Univerzita Pardubice
Dopravní fakulta Jana Pernera

Study on connection of the Pardubice Airport to the Czech Railway Network

Diplomová práce

2021

Univerzita Pardubice
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(projektu, uměleckého díla, uměleckého výkonu)

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Zásady pro vypracování

Create a study of connection of Pardubice Airport to the Czech railway network. The study shall contain at least following parts:

1. covering report,
2. technical report,
3. plan drawing,
4. vertical alignment,
5. drawings of cross sections.

Add other parts upon requests of the supervisor.

Rozsah pracovní zprávy:
Rozsah grafických prací:
Forma zpracování diplomové práce: **tištěná/elektronická**
Jazyk zpracování: **Angličtina**

Seznam doporučené literatury:

- Commision regulation (EU) No 1299/2014 of 18 November 2014, on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union.
- Act No 183/2006 Coll. of 14 March 2006, on spatial planning and building regulations (Building Act). *(Czech)*
- Regulation No 499/2006 Coll. of 10 November 2006, on documentation of structures. *(Czech)*
- Ministry of transport regulation No 177/1995 Coll. of 30 June 1995 on construction and technical rules of railways. *(Czech)*
- ČSN 73 4959. *Platforms and roofs of platforms of state, regional and industrial railways.* Prague: Czech Standardization Agency, 2009. *(Czech)*
- ČSN 73 6301. *Designing of railways.* Prague: Czech Standardization Agency, 1998. *(Czech)*
- ČSN 73 6310. *Design of railway stations.* Prague: Czech Standardization Agency, 1996. *(Czech)*
- ČSN 73 6320. *Structural clearances of state, regional, local or industrial tracks for normal railway guage – National requirements.* Prague: Czech Standardization Agency, 2019. *(Czech)*
- ČSN 73 6360-1. *Geometrical characteristics of railway tracks – Part 1: Layout.* Prague: Czech Standardization Agency, 2008. *(Czech)*
- ČSN 73 6380. *Railway level crossings and pedestrian crossings* Prague: Czech Standardization Agency, 2004. *(Czech)*
- TNŽ 01 3468. *Drawings of railway lines and stations.* Prague: Directorare General of České dráhy, 1993. *(Czech)*

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V Pardubicích dne 28. října 2020

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ACKNOWLEDGEMENT

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ANNOTATION

With further developments and investments in civil aviation at the Pardubice airport, a possible railway link could be established to further ease access to the airport terminal. Sufficiently connecting an airport to other means of public transportation is of vital importance to its further development and growth in prominence. With that incentive in mind, this thesis deals with exploring whether a railway link to the airport is conceivable.

KEYWORDS

Pardubice airport, railway, railway link to an airport

NÁZEV

Studie napojení Pardubického letiště na českou železniční síť

ANOTACE

S dalšími vývoji a investicemi v civilní aviatice na letišti Pardubice by se mohlo otevřít na letiště železniční spojení pro zjednodušení přístupu k letištnímu terminálu. Dostatečně připojit letištní terminál k ostatním druhům dopravy může být velkou důležitostí k rozvoji a vývoji. S touto myšlenkou se zaobírá tato závěrečná práce zjišťuje, zdali je železniční spojení k letišti proveditelné.

KLÍČOVÁ SLOVA

Letiště Pardubice, železnice, železniční spojení na letiště,

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LIST OF ABBREVIATIONS AND SYMBOLS

SYMBOL	APELLATION
ZÚ	Track inception
KÚ	Track terminus
ZP	Start of the transition curve
KP	end of the transition curve
ZO	Start of the curve
KO	End of the curve
Li	Length of the curve area of the circular arc
L1;L2	Length of the transition curve
Lk	Length of the transition curve
Ld	Length of the gradient curve
V;Vn	Speed, permissible speed
D	Railway cant
Deq	Proposed railway cant
I	Cant deficiency
A	Clothoid parameter
α	Angle between tangents of the tangent polynomial
τk	Angle of tangent in the termination point of the transition curve of the Clothoidal shape
Xk	x – coordinate in the termination point of the transition curve of the Clothoidal shape
Yk	y – coordinate in the termination point of the transition curve of the Clothoidal shape
m	Indentation of the radial curve from the transition curve tangent in its inception
t	Partial tangent
T	Overall tangent
R	Curve raidus
ČSN	Czech technical standard (Česká technická norma)
SŽ	Czech railway directorate (Správa železnic)

DPMP	Pardubice public transport company (Dopravní podnik města Pardubic)
nº	Numero sign

INTRODUCTION

Civil aviation in general plays a substantial role in transportation. Whether passenger, cargo or mail transport is considered, transport over air is almost exclusively a type of transport that cannot function without substantial infrastructure that supports it. So as to say, having a railway connection to an airport can benefit an airport immensely.

Railway connection to an airport can play a vital role in bringing passenger, goods or mail directly to the airport in ways that road transport simply cannot. If compared to road transport, trains run on a predetermined schedule and congestion on railways should be less likely. Rail transport is also comparatively faster and as newer, faster, and more efficient trains are being developed, it is also more economical and ecological. Railway terminals and stations are also commonly situated in or near city centres, which is also one of the reasons why connecting Pardubice airport to the rail network might be crucial for its future development.

Railway link to the Pardubice airport could bring faster travel times from Pardubice main railway station and as such allow rapid access of the passengers to and from major city centres located on the first and third railway transit corridor. As the Pardubice airport has been developing, a new civil terminal has been constructed in recent years. This opens the possibility of connecting the terminal to other means of transport, of which railway can be of a vital importance. The existence of a railway spur at the airport compound facilitates this proposal.

1. RAILWAY CONNECTIVITY AND EXISTING CONNECTIONS OF SIGNIFICANT AIRPORTS IN CZECHIA

1.1 VÁCLAV HAVEL AIRPORT (PRAGUE)

There are long term plans to expand the railway line №120 from Prague Masaryk railway station to Kladno railway station to include a new interjacent railway station at the airport. The project by itself is quite complex as there are necessary construction changes on the railway line that precede it. One of these major changes is the renovation of the Masaryk railway station. The railway should shorten the time it takes to get from the main railway station to the airport to about 40 to 45 minutes and make the voyage considerably more comfortable. It is comprised of two parts, during the first phase a tunnel is to be built to the airport from the eastern side, creating a terminal station and during the second phase a second tunnel is to connect the first tunnel from the west, changing the terminal station into an interjacent one. (1)

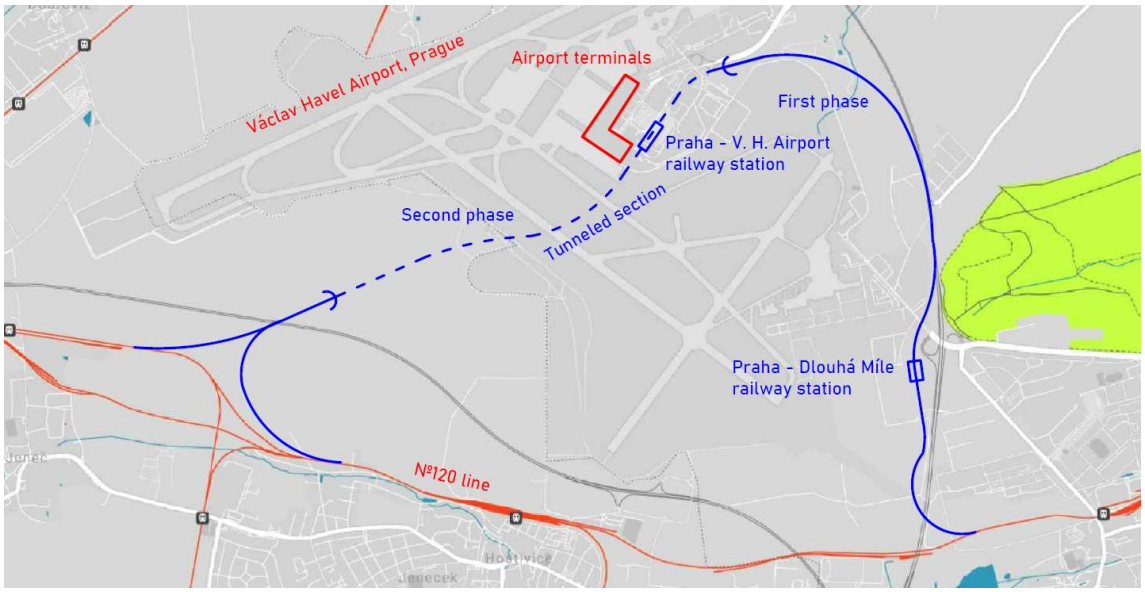


Figure 1 - simplified layout of a possible Prague airport future railway link, built in two phases, the railway would first approach the airport from the east, and then connect through a tunnel back to the №120 line.

Source: [author]

1.2 TUŘANY INTERNATIONAL AIRPORT (BRNO)

There is a plan for the Tuřany airport as part of the 2018 Brno railway hub reconstruction feasibility study in consideration to build a new railway station in a walking distance from the airport terminal as part of an upgrade and modernisation of the №260 railway from Brno to Přerov. The railway would connect Brno city centre with the airport using a new tunnel. (2)

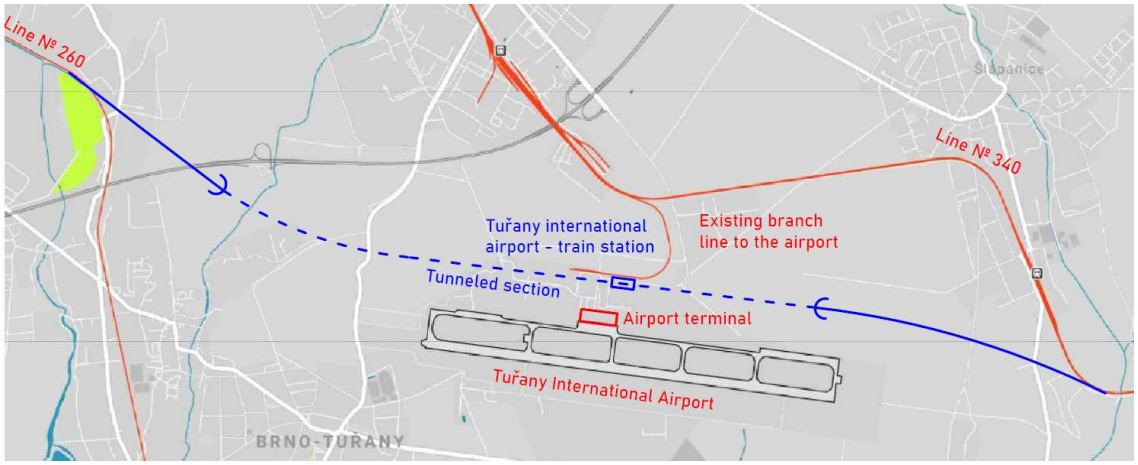


Figure 2 – graphic depiction showing an envisioned tunnelled railway from the "Petrov" B1A variant of the 2018 Brno railway hub feasibility study for passenger access to Tuřany International Airport

Source: [author]

1.3 LEOŠ JANÁČEK AIRPORT OSTRAVA

As of 2021, Ostrava airport is the only airport in Czechia with a dedicated railway station. The railway station is of the terminus type, situated in a short distance from the airport terminal. It forms a part of the №325 railway line from Studénka to Veřovice. Since 2016 a direct train connection between the airport and the Ostrava main railway station is maintained, allowing a direct link to the regional capital.

The railway station is roofed and connected to the airport terminal with a roofed passageway allowing easy access between the train platform and the airport departure/arrival lounge. The station has two tracks with a railroad switch at the entryway allowing two trains to be located at the station at a given time. (3)

Figure 3 - Leoš Janáček airport Ostrava with the adjacent railway station

Source: [(22)]

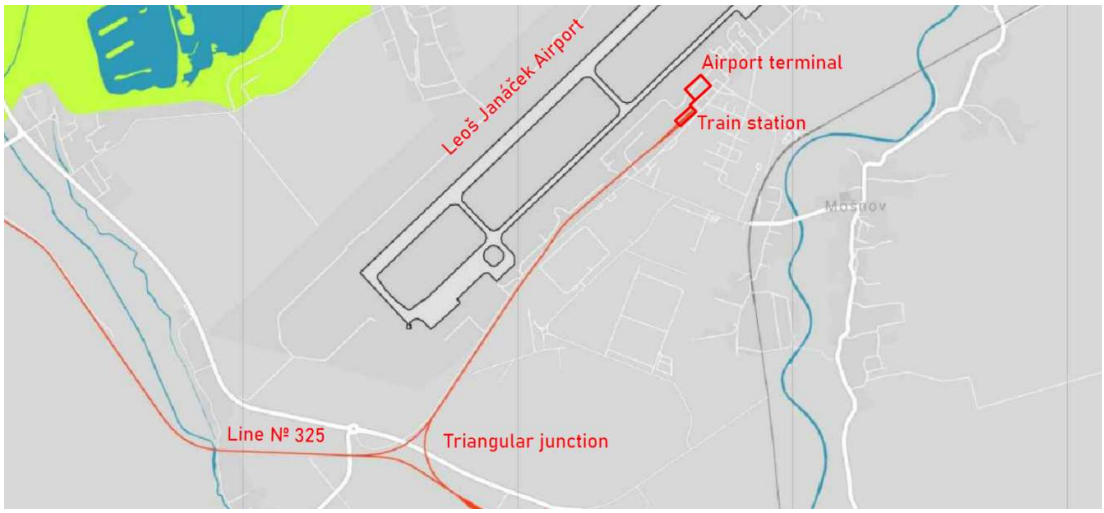


Figure 4 - graphic depiction showing Leoš Janáček airport with its railway station and terminal and adjacent railway line, note the triangular junction allowing the train to pass the airport station.

Source: [author]

1.4 ČESKÉ BUDĚJOVICE AIRPORT

České budějovice airport is a minor airport that has not been certified to accept international flights as of 2021. Nevertheless, efforts are being made by the regional council to certify the airport with IATA to become the next international airport in Czechia. A new airport terminal has been constructed and the runway has been widened and refurbished. Formerly the airport was used by the Czech military, which has constructed a rail branch line to handle cargo at the airport. It is possible that with future developments of the airport a new railway station with a rail extension could be constructed for passenger access to the new terminal. A feasibility study is to be conducted by SŽ (Czech Railway administration) (4)

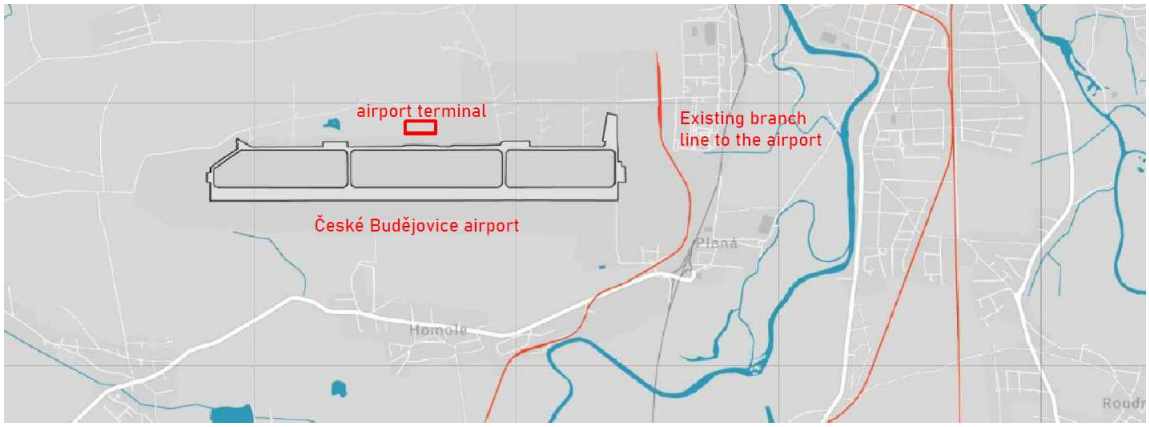


Figure 5 - graphic depiction showing České Budějovice airport and its existing cargo branch line.

Source: [author]

1.5 JAN KAŠPAR AIRPORT PARDUBICE

Currently, Jan Kašpar airport has a cargo rail branch line leading to the military part of the airport. The utilization of this railway, its extension is further examined in consequent chapters. As of 2021 no efforts or plans have been made to utilize the railroad for any other purposes, than for handling cargo by the military personnel of the airport. (5)

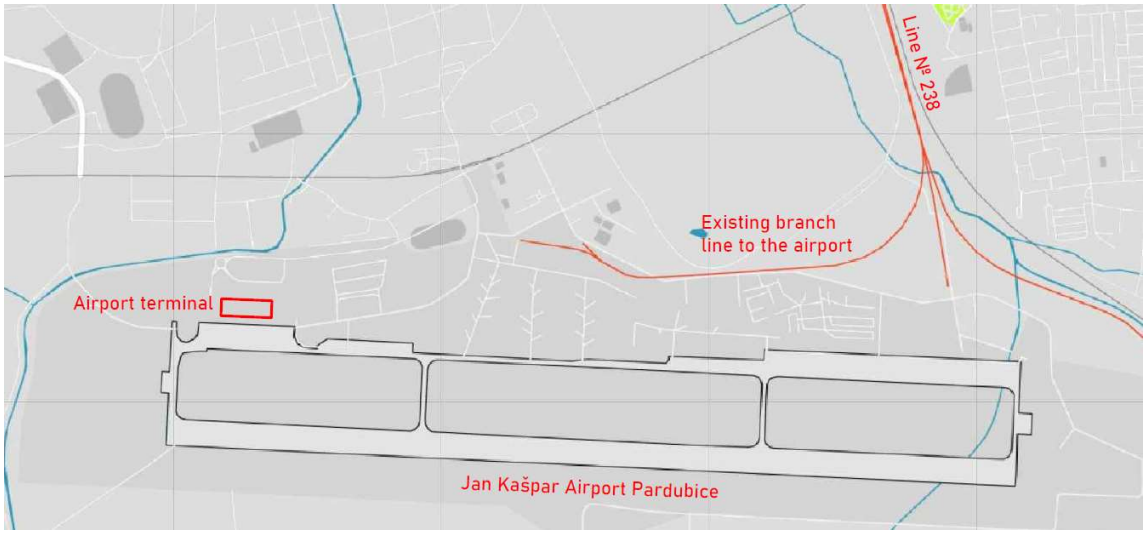


Figure 6 - simple graphic depiction showing the trajectory of the cargo branch line at the Jan Kašpar Airport in tandem with the location of the airport terminal.

Source: [author]

2. RAILWAY CONNECTIONS TO SMALLER AND MEDIUM-SIZED INTERNATIONAL AIRPORTS OUTSIDE OF CZECHIA

The following is a list of examples of international airports with existing train connections with their solutions outlined, that as of 2021 have a comparable number of passengers when set side by side with the aspired optimistic number of passengers that the Pardubice airport could handle that is set for the sake of this thesis at 500 000 passengers per year. (17)

2.1 AALBORG LUFTHAVN, DENMARK

Aalborg lufthavn, lufthavn being the danish word for airport, is an airport situated at the outskirts of the danish town of Aalborg. It is a dual-use airport, meaning it is partially used by the military as well for transport of civilians, which in terms of function is comparable to the Jan Kašpar airport. In terms of passenger statistics, the airport handles 1.5 million passengers annually, which is double or triple, when comparing the potential numbers of passengers, that could use the Jan Kašpar airport. Nevertheless, comparably to the Pardubice airport, a regional railway line was located near the airport. A new branch line was constructed, starting north of

Lindholm station, which is part of the Aalborg commuter rail, a regional danish railway link. (6)

Construction-wise, the case is similar to Pardubice airport, due to the railway station being of the terminus type, as the proposed railway station at the Pardubice airport is. The railway station is located within a walking distance of the airport terminal allowing easy access on foot. (7)

Figure 7 - simple graphic depiction showing the Aalborg railway station with its branch line and adjacent regional railway line.

Source: [author]

2.2 LÜBECK AIRPORT, GERMANY

A smaller airport with approximately 350 000 passengers annually, located in the state of Schleswig-Holstein in coastal Germany, 54 kilometres east of Hamburg. In comparison to the Pardubice airport, it is in a relatively similar situation location-wise. As it is close to Hamburg, it is used for cheaper charter flights for people of Hamburg and the surrounding region. It serves as secondary airport for Hamburg. (8)

In terms of rail connectivity, Lübeck-Flughafen railway station has been in operation since 2008 and has significantly shortened the route to the airport, formerly made solely by bus. The railway station is located on the Kiel-Luneburg route.

The station lies on a part of the railway line, which is tangent and as such is not formed by a separate branch line with a junction. (9)

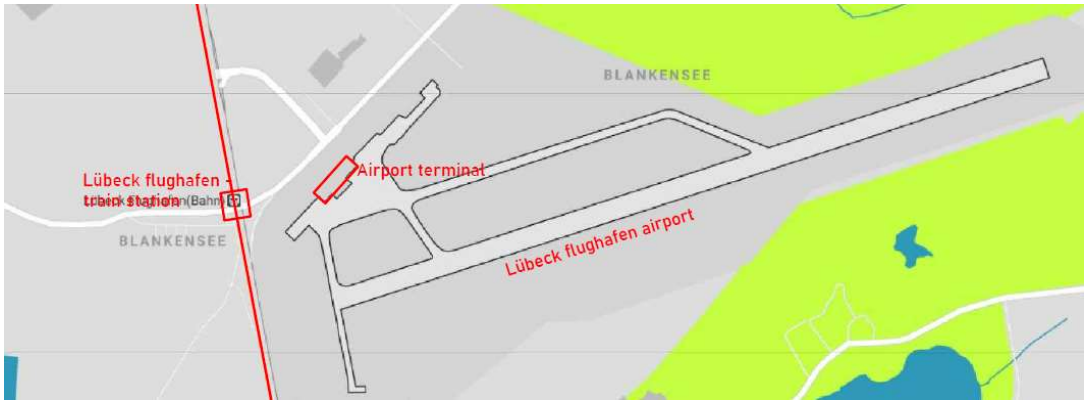


Figure 8 - graphic depiction showing Lübeck airport and its railway station.

Source: [author]

2.3 FRIEDRICHSHAFEN AIRPORT, GERMANY

A minor international airport located near the banks of Lake Constance. The airport is famous for starting its history as a Zeppelin airport. It serves as a tertiary airport for the state of Baden-Wurttemberg. Directly across from the terminal building, the Friedrichshafen Flughafen railway station is located on the Ulm–Friedrichshafen railway, served mostly by DB regio, a subsidiary of the Deutsche Bahn.

As is the case with Lübeck Airport, the station lies on a part of the railway line, which is completely straight and as such is not formed by a separate branch line with a junction. (10)

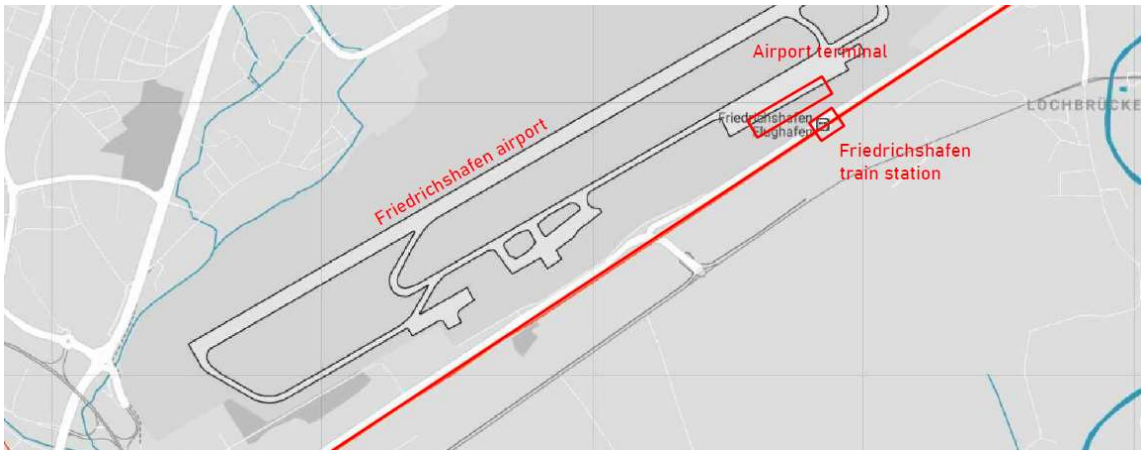


Figure 9 - graphic depiction showing Friedrichshafen airport and its railway station.

Source: [author]

3. DESCRIPTION OF JAN KAŠPAR AIRPORT

Jan Kašpar airport is located near Svítkov a city district of Pardubice the regional capital of Pardubice region. It is partially used by the Czech military, which at times has parts of their air force stationed there. The civil part of the airport is owned by East Bohemian Airport, a company set up by the Pardubice regional government to handle civilian use of the airport. The divisions of the airport may become important as the designed railway is partially comprised of a rail track built and maintained by the military and in order for the railway to reach the civilian terminal, its trajectory has to go through parts of the airport owned or maintained by the military.

3.1 HISTORY

The airport in its current location was constructed during the times of the first Czechoslovak republic by a club of local aeroplane enthusiasts. The airport was occupied by the Nazi Luftwaffe during the second world war and consequently destroyed by the end of the war in allied bombings.

The airport was completely rebuilt in the 1950s to serve primarily as a military installation and remained that way until 1995. During the 1950s a concrete runway with a length of 2500 meters was built to allow landing and take-off of soviet MIG fighter jets and other advanced military aircraft. During the consequent decades, every construction effort was made to suit a certain military purpose. An air traffic control tower, technical facilities for servicing various military and non-military aircraft in tandem with housing and offices for the soldiers and technicians stationed at the military airport were built.

Since the year 1993, the airport has started to be partially used as a civil airport. Parts of the military compound were refurbished to serve as a departure/arrival terminal for civil air traffic.

As the old premises used as the terminal and technical facilities for aircraft servicing were outdated and inadequate for handling larger numbers of international passengers, a new civil airport terminal along with new technical facilities was constructed in the western part of the compound to handle civilian traffic, maintenance and refuelling of civil aircraft at the airport. (11)

3.2 DESCRIPTION OF THE AIRPORT COMPOUND

The following is a list of Pardubice airport facilities, which are in various ways of elevated importance to this thesis and does not provide a full account of all the facilities located at the airport.

In the civil part of the airport:

Airport museum

Neighbouring the entrance to the civil airport is the airport museum dedicated to the aviator Jan Kašpar, a local pioneer and innovator from the dawn of aviation. A car park is Located south of the museum. (11)

Customs office

A customs office is located at the civil airport entrance east of the museum on the opposite side of the street with an adjacent smaller car park.

Old terminal building

Formerly, a different set of 2 buildings than the Jan Kašpar terminal was used as the departure/arrival terminal for civil passengers. Two military office buildings were refurbished at the inception of the civil airport in the 1990s to serve as the main terminal, connected with a simple passageway in between them to allow passengers to walk from one building to the other and to disallow passengers to enter and leave the premises of the departure lounge, once they went through the security check and their baggage has been checked. (11)

Car park for long-term parking

Formerly the site of two warehouses, that were torn down as a part of the construction of the Jan Kašpar terminal. A car park was constructed on the concrete pads that were located under and around the storehouses.

New civil airport terminal

As of 2019 an airport terminal has been constructed and is operational at the western side of the civil airport. A two-storey building located right at the western runway apron for easy access of passengers to the aircraft, without the need to use ground vehicles for transportation to/from the aircraft. The building is comprised of four parts. First part is the vestibule with various airline booths and an area for airport check-in. Second part is comprised of security checks and

a departure lounge with 2 gates used for EU travel and 1 gate for traveling outside the EU Schengen area with an additional passport check. Third part is formed by the section for arrival at the airport with the baggage reclaim and subsequent security check for arrival to Czechia. Fourth part is formed by the higher floor, which is to be comprised of a restaurant and offices for the airport personnel.

The plan to construct the terminal building was in the making since the inception of the civil airport in the 1990s. Before construction was initiated, the airport terminal plans were a subject to changes mostly for financial reasons. Most of the changes involved cutting parts of the building plans to cut cost and as such a terminal was built without a substantially large car park. A vital part of the construction plan was also enlarging of the runway apron to connect with the new terminal. Only a portion of the original plan was constructed, and as of 2021 the large car park that is to be located north of the terminal is still absent. The higher floor with the terminal restaurant is not constructed either. (11)

Civil airport facilities

A set of buildings used for the housing of various equipment used during civil aircraft maintenance activities with adjacent roads to allow ground vehicles to access the buildings from all sides.

Ground vehicle depot

A building used as vehicle depot for various ground vehicles used for aircraft maintenance, refuelling, vehicles used for passenger transit from the terminal to other aprons, aircraft stairs etc.

Access road to the terminal

As the Jan Kašpar Terminal was constructed, a new access road starting at the civil airport gate was built. It is a 7-meter wide S7 type road with an asphalt cover layer presumably of the ACB type. A pedestrian/cycling pathway is built north of this road, terminating at the gate to the civil airport apron. Parking for buses is constructed on the opposite side of the road, when being viewed from the airport terminal. The road is divided by a roundabout at the terminal with the one exit heading to the entrance gate to the civil airport apron and another leading to the terminal itself with adjacent small car park for short term parking opposite of the terminal, whilst continuing to intersect the road again, forming a rectangle.

