PRESENT AND FUTURE EUROPEAN RAILWAY CORRIDORS IN ČR AND SR

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Abstract – Czech and Slovak Republic became contracting parties in European Projects AGC, AGCT, TEN-T, TER which ought to ensure the high speed railway passenger and goods transport in Europe competitive to the road and air transport. This aim has an environmental accent as well because negative ecological influences of railway transport are much less than that of road and air transport.

1. European Projects AGC, AGCT, TEN-T, TER

Czech and Slovak Republic (ČR and SR) are contracting parties of the European Agreement on Main International Railway Lines (AGC, 1985) since 1990 when having been Czechoslovakia acceded to it. The Agreement defined European railway lines network of major international importance (Annex 1) and their infrastructure parameters (Annex 2). The minimum asked speeds are:
- for existing lines and lines to be improved or reconstructed 160 km/h;
- for new lines: 300 km/h on lines for passenger traffic only;
- 250 km/h for passenger and goods traffic,
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The target of the AGC and following agreements AGCT (for combined transport), TER (Trans-European Railway Project), TEN-T (Trans-European Network) is to make the railway transport faster and more attractive against the road and air transport which lasted the environment enormously.

E.g. in Czech Republic (1999) [2],
SO₂ emissions:
- railway transport 127 t,
- road transport 3 464 t;
CO₂ emissions:
- railway transport 4 795 t,
- road transport 343 612 t.

The UIC ordered in 2000 a review about transport negative externalities summarized in EU which was worked out by firms INFRAS (Switzerland) and IWW (Germany) and where the negative externalities were given in €. Results are in Table 1.

Table 1 Negative transport influences in EU (2000)

<table>
<thead>
<tr>
<th>Transport</th>
<th>Goods [€/1000 tkm]</th>
<th>Passenger [€/1000 pers.km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>205</td>
<td>48</td>
</tr>
<tr>
<td>Road</td>
<td>88</td>
<td>87</td>
</tr>
<tr>
<td>Railway</td>
<td>19</td>
<td>20</td>
</tr>
<tr>
<td>Bus</td>
<td>-</td>
<td>38</td>
</tr>
<tr>
<td>Water</td>
<td>17</td>
<td>-</td>
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</tbody>
</table>

But in “socialist” countries, especially in Czechoslovakia, the modernization of railway infrastructure progressed very slowly. The 120 km/h maximum speed on main ČSD lines was the same like some tenth years ago. So – upon the AGC – the reconstruction of European main lines in ČR and SR up to 160 km/h operation speed as well as the order of new rolling stock for speeds 160 km/h and more are serious tasks for Czech Railways (ČD) and Railways of Slovak Republic (ŽSR) today.

2. European corridors in Czech Republic

Main lines in ČR and SR were electrified during the existence of Czechoslovakia so that both fixed installations and rolling stock were by the railway corridors reconstructions nearly the same and electric traction vehicles of long distance trains ČD and ŽSR operate on both railway networks.

But it must be said that in ČR started reconstructions sooner like that in SR and there were invested more costs in it so that the situation in both states is rather different today.

Four corridors were intended in Czech Republic (see Fig. 1):

1 – (Berlin) – Děčín – Praha – Česká Třebová – Brno – Břeclav – (Wien; Bratislava – Budapest);
2 – (Warszawa) – Petrovice u K. – Ostrava – Přerov – Břeclav - (Wien/Bratislava – Budapest);
3 – Praha – Plzeň – Cheb – (Nürnberg/München/Dresden);
The main lines 1 and 2 are at the present reconstructed nearly completely - there were upgraded about 800 km railway lines. The average Super City (SC) Pendolino tilting trains speed is higher than 100 km/h on lines Praha – Ostrava and Praha – Bratislava and it is limited by difficult conditions on the line section Česká Třebová – Brno with many tunnels and curves on corridor 1 and by not completed reconstruction on the part of corridor 3 between Zábřeh – Olomouc. Also the largest stations like Praha, Kolín, Pardubice, Č. Třebová, Brno and others were not reconstructed, some of them are just in the reconstruction now.

On the corridor 3, Praha – Plzeň – Cheb – (D), which may became a part of the Nr. 22 TEN-T Project (line Athens – Sofia – Budapest – Praha – Nürnberg/Dresden), reconstruction works started in 2005. This line has between Praha – Plzeň the maximum allowed speed up to 100 km/h only and between Plzeň – Cheb it is mostly one-track line because of the very complicated geographic line profile. It is the only one-track section on the above mentioned Europe.line so that some 30 km long section between Plzeň und Stříbro is rebuilt on double-track line in the present.

