"YUNITRAN" RESEARCH CENTER

TECHNICAL OFFER

HIGH-SPEED STRING TRANSPORT LINE

"QUEBEC - MONTREAL - OTTAWA - TORONTO"

GOMEL 1997

TECHNICAL OFFER

High-Speed String Transport Line
"Quebec-Montreal-Ottawa-Toronto" (760 km)

1. String Transport System

1.1. Principal Route Diagram

The String Transport System (STS) is a string rail route to carry electrical wheel vehicles. A specific feature of the route are the strings within special rails stretched to the total force 250 tf per rail. The strings are rigidly secured to anchored supports spaced every 500...2000 m, the route structure being carried by intermediate supports spaced every 10...100 m. The strings are arranged within the rails having a deflection of several centimeters increasing to the span center and reducing to zero over the supports. Hence, the rail head supporting the vehicle wheel statically has no deflection or joints throughout its stretch. While remaining highly straight and rigid the STS rigid structure promises to allow speeds of 350...400 km/h and more in the future. The design, technological and other STS features are demonstrated in more detail in [1].

An international invention application "Linear Transport System" has been filed with # PCT/IB94/00065 dated 08.04.94 under which an international patent search has been accomplished, it has undergone expertise and initial patents have been obtained in the Russian Federation and South African Republic (the patenting is underway in 20 countries). The inventor also filed applications for industrial samples of the vehicle and string rail for legal protection of the inventions.

1.2. Route Line Scheme

Fig. 1 shows the route line scheme. The optimal spacing between intermediate supports is 25 m. This spacing can be reduced to 10 m along the stretches with more intricate profiles or increased to 100 m. When the spacing is larger (the modern materials allow to have the spacing 2,000 m and more) the route structure will be supported with ropes or cables (like suspended bridges).

Considering that the STS is easily adaptable to the terrain profile the intercity line can run along the shortest cuts or straight. When necessary, the route structure can be curved in both vertical and horizontal planes. For comfort (so that passengers are not affected by overloading along curved stretches) the curvature radii should be at least 10,000 m.

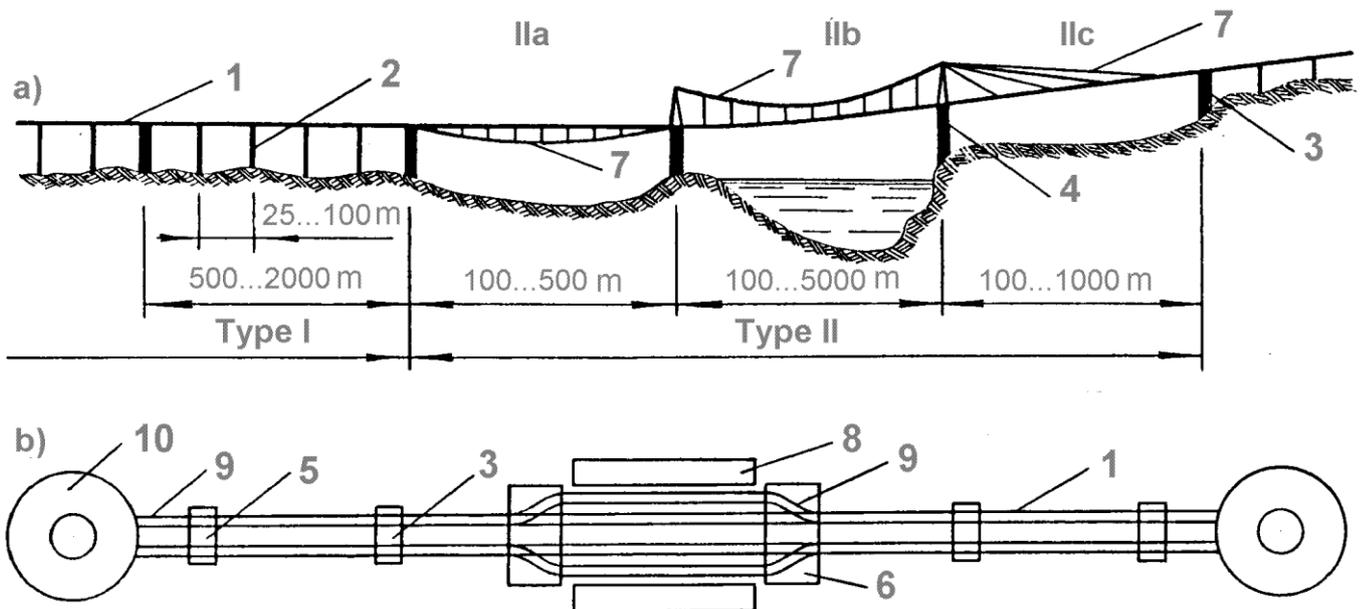The stretch of the route will amount to 760 kilometers.