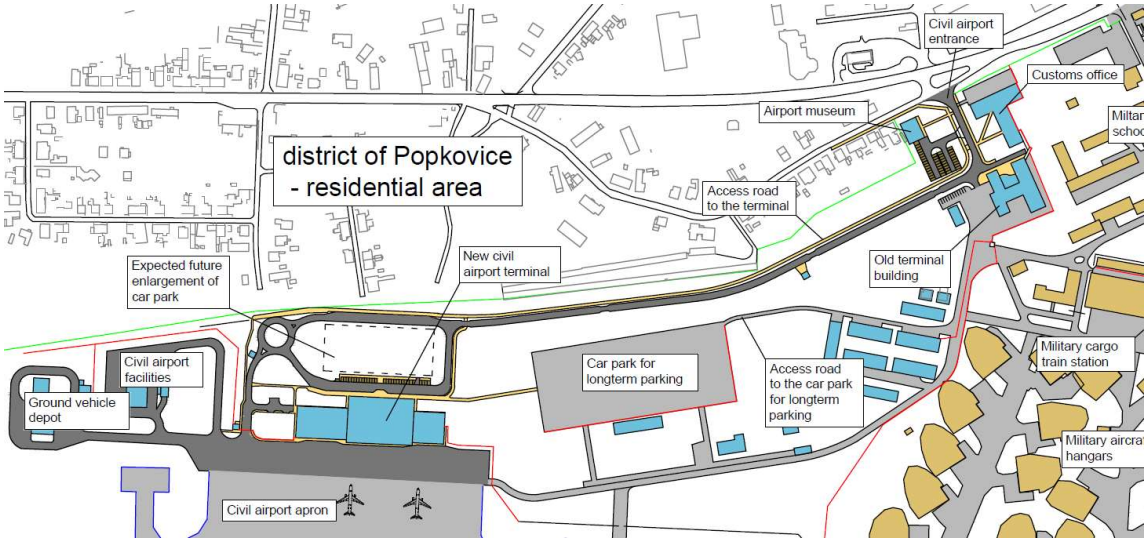


Figure 10 - layout of the civil part of the airport, with the civil airport buildings coloured blue.

Source: [author]

In the military side of the airport:

Military administration and schooling buildings

Various office buildings with adjacent car parks and housing of the Czech military are located near the military gate in the north-eastern part of the compound. Most of the building are of the older modular type of building units for offices and housing built during the 1950s to 1980s.

This area is avoided by the projected railroad track trajectory, as the noise from the trains in tandem with disruption of military and other vehicle movement would create considerable difficulties to the military.

Military freight railway station

A building used for loading and unloading cargo with a ramp located north of the main railway line, the railway line terminates at the western edge of this building by a bumper stop.

This area is avoided by the projected track trajectory, as it may or may not be currently used and as such it may be inconvenient for various military activities in regard to the usage of the spur by the military to use it as part of the railway extension.

Military aircraft hangars

Massive concrete hangars that are covered with a substantial layer of dirt for protective purposes against bombardments are located near the military apron.

Nevertheless, this area is also bypassed by the projected railroad track trajectory as the deconstruction of the hangars would be expensive and difficult.

Military fuel depot

As part of the railroad track within the compound, an underground fuel depot is located adjacent to the railroad track for transferring fuel by a train to the depot. As part of the projected railroad track trajectory, it is vital that the ability for the depot refuelling by a train is maintained as part of the design.

Air traffic control tower

An air traffic control tower is located at the apron overlooking the runway.

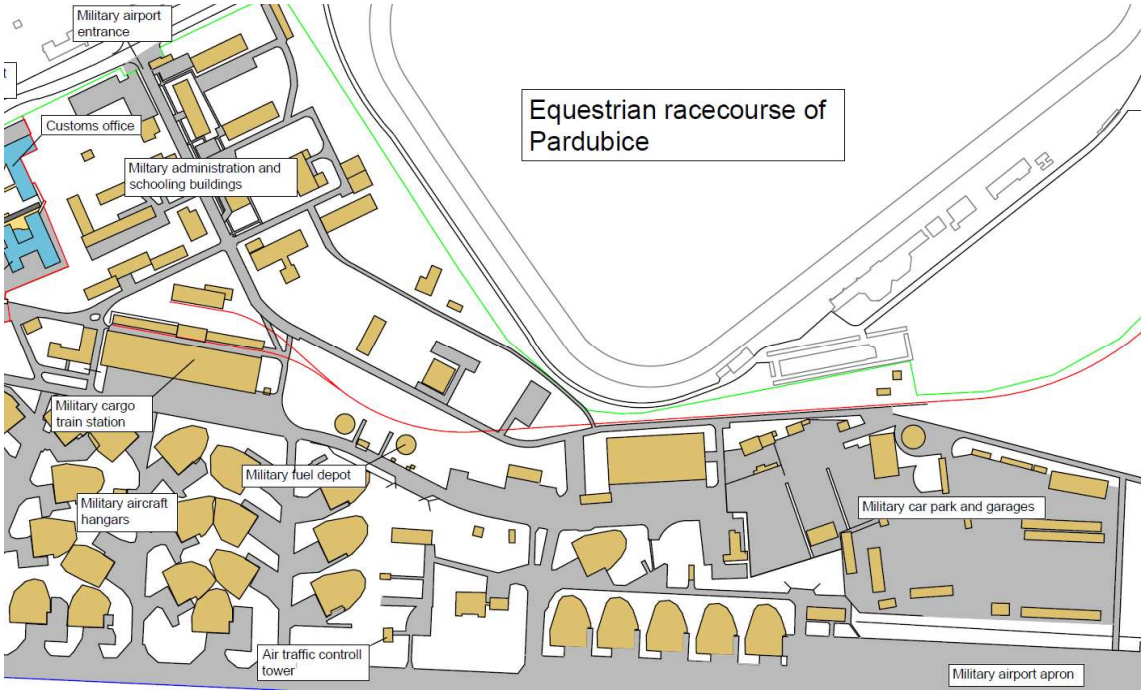


Figure 11 - layout of the military part of the airport, with the military airport buildings coloured beige.

Source: [author]

Military airport apron

Apron used by the military is located on the eastern side of the airport compound adjacent to the eastern taxiway.

Military car park and garages

A military car park used primarily for heavy vehicle maintenance and parking is located at the eastern end of the airport compound. Various military trucks are stored there.

As the position or size of the car park is non-essential, the projected railroad track trajectory marginally affects its placement, as the current railroad track is in close proximity. (11)

Figure 12 - layout of the airport (military compound buildings shown in beige, military area in green hatching, civil airport buildings in light blue and civil airport area in blue hatching)

Source: [author]

3.3 ADJACENT RAILWAY LINES

Pardubice main railway station is situated on the first and third corridor transit railway line and as such, railway connections with both Brno and Prague are relatively fast. As shown on the following Figure, a regional railway line passes through the city from north to south from Hradec Králové to Havlíčkův brod.

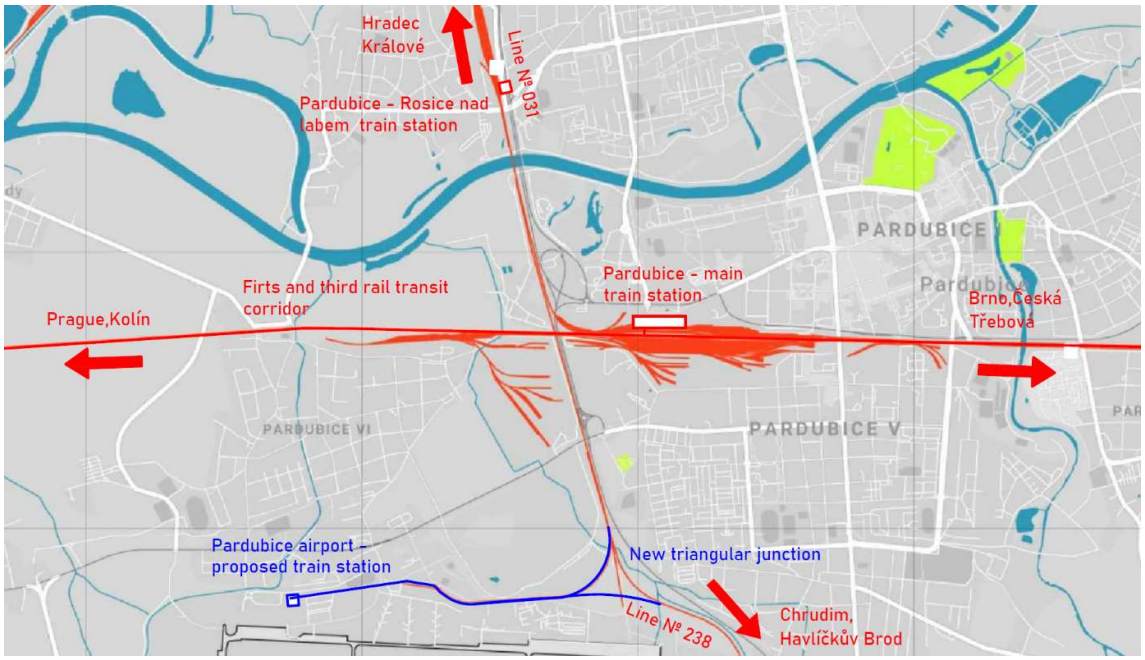


Figure 13 - graphic depiction showing all the possible connections Pardubice airport train station could gain.

Source: [author]

3.4 POSSIBLE PROSPECTS FOR INTEGRATION OF THE PROPOSED PARDUBICE AIRPORT RAILWAY STATION TO THE RAILWAY NETWORK

Since Pardubice airport is by international standards a smaller or minor international airport, its railway connection should reflect that. When looking at other examples of international airports of a similar size across Europe, the railway line chosen as a prospect for connection is commonly of a lower significance, a regional railway link, which is in close proximity to the airport in question. The linking railway line then leads to a railway hub, where faster connecting lines lead to more distant destinations.

General solution

In the case of the Pardubice airport, the general solution is chosen in a similar manner. The important hub, which is to serve as the connecting hub to more distant destinations is the Pardubice main railway station. Pardubice main railway station is an important railway hub, from which passengers can travel with relatively high speeds to Kolín, Prague or Brno and Česká Třebová and other attached railway station as part of the first rail transit corridor. With future developments of high-speed rail in Czechia, the faster connectivity can further be expanded.

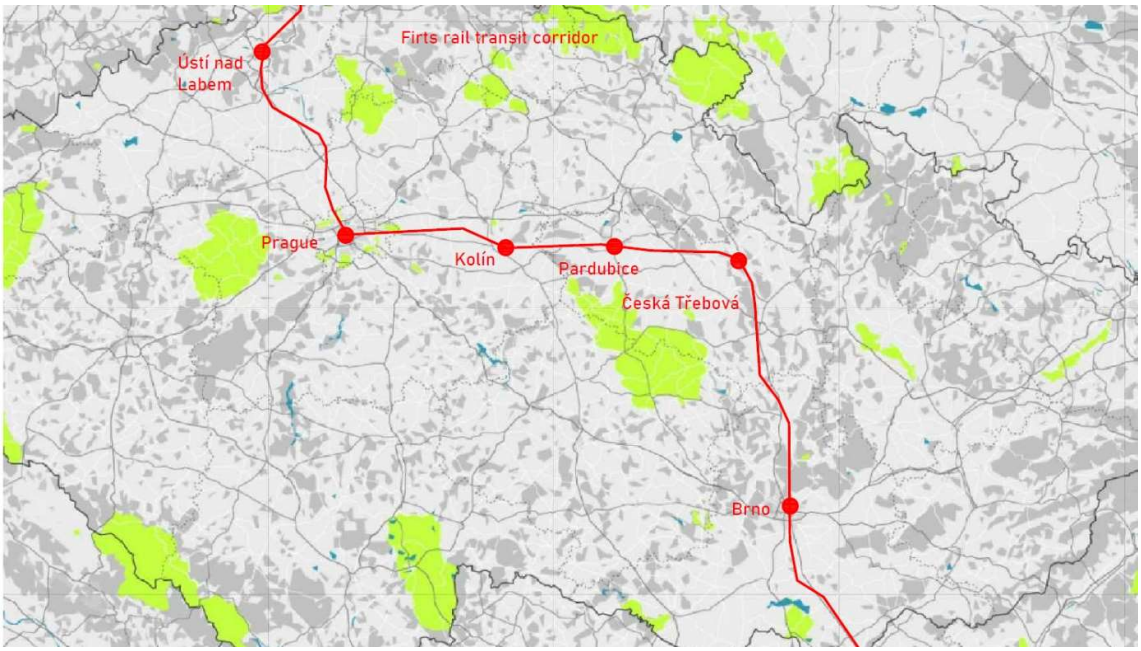


Figure 14 - first rail transit corridor with important population centres on its trajectory marked.

Source: [author]

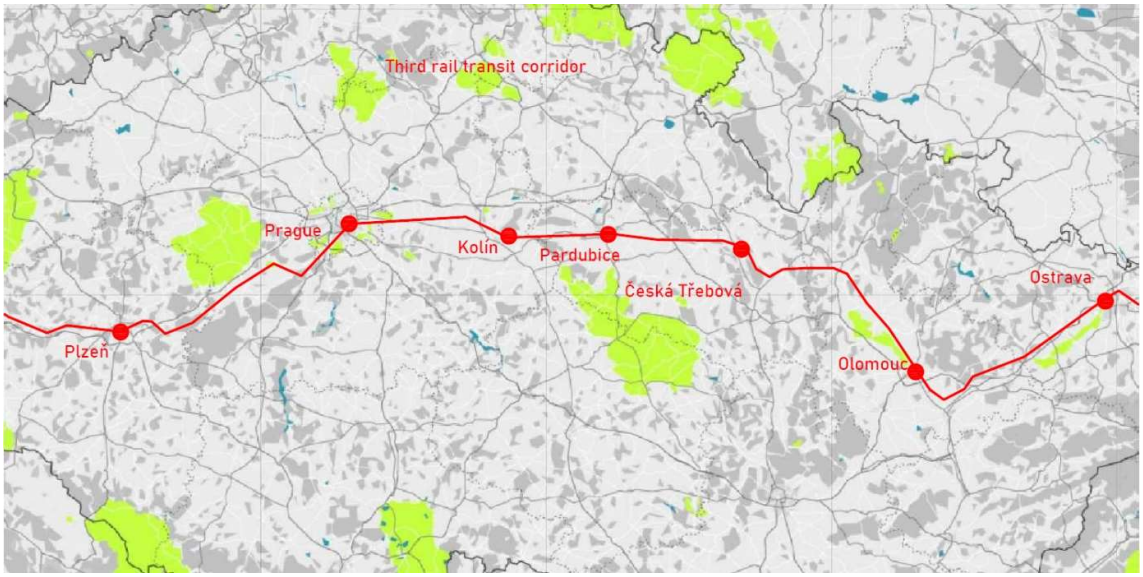


Figure 15 - third rail transit corridor with important population centres on its trajectory marked.

Source: [author]

Since Pardubice main railway station lies on the third rail transit corridor as well, population centres that lay east of Pardubice in Silesia and Moravia could enjoy improved connections as well. The cities in question, not afore mentioned are mainly Olomouc and Ostrava. (13)

High speed rail

With the future advent of the high-speed rail in Czechia, a branch line of the RS5 high speed rail link heading to Hradec Králové main railway station and then on to Wrocław Główny railway station, Poland, is going to be constructed and will terminate at the Pardubice main railway station. The area within which it is still relatively comfortable and short to travel to and from the Pardubice airport is going to be expanded by the emergence of high-speed rail. Expectations are that the journey from Pardubice to Prague is set to take less than 40 minutes, which will be made possible by the maximum speeds exceeding 300 km/h of the high-speed trains. With the travel times from Prague to Pardubice decreased under an hour, it could become significantly faster for passengers from Prague city centre to arrive at the Pardubice airport than by using Prague intercity buses or the metro and subsequent buses to reach the Václav Havel airport, perhaps making Jan Kašpar airport Pardubice more competitive.

With hypothetical travel times of 1 hour and 20 minutes from Wrocław Główny to Hradec Králové, perhaps even passengers from Polish Silesia and Wrocław may use the Pardubice airport, as it would become closer than ever before. (14)

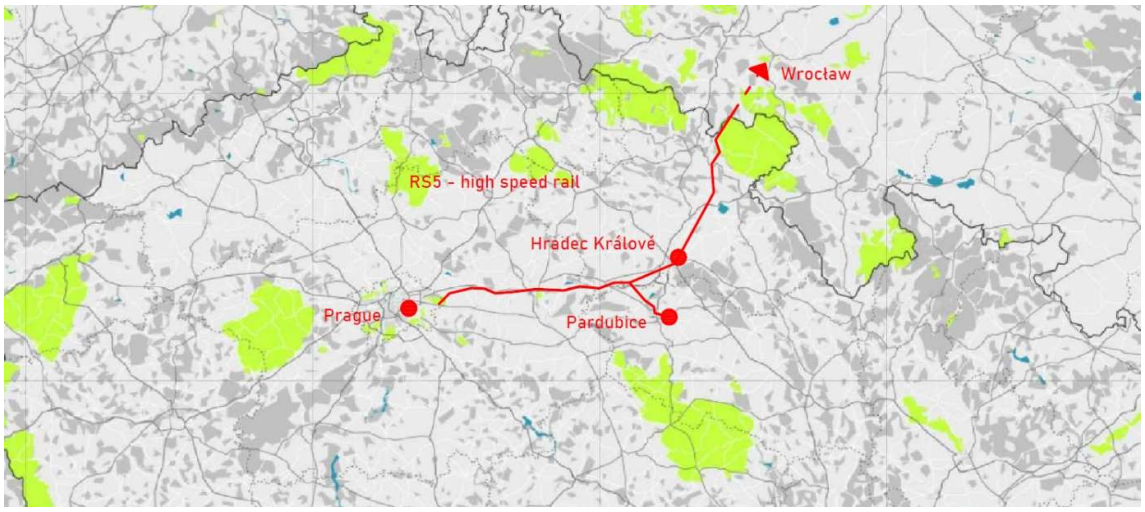


Figure 16 - proposed trajectory of the RS5 line of the high-speed rail proposal

Source: [author]

First chosen railway line for the railway station and the railway extension

The railway selected as one of the appropriate railway links is the Havlíčkův Brod – Pardubice №238 railway line. It is a regional line serving as an important link, connecting a significant portion of the population of Eastern Bohemia. The maximum speed is set at

100km/h which is appropriate for this proposal. As of 2021 it is partially electrified. The railway line terminates at the Rosice nad Labem railway station.

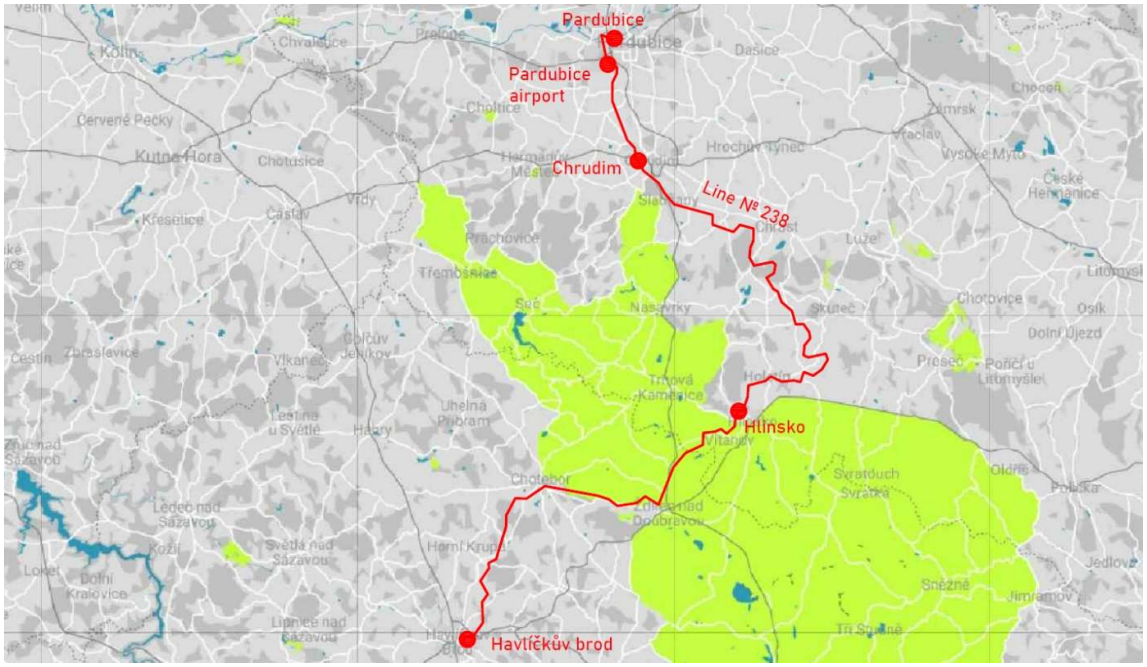


Figure 17 - map showing important regional population centres on the railway line №238.

Source: [author]

The rail link between Chrudim railway station and Pardubice main railway station is therefore comprised of using two railway lines, the №238 which terminates at the Rosice nad Labem railway station and a of a short following distance on the №031 line.

Rosice nad Labem railway station is important for the proposal of this thesis, as it will to a certain degree form a smaller hub together with the Pardubice main railway station, with which the proposed railway station could connect to the region of Eastern bohemia.

As part of the construction of a second railway track on the №031 to achieve a dual track layout on the railway line from Hradec Králové main railway station to Pardubice main railway station, Rosice nad Labem railway station is going to be remodelled and refurbished. A new island platform with a subway and a side platform are going to be built at the station. The station is also going to be remotely operated from a different railway station and is no longer going to be staffed. (13)

For various technological and historical reasons, the railway №238 terminates at the Rosice nad Labem railway station and not at the Pardubice main railway station, which is inconvenient for the passengers coming from the direction of Chrudim, as the trip takes longer than it otherwise

could. Different solutions have been proposed on how to link the line directly to the Pardubice main railway station but as of 2021, the situation is still not solved. As part of the recent reconstruction efforts on the Pardubice railway hub, the train hold-up duration at the Rosice nad Labem railway station is going to be reduced, allowing for a somewhat faster transit time from Chrudim railway station to Pardubice main railway station. However, to a certain extent, the proposal can take advantage of this inconvenience. Passengers coming from Hradec Králové and Jaroměř can disembark the train at the Rosice nad Labem railway station, board the incoming train leaving from Pardubice main railway station for Chrudim and Havlíčkův brod and disembark at the proposed Pardubice airport railway station. (15)(16)

This solution brings forth the advantageous position of the proposed railway link, which is the fact that no new rail link must be established and the railway station together with the railway extension can become a part of an existing rail link, which is favourable during the first years of the station´s existence in terms of sustainability.

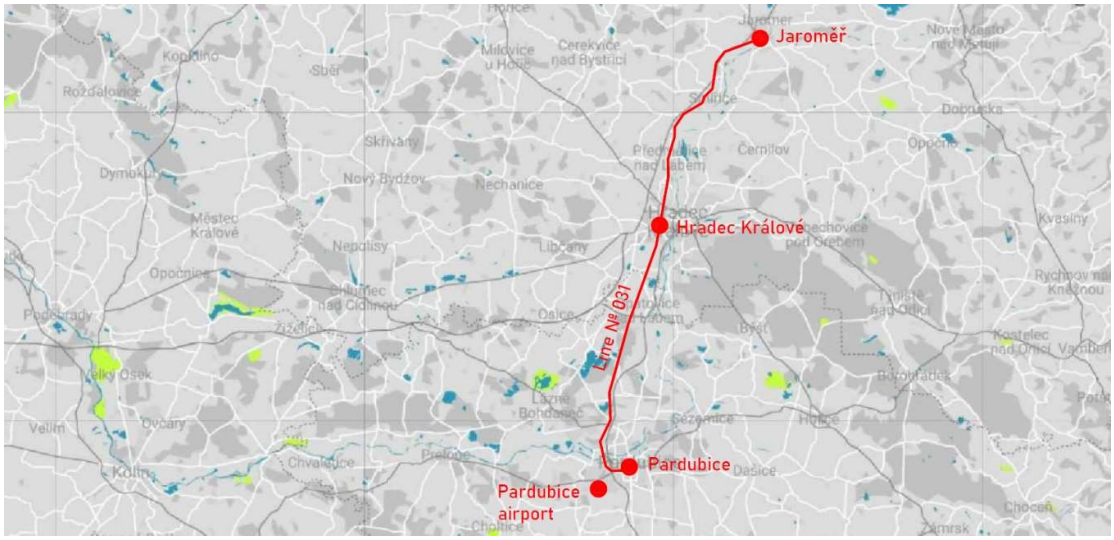


Figure 18 - map showing important regional population centres on the railway line №031.

Source: [author]

If it then became apparent that the railway station is being used by passengers to get to the airport in ample numbers and public awareness of the station´s existence has grown sufficiently, direct rail link through the Rosice nad Labem station to the Pardubice main railway station from the airport station can be established as well as from Jaroměř or Hradec Králové, allowing the population of these cities to have a direct access to the airport.

3.5 DESCRIPTION OF THE RAILROAD TRACK AT THE AIRPORT COMPOUND

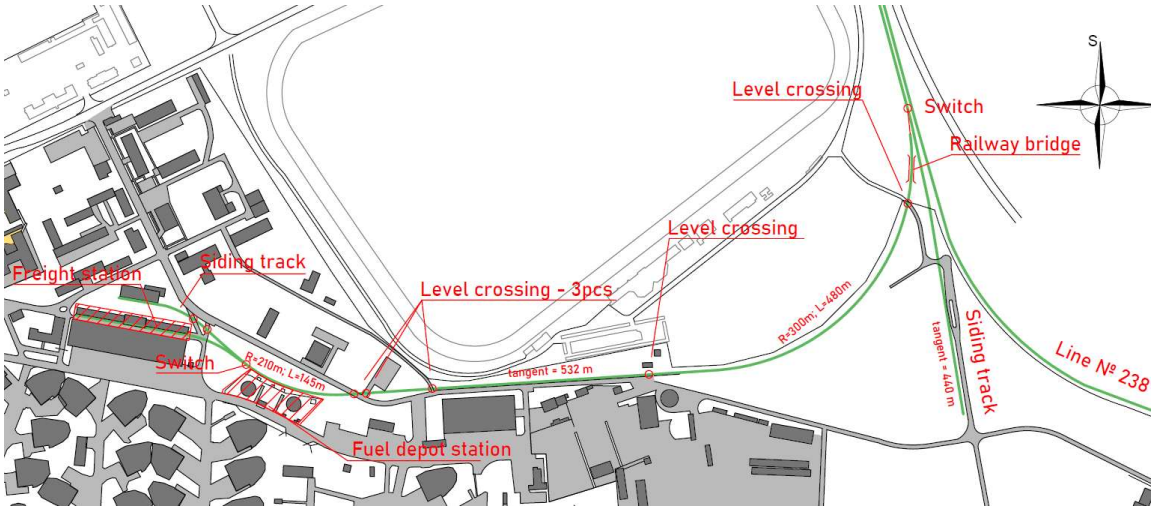


Figure 19 - simplified layout of the current branch track showing its vital elements.

Source: [author]

Track trajectory

The branch track is connected by a track switch to №238 railroad line and continues south until it reaches the only currently operated railway halt called Pardubice-Závodiště. After the station, a switch divides the track to the branch line itself and a siding track. The siding track continues forward while the branch line proceeds to curve to the right, reaching a bridge over the Jesečanský potok, a local rivulet. After the curvature, the track reaches the airport compound and progresses with a tangent track going further inside the compound. 4 simple level crossings are located on this tangent part of the track. The track then leans to the right again with a fuel depot station to the left to reach a second switch that leads forward to secondary smaller siding track and left to a military freight station.

Level crossings

As the railroad branch is located inside the military compound, no safety measures have been taken to make the crossing secure or safe and as such, the crossings do not bear any marking and signs and are not protected by gates.

3.6 CURRENT STATE OF THE BRANCH TRACK

Looking at the state of the main line of the branch track, it is clear, that the railway is in an arguably neglected state, as the branch line is not used or maintained on a regular basis.

Rails and ties

Rail type used on the line is the T rail type, an older type of rail still in use on Czech regional lines and spurs. The surface of the rails is degraded, nevertheless the designed geometric position of the rails seems to be intact. Ties of the track are of the SB8 type, the ties seem to be weathered and lichen growth is sporadically visible on the top side.

Fasteners

Fasteners used on the track are of the flat baseplate type, a type of baseplate commonly used on railway tracks on railroad tracks in Czechia and Czechoslovakia respectively in the 1980s and prior. As it is clear from the following picture, the state of the baseplate is degraded, and the surface of the baseplate is corroded.

Figure 20 - flat baseplate used on the branch line.

Source: [author]

a coach screw is used to tighten ballast to the fastener, as is the case with baseplate, its surface is corroded, and significant weathering took place.

Track Ballast

Of all the elements forming the railroad track, the ballast at least on the track outside the entrance to the compound seems to be in a relatively acceptable state. It is not overgrown by vegetation and its colour would suggest, it has been during the lifetime of the track.

Figure 21 - a portion of the track on the main branch line with rail joints.

Source: [author]

Switches

Switch used to divide the main line from the first side-track is a single slip switch manually operated and right-handed. On closer inspection the steel ballast used under the switch is corroded and weathered and parts of the ties in contact with the ballast have come off.

Figure 22 - rail switch located outside the compound, dividing the branch line into a tangent side-track and right handed curve inside the airport compound.

Source: [author]

Joints and electrification

Joints on the track are formed by 4 bolts and a plate supported by two ties. The branch line is currently not electrified.