The reconstruction target is to increase the line allowed speed up to 110 km/h for classic trains and up to 140 km/h for tilting trains. But for the future HS trains with 250 km/h speed the present line is not suitable and a new HS line direction Praha – Plzeň – Germany must be chosen. The 24,7 km long tunnel between Praha and Beroun ought to create a part of the new line. Its building ought to start in the year 2011 and be finished in 2016.

The situation on the 4th corridor Praha – Č. Budějovice – (Wien/Linz) is similar like with the corridor 3. The one-track line Benešov – Č. Budějovice ought to be rebuilt on double-track one. In the opposite from the 3rd corridor, the line maximum speed can be increased up to 160 km/h. Reconstruction works on many line sections are in progress at the moment.

In Slovakia, these main lines ought to be reconstructed:

V – (Wien) - Bratislava – Žilina – Poprad – Košice – Čierna n.T. – (Užhorod), 536,2 km;
IV – (Brno) – Kúty – Bratislava – Štúrovo – (Budapest), 210, 3 km;
VI – Žilina – Čadca – Skalité – (Zwardoń), 52 km;
IX – (Muszyna) – Plaveč – Prešov – Košice – Čaňa – (Miskolc), 100 km.

The maximum speed on corridors IV and V will be 160 km/h and lines sections Bratislava – Kúty as well as Bratislava – Piešťany have been reconstructed till now. On the corridor VI, the section Žilina – Čadca – (Jablonkov) will be renewed for 120 km/h. The one-track line section Čadca – Škálovice was electrified and reconstructed for 70 km/h. Allowed speeds on the Polish corridor VI parts are today even lower so that a new line may be built if the speed ought to increase on this corridor.
During reconstruction works, all the 3 kV DC system line in Slovakia ought to be rebuilt for the 25 kV, 50 Hz supply system of which the Slovak government decided in the year 2005.

Another idea is to build a new wide-gauge line between Ukraine/Slovakia frontier and Bratislava Danube port.

4. High speed railway net planned in ČR and SR

Czech and Slovakia railway corridors will allow the maximum speed of 160 km/h after finishing reconstructions with exception some line sections. Capitols Praha and Bratislava ought to be connected in this network by new HS lines allowed the maximum speed up to 250 km/h, see Fig. 4.

Fig. 4 – European HS network planned till 2020 year
(Courtesy: UIC - http://www.uic.asso.fr/)

In Czech Republic, new HS railway lines are planned for connections (Stockholm) – (Berlin) – Praha – Brno – (Bratislava) – (Budapest)/Wien and (Warszawa) – Ostrava – Brno - (Bratislava) – (Budapest)/Wien. The most problematic is line Praha – Plzeň – Cheb – (Nürnberg) – (Paris) where after reconstruction the speed allowed will be only 110 – 120 km/h. So it is very probable that the HS line Praha – Plzeň – Rozvadov – Germany will be built as the first one because it will connect Czech and Slovak Republic with Western Europe HS railways network. For the HS railway design, regulations given by AGCT Project and UIC are valid and some lines studies were worked out.

Some main characteristic of Czech HS lines are:

- passenger trains maximum speed 300 km/h,
- goods trains minimum speed 160 km/h (or 120 km/h respectively),
- recommended/minimum curve radius 7000/6500 m,
- maximum line gradient 12,5 ° (in special cases 18,5 °),
- midway between tracks 4,7 m.

5. Rolling stock for reconstructed railway corridors

Czechoslovak Railways (ČSD) had no traction vehicles for the 160 km/h speed in the time when corridors reconstruction started. More over it, after dividing ČSFR and ČSD some series of powerful traction vehicles being suitable to be reconstructed for 160 km/h left only either in ČR or SR (series 150, 372 – ČR/ČD, 350 – SR/ŽSR).

In 90° were series ČD 150, 372 (151, 371 now) as well as series 350 ŽSR reconstructed for 160 km/h. Since the year 2000 new ČD suburban units series 471 went in operation and since the 2006 year operate ČD tilting trains series 380 (Pendolino) on reconstructed lines.

Electric traction vehicles with the maximum speed 140/160 km/h operating on ČD and ŽSR lines at present (Juni 2007):

- 151 series (13 pcs, ČD), reconstructed 150, 3 kV DC, Bo‘Bo’, \( V_{\text{max}} = 160 \text{ km/h} \), 4000 kW nominal output, operation lines Praha – Ostrava, with EC trains Praha – Žilina – Košice (SR).

