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EVALUATION OF INLAND TRANSPORT INFRASTRUCTURE PROJECTS

Phased Approach to Transport Infrastructure Development

Note by the secretariat

1. BACKGROUND

The Working Party on Transport Trends and Economics (WP.5) examined at its twelfth session the transitional geometric standards developed by the TEM and TER projects, and stated that such a phased-approach was adequately addressing the difficulties that many countries would have to reach the standards requested by the AGC, AGTC and AGR Agreements (TRANS/WP.5/26, para. 26).

With an aim of assessing the impact of such an approach on infrastructure investment needs, the Working Party asked the delegate from Hungary to collect information on unit infrastructure costs to upgrade existing infrastructure conditions to the TEM and TER transitional standards, and to make an economic comparison of the different possible phasing strategies for infrastructure improvement. Accordingly, TEM, TER and the Hungarian Government were approached, and requested to comment on the following issues:

- The rationale of intermediate standards. Based on the TER experience and its relationship with AGC, which are the basic criteria to identify the standards that can be temporarily lowered or ignored? (e.g. large impact on construction/maintenance cost, future upgrading easy to implement…).
- Which standards (single/double track, nominal speed, stations and terminals…) should be primarily reviewed, and to what extent?
- Which are the actual TER implementation strategies followed by the countries? Are they upgrading their infrastructure directly to TER standards or are they proceeding on a step-

by-step basis, focused on certain itineraries and standards?

- Have you any economic assessment on the advantages and limits of a phased-approach to infrastructure improvement (linked to parameters such as the target/final standards, the macro-economic framework, the timing among different phases…).
- Based on the TER experience, what elements should be taken into account when considering the potential and the limits of a phased approach to the implementation of some of the TINA projects?
- Could you mention any studies, working papers or research conducted in this area?

Furthermore, other information has recently been made available from the EU: the TINA final report was issued at the end of the year and the PHARE study "Updating of transport infrastructure costs in acceding countries" (COWI) has been completed. Both documents provide information on infrastructure costs.

The purpose of this note is to allow the Working Party to assess the potential and the limits of a "phasing strategy to infrastructure development", thus giving valuable support to the governments and international institutions for the difficult decisions that will have to be taken in the future in order to respond to the increasing transport infrastructure needs, particularly in the CEEC region.

2. TEM AND TER STANDARDS

2.1. TEM standards

The TEM project envisages the development of a motorway network with a design speed of 120 km/h. TEM standards are generally in line with the specifications contained in annex II of the AGC Agreement for motorways. The major differences concern:

- Maximum recommended longitudinal gradient, where TEM recommends slightly lower values (1% less than AGC standards).
- Minimum recommended vertical convex and concave radius, where TEM recommends slightly higher values for the highest design speeds.
- Minimum stopping distances, which are slightly higher for TEM at the highest design speed (140 km/h).
- Minimum traffic lane width, which is higher for TEM (3.75 m) than for AGC (3.50 m).
- Minimum shoulder width, which is lower for TEM (3.00 m) than for AGC (3.25 m).

TEM and AGC specifications for structures are similar: there should be no restriction on the characteristics of the carriageway, and the minimum overhead clearance is 4.5 m.

Finally, it must be said that there are no particular limits on axle loads and vehicle gauge limits in the TEM project: the structural section of the road is calculated following the standard approach (i.e. calculating the number of “equivalent” 100 kN axles from heavy traffic forecasts, and considering a life of service of 20 years (or 40 years for concrete sections)).

Therefore, the TEM project is not setting any “transitional” standards to AGC, but merely developing these standards in even more detail, and setting up slightly higher standards in some cases. This is a sensible approach, as AGC is not intending that the whole E-network be developed as a motorway, but only establishing minimum standards for E-roads, that can be all-purpose roads, motorways or expressways.

2.2. TER standards

A major difference of AGC compared to AGR, is that it establishes very high standards for the European Rail Network. For this reason, TER standards are considered to be intermediate standards. The most significant difference is that AGR recommends a nominal minimum speed of 160 km/h on existing lines whereas the TER nominal minimum speed is only 120 km/h. For new lines, AGC standards are even higher. Other parameters that have been significantly lowered in the TER project are the minimum platform length in principal stations (from 400 m to 250 m) and the minimum useful siding length (from 750 m to 500 m).

As the costs to later upgrade these parameters are quite high, it could be said that countries in the region have clearly chosen to develop a denser network, with lower standards, rather than developing the higher-standard AGC network.