3.7 IMPORTANT POINTS OF DESIGN PRESENT IN ALL VARIANTS OF THE DESIGNED RAILWAY CONNECTION

Triangular junction

A triangular railway junction or sometimes referred to as “wye” in a single-track configuration is a type of railroad junction generally consisting of 2 intermitting railway lines that convene by the use of 3 separate railway switches. Commonly used to connect “spurs” or branch lines to a main line, their main advantage in terms of railway connectivity is that the train unit can enter the particular branch line, reach the branch line terminus and when departing, go through a separate connecting railway that will lead it forward through the main line, no longer necessitating the particular train unit to depart through the same switch as used for entering. In a simple switch configuration, if the particular train unit is to go forward on the main line, it has to come to a complete stop and go in reverse to follow its route. An inconvenient situation, as momentum energy of the heavy train unit is lost, brakes must be applied, transfer time increases and the train conductor must go to the driver´s compartment located on the opposite side of the train unit, furthering the time loss, which occurs by such an arrangement.

Triangular junctions bring flexibility to routing trains, as certain train links on a line can be routed to bypass the branch line. In case of an airport connection to a main line, a train link can bypass the airport line during night or early morning, when flights are not expected to occur, when sending a train unit to a railway station at a time when no passengers would be likely to embark or disembark the train. But also, a train unit going forward from the branch line, can leave the branch line going forward on the main line without the need for stopping and reversing, bringing down transfer times and using less fuel and inflicting less wear and tear on the train units. (18)

Figure 23 – a simplified map showing railway configuration at Manchester Airport, an example of an airport being connected through the use of a triangular junction.

Source: [author]

Terminal railway station in a short distance from the airport terminal

When designing a railway extension to an airport terminal, special constraints are a common issue. As such designing a railway line that would be terminated by a switch at a different or the same line as the line started from or perhaps moving the line closer to the airport to allow a railway station in a walking distance to the airport terminal to be designed can be impractical or perhaps unfeasible depending on the layout of the airport. In general, a new railway connection with an interjacent railway station located in a walking distance from an airport terminal is established by the use of a bored underground tunnel and an underground railway station under or near the airport terminal, which is costly compared to a railway line located on the surface, and feasible only for larger airports.

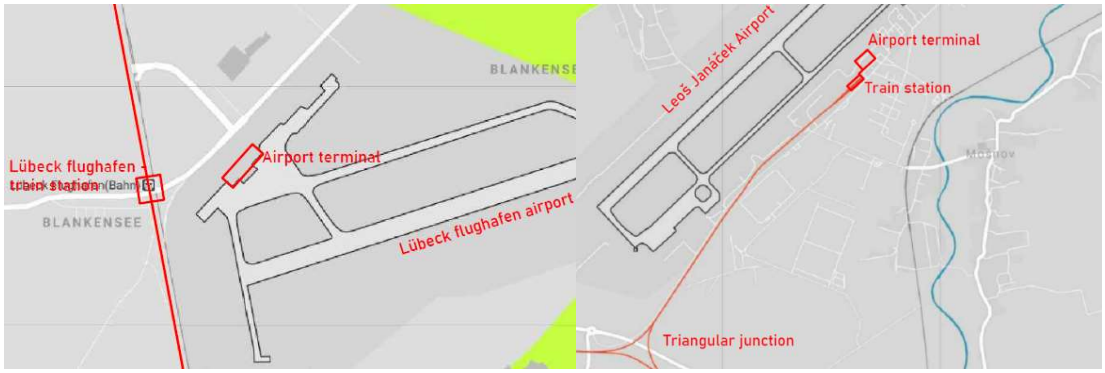


Figure 24 - comparison of two different solutions; left: Lubeck Airport, with an interjacent railway station; right: Leoš Janáček airport with a terminal railway station. both airports and their respective railway stations are further examined in previous chapters.

Source: [author]

As it is clear from the comparison of the two examples above, Lubeck railway station is located much further from the airport terminal, 450 meters by foot, which is a considerably longer distance to walk with traveling luggage than 90 meters at the Leoš Janáček Airport and its adjacent terminal railway station.

The disadvantage of the terminal station layout is its arrival to departure speed and the need for specialized train units. Only trains that are constructed with a dual cabin layout called push-pull trains can make their way to a terminal station and then safely depart it. In the case of Czech regional railways, as the train arrives at the railway station, the train conductor must leave their driver´s compartment, go to the opposite side of the train unit into the other cabin. As so, the time duration of arrival to departure of the train unit to and from the station is longer, when compared to interjacent railway stations. (19)

Pedestrian and cycling bridge over the Bylanka rivulet.

Access to the civil airport compound is at the only possible through the main gate of the civil part of the airport. if the station is to be regularly used by the local residents of the nearby district of Popkovice a more direct route would certainly be beneficial. As shown on the Figure below, the pedestrian and cycling bridge would cut the distance a person would have to walk from 1,5-kilometre distance to approximately 300 meters when standing on the south side of the I/2 road. The proposed bridge is located at the southern end of the Žižkova street in Popkovice. Such a bridge would help integrating the railway station into the railway network by allowing local residents of Popkovice to make use of the station in addition to the station serving airport passengers.

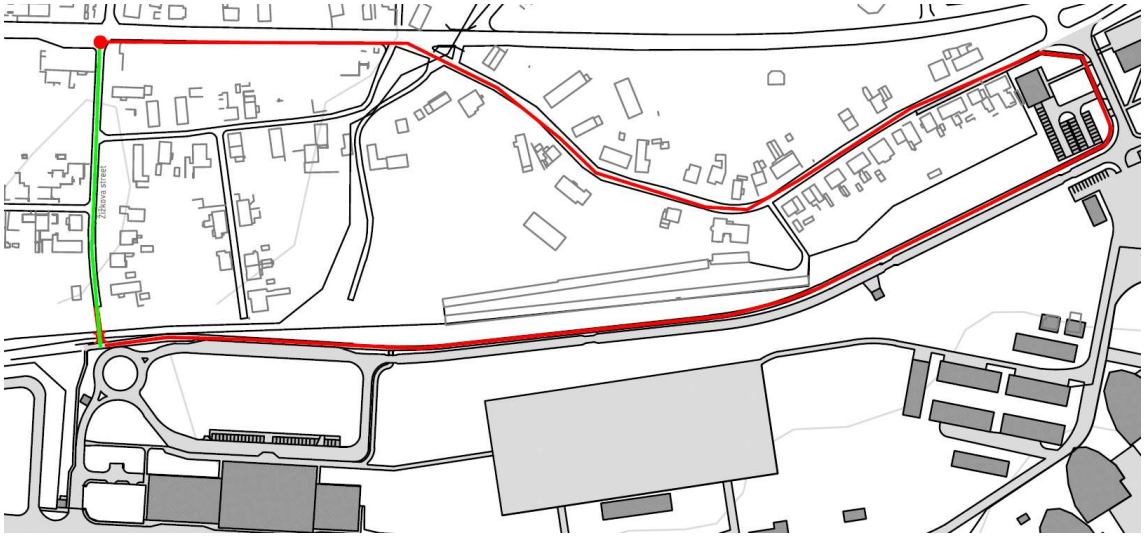


Figure 25 - graphic depiction showing the possible shortcut the pedestrian and cycling bridge might provide, note: red dot signifies a person standing at the I/2 road,: red line indicates the current pedestrian route of approximately 1,6 kilometres, green indicates a shorter route through the proposed bridge connection of approximately 300 meters.

Source: [author]

4. VARIANT A

4.1 INTRODUCTION TO THE PROPOSED SOLUTION

The simplest and arguably most economical solution underlined in variant A to connect the Jan Kašpar terminal to the Czech railway network is to use the existing branch line, extend its length to reach the terminal and design a railway station adjacent to the terminal. nevertheless, such a solution brings many issues with its creation. Railway line is a linear surface structure, and by its inception, the railway is certain to create difficulties for other types of transport inside the airport compound. Roads inside the airport compound need to be relocated to allow the railway to pass through the compound and railway crossings on the new line must be designed to facilitate movement from one side of the track to the other to not to impede on the activity that takes place both at the military side of the airport and the civilian side of the airport as well.

Variant A makes use of the existing railway spur at the airport, extends its length to reach the airport terminal from the eastern side, as so it is designed at lower railway permissible speed when in close proximity to adjacent airport buildings and structures.

4.2 IMPORTANT POINTS OF THE PROPOSED DESIGN IN VARIANT A

Triangular junction located in the eastern part of the airport compound.

On the tangent before the №238 railway track curves right to north to make its way around the limits of the airport approximately at its 89.2 kilometre a left-handed railway switch is designed to create a new connecting railway line to allow train units coming from the direction of Chrudim to go directly inside the airport compound and subsequently to the designed terminal railway station. the railway line meets up with the new original branch railway to the airport to create a triangular junction.

This connecting railway line is located on the plot belonging to the airport compound, a side-track coming from the north is located on its trajectory and such must be partially dismantled to a safe distance from the new railway line, shortened to allow for the new railway line to be built.

Noise barriers inside the military part of the airport

To diminish the visibility of the military airport compound from the train units, lower noise pollution and to create a physical barrier between the railway track and the military compound, a series of concrete noise barriers is constructed around the perimeter of the railway.

The walls are designed to be 4,5 metres tall, 300 millimetres thick made of reinforced concrete with lost timber formwork.

The barriers are designed with free spaces for railway crossings and a free space for the rest of the military spur to join the main line.

Possible use of the line for freight transport

Since the line connects the civil airport terminal and runs in the vicinity of the aprons used for civil aircraft, a possibility arises in using the line for freight and cargo transport. A railway spur could potentially be established starting from the designed line. A freight platform could be constructed adjacent to the spur, allowing cargo to be deposited on or taken off a freight train unit. This concept is not further examined in this thesis.

4.3 RAILWAY TRAJECTORY OF THE A1 LINE

Horizontal trajectory

The railway line enters the airport compound using the original right-handed curve of 296 meters diameter of the spurt crossing the Jesečanský potok rivulet over a concrete bridge, over a railway crossing that connects the road next to the Pardubice equestrian racecourse to the military part of the airport compound. An opposite left-handed switch is located at the end of the curve, that connects the line to the A2 line. The line then goes through a tangent, where a noise barrier is located on the left side of the track. A railway crossing is located near the end of the tangent, that connects the military offices located north with the hangars and vehicle depot and military apron on the south. After the railway crossing, a left-handed switch to the original military spur is positioned, with the spur then following its original trajectory. The railway then curves right with a new trajectory being secluded from the military base on both sides by a noise barrier. The track then goes through a tangent where the third and final railway crossing is located. A space is left in the noise barriers for this crossing. This railway crossing is positioned to connect the main hangars and the original freight station located south with the military offices and other structures to the north. The track then curves left and goes between the military heating plant located just north of the railway track and military freight station located just north. The track than goes through a tangent and then curves left, where it leaves the military part of the airport and enters the civil part of the airport. It then goes through a short tangent and curves slight right where it adjoins a road used for long-term car park access. The track then goes through a short tangent where it reaches the switch of the proposed railway station.

Longitudinal trajectory of the railway

The proposed railway tries to alleviate the need for extensive groundworks by running in close concurrence with the surface of the terrain. as such as single peak is located on its trajectory approximately at the middle.

4.4 RAILWAY TRAJECTORY OF THE A2 LINE

The railway connecting the proposed railway directly the №238 starts with a switch to the main line and then goes through a tangent inside a forest located north-east of the runway still inside the airport compound. Line then goes through a single right-side curve with a railway crossing that connects the road next to the Pardubice equestrian racecourse to the military part of the

airport compound. The line then goes through a tangent where it connects to the №238 line through a railway switch.

4.5 RAILWAY STATION

Proposed railway station layout

The railway station is designed as a single storey concourse, roofed, and walled from 3 sides excepting the side where the railway tracks enter the station. it is designed with two entrances, one from the north, allowing access to the main road at the airport and one from the west in the direction of the sidewalk to the Jan Kašpar terminal. The railway platform is located inside the building.

The platform is equipped with benches for comfort of the waiting passengers.

A waiting area is located at the entrance between the platform and the entrances, allowing passengers to wait for the incoming train unit inside the railway station.

Track layout at the station

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track entrance, disjoining it into two tracks. The platform is located between these two tracks for passenger boarding and disembarkation.

Structure of the station

The railway station is designed as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

Roof of the station

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

The walls of the station

For aesthetic purposes and to allow natural light to reach the interior of the station, all three walls of the station are designed to be of a single layer of glass panel, which will provide

sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

Portico above the entrance

To provide protection against excessive sunlight, rain and snow, a portico is designed above the entrances, with is outer line being symmetrical to the position of the road. Structurally, the portico is designed as a tensile structure hanging on a series of steel cables connecting the outer edge of the portico to the concrete columns. The attic of the portico is made of a sheet of plate corresponding in colour to the darker colour of the attic of the station.

Car park adjacent to the railway station

A small car park with 9 parking spaces and 2 space for persons with disabilities is located at the road opposite of the road connecting the main entrance of the civil airport to the airport terminal to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

Paved surfaces at the station

The original pavement leading from the position of the proposed railway station to the junction connecting the cycling lane located opposite of the road connecting the main entrance of the civil airport to the airport terminal is remodelled to reach the curb of the road by its width and a new pavement is designed at the entrance to the station and under the portico. The pavement is also designed to span north adjacent to the railway station and the road around the proposed car park.

4.6 PERMISIBLE SPEED OF THE RAILWAY IN VARIANT A

For safety reasons and limitations to the safety zone of the railway in variant A because of airport buildings located in the vicinity of the railway. The permissible speed is the lowest in all proposed variants.

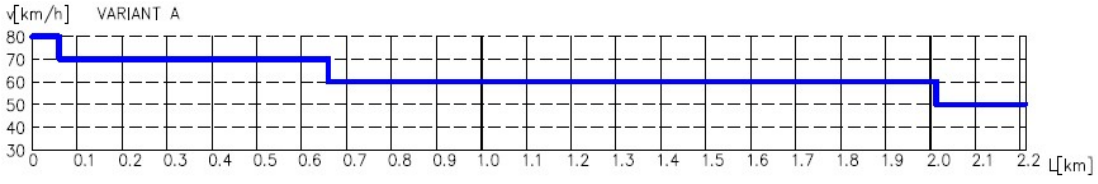


Figure 26 - visual depiction of permissible speed on variant A railway

Source: [author]

The railway in variant A enters the first curve when entering the airport compound, where the permissible speed decreases to 70 km per hour, as it approaches airport buildings the next curve is set with a permissible speed of 60km per hour. This speed is maintained until the railway reaches the switch at the entrance to the station, where the speed is further decreased to 50 km per hour.

4.7 NECCESARY DEMOLITION AND NEW STRUCTURES NEEDED FOR THE RAILWAY LINE CONSTRUCTION NOT AFORE MENTIONED

Road connecting the airport terminal area with long-term car park

As railway crossings tend to create bottlenecks in road transport, a road is proposed connecting the road located at the airport terminal with long-term car park, since the car park is connected by other roads to other facilities around the civil part of the airport. Such a connection would allow civil traffic to access the car park and airport vehicles to access the facilities located on both sides of the railway line without the need to use a railway crossing.

The designed road would have the same width as the road located at the airport terminal and would run north next to an adjacent existing pedestrian pathway used for long-term car park access to the terminal.

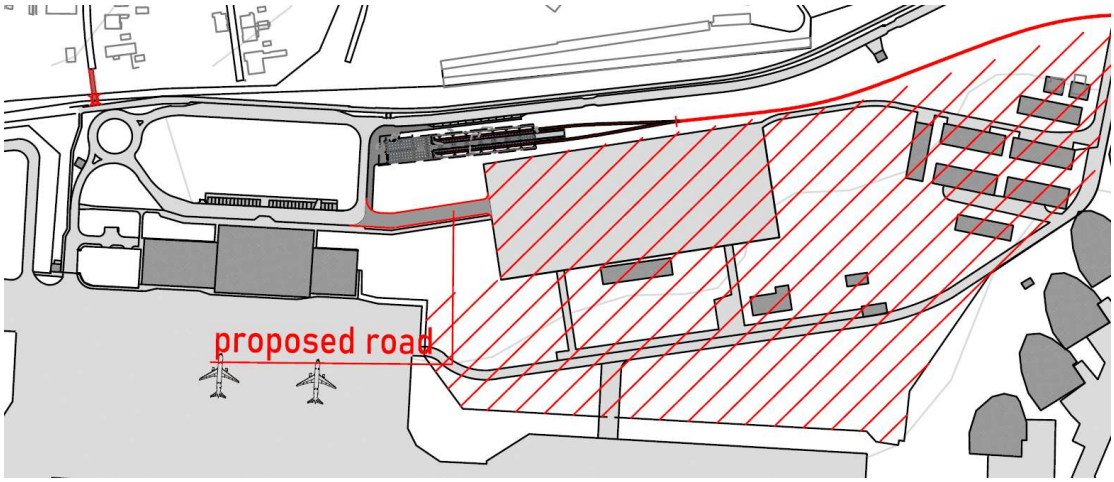


Figure 27 - graphic depiction showing what parts of the civil airport terminal would be connected by the road without the need to use a railway crossing.

Source: [author]

Road relocations at the eastern part of the military airport compound

To streamline the road traffic inside the military airport compound, roads are connected or demolished to lower the amount of railway crossings used on the railway track.

Roads located east of the heating plant and freight station

A new wider road is designed instead of two roads that are crossing the railway line trajectory. The road lowers the points of crossings of the proposed railway and the military spur to only one.

Roads located east of the military depot

Road that would cross the railway line is stopped at the railroad track and is deposed left to connect to another road east of its location, where a railway crossing is located. The angle at which the road would cross over the railway would be too steep and such connecting it to a road that goes approximately perpendicular to the railway track is a preferable option.

Road relocation at the second tangent of the track

as the railway is outfitted with noise barriers, its footprint is wider than of the original military spur. As such a part of the road located south of the railway must be demolished. For the road to have its former width, two patches of road are designed on the south part of this road to widen it to its form width. In order for the relocation to be possible part of a garage located at the military car park has to be demolished as its footprint is located inside the space of the proposed roadway widening.

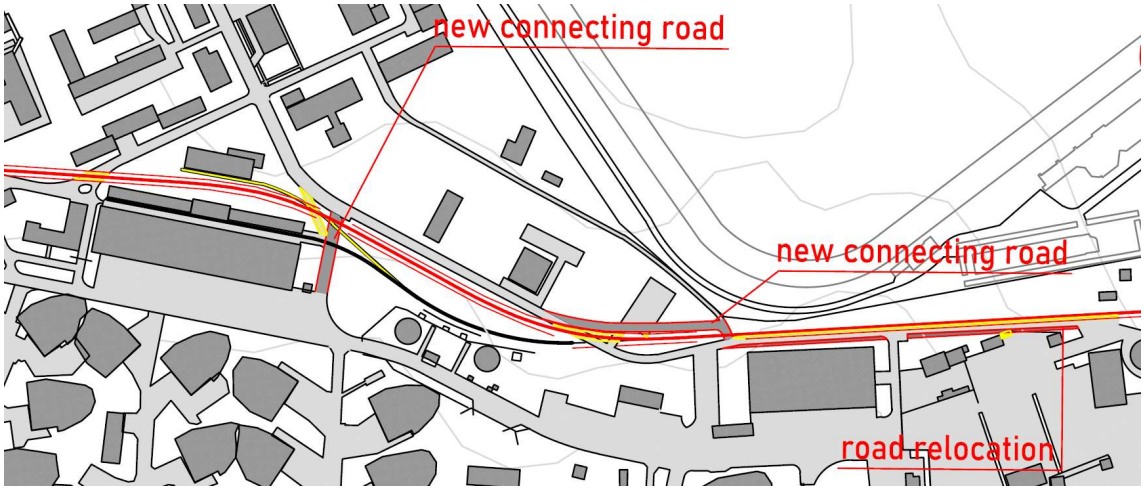


Figure 28 - graphic depiction showing all forementioned three proposed roadworks located at the military part of the airport

Source: [author]

Disassembly of the second railway side-track.

A second railway side-track as part of the military spur used for bringing coal by a freight train to a heating plant located next to it must be disassembled to allow the proposed railway to pass over its former trajectory. The heating plant with the second side-track are no longer used and as such are not necessary for the function of the facilities located at the airport.

5. VARIANT B

5.1 INTRODUCTION TO THE PROPOSED SOLUTION

To counteract the shortcomings and possible disadvantages of the variant A, Variant B uses a similar approach regarding the railway trajectory. The major difference between the two variants is that variant B uses a cut and cover type of shallow tunnel to pass through the airport compound from the east reach the terminal, not interrupting the various activities and movements that take place at the airport above ground. As such it is designed with a higher permissible speed, when passing through the compound and with a terminal railway station located under the ground level.

5.2 IMPORTANT POINTS OF THE PROPOSED DESIGN IN VARIANT B

Triangular junction located in eastern part of the airport compound.

Similarly, as in variant A, a triangular junction is located starting from the tangent before the №238 railway track curves right to north to make its way around the limits of the airport approximately at its 89.2 kilometre with a left-handed railway switch designed to create a new connecting railway line to allow train units coming from the direction of Chrudim to go directly inside the airport compound and subsequently to the designed terminal railway station. the railway line meets up with the new branch railway to the airport to create a triangular junction.

This connecting railway line is located on the plot belonging to the airport compound, a side-track coming from the north is located on its trajectory and such must be partially dismantled to a safe distance from the new railway line, shortened to allow for the new railway line to be built.

Cut and cover type of shallow tunnel

So as to achieve the railway line to pass through the airport compound and not interrupting or negatively affecting the activities that happen at the airport. the designed railway in variant B uses a type of shallow concrete tunnel of the cut and cover type. The tunnel is constructed using diaphragm walls. The positions of the walls are excavated first and cast with concrete, after which the tunnel is excavated down to the height of the tunnel ceiling. Concrete slab is then poured, which forms the ceiling of the tunnel. The tunnel itself is then excavated from the inside, starting at the tunnel entrances, after which additional concrete slab is poured inside the tunnel to form the tunnel floor. As the tunnel is built from ground down and does not require any sloped excavations, it is favourable for this construction because of the vicinity of various buildings around its site.

Similarly, as with the tunnel, the tunnel entrance at the eastern end of the compound is built using diaphragm walls, which act as retaining walls.

5.3 RAILWAY TRAJECTORY OF THE B1 LINE

The railway line enters the airport compound using the original right-handed curve of 296 meters diameter of the spurt crossing the Jesečanský potok rivulet over a concrete bridge, over a railway crossing that connects the road next to the Pardubice equestrian racecourse to the military part of the airport compound. An opposite left-handed switch is located at the end of the curve, that connects the line to the A2 line. The line then goes through a tangent on which

a left-handed switch to the military spur is positioned, after which the railroad descends into the shallow tunnel. It then follows a right-side curve going under the road leading south from the military compound entrance gate. It then goes through a short tangent and goes through a left leaning curve around the freight station and heating plant. It then goes through a tangent, at which the railway crosses the boundary to the civil part of the airport. it then curves slightly to the right and goes through a short tangent, after which the underground railway switch is located.

5.4 RAILWAY TRAJECTORY OF THE B2 LINE

The railway connecting the proposed railway directly the №238 starts with a switch to the B1 main line and then goes through a tangent inside a forest located north-east of the runway still inside the airport compound. Line then goes through a single right-side curve with a railway crossing that connects the road next to the Pardubice equestrian racecourse to the military part of the airport compound. The line then goes through a tangent where it connects to the №238 line through a railway switch.

5.5 RAILWAY STATION

Proposed railway station layout

The railway station is designed as a two-storey concourse, roofed, and walled from all 4 sides. it is designed with two entrances, one from the north, allowing access to the main road at the airport and one from the south to a proposed passageway to the Jan Kašpar terminal. The railway platform is located inside the building on the lower level.

The ground level upon which both entrances are located is connected to the lower level by the use of two lifts, two escalators and concrete stairs.

The platform is equipped with benches for comfort of the waiting passengers.

A waiting area is located at the entrance between the platform and the escalators and the lifts, allowing passengers to wait for the incoming train unit inside the railway station.

Track layout at the station

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track tunnel entrance, which is accessible by a door from the platform and a raised walkway, which leads to the tunnel for maintenance. The platform is located between these two tracks for passenger boarding and disembarkation.

Structure of the station

The railway station is designed as and an underground reinforced concrete tub with retaining walls on all sides made of reinforced concrete, above which a frame bearing structure sits, with a concrete slab on the bottom transferring the load to the underlaying soil. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

The entrance to the station which is on a ground level is as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock.

Roof of the station

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

The walls of the station

For aesthetic purposes and to allow natural light to reach the interior of the station, all the walls above ground level are designed to be of a single layer of glass panel, which will provide sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

Car park adjacent to the railway station

A small car park with 9 parking spaces and 2 space for persons with disabilities is located at the road opposite of the road connecting the main entrance of the civil airport to the airport terminal to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

Portico above the north entrance

A simple small, cantilevered portico is located above the north entrance to the railway station.

Paved surfaces at the station

The original pavement leading from the position of the proposed railway station to the junction connecting the cycling lane located opposite of the road connecting the main entrance of the civil airport to the airport terminal is remodelled to reach the curb of the road by its width and a new pavement is designed at the entrance to the station. The pavement is also designed to span north adjacent to the railway station and the road around the proposed car park.

5.6 CONNETING PASSAGEWAY TO THE AIRPORT TERMINAL

As part of the variant B design a roofed passageway to the Jan Kašpar Terminal is proposed to link the underground railway station to the main entrance hall. The passageway would alleviate the need of the passengers to walk the distance to the terminal and vice versa.

Layout of the passageway

The L-shaped passageway starts at the southern entrance to the railway station, it passes the pathway to be used for long-term car park access, where two exits on both sides of the pathway are located. It then turns right joining itself to the structure of the airport terminal north-eastern façade and joins the terminal main hallway at the emergency exit, which is located on the eastern glass wall next to the arrival hallway. The emergency exit is moved and is located on the north wall of the passageway close to its original location.

Roof of the passageway

The passageway is designed with a flat roof and as it is designed to not to be heated, the surface of the roof lacks any type of heat insulation. it is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the side of the passageway where a gutter is located.

Structure of the passageway

The passageway is designed as a frame bearing structure, with steel columns on concrete spread footings transferring the load to the underlaying soil. Upon the columns rest steel girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by steel beams reinforcing the load bearing structure that holds the roof.

The walls of the station

For aesthetic purposes and to allow natural light to reach the interior of the passageway, all the walls are designed to be of a single layer of glass panel, which will provide sufficient protection

of the passageway users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

5.7 DESIGN AND LOCATION OF THE TUNNEL ENTRANCE

As per railway train unit needs, the gradient with which the train unit descends to the proposed tunnel dictates to a degree the position of the tunnel entrance. The original tangent of the branch line right after the first curve at the railway entrance to the railway compound is a prime and possibly only viable location, where an entrance with sufficiently long gradual slope could be achieved. The entrance walls are designed as concrete diaphragm walls, that would be excavated with the rest of the tunnel.

5.8 PERMISIBLE SPEED OF THE RAILWAY IN VARIANT B

Railway in variant B makes use of a tunnel and as such poses no danger or noise pollution to the area. Curves designed for variant B are of larger diameter and the designed permissible speed corresponds with that.

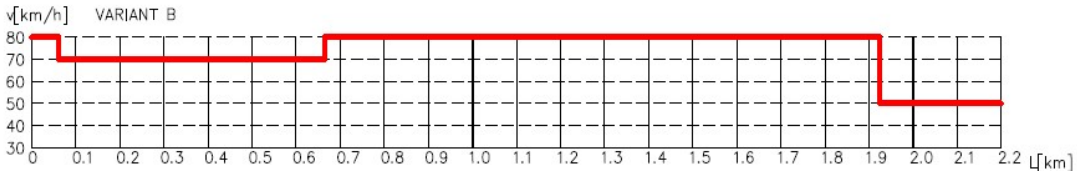


Figure 29- visual depiction of the permissible speed on the railway track in variant B

Source: [author]

As the railway enters the airport compound it uses the first curve, which is left with its original diameter because of spatial constraints. As so the permissible speed of 70km per hour is lower for the first curve than for other curves, with which the speed increases to 80 kilometres per hour. The permissible speed is then significantly decreased when the track reaches the switch at the entrance to the railway station.

5.9 NECCESARY DEMOLITION AND NEW STRUCTURES NEEDED FOR THE RAILWAY LINE CONSTRUCTION NOT AFORE MENTIONED

Demolition of the structures located on the trajectory of the railway line

As the tunnel used for the railway has to be excavated from the ground down, all the structures located on the surface that by its footprint intersect the proposed trajectory must be demolished and subsequently rebuilt to its former function. Various roads and pathways inside the military side of the airport must undergo this process together with the spur side-track 2, which will have to be demoted and either returned to its former place or discarded. An entrance booth is also located on the trajectory of the tunnel. The booth is mobile and as such can be returned to its former spot, after the construction of the tunnel has finished.

Relocation of the road east of the military depot

Because of the tunnel entrance length, the tunnel passes the trajectory of an existing road going from the military offices to the north of the compound and such part of it is relocated to go around the tunnel entrance.

Relocation of the original branch line

The original branch line is dismantled and moved to a new location south of its current location to run concurrently with the tunnel entrance, being connected by a switch to the designed line by a switch.

Road relocation at the second tangent of the track

as the military branch line must be moved, its footprint is wider than of the original spur. As such a part of the road located south of the railway must be demolished. For the road to have its former width, two patches of road are designed on the south part of this road to widen it to its form width. In order for the relocation to be possible part of a garage located at the military car park has to be demolished as its footprint is located inside the space of the proposed roadway widening.