Fig. 1. Route Line Scheme:
a) side view; b) top view; 1 - double-track structure; 2 - support; 3,4,5,6 - anchored supports, correspondingly: intermediate; pylon; end; with switch point; 7 - supporting rope; 8 - intermediate station; 9 - part of the route constructed with normal rails (railway type); 10 - end of route station.

1.3. Route Structure

Depending upon the span the STS structure is divided into two typical types (Fig. 1): I - common design (the span is up to 100 m); II- additional supporting cable structure (the span is over 100 m) with the cable arranged: (*a*) underneath; (*b*) above with parabolic deflection (*c*) above as guy ropes.

1.3.1. Rail-String

Fig. 2 shows the rail-string design. Each rail head is a current carrier electrically insulated from the carrying structure and other supports and rails. Each rail has three strings of wires 1...3 mm in diameter stretched with the total force 500 tf for the route structure and 1000 tf for the double-track route. The wires in the string are encapsulated in a protective sheath between the supports, they are not linked together being arranged in a special corrosion resistant composition. The strings are rigidly secured in the anchored supports. The rail design is described in more detail in [1].
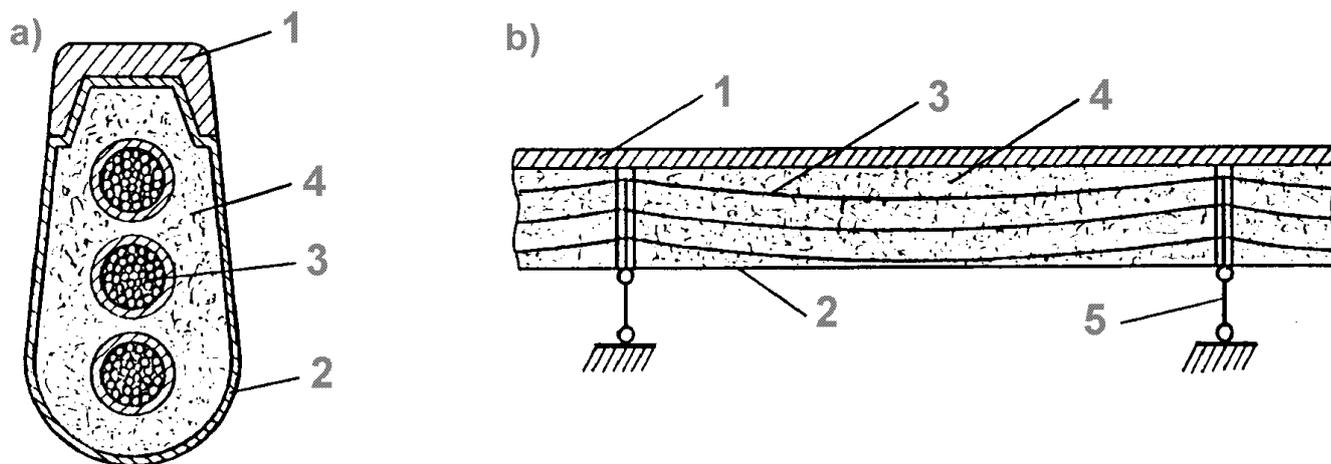

Fig. 2. Rail-string Design:
a) cross section; b) lengthwise section; 1 - head; 2 - body; 3 - string; 4 - filling; 5 - support.

1.3.2. Carrying Cable

Like the strings in the rail, the carrying cable is made from heat resistant steel wires enclosed into a protective watertight sheath. The free space in the cable is filled up with a corrosion resistant filler. The longer the span the greater is the cable diameter. For example, due to a low material consumption for the route structure and its light weight, the cable 100 mm in diameter carries the STS span 500...1000 m long, i.e. it allows to cross wide rivers in a single span.

1.3.3. Route Structural Rigidity

The STS route structure requires little material, about 100 kg/m, still allowing to achieve a highly strong tensioning of the strings. It has a typical small deflection of the structural elements both under its own weight (see Table 1) and under the weight of moving vehicles.

Table 1

Deflection of the STS Structure under its Own Weight

Span, m	Static (erection) deflection of structural elements			
	string in rail		guy cable	
	Absolute deflection, cm	Relative deflection	Absolute deflection, m	Relative deflection
25	1.6	1/1600	-	-
50	6.3	1/800	-	-
75	14.1	1/530	-	-
100	25	1/400	0.25	1/400
250	-	-	1.56	1/160
500	-	-	6.25	1/80
750	-	-	14.1	1/53
1000	-	-	25	1/40

The deflection figures in Table 1 determine the height of the STS spans, their sliminess and aesthetic appearance. In any case, the STS structure is much slimmer than bridges, road arteries, viaducts and other similar structures of highways and railways or girders of monorails.

The strings will have a deflection after erection concealed within the rail. When the span is 25...50 m the string will have the relative deflection 1/1600...1/800 and absolute deflection 1.6...6.3 cm in respect to the span. This deflection is easily accommodated within a specially designed rail 20...25 cm high.