3. PHASING APPROACH: PROSPECTS AND LIMITS

3.1. TEM experience

According to the information provided by the UN/TEM PCO (see annex 1), the only feasible phased approach for roads is to construct only one carriageway in the first phase, and leaving overpasses ready for the second carrriageway. This approach could make sense when low traffic is expected in the first years of operation of the motorway. However, attention must be paid to traffic safety, to make sure that this solution does not have any negative impact. For example, the layout design for the first carriageway should include appropriate sections with sufficient overtaking visibility (which is not a concern when a motorway is constructed) and should make it absolutely clear for the user that he/she is not driving on a motorway.

Nevertheless, this approach has not been extensively used in the TEM project: Austria , Bulgaria, Croatia, Hungary Poland and Slovakia have occasionally used it. Austria, Poland and Slovakia have done so only in cases of long tunnels or bridges.

The assessment of a phased approach can be adequately made in the framework of a socio-economic cost benefit analysis, such as the assessment methodology proposed by the TINA project. The critical variables here will be the right timing for the second stage (probably somewhere between 5 to 15 years since the first stage was completed) and the adequate assessment of potential negative impacts to users (in terms of level of service and safety).

3.2. TER experience

The establishment of technical standards and operational parameters for the TER lines was in the beginning of the nineties a priority area of work, as a means to render the TER Project operational in the shortest possible time.

Bearing in mind the economic difficulties of the TER countries, the following recommendations were laid down and approved by the TER member countries in September 1993:

1. To consider the technical standards from the European Agreement on Main International Railway lines (AGC-Annex II) and the European Agreement on Important International Combined Transport Lines and Related Installations (AGTC – Annex III and IV) as long term objectives to be reached by the TER network. A justification for this decision was the example of the estimated necessary investment for one TER corridor to bring it up to the AGC parameters.

2. To consider the TER parameters as short term objectives for the TER network.

   The aim of approving the TER parameters was to take the necessary steps for a harmonized development of the TER network, so that a uniform quality of railway and combined transport services could be offered all along the TER network.

   It was stressed that important investments in infrastructure are necessary to bring the TER network, in its entire length, up to the values of the TER parameters; but these investments could be considered reasonable in comparison with those for the implementation of the AGC and AGTC parameters.

3. A similar decision was was adopted in relation to AGTC parameters: these were considered as long-term objectives, while TER operational parameters were adopted as short-term objectives.

Additionally, in the fifth TER Meeting of the Director Generals of Railways that took place on 1 – 2 October 1998 in Slovenia, it was suggested by some participants to further lower the TER standards, particularly on nominal speed. However, the participants finally agreed in confirming that the TER parameters were appropriate and that they should be considered as minimum parameters for renewal and upgrading of the railway infrastructure in all TER member countries. Exceptions are the regions where, from the topographical point of view, their implementation is too expensive.

3.3. <u>Data on investment costs</u>

Transport infrastructure costs are controversial, particularly in Central and Eastern Europe. Any figures suggested by Governments or proposed in different Phare studies have been immediately contested on various grounds (comparison with other countries, experience on actual costs…).

This problem has emerged again with the information received from Hungary on road and rail investment costs (annex 2).

However, it must be stressed that any of those data allows a first checking on the interest of a phased approach, following the TINA socio-economic cost-benefit analysis.

4. FOLLOW-UP

A phased approach seems to have a narrow, although certain field of application, mainly for projects where traffic forecasts for year 2015 appear to be low or most uncertain (below 15000 AADT or 80 trains/day) and for major, expensive structures (tunnels and bridges). Other areas where a phased approach can be considered may be urban by-passes (the first stage immediately removes most environmental and safety problems linked to through roads), and high speed train lines (where upgrading of existing lines and use of tilting technologies may prove to offer competitive services compared to the high-cost linked to new construction).

In case of a phased approach, much care has to be given to design standards that may have a negative impact on traffic safety, particularly for roads. In this case, as the first stage usually implies the construction of only one carriageway (or upgrading of the existing one), aspects such as overtaking distances and user's perception of the road (making sure he does not get the impression of driving on a motorway) must be given careful attention.

For railways: a phased approach concerning the number of tracks would have little impact, as most of the TINA rail network is already double track and electrified. However, it can be considered for all new projects. Additionally, the upgrading of existing lines up to 220 km/h could also be considered as an alternative to the construction of HST lines. The fact that CEECs have opted for moderate design speeds in the TER project suggests that a staged approach based on further transitional speeds may be feasible.