6. VARIANT C

6.1 INTRODUCTION TO THE PROPOSED SOLUTION

Variant C uses a completely different trajectory to reach the airport terminal than the 2 other variants. Instead, the outlined solution makes use of the first and third transit corridor to connect to the network and approaches the airport compound and the airport terminal respectively from the west, bypassing the military part of the airport. As so it does not require to use the Rosice nad Labem railway station to reach the Pardubice main railway station and connects to it by a direct route.

6.2 IMPORTANT POINTS OF THE PROPOSED DESIGN IN VARIANT C

Cut and slope construction around the railway perimeter

To lower the footprint the railway line would have on its surrounding environment, the railway line is designed to be in a small cut most of its trajectory to lower noise pollution and to protect the surrounding nature and wildlife with physical barriers on both sides of the designed railway. The excavated soil is first deposited and then piled around the railway track to create a slope to approximately similar height above the surrounding terrain. the accumulated soil can also be used on groundworks related to building adjustments to road and pathway infrastructure necessary for the railway construction.

Double junction with flyover at the corridor double-track railway

Because of the high intensity of the №010 railway track a connection using a ladder would be inadequate and as such the proposed railway junction is designed with a flyover using an underpass to pass under the №010 railway. This type of junction allows for the railway to pass to the left side of the railway without the need to cross over the railway used for trains coming from the opposite direction.

6.3 RAILWAY TRAJECTORY

The railway line disconnects from the №010 line by a switch and goes through an underpass under the №010 line with a left-sided curve over a farm field located south of the №010 line. It then follows a tangent through a woodland area and curves with a left-sided curve in proximity to a local wholesaling grocery store. It then follows with a tangent and goes through a subway under a cycling and pedestrian pathway connecting the district of Popkovice with the district of Staré Čivice. It then passes under the I/2 road with another subway going left with a wide curve gaining inclination to reach the airport compound. It then goes over a small railway bridge over the Bylanka rivulet and passes over a road with a railway crossing that leads to the I/2 road to the western edge of the airport. it then goes through a tangent terminating with a switch located outside of the proposed railway station.

6.4 RAILWAY STATION

Proposed railway station layout

The railway station is designed as a single storey concourse, roofed, and walled from 3 sides excepting the side where the railway tracks enter the station. it is designed with two entrances, both of them from east, allowing access to the main road at the airport and adjacent cycling lane at the airport terminal. The railway platform is located inside the building.

The platform is equipped with benches for comfort of the waiting passengers.

A waiting area is located at the entrance between the platform and the entrances, allowing passengers to wait for the incoming train unit inside the railway station.

Track layout at the station

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track entrance, disjoining it into two tracks. The platform is located between these two tracks for passenger boarding and disembarkation.

Structure of the station

The railway station is designed as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

Roof of the station

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

The walls of the station

For aesthetic purposes and to allow natural light to reach the interior of the station, all three walls of the station are designed to be of a single layer of glass panel, which will provide sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

Portico above the entrance

To provide protection against excessive sunlight, rain and snow, a portico is designed above the entrances. Structurally, the portico is designed as a tensile structure hanging on a series of steel cables connecting the outer edge of the portico to the concrete columns. The attic of the portico is made of a sheet of plate corresponding in colour to the darker colour of the attic of the station.

Car park adjacent to the railway station

A small car park connected to an adjacent roundabout by a small stretch of road with 3 parking spaces and 1 space for persons with disabilities is located at the main entrance of railway station to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

Paved surfaces at the station

The paved surfaces at the railway station are designed to connect to the adjacent cycling lane and a sidewalk that leads to the Jan Kašpar terminal.

6.5 PERMISIBLE SPEED OF THE RAILWAY IN VARIANT C

The variant C takes a western route to the airport to avoid the military part of the airport and as so its safety zone is in no way affected by buildings in its vicinity. For that reason, its able to keep a very steady permissible speed.

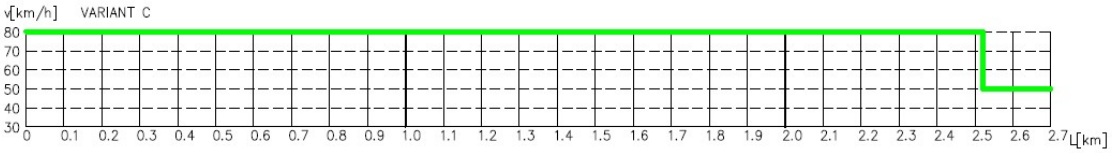


Figure 30 - permissible speed of the variant C railway track

Source: [author]

The route in variant C is able to keep with permissible speed of 80 km per hour speed through most of its journey only decreasing when the railway reaches the switch at the entrance to the railway station.

6.6 NECCESARY DEMOLITION AND NEW STRUCTURES NEEDED FOR THE RAILWAY LINE CONSTRUCTION NOT AFORE MENTIONED

Bridges for the cycling pavement and I/37 road

To allow the road traffic on an important regional road to run smoothly without congestions caused by the railway operation, a road bridge is proposed to be constructed over the railway.

Similarly, a cycling bridge over the railway is proposed. As the proposed railway is designed in a slight cut, the road and cycling bridges do not require substantial groundworks and soil accumulated by the construction of the railroad cuts can be used for slope laying connected with the construction of these bridges.

Demolition of noise barriers and fence disassembly and relocation

Because the railway station is located in a very constrained space between the Bylanka rivulet and civil airport maintenance facilities, some of the noise barriers located west of the roundabout must be demolished. The railway station as a relatively tall building should have a similar noise cancelling effect for the nearby residents of the district of Popkovice

Part of the footprint of the railway station is located inside the wire fence of the civil airport facilities meaning the fence and streetlights located near a turn-around road for airport vehicles need to be dismantled and moved to a different location.

7. COMPARISON OF ALL THE VARIANTS

7.1 COMPARISON BASED ON PROPERTY OWNERSHIP ON THE RAILWAY TRAJECTORY

Acquisition of the properties necessary for construction of an infrastructure project is a vital part of the process of design. Private citizens have a legal right to refuse to sell the necessary properties rendering the whole design impracticable and as such comparing the variants through property acquisition complexity might be considered a significant factor of evaluation.

Variants:	Percentage of the trajectory of the railway line owned by the state or state-run agencies	Percentage of the trajectory of the railway line owned by private subjects
Variant A	100%	0%
Variant B	100%	0%
Variant C	29.6%	70.4%

Figure 31 - table comparing property ownership on the railroad trajectory

Source: [author]

As it is clear from the table above, both variants A and B have their trajectories located on properties owned by the state and administered by state agencies or state-run companies. Variant C takes a route northwest of the airport over farmlands, woodlands, and other types of open areas, that are mostly owned by private citizens and as such the acquisition of the properties needed for the construction of the railway may be more complicated.

7.2 COMPARISON BASED ON PERMISSIBLE SPEED AND ESTIMATED TRAVEL TIMES

Permissible speed

Permissible speed can be a deciding factor when choosing a railway construction variant. Whether an infrastructure project is plausible is to a large extent dependent on the speed of transit that is able to be achieved.

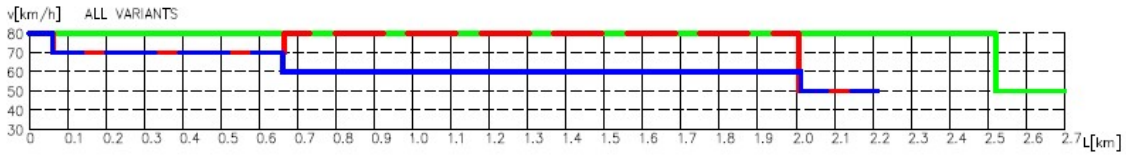


Figure 32 - comparison of all visual projections of permissible speed of the variants

Source: [author]

Variant C is able to hold onto a constant relatively high speed during most of its distance. The tunnelled variant B has a lowered permissible speed at the first curve, which remains at the same diameter as the original curve of the spur and even with higher cant is only able to reach 70 kilometres per hour and unable to match the resulting permissible speeds on the curves inside the tunnel. The variant A does not exhibit this issue, as it is designed with lower accessible speeds for safety and as such paradoxically the first curve that limits the permissible speed on the variant B has the fastest permissible speed of the extension of variant A.

Estimated travel times

Estimated travel times are to an extent more important than permissible speed design as the three variants use two completely different railway lines to commence from. Railway in variant C even though longer is connected directly to Pardubice main railway station whereas railways in variant A and B must go through Rosice nad Labem railway station and then with train waiting times go through a switchback to the Pardubice main railway station.

Variant:	Est. travel time over the proposed railway trajectory	Est. travel time to reach Pardubice main railway station (20)	Sum of these times	DPMP Bus link from Pardubice main railway station to arpt terminal for reference (21)
Variant A	2 minutes 3 seconds	8 minutes	10 minutes 3 seconds	22;29 or 48 minutes depending on the bus line chosen
Variant B	1 minute 23 seconds	8 minutes	9 minutes 23 seconds	
Variant C	1 minute 57 seconds	4 minutes	5 minutes 57 seconds	

Figure 33 - table comparing estimated travel times between Jan Kašpar terminal and Pardubice main railway station.

Source: [author]

The tunnelled version in variant B is the fastest link when comparing the times, the train unit were to transit from the railway station to the edge of the proposed railway link. Nevertheless, the fastest connection is variant C thanks to fast speeds of the corridor railway line. All of the variants are faster than city bus links operated by DPMP.

7.3 COMPARISON BASED ON INDICATORS OF TECHNICAL ASPECTS

Indicator	Variant A	Variant B	Variant C
Railway length	2.793890	2.781690	3.874660
Railway bridges[pcs]	1	1	3
Railway underpass[pcs]	0	0	3
Railway bridges [km]	0.007	0.007	0.012
Railway culverts [pcs]	0	0	1
Railway underpass[km]	0	0	0.115
Railway crossings [pcs]	4	1	1
Tunnelled sections [km]	0	0.974	0
Approximate amount of groundwork [m^3]	10972.5	85835.75	91264.25
Volume of rail ballast (31,5 – 63 mm) [m^3]	4256.783	4017.806	5227.628
Volume of the construction layer (0-32) [m^3]	8407.975	7935.948	10325.58

Figure 34 - table showing comparisons based on technical indicators.

Source: [author]

7.4 COMPARISON BASED ON ESTIMATED PRICES OF THE VARIANTS

	Variant A (km)	Price standard (Czk/km)	Price (Czk)
Railway station above ground	1 station	100000000	100000000
Buildings (bridges, barriers)	1.2	82000000	98400000
Railway crossings	0.15	3800000	570000
Railway superstructure	2.85	22500000	64125000
Railway substructure	2.85	31500000	89775000
	Variant A (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks	10972.5	1200	13167000
Total price			**366037000**

	Variant B (km)	Price standard (Czk/km)	Price (Czk)
Railway station underground	1 station	150000000	150000000
Buildings (bridges, tunnel)	1.45	82000000	118900000
Railway crossings	0.1	3800000	380000
Railway superstructure	2.69	22500000	60525000
Railway substructure	2.69	31500000	84735000
	Variant B (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks	85835.75	1200	103002900
Total price			**517542900**

	Variant C (km)	Price standard (Czk/km)	Price (Czk)
Railway station above ground	1 station	10000000	10000000
Buildings (bridges,)	0.15	82000000	12300000
Railway crossings	0.05	3800000	190000
Railway superstructure	3.5	22500000	78750000
Railway substructure	3.5	31500000	110250000
	Variant C (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks	91264.25	1200	109517100
Total price			**321007100**

Figure 35 - table showing a comparison based on price of the proposed variants

Source: [author,(24)]

7.5 COMPARISON BASED ON TRAIN CONNECTIVITY AND STARTING LINE INTENSITY IN TANDEM WITH THE JUNCTION TYPE

Intensity of the starting railway lines

As its clear from the tab below, the intensity on the №010 line is very high compared to the №238 regional line and as such a dedicated line reaching the Pardubice main railway station from the airport railway extension may not be able to be maintained with high intensity of rail links as compared to the №238 line where the intensity is much lower.

Variant:	Starting railway line:	Est. train intensity per day
Variant A, B	№010	130 and more (23)
Variant C	№238	30 (20)

Figure 36 - table showing estimated intensity of train connections on the lines in question; note: variant C №238 est. train intensity encompasses only passenger rail links intensity during a weekday and as such the line intensity may or may not be higher

Source: [author]

Comparison of designed junction types

As clear from the figure below variant A and variant B use a triangular junction as a connection point to the №238 line. As such the railway extension resulting from these variants can become a part of an existing rail link Pardubice main railway station, Chrudim and Havlíčkův Brod and other population centres on the trajectory of the line. This gives the railway extension flexibility, as parts of the rail links that link the cities that the №238 connects can be redirected to reach the airport station and then continue the original trajectory and other links during times when no flights are expected to take place the rail link can pass the station completely.

Variant C is connected to the №010 line using a flyover through an underpass. This gives the trains coming from the direction Pardubice main railway station to pass the opposite track without directly passing through its trajectory. However, trains coming from the direction of Kolín railway station cannot go directly to the designed line and as such the connection from Pardubice main railway station to the airport station cannot be maintained by modifying existing rail links.

Figure 37 - comparison of the junction types in the designed variants

Source: [author]

7.6 DISRUPTION OF THE AIRPORT ACTIVITIES BY THE PROPOSED RAILWAY LINE

The proposed railway line in variant A takes the existing railway spur and extends its length to reach the Jan Kašpar terminal. as such it intersects 7 roads, 3 of which are not currently intersected by the spur located inside the airport compound. The resulting crossings depending on the intensity of rail links to the proposed airport railway station can potentially create disruptions to the airport function. Variant B uses the trajectory of the original spur to enter the airport but uses a shallow tunnel to cross the airport compound. As such its disruption to the airport function aside of the groundworks resulting from constructions are minimal. Variant C uses a different trajectory of the original railway spur and arrives at the airport from the west. It intersects one road at the western edge of the airport and as such its disruption to the airport activities is minimal.

7.7 MULTICRITERIA ANALYSIS COMPARING THE PROPOSED VARIANTS

Below is a multicriteria analysis comparing all 3 variants according to the comparisons shown before. The grading of the criteria is from best to worst as follows: good-1, more or less good-2, more or less bad-3, bad-4. The grade is then divided by an estimated importance factor shown in the first column.

Criteria (importance factor)	Variant A (resulting grade)	Variant B (resulting grade)	Variant C (resulting grade)
PROPERTY OWNERSHIP (1)	Good-1(1)	Good-1(1)	Bad-1(1)
ESTIMATED TRAVEL TIMES (0.5)	More or less good-2(4)	More or less good-2(4)	Good-2(4)
COST (0.2)	Good-1(5)	More or less bad-3(15)	Good-1(5)
STARTING LINE INTESITY (0.5)	Good-1(2)	Good-1(2)	Bad-4(8)
JUNCTION TYPE FLEXIBILITY (0.5)	Good-1(2)	Good-1(2)	Bad-4(8)
DISRUPTION OF AIRPORT FUNCTION (0.8)	Bad-4(5)	Good-1(1.25)	Good-1(1.25)
Result sum	19	25.25	27.25

Figure 38 - multicriteria evaluation of all the variants

Source: [author]

CONCLUSION

The feasibility study was made in 3 solutions, each showing different approach at exploring whether a railway connection to the Pardubice airport is possible, economical or practical.

Using the original railway spur in tandem with the No 238 line has turned out to be possible, even though the railway is in a derelict state and would require extensive refurbishment. A major complication in finding appropriate design of the railway was finding an appropriate and safe route through the Pardubice airport compound without encroaching on activities that are conducted at the airport. the solution was made in use of two different techniques described in variant A and B. variant A employs series of concrete barriers located in close vicinity of the railway mitigating view of the military compound from the train and protecting the buildings in the vicinity from excessive noise. Additional proposals to construction changes of the road network inside the airport was made to assure safety of road vehicle traffic in tandem with railway traffic at the airport. Variant B employs usage of an underground tunnel to traverse the airport compound without impeding in any way on necessary activities that are conducted above ground. It employs use of a shallow tunnel and an underground railway station with a passageway to the Jan Kašpar terminal. variant C tries to reach the airport going from a different route than envisioned in the first two variants. It instead starts from the No 010 corridor line to reach the airport terminal from the north-west.

Variant a and B are designed with an intended usage of a triangular junction formed by the proposal in the eastern part of the compound furthering the flexibility the railway extension could yield.

Variant C is designed with a flyover underpass to safely traverse the highly congested corridor line.

Comparisons of the proposed variants were made with adequate focus on the speed of transfer that might be reached with railway extension, pricing and technical aspect indicators. The resulting variant to be the best is the version in variant A, which is able to use the existing railway spur to the airport and avoid the disruption to the airport compound by the use of noise barriers.

LIST OF ANNEXES

REFERENCES

(1) Železnice na letiště - www.spravazeleznic.cz. Hlavní stránka - www.spravazeleznic.cz [online]. Copyright © 2020 Správa železnic, státní organizace [cit. 23.04.2021]. Available at: https://www.spravazeleznic.cz/zeleznice-na-letiste

(2) Železniční uzel Brno - studie proveditelnosti - YouTube. YouTube [online]. Copyright © 2021 Google LLC [cit. 23.04.2021]. Available at: https://www.youtube.com/watch?v=a6WDE1EY7mM

(3) Mošnovské letiště: první v republice napojené na železnici - Moravskoslezský deník. Moravskoslezský deník - informace, které jsou vám nejblíž [online]. Copyright © [cit. 23.04.2021]. Available at: https://moravskoslezsky.denik.cz/zpravy_region/mosnovske-letiste-prvni-v-republice-napojene-na-zeleznici-20141216.html

(4) [online]. Available at: http://www.idnes.cz/ceske-budejovice/zpravy/ceske-budejovice-sprava-zeleznic-letiste-koleje-vlak-doprava-mesto.A201113_580999_budejovice-zpravy_jbr

(5) Pardubice Airport – Fly comfortably from Pardubice Airport. Letiště Pardubice – Létejte pohodlně z letiště Pardubice [online]. Copyright © 2021 Pardubice Airport. Created by ML Promotion s.r.o. [cit. 23.04.2021]. Available at: https://airport-pardubice.cz/en/home/

(6) [online]. Available at: https://www.ft.dk/samling/20151/almdel/tru/bilag/334/1654105.pdf

(7) Høringliste for Ny bane til Aalborg Lufthavn 2. marts april PDF Free Download. Vi tilbyder dig praktiske og gratis værktøjer til at offentliggøre og dele information. [online]. Copyright © DocPlayer.dk [cit. 23.04.2021]. Available at: https://docplayer.dk/17582880-Hoeringliste-for-ny-bane-til-aalborg-lufthavn-2-marts-27-april-2015.html

(8) Lübeck-Flughafen station - Wikipedia. [online]. Available at: https://en.wikipedia.org/wiki/Lübeck-Flughafen_station

(9) Lübeck-Flughafen | Deutsche Bahn AG. 301 Moved Permanently [online]. Copyright © [cit. 23.04.2021]. Available at: https://www.bahnhof.de/bahnhof-de/bahnhof/L-C3-BCbeck-Flughafen-1038672

(10) Anreise Bodensee-Airport Friedrichshafen. Bodensee-Airport Friedrichshafen (FDH-Airport) [online]. Available at: https://www.bodensee-airport.eu/de/passagiere-und-besucher/anreise/

(11) Muzeum letectví. Muzeum letectví [online]. Available at: https://www.muzeumletectvi.cz

(12) Ministerstvo dopravy ČR - Tranzitní železniční koridory. Ministerstvo dopravy ČR - Domovská stránka [online]. Copyright © 2021 Ministerstvo dopravy ČR [cit. 23.04.2021]. Available at: https://www.mdcr.cz/Dokumenty/Drazni-doprava/Zeleznicni-infrastruktura/Tranzitni-zeleznicni-koridory

(13) HKCITY » Dvoukolejka Hradec Králové Opatovice Pardubice. HKCITY [online]. Copyright © Hradec Králové City [cit. 23.04.2021]. Available at: http://www.hkcity.cz/dvoukolejka-hradec-kralove-opatovice-pardubice/

(14) Aktuální stav přípravy vysokorychlostních tratí v ČR - YouTube. YouTube [online]. Copyright © 2021 Google LLC [cit. 23.04.2021]. Available at: https://www.youtube.com/watch?v=EU0V75UC5DE&t=878s

(15) Pardubice hlavní nádraží – Wikipedie. [online]. Available at: https://cs.wikipedia.org/wiki/Pardubice_hlavní_nádraží#První_a_druhé_nádraží

(16) Pardubice-Rosice nad Labem (nádraží) – Wikipedie. [online]. Available at: https://cs.wikipedia.org/wiki/Pardubice-Rosice_nad_Labem_(nádraží)

(17) Nad očekávání: Pardubické letiště odbavilo skoro 150 tisíc pasažérů, táhne ho Ryanair - Zdopravy.cz. Zdopravy.cz - Dopravní zpravodajství - Doprava v ČR a ve světě [online]. Copyright © 2017 [cit. 23.04.2021]. Available at: https://zdopravy.cz/nad-ocekavani-pardubicke-letiste-odbavilo-skoro-150-tisic-pasazeru-tahne-ho-ryanair-21795/

(18) Wye (rail) - Wikipedia. [online]. Available at: https://en.wikipedia.org/wiki/Wye_(rail)

(19) Train station - Wikipedia. [online]. Available at: https://en.wikipedia.org/wiki/Train_station

(20) IDOS • Vlaky + Autobusy + MHD (všechna) • Vyhledání spojení. Object moved [online]. Available at: https://idos.idnes.cz/vlakyautobusymhdvse/spojeni/?f=Pardubice-Svítkov&fc=100003&t=Pardubice%20hl.n.&tc=100003

(21) Detail spojení | Dopravní podnik města Pardubic a.s.. MHD jízdní řády | Dopravní podnik města Pardubic a.s. [online]. Copyright ©2021. Dopravní podnik města Pardubic a.s. [cit. 10.05.2021]. Available at: https://www.dpmp.cz/cestovani-mhd/vyhledat-spojeni/detail-spojeni.html?line_search%5Bstart%5D=Hlavní+nádraží&line_search%5Bdestination%5D=Letiště+terminál&line_search%5Bdate%5D=&line_search%5Btime%5D=

(22) Mapy.cz. Mapy.cz [online]. Available at: https://en.mapy.cz/zakladni?x=18.1162479&y=49.6930228&z=17&source=base&id=1703726

(23) Theses.cz – Vysokoškolské kvalifikační práce [online]. Copyright © [cit. 11.05.2021]. Dostupné z: https://theses.cz/id/jfgp3u/vlpriloha5.pdf?lang=en

(24) [online]. Dostupné z: https://www.sfdi.cz/soubory/obrazky-clanky/cenove-databaze/2013_cenove_normativy_2012-09.pdf?fbclid=IwAR2_BHZ5zfth8pXqnWWWjvSJwTINYWEe0-Y1S6CHlXflLk4t_MJEwBSdyNI

Written by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	
DIPLOMA THESIS		Univerzita Pardubice Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network		Subject code: Date: 05/2021 — Format: A4x3
Annex: ACCOMPANYING REPORT		Annex number: A
Field of study: Civil engineering, Master studies, 2nd year		

A. ACCOMPANYING REPORT

A.1 IDENTIFICATION:

A.1.1. Identification data:

Building appellation:	**Railway link to the Pardubice Airport**
Building location:	Popkovice, Svítkov
Region:	Pardubický
Cadastral zoning:	district of Popkovice (718068) district of Staré Čivice(754170), district of Staré Jesenčany(754412), district of Pardubice(717657), district of Svítkov(718033), district of Srnojedy(679097)
Building class:	New construction
Stage of project documents:	Feasibility study
Building purpose:	***linear infrastructure, transport buildings,***

A.1.2. Order party:

Appellation and address of the order party of the building and project documents:

Univerzita Pardubice, Dopravní fakulta Jana Pernera

Studentská 95,

530 09 Pardubice II-Polabiny

A.1.3. designer:

Bc. Miroslav Jícha

Polská 822

530 03 Pardubice

Project contractor: Bc. Miroslav Jícha

Project supervisor: Ing. Petr Vnenk

A.2 DIVISIONS OF THE CONSTRUCTION TO SEGMENTS AND TECHNICAL AND TECHNOLOGICAL FACILITIES

„**Railway link to the Pardubice Airport**“ is not divided in any form and constitutes a singular article.

A.3 LIST OF PRELIMINARY DATA

Cadastral map

Diploma thesis assignment instructions

Photo documentation

Written by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	
DIPLOMA THESIS		Univerzita Pardubice Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network		Subject code: Date: 05/2021 — Format: A4x33
Annex: SUMMARY REPORT		Annex number: B
Field of study: Civil engineering, Master studies, 2nd year		

B. SUMMARY TECHNICAL REPORT

B.1 DESCRIPTION OF THE TERRITORY OF THE LINEAR INFRASTRUCTURE AND ASOCIATED BUILDINGS

Note: from henceforth, the linear infrastructure and associated buildings (railway station) is referred to as a „ railway structure“ if not expressly stated otherwise.

a) Territory characteristics

Railway structure is located mostly at the Popkovice district and Svítkov district of Pardubice. The surrounding land of the construction is levelled without major elevation changes. Its purpose is a railway connection to the Pardubice airport Jan Kašpar terminal and adjacent terminal railway station with supplementary road and pathway constructions.

The railway construction is devised in 3 variants.

Variant A and B are located at the district of Staré Jesenčany (754412), district of Popkovice (718068) and district of Pardubice (717657)

Variant C is located at the cadastral area of district of Popkovice (718068), district of Staré Čivice (754170), district of Staré Jesenčany (754412), district of Pardubice (717657), district of Svítkov(718033), district of Srnojedy(679097)

b) Territorial planning

Variant A and B: the railway construction is located in the compound in areas categorised as “other areas” of the Pardubice airport, north of the Pardubice airport runway.

Variant C: the railway is located north of the №010 railway line near the district of Svítkov, crossing the I/2 road between the district of Staré Čivice and the district of Popkovice in areas categorised as arable land and other areas”.

c) Geological and hydrogeological characteristics

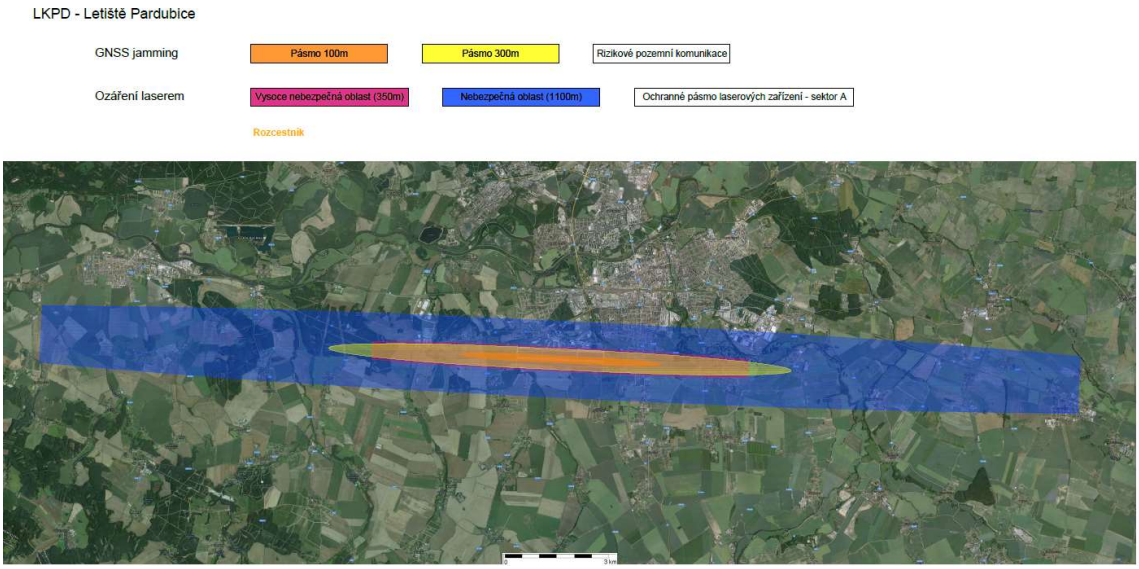
Geological and hydrogeological soil rations are to be determined during later stages of the project documents.

d) conclusions of site reconnaissance

Any possible breaches of adjacent utility constructions are to be consulted with authorised officials and local utility administrators respectively and subsequently returned to their former functional state in accordance with the requirements set forth by the administrator. Statements by the utility administrators and their usage conditions of the utilities for manipulation and construction in their vicinity must be met.

e) Land preservation

The railway construction is not a cultural landmark or monument and is not situated in any historical preservation zones or reservations, the railway construction is located within the zone 1100m protective GNSS jamming zone, a protective zone of the Pardubice Airport. The railway construction site affects protective zones of utility. Constructions and construction procedures in the vicinity of the utility constructions is managed by the competent utility managers. Recommended procedures are described here-after.



f) Location in reference to inundated land

Parts of the railway construction are located in Q5, Q20 and Q100 areas, as visible from the following map.

g) Impact of the construction on its surroundings

Railway station in all variants

Rain accumulated on the rooftop of the railway station building is released to gutters located at the centre of the building, through which it will be released to the surrounding grassland. The rainwater from the paved surface is gravitationally through longitudinal slope moved to drains located at the foot of the street.