Fig. 5 – Reconstructed corridors and planned HS lines in ČR

Fig. 6 – 151 locomotive on the line Olomouc – Ostrava

These locomotives haul EC/IC/SC express trains on the lines mentioned.
- **350** series (18 pcs, ŽSR), reconstructed 2 – systems 3 kV DC/25 kV AC; 50 Hz, Bo’Bo’, $V_{\text{max}} = 160$ km/h, 4000 kW nominal output, operation lines (Budapest, MÁV) - Bratislava – Praha (ČD), Bratislava – Košice with EC/IC/R trains. The both mechanical and electrical part unified with 150/151 series, similar traction characteristics (Fig. 7).

- **371** series (6 pcs, ČD), reconstructed 372, Bo’Bo’, 2 – systems 3 kV DC/15 kV; 16.7 Hz, $V_{\text{max}} = 160$ km/h, 3080 kW nominal output, operation line Praha – Dresden (DB). Rheostatic power control, unified with series 162, 163, 362, 363, 263. For EC trains on this line.

- **162** series (17 pcs ČD, 8 pcs ŽSR), Bo’Bo’, 3 kV DC supply, $V_{\text{max}} = 140/125$ km/h, 3060 kW nominal output, operation lines Praha – Ostrava (ČD), Žilina – Košice – Čierna n.T./Michalovce (ŽSR). Chopper control. For fast and passenger trains.

- **362** series (ČD 14 pcs, ŽSR 15 pcs), Bo’Bo’, 3 kV DC/25 kV; 50 Hz , $V_{\text{max}} = 140$ km/h, 3060 kW nominal output, on lines Praha – Břeclav, Bohumín – Břeclav (ČD), Bratislava – Žilina – Košice (ŽSR). Unified with 162, chopper control (Fig. 10).

Series 362 locomotive is unified with series 162 locomotive both in mechanical and electrical parts. The only difference represents the input 25/3 kV transformer with diode rectifier needed for the 25 kV; 50 Hz supply.
- **471** series electric motor unit (EMU) (ČD – 25 pcs, 9 ordered), 3 kV DC, Bo´Bo´ + 2´2´ + 2´2´, 140 km/h, 2000 kW traction/EDB output, consisting of 471 series driving trailer, 971 series steering coach, 071 series intermediate passenger coach.

Fig. 11 – ČD 471EMU called “City Elefant” at the Praha hl.n. station

The 471 driving trailer is the world 1st traction vehicle with asynchronous drive with VVVF IGBT inverter fed directly from 3 kV DC supply network. The EMU can be automatically driven by AŽD Praha ATO system with automatic target braking involving energy supply optimizing programme. The 471 EMU was described in [1] more in detail.

The double-deck aluminium bodied EMUs serve in suburban traffic in Praha and Ostrava regions but because their mechanical part is designed for 160 km/h speed, they can be produced like express units as well.

- **680** series tilting 3-systems EMU (ČD – 7 pcs), 3 kV DC; 25 kV, 50 Hz; 15 kV, 16,7 Hz, 3920 kW, traction/EDB output, max. speed 230/160 km/h, (1A)(A1)22'(1A)(A1)22'(1A)(A1)22'(1A)(A1), lines Praha – Ostrava, Praha – Bratislava like Super City (SC) express trains since January 2006. The 7-section EMU 680 is produced by ALSTOM Ferrovia S.p.A. (Italy) and originally intended for the line Berlin – Praha – Wien. 680 EMU was tested for 160 km/h on ČD lines and for 230 km/h on DB lines but it was not confirmed for the regular service on DB lines yet.

Fig. 12 – ČD EMU 680 “Pendolino” on the line Praha - Bratislava

- **380** series 3-systems electric locomotive (ČD – ordered 20 pcs), Bo´Bo´, 3 kV DC; 25 kV, 50 Hz; 15 kV, 16,7 Hz, 6400 kW, 200 km/h.

Fig. 13 – Locomotive 380 traction circuits

This powerful “Middle Europe” locomotive ought to be delivered for ČD since the year 2008. The asynchronous traction drive was completed in the spring 2006 and since that time it is tested in “economical” connections on the ŠKODA research stand where always two traction motors are fed by original VVVF inverters.

Fig. 14 – Traction drive testing stand (Courtesy: [3])
The stand allows:
- "animating" inverters and drives,
- type tests performance,
- realization of research tests.

More over it, the stand allows managing different tests which would not be possible to do after installing the traction equipment into the locomotive body. Tests ought to be finished at the beginning of the 2008 year and the motion tests will follow after it.

Two locomotive bodies were set up and absolved successfully all tests upon the newest European regulations.

6. Conclusions

Czech and Slovak Republic and railway institutions improved their effort in modernisation of main railway lines and rolling stock last years also with EU support. But the integration of both ČD and ŽSR into the European HS railway network is a great task for next 10 – 15 years.

References