In Central and Eastern European countries, the TINA project has been successful in gathering most of the information needed to undertake an analysis on the impact of a phasing approach to the development of the TINA network. In this sense, the Working Party may ask the Government concerned to make such an estimate and to present their results to the forthcoming session.

Annex 1

COMMENTS FROM THE UN/TEM PROJECT CENTRAL OFFICE

Since the main reason for phased construction is usually the shortage of financial resources, the basic criterion to identify the standards to be temporarily lowered or ignored is the substantial saving of construction costs. However, only such savings are acceptable which will not considerably decrease the motorway's level of service and which will not result in greater deterioration of traffic safety both during the intermediate period and in the course of the delayed construction of the final motorway stage. Further criteria to be taken into account are that this final stage should be relatively easy to materialize and that the total (undiscounted) costs of both phases should not be too high in comparison to the costs of construction of full-fledged motorway (both stages) at once.

In most cases, the only feasible phase approach is to construct one carriageway only (with at least over passes ready for both carriageways). In case of relatively low traffic volumes in the first years of operation of the motorway (in most cases in the TEM region between AADT 5000 and 15000), the impact of this solution of traffic safety is not pronounced. At the same time, the construction of the second carriageway in the future is relatively easy and related traffic disturbances are limited.

All other stage construction options, such as lowering the design speed in the first phase, deletion of shoulders or construction of temporary at-grade intersections, etc. do not provide substantial savings, result in high second-stage costs (changes of horizontal alignment parameters related to subsequently increase of design speed) or in increased accident rates both during the intermediate period and during the construction of the second stage (at-grade intersections, deleted shoulders).

There are two main strategies implemented by the TEM member countries with regard to motorway construction:

1. The Czech Republic, Italy (on TEM), Lithuania, Romania and Turkey do not implement the stage approach in motorway construction;
2. Austria, Bulgaria, Croatia, Hungary, Poland and Slovakia sometimes use the one carriageway first motorway stage, but Austria, Poland and Slovakia only in cases of long tunnels (Austria - Tauertunnel, Karwankentunnel, Plabutschtunnel, Gleinalmtunnel, Arlbergtunnel, Bosrucktunnel, etc., Slovakia - Branisko tunnel) or big bridges (Poland - Torun bridge over Vistula river).

Other approaches (lower design speeds, no shoulders) are not followed. There is only one example of the "at-grade" first construction phase (Poland, section Iotrkow-Czestochowa) constructed about 30 years ago, which would not be repeated.

There is not generally valid economic assessment of the advantages/disadvantages of the phased approach, since each case is different (type of terrain, price levels, number of large bridges and tunnels, traffic volumes and traffic flow composition, accident rates, etc.). Users' costs and accident costs not taken into account, the average saving when constructing one carriageway only is about 30% of the standard (both carriageways) motorway construction costs. The total nominal costs of such a stage construction are of course higher (about 120-130% of the "at once" approach), but real (discounted) costs are almost always much lower, the difference depending on the time space between the first and second construction phase and on the rate of inflation.

Basically, the decision on the phased approach (i.e. regarding motorways practically on one-carriageway or dual carriageway first stage) should be based on the comparison of TINA project construction costs (listed in the 1999 TINA Final Report) with the users' benefits (time and fuel savings, accident rate reduction, etc.). Users' benefits could be derived from the future traffic volumes contained in the Traffic Forecast Study. Apart from this economic evaluation of the phased/non-phased approach, also the environmental and socio-economic impacts may be taken into account.

The following documents may be relevant:

- Highway Capacity Manual, TRB Special Report 209, Washington D.C., 1998
- Issues in Central and East European Transport, World Bank, Washington D.C., 1990
- AECOTEM Guidelines, document TEM/CO/TEC/46, Warsaw, September 1991
- Economic Evaluation of Highway Projects, document TEM/CO/TEC/4, Warsaw, December 1985
- Traffic Forecast on the Ten Pan-European Transport Corridors of Helsinki, Final Report, NEA-INRETS-IWW, August 1999
- TINA Final Report, Vienna, October 1999
- A Policy on Geometric Design of Highways and Streets, AASHTO, Washington D.C., 1990
- TEM Standards and Recommended Practice, document TEM/CO/TEC/51, July 1992 (under revision)
- Phare Study "Updating of Transport Unit Costs in Acceding Countries", Cowiconsult, Denmark, 1999.