Railway in variant A:

Railway in variant A is outfitted with 3,5 meters tall noise barriers to protect the buildings in the vicinity from noise pollution and lower visibility of the military side of the airport from the train units. It is outfitted with drainage gutters on both side of the track to collect rain and melted snow water that would accumulate on the track.

Railway in variant B:

Railway in variant B runs through a substantial part of its trajectory in a shallow tunnel that cancels any potential noise pollution, the railway usage might bring. When on the surface, it is outfitted with drainage gutters on both side of the track to collect rain and melted snow water that would accumulate on the track.

Railway in variant C:

Railway in variant C runs in a shallow cut relative to the surrounding terrain to lower its footprint on the surrounding nature and wildlife. Where possible, artificial slopes are constructed around the railway trajectory to further lower noise pollution to the surrounding area and hide the railway from plain sight.

It is also outfitted with drainage gutters on both side of the track to collect rain and melted snow water that would accumulate on the track.

After construction conclusion, the railway structure is not intended to have any negative impact on its surroundings.

h) Requirements for fumigation, demolition, and wood clearance

Demolition:

Variant A:

Road relocations at the eastern part of the military airport compound

To streamline the road traffic inside the military airport compound, roads are connected or demolished to lower the amount of railway crossings used on the railway track.

Roads located east of the heating plant and freight station

A new wider road is designed instead of two roads that are crossing the railway line trajectory. The road lowers the points of crossings of the proposed railway and the military spur to only one.

Roads located east of the military depot

Road that would cross the railway line is stopped at the railroad track and is deposed left to connect to another road east of its location, where a railway crossing is located. The angle at which the road would cross over the railway would be too steep and such connecting it to a road that goes approximately perpendicular to the railway track is a preferable option.

Road relocation at the second tangent of the track

As the railway is outfitted with noise barriers, its footprint is wider than of the original military spur. As such a part of the road located south of the railway must be demolished. For the road to have its former width, two patches of road are designed on the south part of this road to widen it to its form width. In order for the relocation to be possible part of a garage located at the military car park has to be demolished as its footprint is located inside the space of the proposed roadway widening.

Disassembly of the second railway side-track

A second railway side-track as part of the military spur used for bringing coal by a freight train to a heating plant located next to it must be disassembled to allow the proposed railway to pass over its former trajectory. The heating plant with the second side-tracks are no longer used and as such are not necessary for the function of the facilities located at the airport.

variant B:

As the tunnel used for the railway must be excavated from the ground down, all the structures located on the surface that by its footprint intersect the proposed trajectory must be demolished and subsequently rebuilt to its former function. Various roads and pathways inside the military side of the airport must undergo this process together with the spur side-track 2, which will have to be demoted and either returned to its former place or discarded. An entrance booth is also located on the trajectory of the

tunnel. The booth is mobile and as such can be returned to its former spot, after the construction of the tunnel has finished.

Relocation of the road east of the military depot

Because of the tunnel entrance length, the tunnel passes the trajectory of an existing road going from the military offices to the north of the compound and such part of it is relocated to go around the tunnel entrance.

Relocation of the original branch line

The original branch line is dismantled and moved to a new location south of its current location to run concurrently with the tunnel entrance, being connected by a switch to the designed line by a switch.

Road relocation at the second tangent of the track

As the military branch line must be moved, its footprint is wider than of the original spur. As such a part of the road located south of the railway must be demolished. For the road to have its former width, two patches of road are designed on the south part of this road to widen it to its form width. In order for the relocation to be possible part of a garage located at the military car park has to be demolished as its footprint is located inside the space of the proposed roadway widening.

variant C:

Bridges for the cycling pavement and I/37 road

To allow the road traffic on an important regional road to run smoothly without congestions caused by the railway operation, a road bridge is proposed to be constructed over the railway.

Similarly, a cycling bridge over the railway is proposed. As the proposed railway is designed in a slight cut, the road and cycling bridges do not require substantial groundworks and soil accumulated by the construction of the railroad cuts can be used for slope laying connected with the construction of these bridges.

Demolition of noise barriers and fence disassembly and relocation

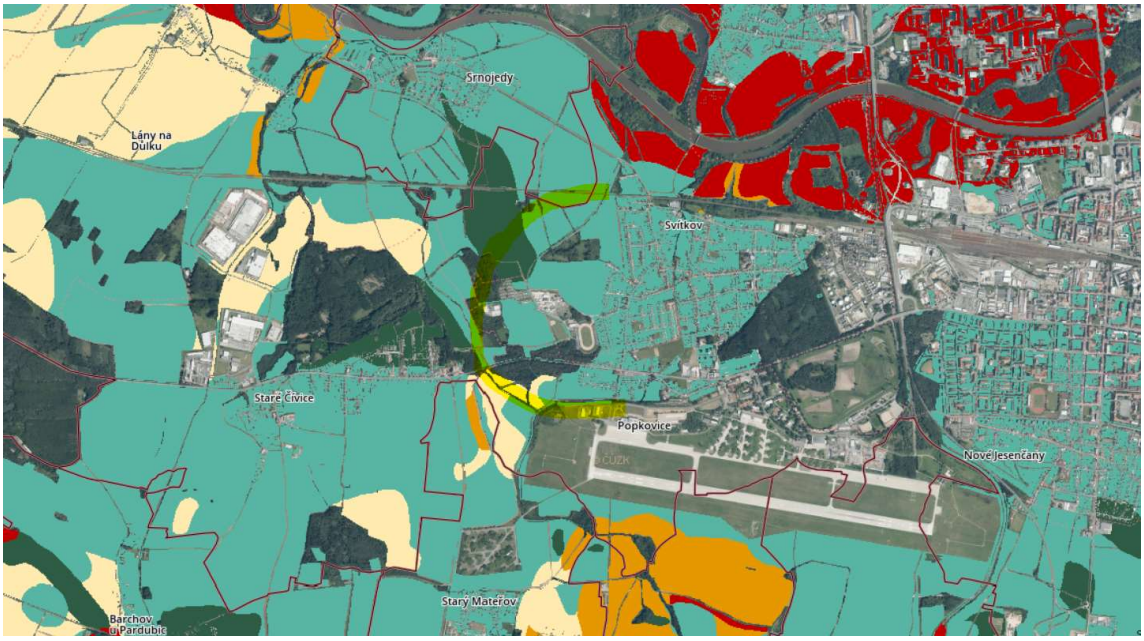
Because the railway station is located in a very constrained space between the Bylanka rivulet and civil airport maintenance facilities, some of the noise barriers located west of the roundabout must be demolished. The railway station as a relatively tall building should have a similar noise cancelling effect for the nearby residents of the district of Popkovice.

Part of the footprint of the railway station is located inside the wire fence of the civil airport facilities meaning the fence and streetlights located near a turn-around road for airport vehicles need to be dismantled and moved to a different location.

i) Requirements for maximal land acquisitions of the farmland soil fund or properties specified for woodland function (temporary/permanent)

Variant A, B: the trajectory of the proposed railway does not impede any territory categorised as farmland or as woodland.

Variant C: Since the variant C takes a different path from the original railway spur, its territorial acquisition takes it over woodlands, grassland and farmlands located east of the district of Svítkov, east of the district of Popkovice and west of the district of Staré Čivice, all districts of the city of Pardubice.



j) Territorial technical requirements

Territorial technical requirements that are to be met, are a part of a later stage of project documents.

k) Substantive and temporal limitations of the railway construction, conditioned by, induced by the construction, or associated investments

No substantive temporal or other limitations are known during this stage project documents.

l) List of affected properties by the railway construction

variant A:

Nº	Parcel Nº	Cadastral area	Owner (administered by)	Area usage	Form of protection	Property size [m^2]
1	2802/1	Pardubice (717657)	Czech Republic, (SŽ -Railway administration)	Other areas	none	22810
2	374	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	5380
3	70/23	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	446941
4	373	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	7394
5	372	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	1074
6	371	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	530
7	365/3	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	63207
8	365/12	Popkovice (718068)	LOM PRAHA I.E.,	Other areas	none	3164
9	121/1	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	933548
10	121/15	Popkovice (718068)	Pardubický kraj, Statutory city of Pardubice	Other areas	none	136848

11	178/4	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	7973
12	70/26	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	7411
13	56/18	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	2546

Variant B:

Nº	**Parcel Nº**	**Cadastral area**	**Owner (administered by)**	**Area usage**	**Form of protection**	**Property size [m^2]**
1	2802/1	Pardubice (717657)	Czech Republic, (SŽ -Railway administration)	Other areas	none	22810
2	374	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	5380
3	70/23	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	446941
4	373	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	7394
5	372	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	1074
6	371	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	530
7	365/3	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	63207

8	365/12	Popkovice (718068)	LOM PRAHA I.E.,	Other areas	none	3164
9	121/1	Popkovice (718068)	Czech Republic (ministry of defence)	Other areas	none	933548
10	121/15	Popkovice (718068)	Pardubický kraj, Statutory city of Pardubice	Other areas	none	136848
11	178/4	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	7973
12	70/26	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	7411
13	56/18	Staré Jesenčany (754412)	Czech Republic (ministry of defence)	Other areas	none	2546

Variant C:

Nº	**Parcel Nº**	**Cadastral area**	**Owner (administered by)**	**Area usage**	**Form of protection**	**Property size [m^2]**
1	161/3	Srnojedy (679097)	Czech Republic, (SŽ -Railway administration)	Other areas	none	9652
2	161/8	Srnojedy (679097)	Štěpán Radek	Arable land	none	7936
3	161/1	Srnojedy (679097)	Mlynář Jaroslav	Arable land	none	8377
4	159/19	Srnojedy (679097)	AGRO-SLUŽBY SECKÝ ltd., Hvránek Petr	Arable land	None	4432

5	552/13	Svítkov (718033)	Statutory city of Pardubice	Permanent grassland	None	9867
6	614/1	Svítkov (718033)	Roman-catholic church – archdiocese of Pardubice	Arable land	None	26796
7	576/1	Svítkov (718033)	Sikáčková Libuše	Arable land	None	15970
8	576/2	Svítkov (718033)	Barnová Jaroslav and others	Arable land	None	5956
9	610/1	Svítkov (718033)	Medková Albína	Arable land	None	2264
10	592/3	Svítkov (718033)	Vejdělek Vladimír	Arable land	None	11077
11	596/1	Svítkov (718033)	Šalplachta Václav	Woodland property	None	2347
12	598/1	Svítkov (718033)	Prostřední Jarmila	Woodland property	None	2399
13	309/8	Popkovice (718068)	Sedláková Jana	Woodland property	None	992
14	309/11	Popkovice (718068)	Sedláková Jana	Woodland property	None	3878
15	611/8	Popkovice (718068)	Brancuská Zdeňka Ing. and others	Woodland property	None	11412
16	611/9	Popkovice (718068)	Brancuská Zdeňka Ing. and others	Permanent grassland	None	14152

17	782/23	Pardubice (717657)	Czech Republic, Road and motorway directorate	Other areas	None	15008
18	277/2	Popkovice (718068)	Brancuská Zdeňka Ing. and others	Woodland property	None	4464
19	293/4	Popkovice (718068)	Brancuská Zdeňka Ing. and others	Arable land	None	10212
20	293/3	Popkovice (718068)	Brancuská Zdeňka Ing. and others	Arable land	None	15629
21	286/1	Popkovice (718068)	Nadace pro rozvoj Pardubic	Arable land	None	10528
22	259/1	Popkovice (718068)	Czech Republic (ministry of defence)	Body of water	none	23504
23	121/34	Popkovice (718068)	Pardubický kraj, Statutory city of Pardubice	Other areas	None	93760

After railway construction conclusion, all temporary property acquisitions used for access to the construction site are to be returned to their pre-construction state.

m) List of properties upon which protective zones are to be

All properties mentioned in the previous chapter will partially lay within a protective zone of the designed railway of the proposed variants.

n) Requirements for monitoring and reshaping

No requirements for monitoring are set.

o) Possible connections of the railway construction to the public transportation network and technical network

The railway lines in all three variants connect to the Czech railway network. A bus stop of the Pardubice public bus network is located at the Jan Kašpar Terminal.

B.2 GENERAL DESCRIPTION OF THE RAILWAY CONSTRUCTION

B.2.1 General concept of construction solution

Cross-section showing particular elements used during construction of the railway is at appendix D.001 Typical cross-sections of the variants.

Triangular junction I variant A and variant B

A new second line connects the Nº238 line to the railway line forming a triangular railway junction in the eastern part of the Pardubice airport compound. On the tangent before the №238 railway track curves right to north to make its way around the limits of the airport approximately at its 89.2 kilometre a left-handed railway switch is designed to create the new connecting railway line to allow train units coming from the direction of Chrudim to go directly inside the airport compound and subsequently to the designed terminal railway station. the railway line meets up with the new original branch railway to the airport to create a triangular junction.

Variant A:

Railway design

The railway line in variant A is designed to keep the longitudinal profile near the existing surface and follow the original layout of the branch line as much as possible. The railway line is outfitted with drainages on both sides of the railway to allow rain and melted snow water runoff from the railway line ballast.

In terms of horizontal layout, the variant A line is designed with curves of smaller diameter, resulting in lower permissible speed, because of the vicinity of the airport buildings, that for safety reasons require the speed to be low.

Bridges and tunnels:

Distance[km]	type
0,190030	Railway bridge

Railway crossings:

Distance[km]	Type
0,236300	Railway crossing
0,371650	Railway crossing
1,025640	Railway crossing
1,363180	Railway crossing

Table of horizontal trajectory:

Curve radius[m]	Distance[km]		Parameters of horizontal trajectory	Length tangent[m]
R1=296	ZP=0,059870	ZO=0,134870	L1=75 m; Li=449.97 m; L2=75 m; V=70 km/h; D=117 mm	59,87
	KO=0, 587830	KP=0,659830		390,58
R2=250	ZP=1,050420	ZO=1,125420	L1=75 m; Li=63.65 m; L2=75 m V=60 km/h; D=102 mm	
	KO=1,189060	KP=1,264060		62,02
R3=250	ZP=1,326080	ZO=1,401080	L1=75.00 m; Li=34.44 m; L2=75.00 m V=60 km/h; D=102 mm	
	KO=1,435520	KP=1,510520		149,53
R4=250	ZP=1,660050	ZO=1,680050	L1=20.00 m; Li=84,88 m; L2=20.00 m V=60 km/h; D= 102 mm	
	KO=1,764930	KP=1,784930		80,99
-	ZP=1,865920	ZO=1,920920	L1=55.00 m; Li=259,01 m; L2=55.00 m V=60 km/h; D=117 mm	
	KO=1,920920	KP=1,975920		236,11
R6=600	ZP=0,216410	ZO=0,246410	L1=30.00 m; Li=169,84m; L2=30.00 m V=100 km/h; D=118 mm	216,41
	KO=0,416250	KP=0,446250		135,61

Table of vertical trajectory:

distance[km]			
INICIATION	TERMINATION	length[m]	Slope
0	1.05434	1054.34	+3.59‰
1.05434	2.20818	1153.80	-0.30‰
0	0.58186	581.86	-1.17‰

Noise barriers inside the military part of the airport

To diminish the visibility of the military airport compound from the train units, lower noise pollution and to create a physical barrier between the railway track and the military compound, a series of concrete noise barriers is constructed around the perimeter of the railway.

The walls are designed to be 4,5 metres tall, 300 millimetres thick made of reinforced concrete with lost timber formwork.

The barriers are designed with free spaces for railway crossings and a free space for the rest of the military spur to join the main line.

Layout of the proposed track is at appendix C.003 Layout of the proposed track – variant A

Railway station design

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track entrance, disjoining it into two tracks. The platform is located between these two tracks for passenger boarding and disembarkation.

The railway station is designed as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

For aesthetic purposes and to allow natural light to reach the interior of the station, all three walls of the station are designed to be of a single layer of glass which will provide sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

To provide protection against excessive sunlight, rain and snow, a portico is designed above the entrances, with is outer line being symmetrical to the position of the road. Structurally, the portico is designed as a tensile structure hanging on a series of steel cables connecting the outer edge of the portico to the concrete columns. The attic of the portico is made of a sheet of plate corresponding in colour to the darker colour of the attic of the station.

A small car park with 9 parking spaces and 2 space for persons with disabilities is located at the road opposite of the road connecting the main entrance of the civil airport to the airport terminal to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

The original pavement leading from the position of the proposed railway station to the junction connecting the cycling lane located opposite of the road connecting the main entrance of the civil airport to the airport terminal is remodelled to reach the curb of the road by its width and a new pavement is designed at the entrance to the station and under the portico. The pavement is also designed to span north adjacent to the railway station and the road around the proposed car park.

Layout of the proposed railway station, elevations and cross sections are at appendix D.002 Railway station - variant A

Variant B:

Variant B uses a similar approach regarding the railway trajectory. The major difference between the two variants is that variant B uses a cut and cover type of shallow tunnel to pass through the airport compound from the east to reach the terminal, not interrupting the various activities and movements that take place at the airport above ground.

As such it is designed with wider curves of higher diameter in comparison to variant A with a higher permissible speed, when passing through the compound and with a terminal railway station located under the ground level.

Bridges and tunnels

Distance[km]	Type
0,18888	Railway bridge
1,044915-2,099684	Tunel

Railway crossings

Distance[km]	type
0,235710	Railway crossing
0,371490	Railway crossing

Table of horizontal trajectory

Curve radius[m]	Distance[km]		Parameters of horizontal trajectory	Length tangent[m]
R1=297	ZP=0,061860	ZO=0,136860	L1=75.00 m; Li=453,37 m; L2=75.00 m V=70 km/h; D=117 mm	61,86
	KO=0,59022	KP=0,66522		328,13
R2=500	ZP=0,993350	ZO=1,068350	L1=75.00 m; Li=160,15m; L2=50.00 m V=80 km/h; D=91 mm	
	KO=1,228510	KP=1,278510		64,08
R3=500	ZP=1,342590	ZO=1,392590	L1=50.00 m; Li=275,44m; L2=50.00 m V=80 km/h; D=91 mm	
	KO=1,668030	KP=1,718030		106,10
-	ZP=1,824130	ZO=1,874130	L1=50.00 m; L2=50.00 m V=80 km/h; D=118 mm	
	KO=1,874130	KP=1,924130		275,70
R5=600	ZP=0,216410	ZO=0,246410	L1=30.00 m; Li=169,84m; L2=30.00 m V=100 km/h; D=118 mm	216,41
	KO=0,416250	KP=0,446250		135,61

Table of vertical trajectory

distance[km]			
INICIATION	TERMINATION	length[m]	Slope
0	0.71985	719.85	-0.00‰
0.71985	0.97342	253.57	-11.70‰
0.97342	2.12001	1146.59	-0.01‰
0	0.58245	582.45	1.69‰

Layout of the proposed track is at appendix C.004 Layout of the proposed track – variant B

Variant B railway station:

The railway station is designed as a two-storey concourse, roofed, and walled from all 4 sides. it is designed with two entrances, one from the north, allowing access to the main road at the airport and one from the south to a proposed passageway to the Jan Kašpar terminal. The railway platform is located inside the building on the lower level.

The ground level upon which both entrances are located is connected to the lower level by the use of two lifts, two escalators and concrete stairs.

A waiting area is located at the entrance between the platform and the escalators and the lifts, allowing passengers to wait for the incoming train unit inside the railway station.

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track tunnel entrance, which is accessible by a door from the platform and a raised walkway which leads to the tunnel for maintenance. The platform is located between these two tracks for passenger boarding and disembarkation.

The railway station is designed as and an underground reinforced concrete tub with retaining walls on all sides made of reinforced above which a frame bearing structure sits, with a concrete slab on the bottom transferring the load to the underlaying soil. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

The entrance to the station which is on a ground level is as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock.

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

For aesthetic purposes and to allow natural light to reach the interior of the station, all the walls above ground level are designed to be of a single layer of glass which will provide sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

A small car park with 9 parking spaces and 2 space for persons with disabilities is located at the road opposite of the road connecting the main entrance of the civil airport to the airport terminal to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

A simple small, cantilevered portico is located above the north entrance to the railway station.

The original pavement leading from the position of the proposed railway station to the junction connecting the cycling lane located opposite of the road connecting the main entrance of the civil airport to the airport terminal is remodelled to reach the curb of the road by its width and a new pavement is designed at the entrance to the station. The pavement is also designed to span north adjacent to the railway station and the road around the proposed car park.

Layout of the proposed railway station, elevations and cross sections are at appendix D.003 Railway station - variant B

Variant C

Railway design:

Variant C uses a completely different trajectory to reach the airport terminal than the 2 other variants. Instead, the solution is to use of the first and third transit corridor to connect to the railway network and approaches the airport compound and the airport terminal respectively from the west, bypassing the military part of the airport. As so it does not require to use the Rosice nad Labem railway station to reach the Pardubice main railway station and connects to it by a direct route.

To lower the footprint the railway line would have on its surrounding environment, the railway line is designed to be in a small cut most of its trajectory to lower noise pollution and to protect the surrounding nature and wildlife with physical barriers on both sides of the designed railway. The excavated soil is first deposited and then piled around the railway track to create a slope to approximately similar height above the surrounding terrain. the accumulated soil can also be used on groundworks related to building adjustments to road and pathway infrastructure necessary for the railway construction.

Double junction with flyover at the corridor double-track railway

Because of the high intensity of traffic on the №010 railway track a connection using a ladder would be inadequate and as such the proposed railway junction is designed with a flyover using a subway under the №010 railway. This type of junction allows for the railway to pass to the left side of the railway without the need to cross over the railway used for trains coming from the opposite direction.

Bridges and tunnels

Distance[km]	Type
0,584730	Railway subway
1,614100	Railway underpass
1,754810	Railway underpass
2,344050	Railway bridge

Railway crossings

Distance[km]	Type
2,383580	Railway crossing

Horizontal trajectory:

Curve radius[m]	Distance[km]		Parameters of horizontal trajectory	Length tangent[m]
R1=296	ZP=0,059870	ZO=0,134870	L1=75 m; Li=449.97 m; L2=75 m; V=70 km/h; D=117 mm	59,87
	KO=0, 587830	KP=0,659830		390,58
R2=250	ZP=1,050420	ZO=1,125420	L1=75 m; Li=63.65 m; L2=75 m V=60 km/h; D=102 mm	
	KO=1,189060	KP=1,264060		62,02
R3=250	ZP=1,326080	ZO=1,401080	L1=75.00 m; Li=34.44 m; L2=75.00 m V=60 km/h; D=102 mm	
	KO=1,435520	KP=1,510520		149,53
R4=250	ZP=1,660050	ZO=1,680050	L1=20.00 m; Li=84,88 m; L2=20.00 m V=60 km/h; D= 102 mm	
	KO=1,764930	KP=1,784930		80,99
-	ZP=1,865920	ZO=1,920920	L1=55.00 m; Li=259,01 m; L2=55.00 m V=60 km/h; D=117 mm	
	KO=1,920920	KP=1,975920		236,11
R6=600	ZP=0,216410	ZO=0,246410	L1=30.00 m; Li=169,84m; L2=30.00 m V=100 km/h; D=118 mm	216,41
	KO=0,416250	KP=0,446250		135,61

Vertical trajectory:

distance[km]			
initiation	termination	length[m]	slope
0	1.05434	1054.34	+3.59‰
1.05434	2.20818	1153.80	-0.30‰
0	0.58186	581.86	-1.17‰

Layout of the proposed track is at appendix C.005 Layout of the proposed track – variant C

Railway station

The railway station is designed as a single storey concourse, roofed, and walled from 3 sides excepting the side where the railway tracks enter the station. it is designed with two entrances, both of them from east, allowing access to the main road at the airport and adjacent cycling lane at the airport terminal. The railway platform is located inside the building.

A waiting area is located at the entrance between the platform and the entrances, allowing passengers to wait for the incoming train unit inside the railway station.

To allow two train units to be located at the railway station at a given time, the railway station is equipped with a switch at the track entrance, disjoining it into two tracks. The platform is located between these two tracks for passenger boarding and disembarkation.

The railway station is designed as a frame bearing structure, with reinforced concrete columns on concrete piles transferring the load to the bedrock. Upon the columns rest reinforced concrete girders resting on opposing columns creating a rectangular structure of the frame. the girders are also connected by concrete beams reinforcing the load bearing structure that holds the roof.

The station is designed with a flat roof and as it is designed to not to be heated, the surface of the railway station lacks any type of heat insulation. The surface of the roof is made of paint corrugated steel roofing sheet with the sheets being tilted under an angle to allow water run-off to the centre of the railway station where a gutter is located.

For aesthetic purposes and to allow natural light to reach the interior of the station, all three walls of the station are designed to be of a single layer of glass which will provide sufficient protection of the railway station users against wind and other elements of weather. The attic of the station is composed of two sheets of plate of different colour.

To provide protection against excessive sunlight, rain and snow, a portico is designed above the entrances. Structurally, the portico is designed as a tensile structure hanging on a series of steel cables connecting the outer edge of the portico to the concrete columns. The attic of the portico is made of a sheet of plate corresponding in colour to the darker colour of the attic of the station.

A small car park connected to an adjacent roundabout by a small stretch of road with 3 parking spaces and 1 space for persons with disabilities is located at the main entrance of railway station to allow kiss and ride parking for locals that may use the airport railway station to travel on the regional line.

The paved surfaces at the railway station are designed to connect to the adjacent cycling lane and a sidewalk that leads to the Jan Kašpar terminal.

Layout of the proposed railway station, elevations and cross sections are at appendix D.004 Railway station - variant C

b) Purpose of railway construction usage

railway extension together with the railway station are to serve as an extension of the Czech railway network and connect the Pardubice airport by a rail connection with a dedicated railway station with other supplementing structures facilitating usage of the railway station by residents of Popkovice.

c) Is the designed building permanent.

Yes

d) Authorised exceptions of the technological requirements for structures a technical requirements for access of persons with disabilities

the designed railway together with the railway station do not have any exceptions of technical requirements or requirements of usage of the building of persons with disabilities.

e) Adjustments of requirements of mandatory statements of affected government authorities

Requirements made by authorities are to be implemented to the design documents in later stages of the project documents.

f) General description of the construction solution

a railway link is to be built starting from a point on the Czech railway network linking the Pardubice airport and its Jan Kašpar civil terminal respectively, with a railway station located in the vicinity of the afore mentioned terminal.

the outline solution is made in 3 variants, with each taking in consideration different favourable aspects of the proposed design.

g) Protection of the railway structure by other legislative measures

the railway structure is not protected by other legislative measures.

h) Fundamental evaluation of refuse during construction

refuse composed building rubble is expected to be produced by construction process. Soil excavated during groundworks is expected to be used in building necessary slopes for the railway or discarded at a nearby pre-determined site upon approval of the order party. Types of refuse are shown in the tab with a designated code according to the regulation № 93/2016Sb. The tab also specifies method of discarding and handling of the refuse.

Discarding of refuse is to be made by the construction contractor at a designated site according to the category of the refuse in accordance with the law №185/2001 Sb.

Handling of refuse created during the construction process and its secure discarding is in accordance with the law №185/2001 Sb the responsibility of the refuse producer meaning the physical or legal person authorised to the entrepreneurship during which the refuse is produced. The construction contractor is to temporarily store the refuse at the construction site according to their category and ensure removal of the refuse of the construction site in accordance with the law. In accordance with the regulation №93/2016 Sb the producer of the refuse is obligated to keep records of the refuse with details on how to safely handle the refuse.

i) Fundamental projections of construction commencement

the construction is to commence after the necessary project documents have been submitted to affected authorities and approved, after which a construction contractor is to be appointed.

j) Fundamental requirements for usage of the construction earlier than the construction termination

The railway structure is not to be approved for usage before the construction is terminated.

k) preliminary expenses of the construction

	Variant A (km)	Price standard (Czk/km)	Price (Czk)
Railway station above ground	1 station	100000000	100000000
Buildings (bridges, barriers)	1.2	82000000	98400000
Railway crossings	0.15	3800000	570000
Railway superstructure	2.85	22500000	64125000
Railway substructure	2.85	31500000	89775000
	Variant A (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks	10972.5	1200	13167000
Total price			**366037000**

	Variant B (km)	Price standard (Czk/km)	Price (Czk)
Railway station underground	1 station	150000000	150000000
Buildings (bridges, tunnel)	1.45	82000000	118900000
Railway crossings	0.1	3800000	380000
Railway superstructure	2.69	22500000	60525000
Railway substructure	2.69	31500000	84735000
	Variant B (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks	85835.75	1200	103002900
Total price			**517542900**

	Variant C (km)	Price standard (Czk/km)	Price (Czk)
Railway station above ground	1 station	10000000	10000000
Buildings (bridges,)	0.15	82000000	12300000
Railway crossings	0.05	3800000	190000
Railway superstructure	3.5	22500000	78750000
Railway substructure	3.5	31500000	110250000
	Variant C (m3)	**Price standard (Czk/m3)**	**Price (Czk)**
Groundworks construction	91264.25	1200	109517100
Total price			**321007100**

B.2.2 General urbanistic and architectonic solution

a) Urbanist perspective

Variant A, B: the railway structure corresponds to the site of the original branch line located at the airport compound and such is classified as an extension of an existing structure.

Variant C: the railway structure in variant C connects to the airport from the №004 railway line west of the district of Popkovice and as such requires change to the town plan.

b) Architectonic solution

Railway station in all variants

The railway station outer shell is designed to correspond with the architectonic design of the Jan Kašpar terminal and as such it is designed to have walls composed of glass in a similar manner as the main entrance hall at the adjacent airport terminal. it is also designed with a flat roof as the terminal with an attic made to be similar to the attic used on the terminal building but using a different colour scheme to reflect the different type of transport for which the building serves.

