor, reinforcing and concreting of roof slab* *5. Watertight coat and protective concrete* *6. Injection sheeted trenches* *7. Refilling with sand cement*	*8. Repair of platform and ground surface* *9. Excavation of dumpling 1st phase up to the intermediate slab* *10. Reinforcing and concreting of intermediate slab* *11. Excavation up to bottom side of bottom slab* *12. Working floor, reinforcing and concreting of bottom slab*

In 3 months time the hardening of the platform needs to be demolished and excavated to the bottom side of the roof slab; also the walls need to be executed in sheeted trenches (in some areas 100 % according to section B, in other areas 1 to 2, according to section A), the roof slab reinforced and concreted, filled up and the concrete hardening repaired in its original condition. The further part of the tunnel is executed entirely with underground construction methods.

3. Present situation

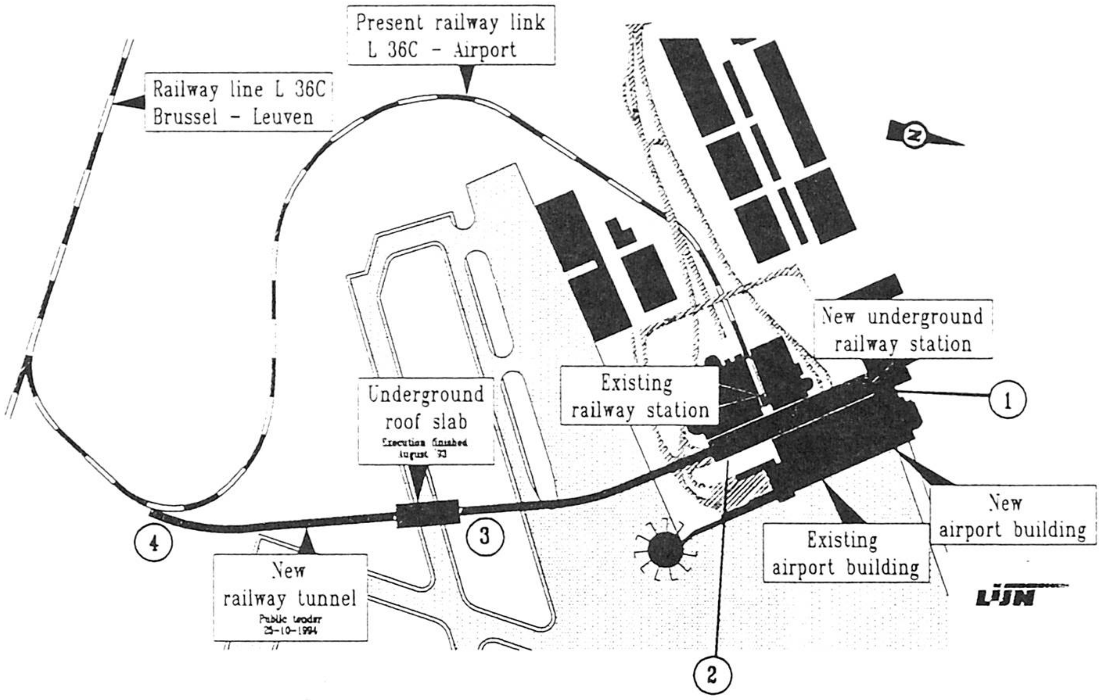
3.1. Main structure

Parts 1 and 2 of the station are finished.
Part 3 is a part which is constructed together with the tunnel under the airport. Works started on 03.04.1995 with finishing date at the end of 1997.

3.2. Architectural finishing and electro-mechanical equipment

Works are in execution and will be finished mid 1998.

3.2.1. Security measures



A lot of attention is paid to the security of the passengers. In case of fire or emergency situations, four emergency exits can be used, as well in the northern and the southern part of the station as in the mid part and at the southern end of the tunnel.

The emergency exit Nr. 1 is situated at the northern side of the station and runs from the platform level into the open air. The northern side of the station is situated at the Diamant area of the new airport building.

The emergency exit Nr. 2 is situated at the southern end of the station. From platform level, it runs into the English basement of the old airport building. From this basement it is possible to reach the arrival hall, which is situated in the immediate neighbourhood of the local fire services.

The emergency exit Nr. 3 is about situated halfway the 1 km long tunnel under the airside lane of the airport. As the airport management did not allow the construction of a direct emergency exit, running into the open air at airside, an emergency stair runs from the track level into an underground escape route that is situated on top of the tunnel. The escape route runs into the open air in the airside area at the arrival level.

The emergency exit Nr. 4 is located in the southern end of the tunnel. The tunnel is provided with a platform for fire extinction and a special approach for the fire engines.

Both the tunnel and the station have sufficient fire extinguish devices, such as fire detectors, ventilators to suck off smoke, heat and gas, sprinklers, smoke screens and curtains to keep the smoke in a clearly defined area, fire hydrants, fire boxes, movable platforms for evacuations by track etc.

The ceiling of the station is sprayed with a product that increases the insulation and the fire-resistance. The product is on a rockwool base and does not contain asbestos particles, cellulosis fibres, cement or any solvable silicate. It is sprayed with a layer thickness of 40 mm and fireproof. A fire resistance Rf of 2 hours of the lining is guaranteed. The product also reduces the noise level in the tunnel.

3.3. Track installation and connection with the existing railway line Brussel - Leuven

As the track laying is concerned, both station and tunnel are provided with reinforced mats. Track laying occurs on concrete cross beams which are captured in neoprene shoes, functioning as anti-vibration elements. The whole study of the anti-vibration is figured out by the D2S company - Leuven - Belgium.
Once the track laying is finished, a slab is concreted under the cross beams, hanged on metal profiles. The assembly can be manipulated in heigth and width in order to determine the right alignment.
Track laying in the open air occurs according to the traditional ballasted track laying system.
The target date for operation is mid 1998.

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