ANNEX 2. INFORMATION RECEIVED FROM HUNGARY

COMMENTS FROM HUNGARY ON ROAD INVESTMENTS

The phasing approach was very negative as many and severe accidents occurred. One such section of the Motorway M1 was named “Death road” by the public and the press.

The costs of upgrading were cca half of those of the complete motorway.

Another case of phased construction is the Southern part of the motorway ring M0 around Budapest, where 2x2 lanes operate on a single carriageway. Here there are also frequent and grave accidents. Thus the two traffic directives were separated by “New Jersey” type barriers on the continuous sections.

In case of a phased approach, all traffic engineering equipment must have maximum standards, signing and marking must be most carefully implemented, because of the higher accident risk.

Net unit road investment cost in Hungary (*Million HUF/km* **- Million Euro/km)**
Price level of January 2000

ROAD TYPE	RURAL SECTION			URBAN SECTION		
	Plain	**Hilly**	**Mountain**	**Plain**	**Hilly**	**Mountain**
Motorway (2x2 lanes)	*1400* **5,41**	*1700* **6,56**	*1900* **7,34**	-	-	-
Expressway (2x2 lanes)	*750* **2,89**	*1020* **3,94**	*1200* **4,63**	*1100* **4,24**	*1450* **5,60**	*1700* **6,56**
First class main road (total cross-section width: 23,0 m)	*500* **1,93**	*650* **2,51**	*780* **3,01**	*700* **2,70**	*900* **3,47**	*1100* **4,25**
(total cross-section width: 17,5 m)	*410* **1,58**	*530* **2,05**	*630* **2,43**	580 **2,24**	*750* **2,90**	*870* **3,36**
(total cross-section width: 12,0 m)	*320* **1,24**	*410* **1,58**	*480* **1,85**	*450* **1,74**	*570* **2,20**	*670* **2,59**
Second class main road (total cross-section width: 11,0 m)	*240* **0,93**	*300* **1,16**	*350* **1,35**	*300* **1,16**	*380* **1,47**	*460* **1,78**
Connecting road (total cross-section width: 9,5 m)	*140* **0,54**	*190* **0,73**	*230* **0,88**	*180* **0,69**	*260* **1,00**	*310* **1,19**
Secondary road (2x1 lanes)	*90* **0,35**	*130* **0,50**	160 **0,61**	*120* **0,46**	*160* **0,62**	*220* **0,84**
Cycle road (total cross-section width 4,0 m)	*40* **0,15**	*60* **0,23**	*70* **0,27**	*60* **0,23**	*80* **0,31**	*90* **0,35**

Net unit rail investment costs in Hungary (*Million HUF* - **Million Euro)**
(Price level of March 2000)

Name	Unit	Unit price		With costs of overhead wires and safety equipment	
Track replacement: 54 kg/m joint-less rails, 50 cm bed 20 cm improved soil, terfil	km				
Replacement with machine chain, concrete sleepers, elastic fastenings					
- trapezoidal section, distance of sleepers 60 cm		*123,4*	**0,48**	*197,4*	**0,76**
- box section -"-		*107,9*	**0,42**	*172,6*	**0,67**
New track construction: 54 kg/m rails	km				
Construction with machine chain; joint-less 50 cm ballast, distance of sleepers 60 cm, 20 cm improved soil + terfil with trapezoidal section		*108,2*	**0,42**	*173,1*	**0,67**
New track construction: 64 kg/m rails	km				
Construction with machine chain; joint-less 50 cm ballast, distance of sleepers 60 cm, 20 cm improved soil + terfil with trapezoidal section		*114,5*	**0,44**	*183,2*	**0,71**
Replacement of switches in the track	rail-siding				
Replacement of "48.XI" switches on concrete sleepers with 20 cm improved soil		*13,7*	**0,05**	-	
Replacement of "38.XIII" switches on wooden sleepers with 20 cm improved soil		*10,3*	**0,04**	-	

In the latest years Hungary constructed only 19 km brand new railway line towards Slovenia (Zalalövõ-Bajánsenye/Hodos). The joint-less track's operating speed limit is 120 km/h for diesel powered engines. The one third part of the track runs on bridges or in tunnels because the hilly geographical situation.

The unit cost of this track is: 1.158 million HUF/km = 4.47 million EURO/km.

This cost contains of the cost of dispossession of property for railway purposes.