B.2.3 Overall technical solution

a) Description of the technical solution

Cross-section showing particular elements used during construction of the railway is at appendix D.001 Typical cross-sections of the variants.

Variant A:

Railway proposed in variant A makes use of the original trajectory of the airport railway spur and continues west near the site of the military freight railway station to reach the Jan Kašpar terminal and its adjacent road, terminating at a proposed railway station.

Layout of the proposed track and position of the railway station is at appendix C.003 Layout of the proposed track – variant A

Variant B:

Railway proposed in variant B makes use of the original trajectory of the airport railway spur and after the first right-sided curve declines into a tunnel and continues west near the site of the military freight railway station to reach the Jan Kašpar terminal and its adjacent road, terminating at a proposed underground railway station.

Layout of the proposed track and position of the railway station is at appendix C.004 Layout of the proposed track – variant B

Variant C:

Railway proposed in variant C starts from the №010 railway from the direction of Pardubice main railway station separating to the north and going through an underpass it reaches a railway switch, through which the line can connect to the other railway and head in the direction of Pardubice again. Going forward on the line, it intersects the I/7 road through an underpass and continues to gain

inclination to arrive at a proposed railway station west of the roundabout located at the Jan Kašpar terminal.

Layout of the proposed track and position of the railway station is at appendix C.005 Layout of the proposed track – variant C

b) Overall evaluation of all the necessary types of power usage

electric tools are to be used at the site of the construction, electric appliances, if necessary, the construction contractor is to provide electricity generation equipment in the form of a diesel power generator. Other types of power are not to be used during construction; the majority of the construction works is not to necessitate access to external sources of power.

c) Overall water consumption

during construction, the construction contractor is to provide adequate hygienic conditions for the construction workers, vitally potable water and lavatories without any connections to the local sewage system.

d) Total amount of produced waste and types of refuse and emissions created at the construction site

refuse produced during construction is expected to be mainly composed of surplus of excavated soil, stumps and construction waste. Surplus of excavated soil can be stored at a near-by landfill or left at a designated area at the construction site upon agreement of the order party.

Types of refuse are shown in the tab with a designated code according to the regulation № 93/2016Sb. The tab also specifies method of discarding and handling of the refuse.

Discarding of refuse is to be made by the construction contractor at a designated site according to the category of the refuse in accordance with the law №185/2001 Sb.

Handling of refuse created during the construction process and its secure discarding is in accordance with the law №185/2001 Sb the responsibility of the refuse producer meaning the physical or legal person authorised to the entrepreneurship during which the refuse is produced. The construction contractor is to temporarily store the refuse at the construction site according to their category and ensure removal of the refuse of the construction site in accordance with the law. In accordance with the regulation №93/2016 Sb the producer of the refuse is obligated to keep records of the refuse with details on how to safely handle the refuse.

Waste type code	Type of waste	Code of waste discarding
02 01 03	**Bio-waste**	D10 Incineration
17 01	**Concrete, bricks, tiles and ceramics**	D1 Landfill, recycling
17 05	**Soil and stone containing dangerous substances**	D1 landfill
17 09 04	**Miscellaneous construction or demolition waste not containing dangerous substances**	D1 landfill

e) requirements of public network of communication lines and electronic communication devices of the public communication network

no requirements for communication network capacity are to be made.

B.2.4 Obstacle-free usage of the railway structure

a) principles of adjustments for person with limited eyesight

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

b) principles of adjustments for person with eyesight disability

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

c) principles of adjustments for person with hearing disability

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

d) usage of construction products for obstacle-free usage

the underground station in variant B as the only railway station variant not located on ground level is equipped with elevators to reach the platform located on the lower floor.

Additional adjustments for people with disabilities regarding entrances, road protection and pavements are outside of the scope of this feasibility study.

B.2.5 Safety during railway structure usage

Proposed materials and construction solutions of the construction objects corresponds with the valid technical standards technical-quantitative conditions and as such no other valid assessments are necessary.

All valid work safety regulations namely law №309/2006 sb. and governmental regulations №591 and №592/2006 Sb. all activities during all the construction work must be carried out in accordance with pre-described technological procedures from materials in accordance with these procedures. The materials must have the necessary certifications and inspections. The certifications and inspections of the used materials are to be given by the construction contractor to the order party during final inspection.

Construction equipment must be placed only on designated properties chosen for construction including appliances for company construction workers, sites for material handling, equipment for the construction, parking of construction technicians and construction vehicles.

Ground works and works related to usage of heavy machinery in the vicinity of underground or overground lines must be conducted in accordance with regulations related to these types of activities to not to endanger persons or the respective lines. During the activity, work inspections, all requirements of valid technological a material standards and regulations must be abided by.

B.2.6 Fundamental characteristic of construction objects

See B.2

B.2.7 fundamental characteristic of technical and technological facilities

Technical and technological facilities are not part of this feasibility study.

B.2.8 principles of fire-security solution

Fire-security solution is not part of this feasibility study.

B.2.9 Energy saving and heating insulation.

The railway stations in all variants are designed to not to be heated and so, heat insulation is not part of the project document.

B.2.10 hygienic requirements of the construction process, requirement for work environment

The construction is to be conducted during day hours of 6 am to 8 pm. The surrounding area is not to be damaged in long-term by the construction, any types of impacts of the construction on the surrounding

environment are to be returned to their original state before the construction termination. The construction is to not cause any water pollution of the water currents in the area, sewage systems or water pipelines.

During construction all valid safety regulations for conducting civil or building constructions must be abided by. Character of the construction sets the conditions, which influence the current environment. The construction is not to affect historical landmarks and other significant creations of human endeavour. The construction itself has a negative influence on the environment regarding groundworks, traffic limitations, noise increase or dust level rise. The duty of the order party and the construction contractor is to mitigate all these issues during the construction process.

During the construction works, protection against oil leaks or hydraulic additives into the terrain, ground or underground waters must be secured.

It is presumed that the production of concrete mixtures is to be produced in centralized factories. Landfills for stone and bitted material must be kept at lowest possible area. Landfills of surplus unusable soil and landfills materials containing tar are to be outside the area of construction site. Demolished materials containing tar must be stored in accordance with valid regulations of landfill contaminated waste.

B.2.11 principles of protection of the construction sites against negative influences of the surrounding environment

Not part of the feasibility study.

B.3 CONNECTIONS TO THE TECHNICAL INFRASTRUCTURE

Not part of the feasibility study.

B.4 TRAFIC SOLUTION

a) Description of the civil solution including obstacle-free access

the railway structure is intended to serve as an environmentally friendly railway connection to the Pardubice airport and its respective civil terminal.

principles of adjustments for person with limited eyesight

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

principles of adjustments for person with eyesight disability

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

principles of adjustments for person with hearing disability

platforms at the station are equipped with a safety yellow line from a material that has a different texture from the rest of the floor to outline the safe distance from the arriving/embarking train unit.

usage of construction products for obstacle-free usage

the underground station in variant B as the only railway station variant not located on ground level is equipped with elevators to reach the platform located on the lower floor.

Additional adjustments for people with disabilities regarding entrances, road protection and pavements are outside of the scope of this feasibility study.

b) connection of the structure to the current infrastructure

the newly designed railway connection is to connect to current Czech railway network**.**

c) parking

variant A, B: 9 parking lots for personal vehicles + 2 parking lots for persons with disabilities

variant C: 3 parking lots for personal vehicles + 1 parking lot for persons with disabilities

d) pedestrian and cycling zones

part of the proposed design are paved surfaces adjacent to the proposed railway stations as well as a pedestrian, cycling bridge to connect to the Žižkova street in Popkovice in the vicinity to the proposed railway station.

B.5 VEGETATION AND OTHER ASSOCIATED TERRAIN ADJUSTMENTS

a) Terrain adjustments

cutting down trees is expected to occur in the vicinity of the railway station and the proposed railway line in a 3-meter distance on both sides from the centre line of the railway.

b) used vegetation elements

Shrubs and smaller coniferous trees are expected to be planted after construction in the vicinity of the railway station.

c) biotechnical, anti-erosion measures

unnecessary given the character of the construction.

B.6 DESCRITION OF THE INFLUENCE OF THE RAILWAY STRUCTURE ON THE ENVIRONMENT AND ITS PROTECTION

a) influence of the structure on the environment

the structure is not expected to pollute the air after it commences its operation, rainwater from surfaces is to be brought down through gutters or slopes to the surrounding vegetation.

b) Influence on nature and countryside

not necessary at the given site.

c) influence on the system of protected areas Natura 2000

the given site is not part of such an area.

d) method of adjustment to conditions of a mandatory statement of survey of influence of the construction on the environment

not necessary

e) in the case of intentions in reference to the law about integrated prevention fundamental parameters of methods of fulfilling conclusions about the most adequate techniques or integrated approval, if given

not necessary

f) proposed protection and safety zones

a safety zone is expected to be created in a 3-meter distance to both sides of the railway.

B.7 PROTECTION OF CITIZENRY

Not part of the feasibility study.

B.8 PRINCIPLES OF CONSTRUCTION PROCESS

B.8.1. technical report

a) needs uses of deciding media and fuel, their provisions

not part of the feasibility study

b) construction site water run-off

not part of the feasibility study

c) connecting the construction site to the current civil and technical infrastructure

not part of the feasibility study

d) influence of construction process on the surrounding structures and properties

not part of the feasibility study

e) protection of the surroundings of the construction site and requirements for related decontaminations, demolitions, felling activities

not part of the feasibility study

f) maximal temporary and permanent acquisitions of construction site

not part of the feasibility study

g) requirements for obstacle free construction site walk-arounds

not part of the feasibility study

h) maximal produced amounts and types of refuse and emissions during construction process and their discarding processes

not part of the feasibility study.

i) ratio of groundworks, requirement for bringing in or landfilling of soil

not part of the feasibility study

j) protection of the environment during construction

not part of the feasibility study

k) principles of security and protection of health during work conducted at the construction site

not part of the feasibility study

l) adjustments for obstacle-free usage of structures affected by the construction

not part of the feasibility study

m) principles for civil adjustments

not part of the feasibility study

n) setting of special conditions for construction process

not part of the feasibility study

o) equipment at the construction site with access to the site marking

not part of the feasibility study

p) Method of construction, deciding factors

not part of the feasibility study

B.8.2 Drawings

not part of the feasibility study

B.8.3 timetable of the construction process

not part of the feasibility study

B.8.4 diagram of construction processes

not part of the feasibility study

B.8.5 Ratio of excavated/laid soil

It is expected that ration of excavated soil/laid soil is going to be in excavated soil surplus.

B.9 overall water management solution

Outflow of rainwater from surfaces is expected to be managed by inclined surfaces of the railway station roof and then brought to adjacent gutters that move the rainwater to the surrounding vegetation. The slope of the lower layers of substrate under the railway is designed with a slope to bring rainwater to the designed drainage gutters and to surrounding vegetation.

10th May 2021 written by: Bc. Miroslav Jícha

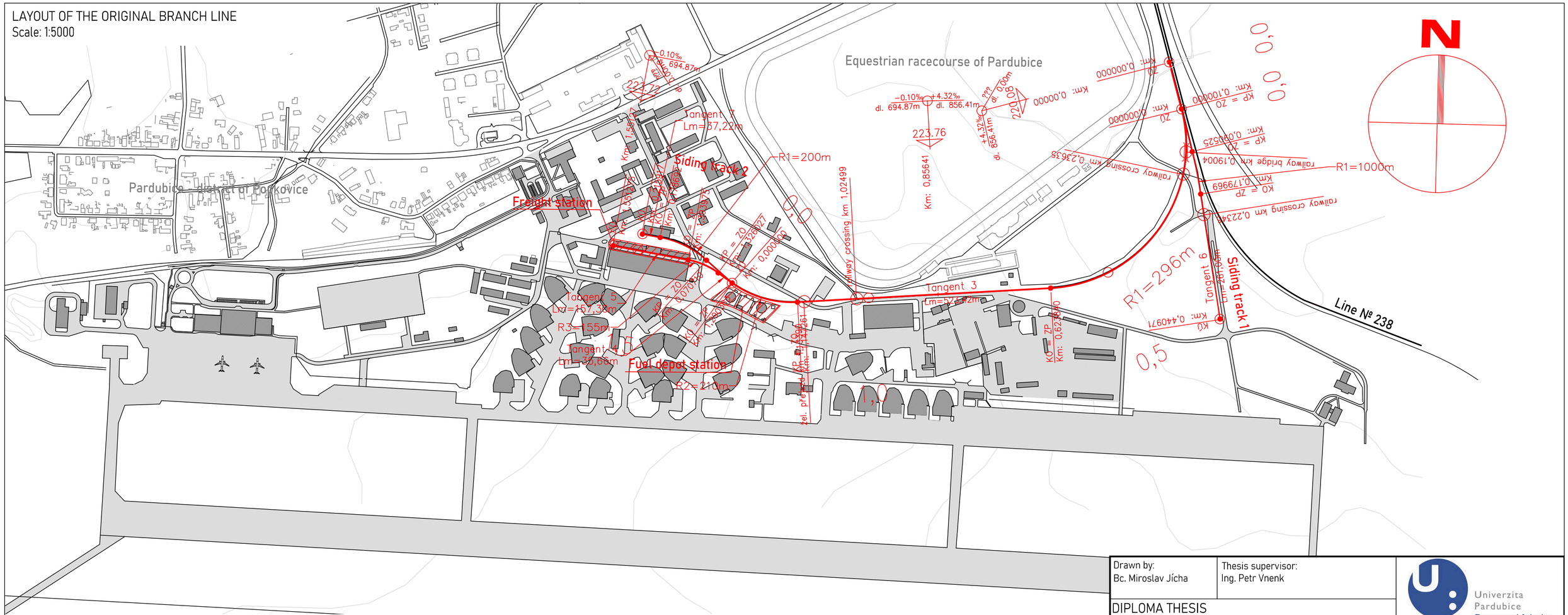
LAYOUT OF 3 PROPOSED VARIANTS
Scale: 1:10000

N

LEGEND:
VARIANT A
VARIANT B
VARIANT C
RAIL NETWORK

Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk
DIPLOMA THESIS	Univerzita Pardubice, Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK; Format:XxA4; Date: 04/2021; Scale: 1:10000
Drawing Title: LAYOUT OF 3 PROPOSED VARIANTS	Drawing number: C.001
Field of study: Civil engineering, Master studies, 2nd year	

LAYOUT OF THE ORIGINAL BRANCH LINE
Scale: 1:5000

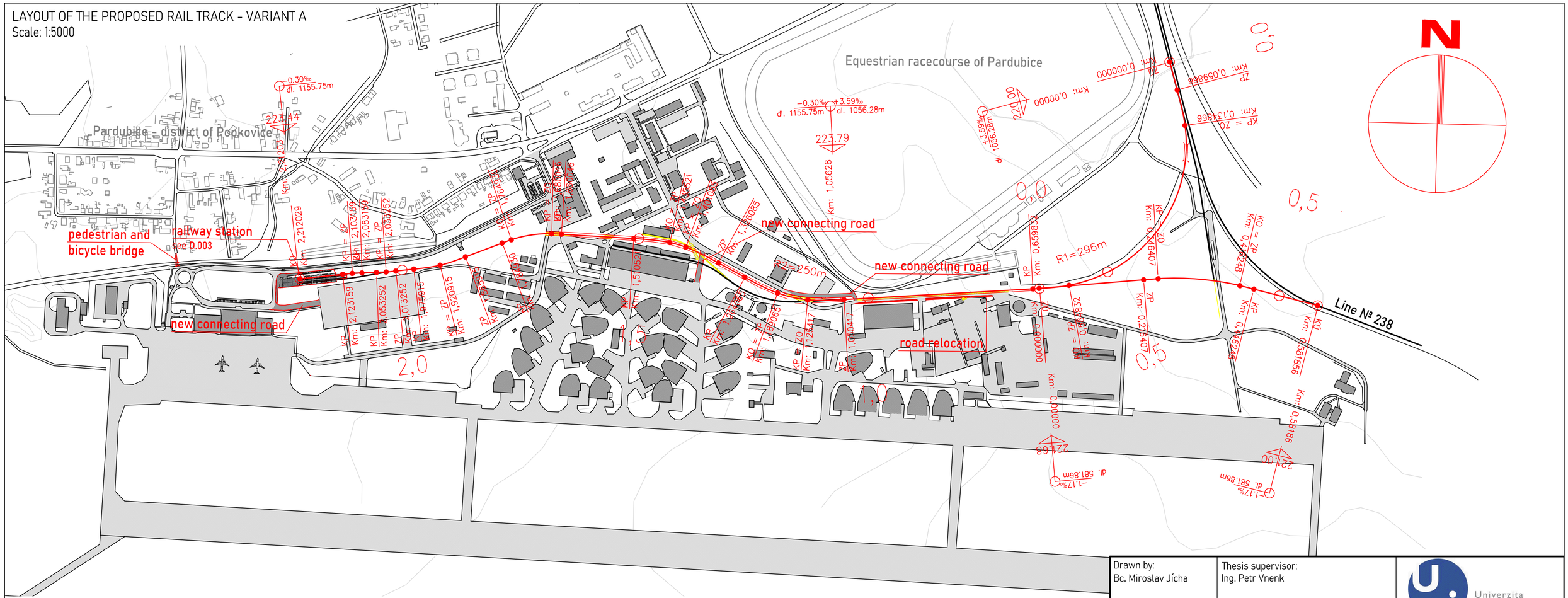


LEGEND:

- original branch line
- stations
- internal arpt roads
- arpt buildings

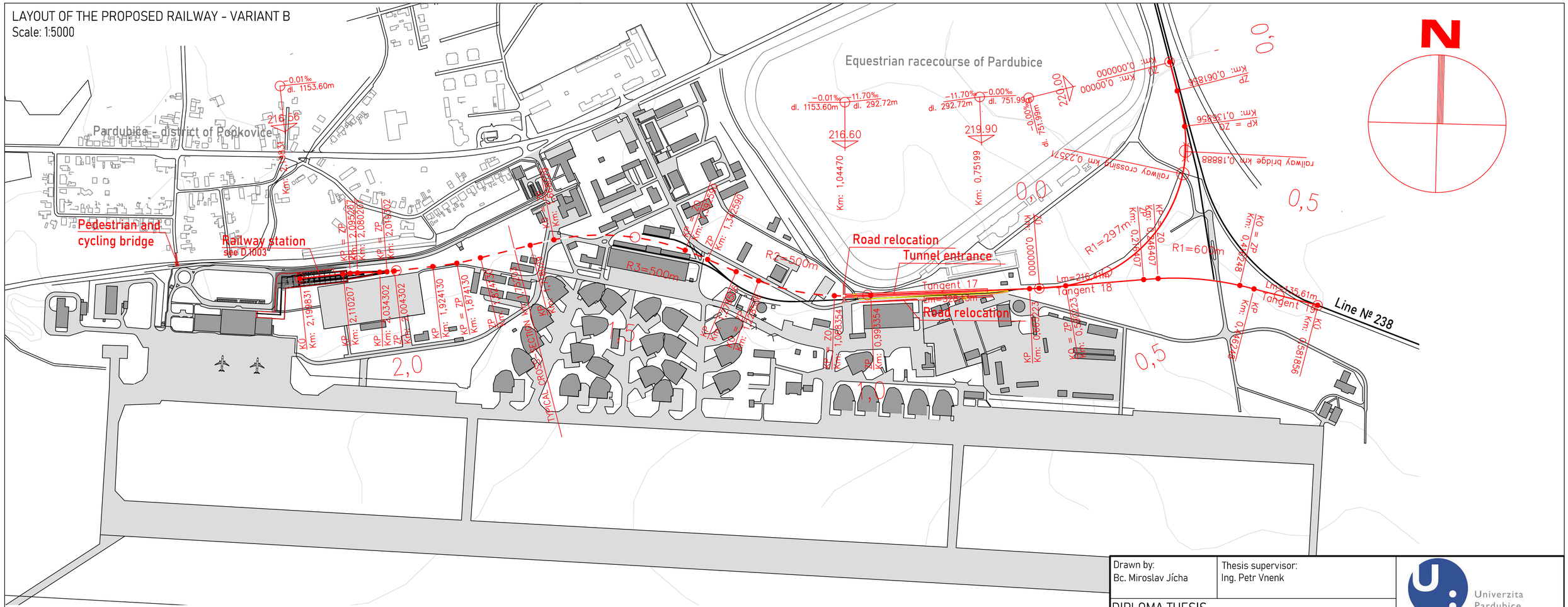
Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk
DIPLOMA THESIS	Univerzita Pardubice, Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK; Format:XxA4; Date: 04/2021; Scale: 1:5000
Drawing Title: LAYOUT OF THE ORIGINAL BRANCH LINE	Drawing number: C.002
Field of study: Civil engineering, Master studies, 2nd year	

LAYOUT OF THE PROPOSED RAIL TRACK - VARIANT A
Scale: 1:5000



Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk
DIPLOMA THESIS	Univerzita Pardubice, Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK; Format:XxA4; Date: 04/2021; Scale: 1:5000
Drawing Title: LAYOUT OF THE PROPOSED RAIL TRACK - VARIANT A	Drawing number: C.003
Field of study: Civil engineering, Master studies, 2nd year	

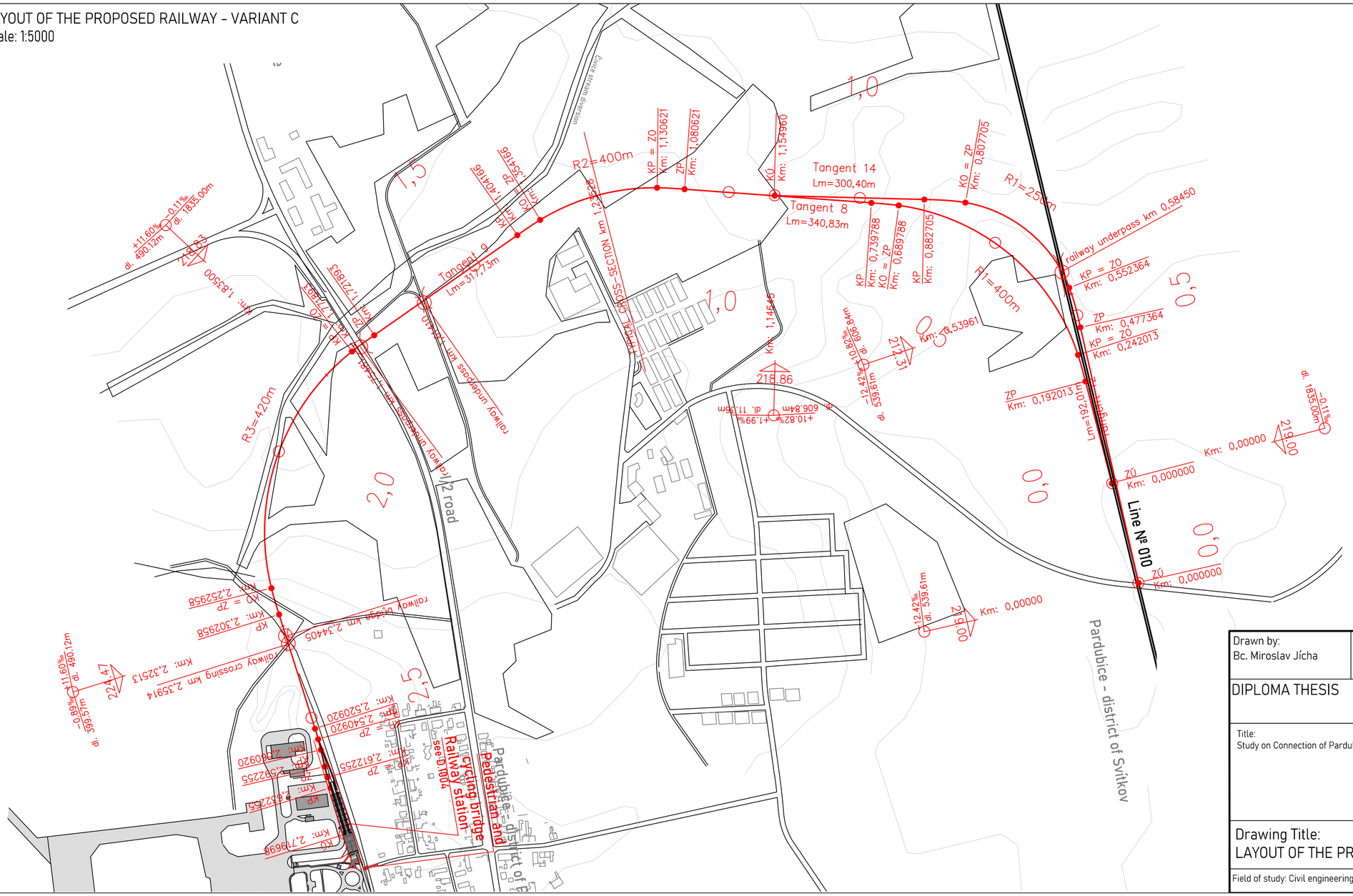
LAYOUT OF THE PROPOSED RAILWAY - VARIANT B
Scale: 1:5000



LEGEND:
- variant B lines
- demolition
- new arpt pathways
- internal arpt roads
- arpt buildings

Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk
DIPLOMA THESIS	Univerzita Pardubice, Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK; Format:3xA4; Date: 04/2021; Scale: 1:5000
Drawing Title: LAYOUT OF THE PROPOSED RAILWAY - VARIANT B	Drawing number: C.004
Field of study: Civil engineering, Master studies, 2nd year	

LAYOUT OF THE PROPOSED RAILWAY - VARIANT C
Scale: 1:5000

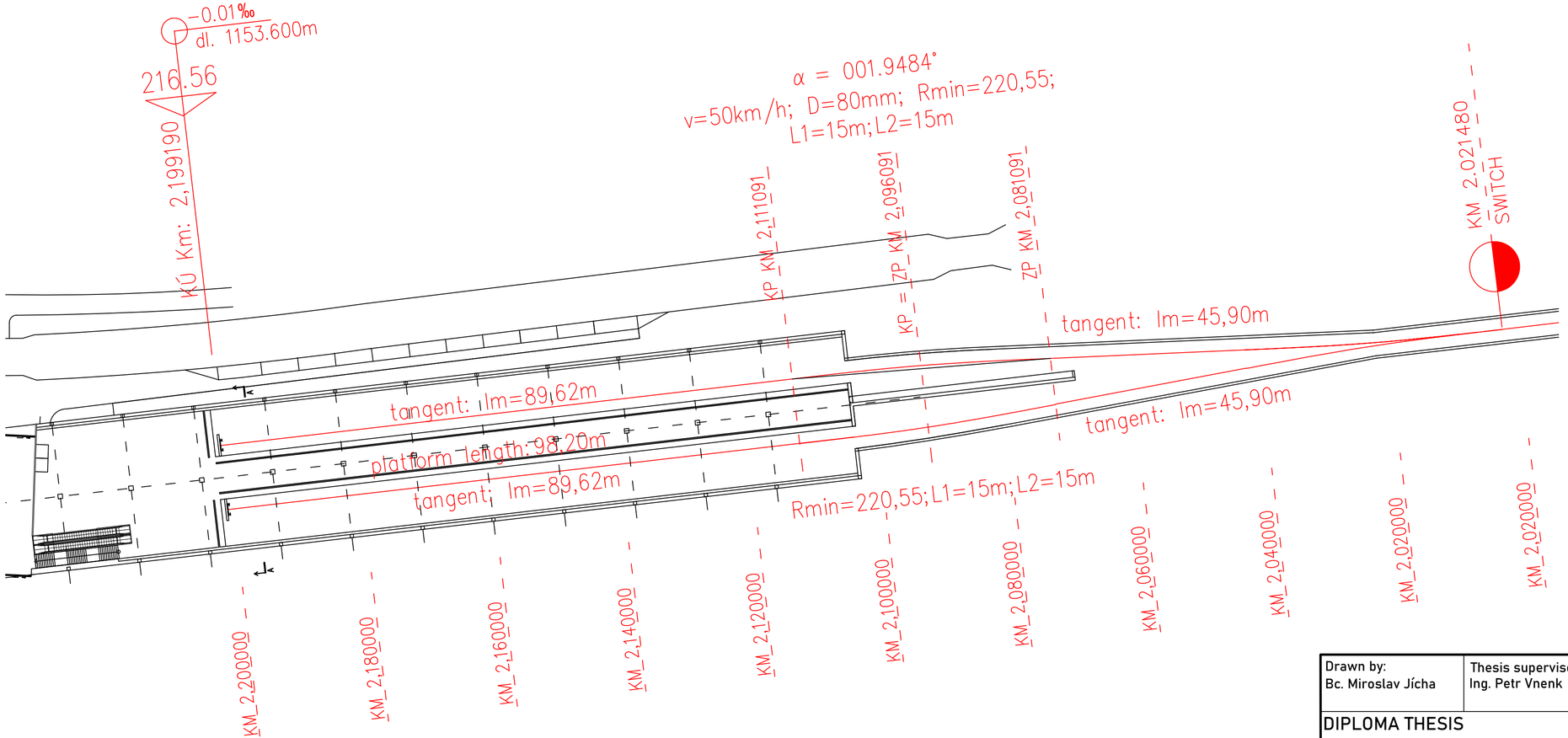


LEGEND:
- variant C lines
- demolition
- new arpt pathways
- internal arpt roads
- arpt buildings

Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk
DIPLOMA THESIS	Univerzita Pardubice, Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK; Format:3xA4; Date: 04/2021; Scale: 1:5000
Drawing Title: LAYOUT OF THE PROPOSED RAILWAY - VARIANT C	Drawing number: C.002
Field of study: Civil engineering, Master studies, 2nd year	

DETAILED LAYOUT OF THE RAILWAY AT THE STATION - VARIANT B

1:500

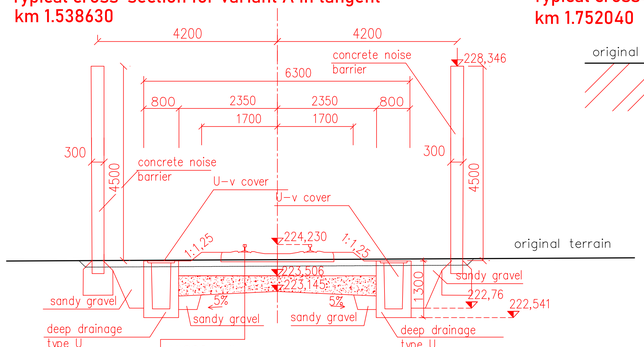


Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice, Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDPCK Date: 04/2021 Scale: 1:500	Format:3xA4
Drawing Title: DETAILED LAYOUT OF THE RAILWAY AT THE STATION - VARIANT B	Drawing number: C.006	
Field of study: Civil engineering, Master studies, 2nd year		

TYPICAL CROSS SECTIONS OF THE VARIANTS

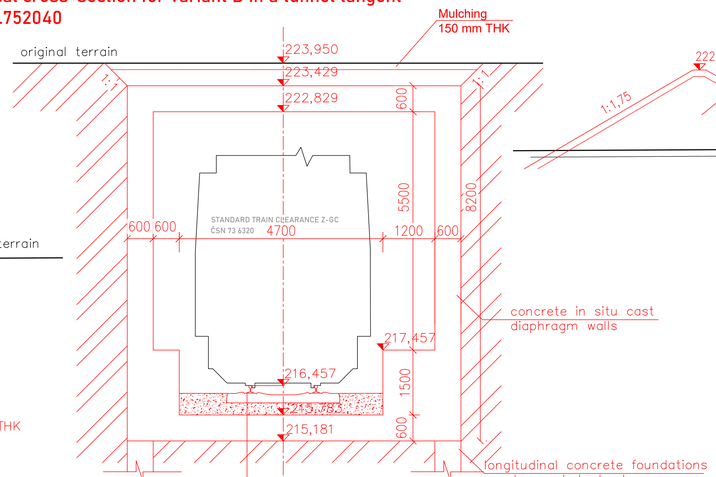
1:50

Typical cross-section for variant A in tangent km 1.538630



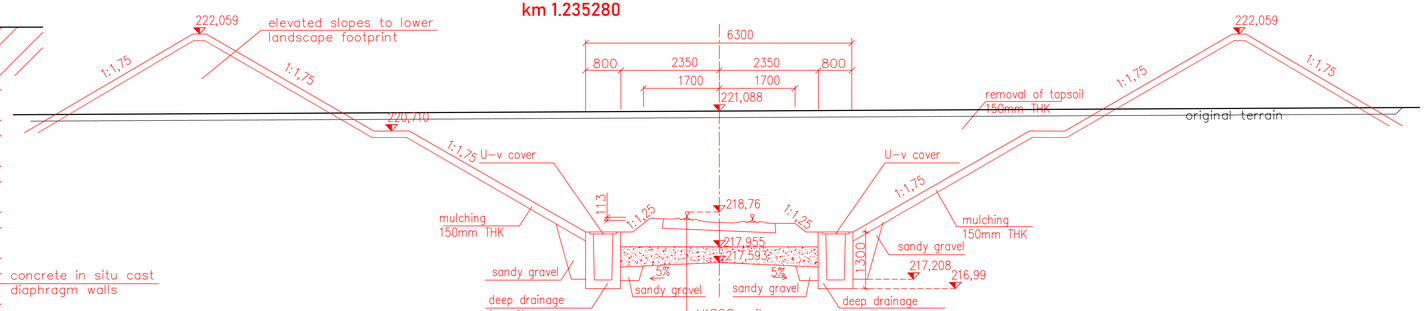
- UIC60 rail
- Skl 24 fasteners
- B91/S reinforced concrete railway tie
- trackbed gravel of fr. 31,5–63, 350mm THK
- gravel chipings fr. 0–32 360 THK
- reinforcing layer of chipped aggregate fr. 0–125 300mm THK
- original terrain/cohesive soil

Typical cross-section for variant B in a tunnel tangent km 1.752040



- concrete in situ cast diaphragm walls
- longitudinal concrete foundations are to reach bedrock
- UIC60 rail
- Skl 24 fasteners
- B91/S reinforced concrete railway tie
- trackbed gravel of fr. 31,5–63, 275mm THK
- reinforced concrete C30/37 grade, 600mm THK

Typical cross-section for variant C in a 400m curve km 1.235280



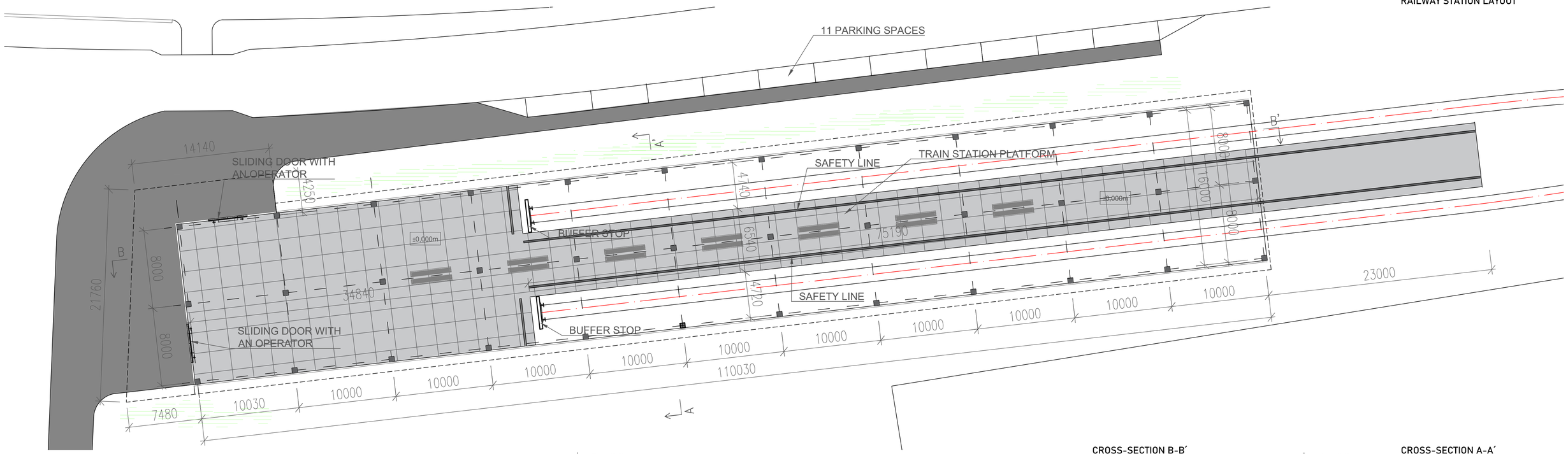
- UIC60 rail
- Skl 24 fasteners
- B91/S reinforced concrete railway tie
- trackbed gravel of fr. 31,5–63, 350mm THK
- gravel chipings fr. 0–32 360 THK
- reinforcing layer of chipped aggregate fr. 0–125 300mm THK
- original terrain/cohesive soil

Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice, Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDPCK	Format:3xA4
	Date: 04/2021	
	Scale: 150	
Drawing Title: TYPICAL CROSS-SECTIONS OF THE VARIANTS	Drawing number: D.001	
Field of study: Civil engineering, Master studies, 2nd year		

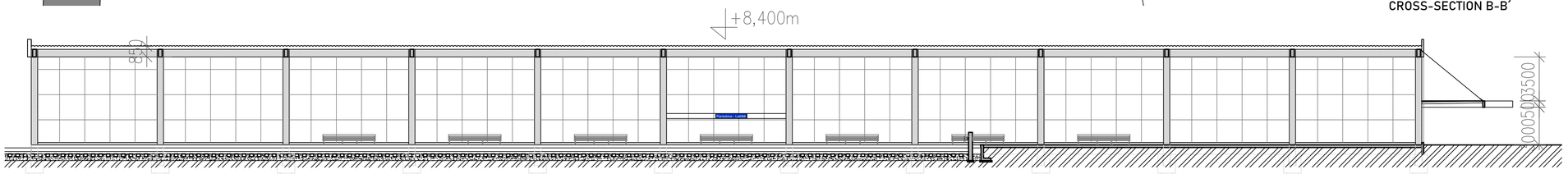
RAILWAY STATION VARIANT A

1:200

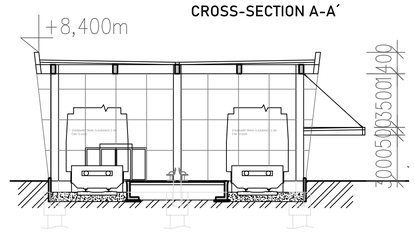
RAILWAY STATION LAYOUT



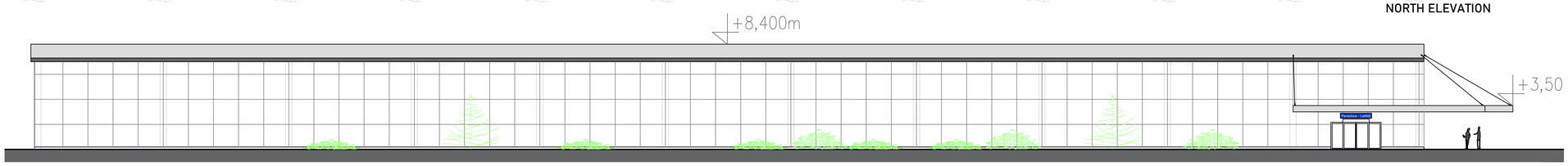
CROSS-SECTION B-B´



CROSS-SECTION A-A´

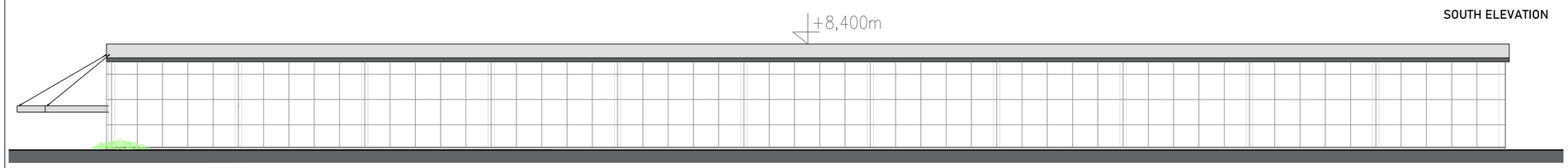


NORTH ELEVATION



WEST ELEVATION

SOUTH ELEVATION



N

RENDER VIEW

LEGEND:

concrete cross-section/elevation

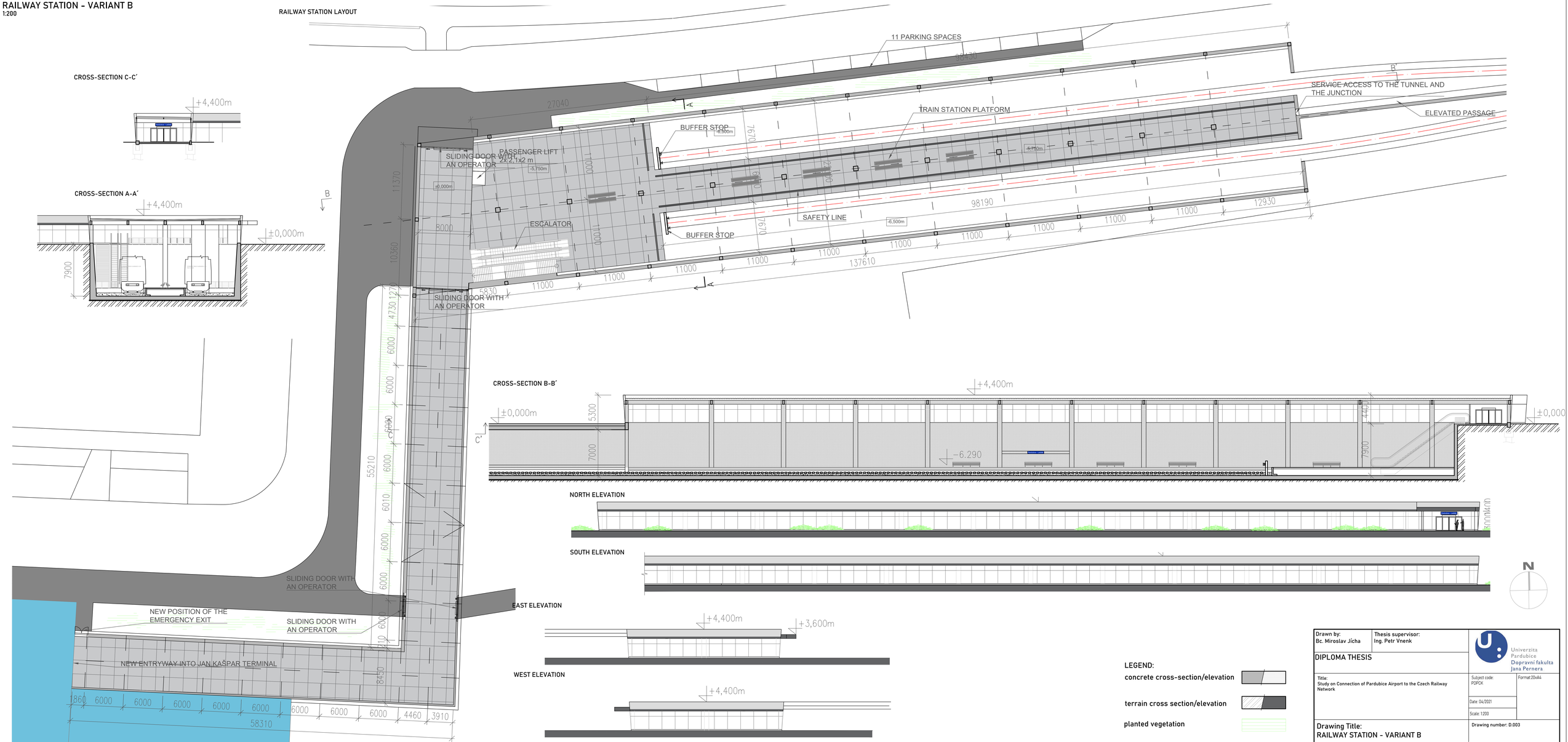
terrain cross section/elevation

planted vegetation

Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice, Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK	Format:16xA4
	Date: 04/2021	
	Scale: 1:200	
Drawing Title: RAILWAY STATION - VARIANT A	Drawing number: D.002	
Field of study: Civil engineering, Master studies, 2nd year		

RAILWAY STATION - VARIANT B
1:200

RAILWAY STATION LAYOUT



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DIPLOMA THESIS	
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: POPCK
	Format:20xA4
	Date: 04/2021
	Scale: 1:200
Drawing Title: RAILWAY STATION - VARIANT B	Drawing number: D.003
Field of study: Civil engineering, Master studies, 2nd year	

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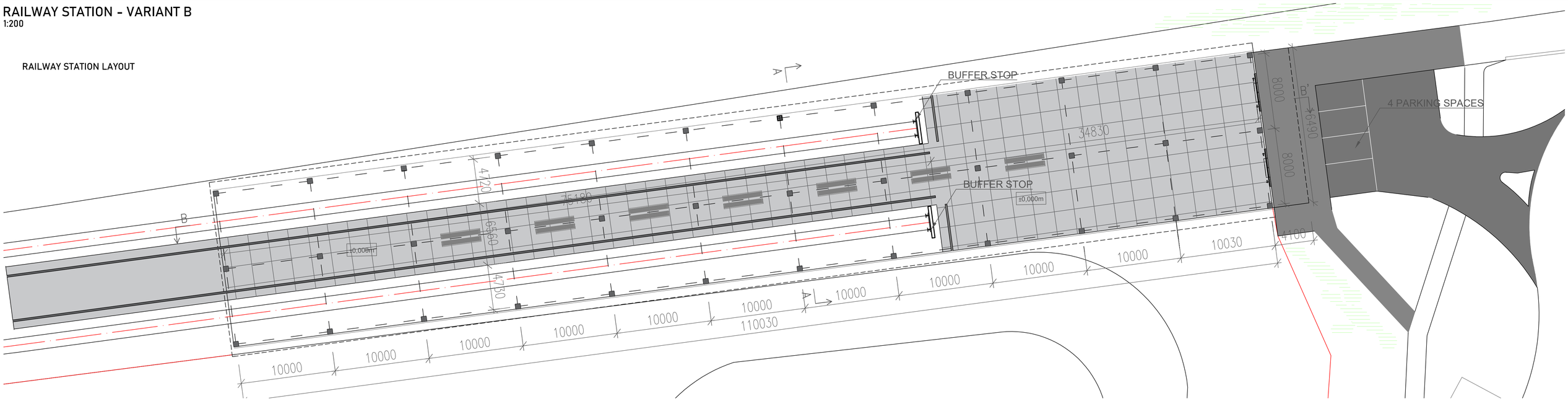
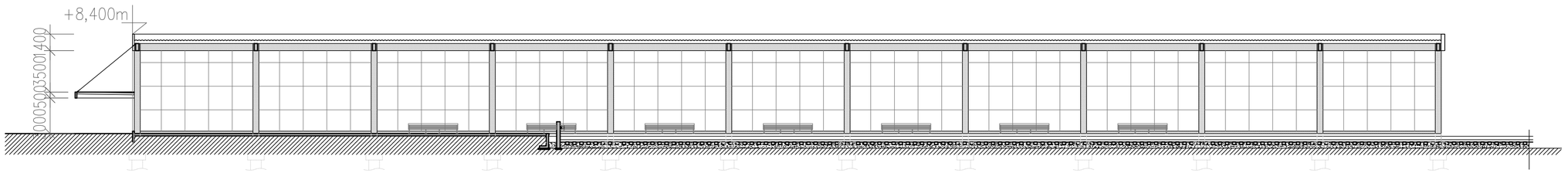
RAILWAY STATION - VARIANT B
1:200

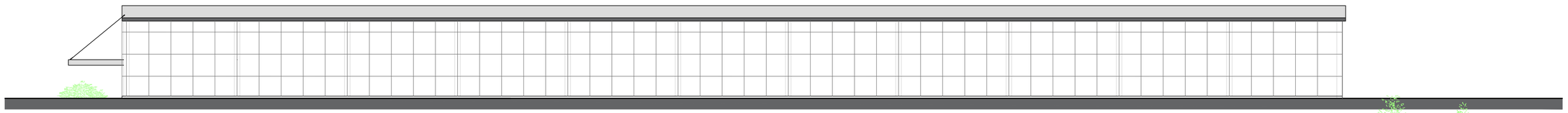
RAILWAY STATION LAYOUT



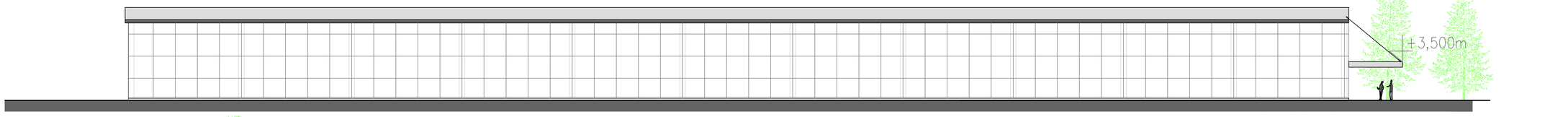
CROSS-SECTION B-B´



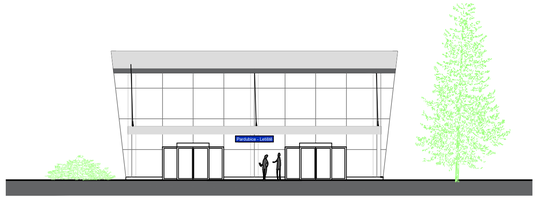
NORTH ELEVATION



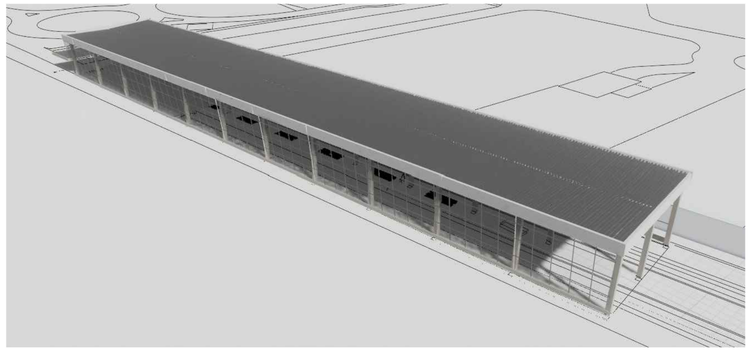
SOUTH ELEVATION



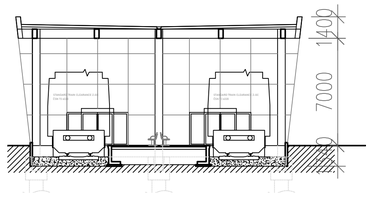
EAST ELEVATION



RENDER VIEW



CROSS-SECTION A-A´



LEGEND:

concrete cross-section/elevation

terrain cross section elevation

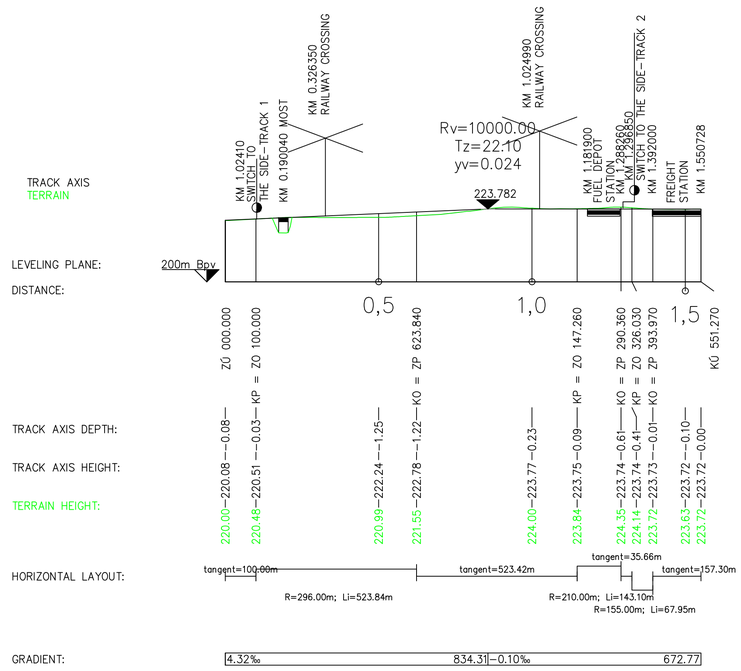
planted vegetation

N

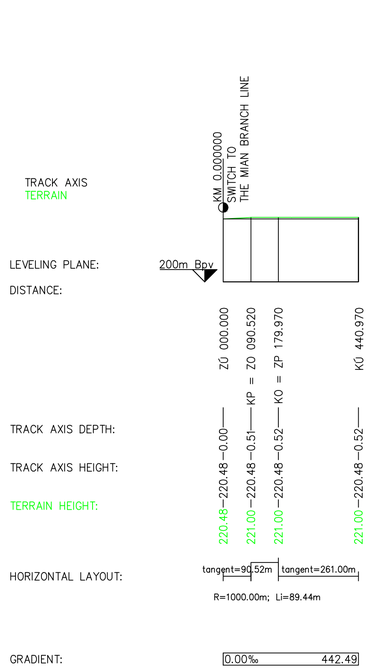
Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice, Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDPCK	Format:16xA4
	Date: 04/2021	
	Scale: 1:200	
Drawing Title: RAILWAY STATION - VARIANT C	Drawing number: D.004	
Field of study: Civil engineering, Master studies, 2nd year		

LONGITUDINAL PROFILE OF THEORIGINAL BRANCH LINE
Scale: 1:5000/1000

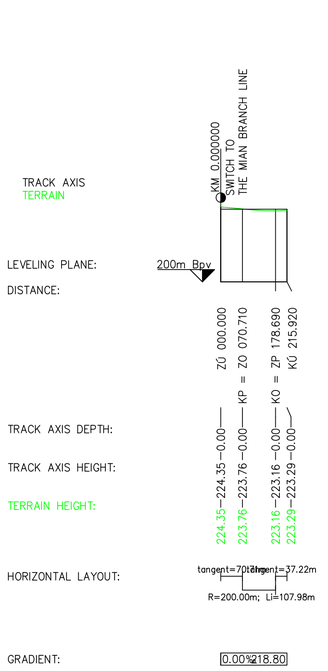
Longitudinal profile: BRANCH RAILWAY TO THE AIRPORT – MAIN LINE M 1:10000/1000
Range: km 0,00000 – km 1,55127



Longitudinal profile: SIDING TRACK 1 M 1:10000/1000
Range: km 0,00000 – km 0,44097



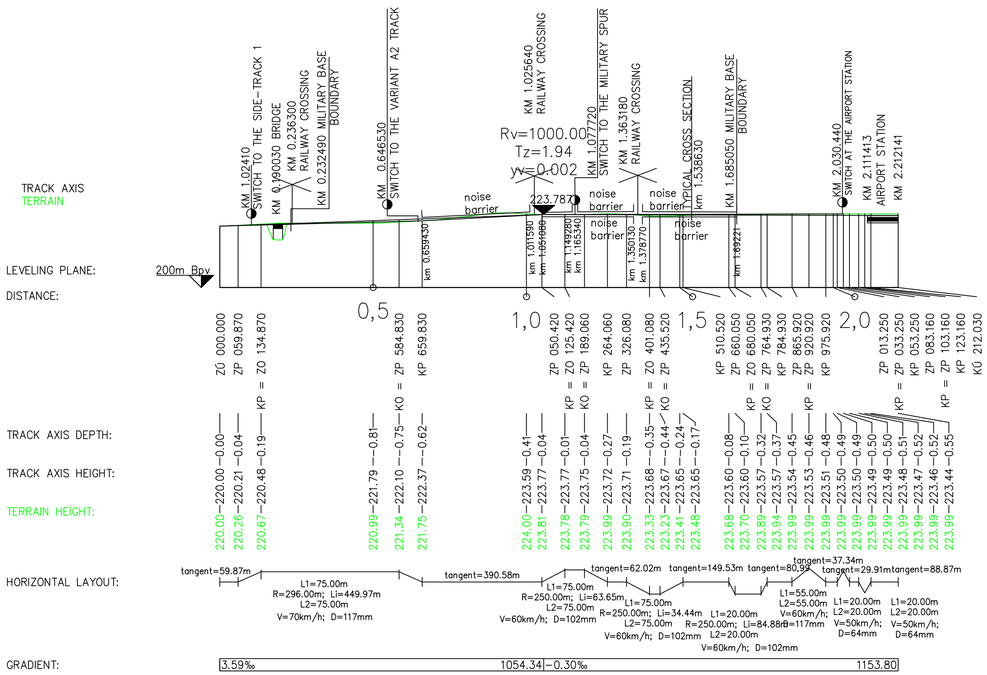
Longitudinal profile: SIDING TRACK 2 M 1:10000/1000
Range: km 0,00000 – km 0,21592



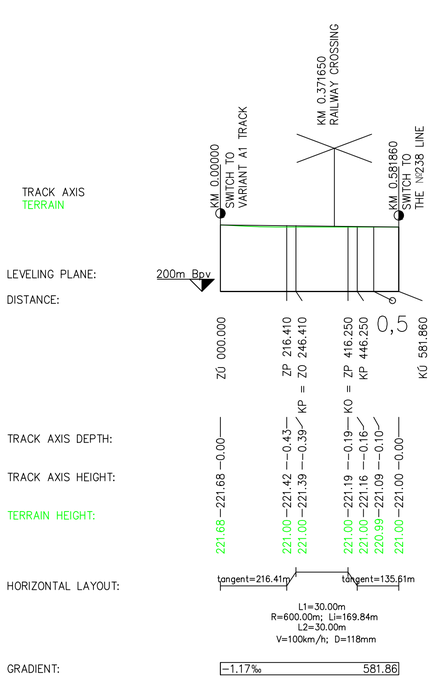
Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK	Format:4xA4
	Date: 04/2021	
	Scale: 1:5000/1000	
Drawing Title: LONGITUDINAL PROFILE OF THE ORIGINAL BRANCH LINE	Drawing number: D.005	
Field of study: Civil engineering, Master studies, 2nd year		

LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY - VARIANT A
Scale: 1:5000/1000

Longitudinal profile: VARIANT A1 M 1:5000/1000
Range: km 0,00000 – km 2,21203



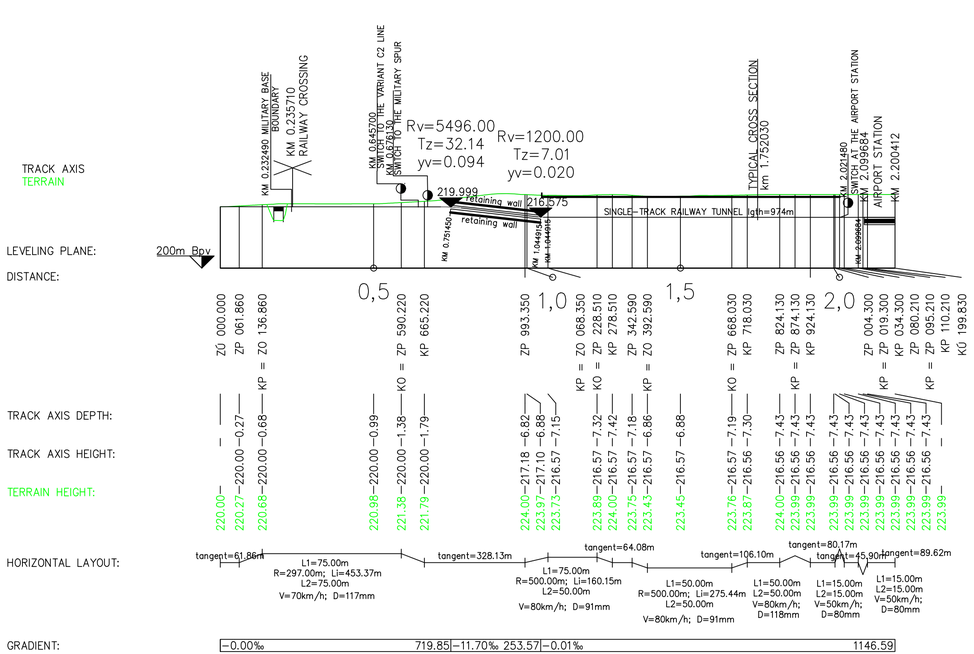
Longitudinal profile: VARIANT A 2 M 1:5000/1000
Range: km 0,00000 – km 0,58186



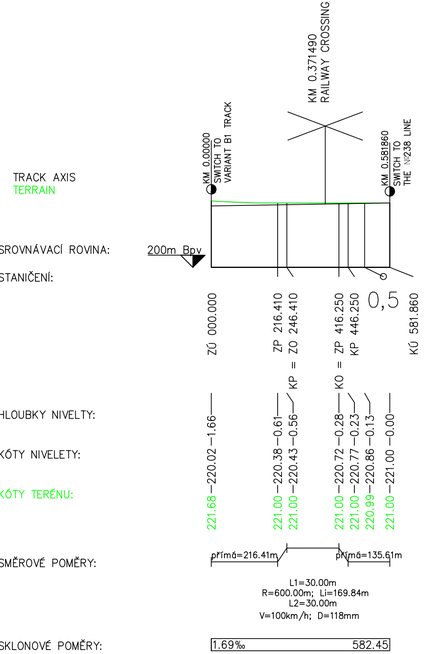
Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK	Format:4xA4
	Date: 04/2021	
	Scale: 1:5000/1000	
Drawing Title: LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY - VARIANT A	Drawing number: D.006	
Field of study: Civil engineering, Master studies, 2nd year		

LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY - VARIANT B
Scale: 1:5000/1000

Longitudinal profile: VARIANT B1 M 1:5000/1000
Range: km 0,00000 – km 2,19983



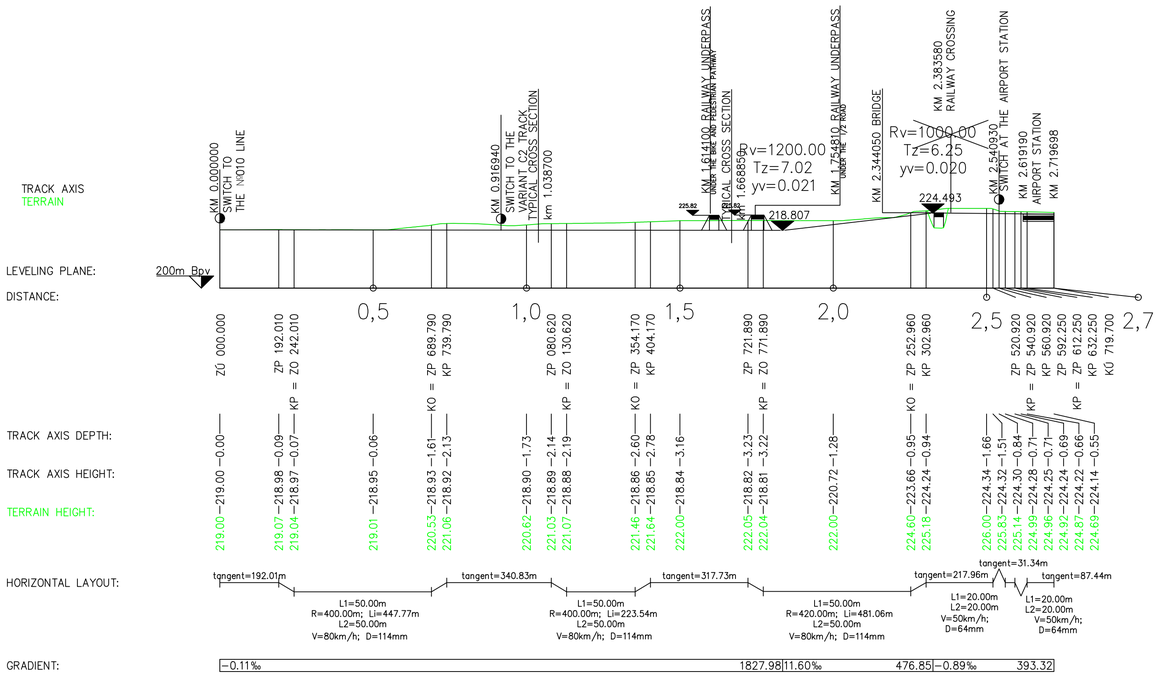
Longitudinal profile: VARIANT B2 M 1:5000/1000
Range: km 0,00000 – km 0,58186



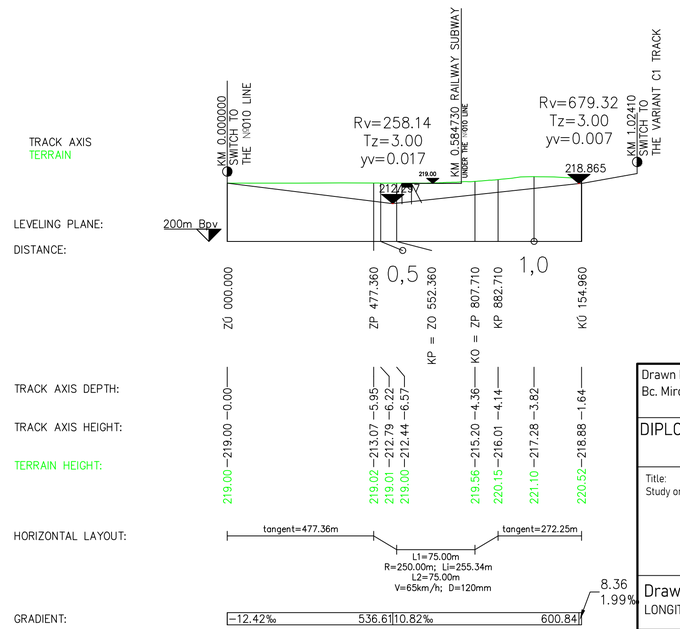
Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK	Format:4xA4
	Date: 04/2021	
	Scale: 1:5000/1000	
Drawing Title: LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY - VARIANT B	Drawing number: D.007	
Field of study: Civil engineering, Master studies, 2nd year		

LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY VARIANT C
Scale: 1:5000/1000

Longitudinal profile: VARIANT C M 1:5000/1000
Range: km 0,00000 – km 2,71970



Longitudinal profile: VARIANT C 2 M 1:5000/1000
Range: km 0,00000 – km 1,15496



Drawn by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	Univerzita Pardubice Dopravní fakulta Jana Pernera
DIPLOMA THESIS		
Title: Study on Connection of Pardubice Airport to the Czech Railway Network	Subject code: PDCK	Format: 4x4 A4
	Date: 04/2021	
	Scale: 1:5000/1000	
Drawing Title: LONGITUDINAL PROFILE OF THE PROPOSED RAILWAY VARIANT C	Drawing number: D.008	
Field of study: Civil engineering, Master studies, 2nd year		

Written by: Bc. Miroslav Jícha	Thesis supervisor: Ing. Petr Vnenk	
DIPLOMA THESIS		Univerzita Pardubice Dopravní fakulta Jana Pernera
Title: Study on Connection of Pardubice Airport to the Czech Railway Network		Subject code: Date: 05/2021 — Format: A4x24
Annex: PHOTO DOCUMENTATION		Annex number: E
Field of study: Civil engineering, Master studies, 2nd year		

Image 1 - Pardubice Závodiště railway halt

Image 2 - view in the direction of the airport from the Pardubice Závodiště halt

Image 3 - view north from Pardubice Závodiště halt, showing the airport branch line buffer stop and a crossover switch to N°237 line.

Image 4 - the crossover switch to the airport branch line as seen from the opposite side, looking in the direction of the airport.

Image 5 - view showing the N°238 line on the left and the airport branch line to the right with a distance marker on the right side of the branch track.

Image 6 - detailed view of the branch line fastener and the concrete ballast

Image 7 - railroad switch located on the edge of the airport compound separating the branch line into a tangent side-track with the main track curving right into the eastern portion of the airport compound.

Image 8 - another view of the switch with a distance marker of the branch line on the right

Image 9 - concrete beam bridge located on the main track of the branch line at the entrance to the airport compound

Image 10 - concrete beam bridge located on the side-track of the branch line at the entrance to the airport

compound

Image 11 - concrete beam bridge located on the 237 line over the Jesečanský potok rivulet, east of the two bridges afore mentioned.

Image 12 - view north from the compound entrance showing ČD class 814 "Regionova" on the 237 line, a type of train unit, that could operate on the extension of the branch line, since the unit has crew compartments on both front and rear of the unit.

Image 13 - railway crossing at the entrance to the compound on the main line of the branch railway.

Image 14 - view of the side-track from the east, showing a railway crossing of a road leading south to the airport apron.

Image 15 - left learning curve on the 237 line, which would form a part of the proposed triangular junction, with a distance marker on the right.

Image 16 - tangent stretch of the 237 line, upon which a switch would connect leaning left, to create the proposed triangular junction.

Image 17 - View of the Jan Kašpar Terminal with the site of the proposed railway station in A and B variants in the front

Image 18 - site of a possible river crossing for pedestrians to allow quick access on foot to the proposed railway station.

Image 19 - view looking in the westward direction of the airport terminal, where the track of the Variant C would be approaching to the Variant C railway station.

Image 20 - view looking eastward in the direction of the roundabout located at the terminal, next to which the variant C railway station would be located.

Image 21 - site of a possible entrance of the passageway of the variant B to the Jan Kašpar terminal, an emergency exit door utilized as an entrance to the passageway.

Image 22 - Jan Kašpar airport terminal main hall viewed from its western side for reference.

Image 23 - site of the railway station proposed in the variant A and B.

Image 24 - view west, near the centre of the airport compound, car park for long-term parking on the left, with a road leading to the Jan Kašpar terminal on the right. Proposed railway in variant A and B would run through the middle to reach the proposed railway stations.

Image 25 - view north, from the road, which is now used for access to the long-term parking car park. the proposed railway of the A and B variant would cross the dividing fence between the civil and military part of the airport at this site.

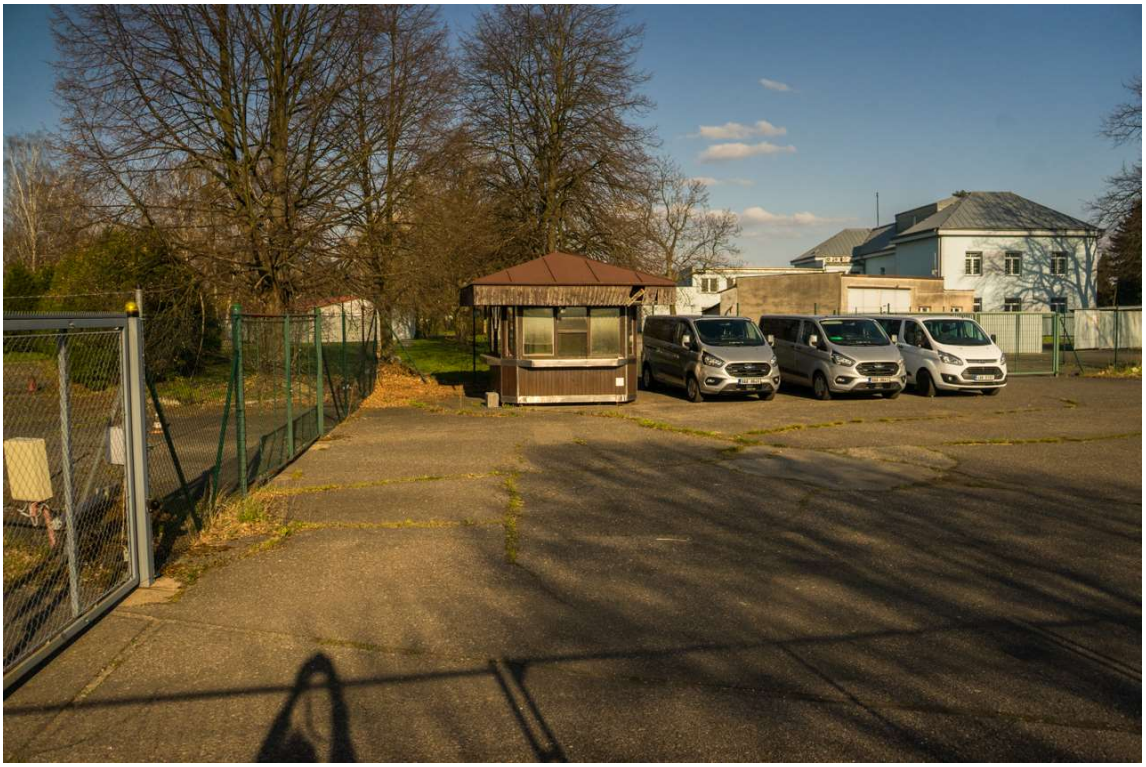


Image 26 - site of an entrance booth at the military side of the airport, which is no longer used, which would have to be demolished or moved for the construction of the proposed variant A or variant B.

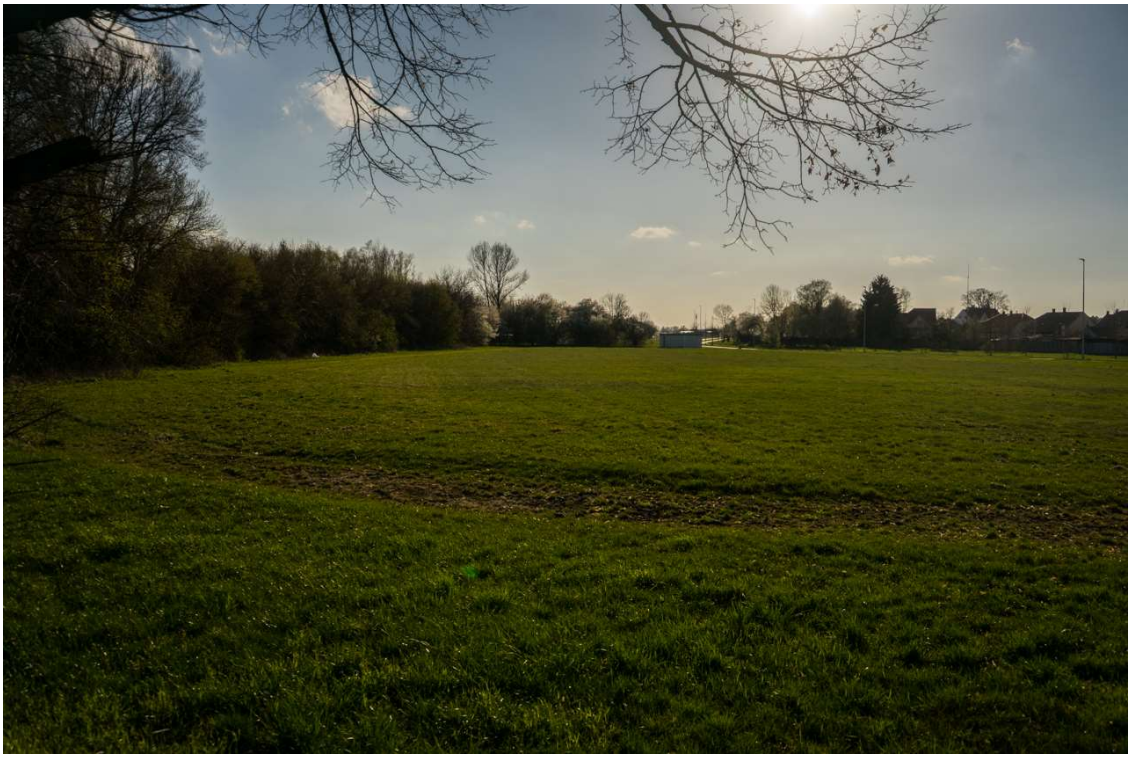


Image 27 - view west, showing the location, where the variant A and variant B lines would be approaching the station at civil part of the airport.

Image 28 - view of the military freight station from the civil part of the airport

Image 29 - view of the old airport terminal building

Image 30 - a garage located north of the proposed variant A and B lines, near the dividing fence of the civil and military part of the airport.

Image 31 - customs office and the seat of the East bohemian airport Plc

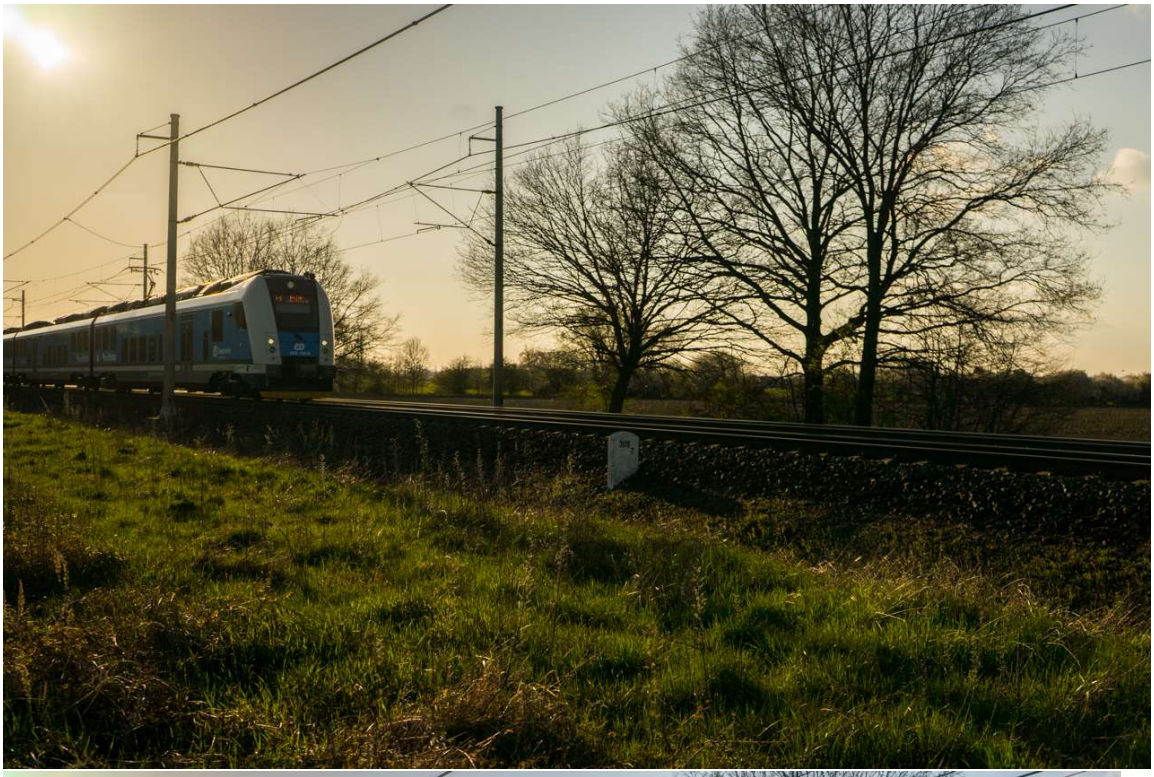
Image 32 - view of the airport museum dedicated to Jan Kašpar, a Czech aviation pioneer.

Image 33 - view of a cropland located west of the airport compound, a site where the variant C line would approach the airport.

Image 34 - a farmland, where the variant C proposed line would the crossing of the I/2 road

Image 35 - a road beam bridge east of the proposed triangular junction of the variant C line, located near the Pardubice Svítkov railway halt.

Image 36 - view of the first and third corridor line, where the variant C would connect to the railway network.




České dráhy
InterPanter

Image 37 - field located south of the first and third corridor line, west of the Svítkov railway halt, where the triangular junction of the variant C line would be located.

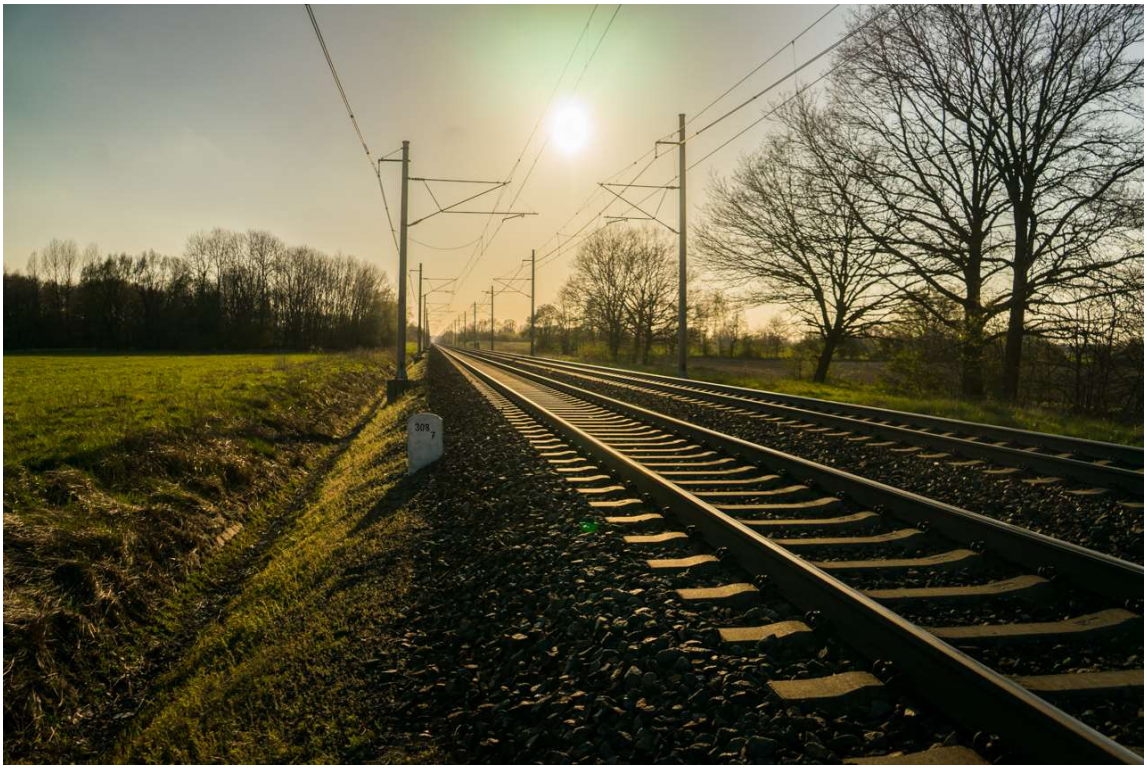


Image 38 - view of the afore mentioned line with a visible distance marker on the left

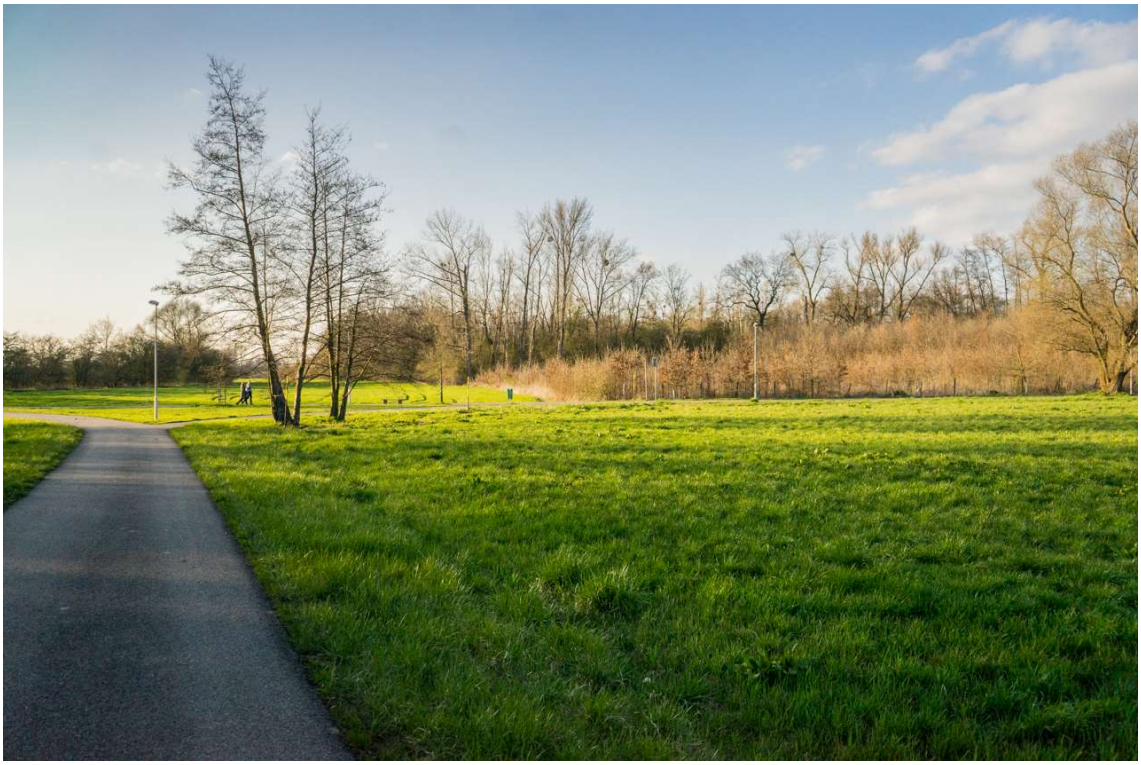


Image 39 - view of a pedestrian pathway, which the variant C would cross

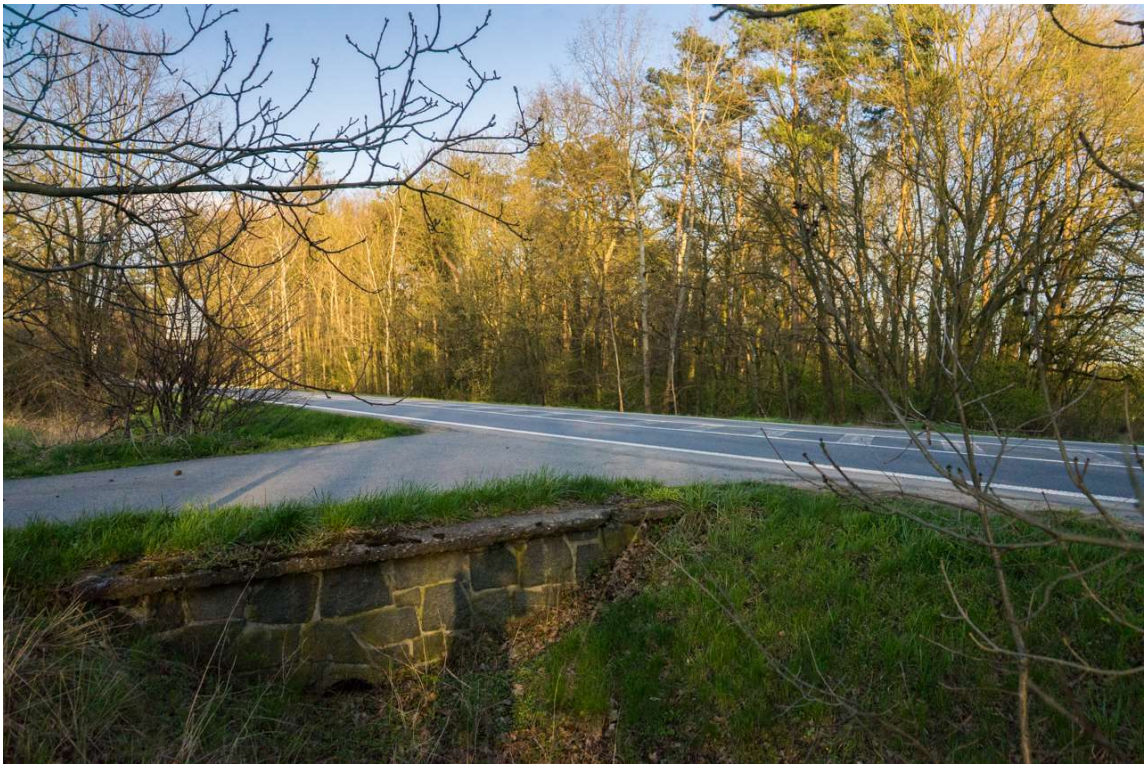


Image 40 - site on the I/2 road, where a subway for the proposed C line would be located.

Image 41 - view south of the I/2, where the variant C line would go to approach the airport.

Image 42 - view north of the I/2 road in the direction of the pedestrian pathway