In any case, the above deflections appear after erection without affecting the smoothness of rail heads which are very rectilinear when unloaded. The route curvilinearity in the vertical plane appears under a moving load, it is induced by winds and moving vehicles in the horizontal plane. The maximum static deflection produced by a vehicle (2,500 kgf) braked in the span center will be within 1/800 for the rail and 1/2400 for the span supported by the cable. Dynamic deflections at speeds over 200 km/h will be significantly less than those indicated above (within 1/10,000...1/2,000, or within 5...10 mm in absolute figures for a 25-m span). These figures prove that the STS is more rigid (in respect to the rolling stock) than railways, bridges and highway loops which have a greater estimated deflection under nominal loads.

The structural features of the route and the modes of movement of the vehicles have been investigated and designed so as to eliminate resonance phenomena in the rail-string. Moreover, appearing vibrations will remain behind a moving vehicle, they will attenuate within 0.1...0.5 s, consecutive vehicles will run along undeflected, perfectly smooth rails.

Variations of temperature-induced deformations of rail-strings are compensated by temperature strains, hence, variations of the span relative deflection will insignificantly affect the route's rail-string smoothness when the span between the anchored supports remains unchanged. The string will not have any deformation seams along its stretch, it will respond to temperature variations like a telephone wire or a power transmission line which are also suspended with deflection between supports without joints for several kilometers, like the strings in the rail. The maximum temperature variations for 100° C, for example, -50° C (winter) to $+50^o$ C (summer) will cause relative deflection variations within 1/10,000 basically without any effect upon the route smoothness. Elongation strains in the string will add approximately 500 kgf/cm^2 in and deduct the same 500 kgf/cm^2 in winter. A smaller temperature difference will produce a milder strain deformation of the rail-string.

Taking into account a highly streamlined design of the STS and the vehicles, the relative deflection of the STS route under the influence of lateral winds blowing with the speed 100 km/h will amount to 1/10,000...1/5,000 without any significant effect upon the transport line's performance.

The route's smoothness will not be affected by the ice appearing on the STS structural elements at negative air temperatures. Yet, considering the rail-string small cross section, the streamlined design, high- and low-amplitude vibrations and other factors inhibiting icing, the latter can be fully eliminated. For example, special modules equipped with gas turbine engines can be sent regularly to melt ice film with hot air stream along the route during the most risky winter periods.

1.4. Supports

The carrying structure of the supports comprises two basic types: (a) the anchored supports to undertake horizontal forces produced by string and cable elements (Fig. 3); (b) carrying supports to undertake just the vertical load of the STS route structure and vehicles (Fig. 4).
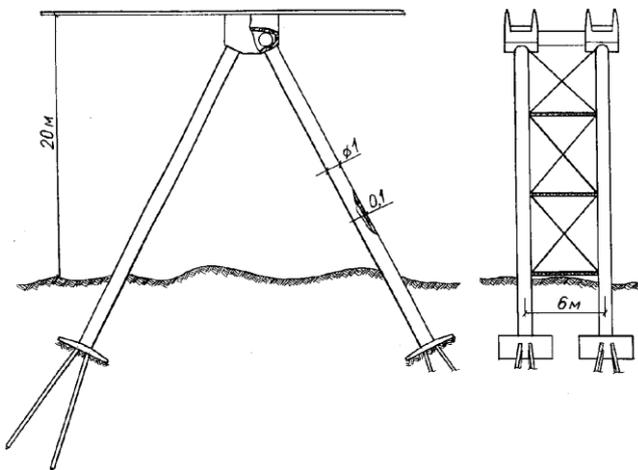

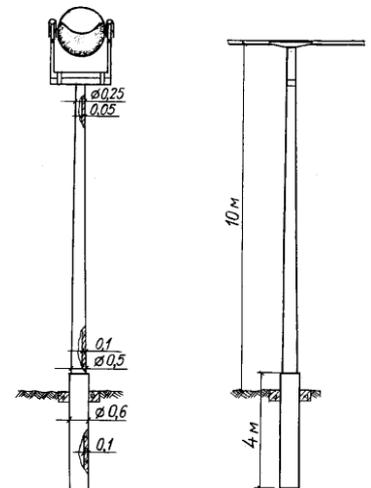Fig. 3. Anchored support of double-track STS route   Fig. 4. Small height intermediate support of single-track STS route

The anchored supports can be spaced at 0.5...2 km (the optimum span is 1 km), depending upon the terrain relief. The maximum horizontal loads experienced just by the terminal anchored supports (they are affected by one-way loading) are: 1,000 tf for the double-track and 500 tf for the single-track routes. The intermediate anchored supports (they comprise over 90% of the total number) will not experience any significant horizontal load in operation, because the forces acting upon the support from each side will become mutually balanced.

In accordance with the terrain relief the carrying supports will be spaced at 10...100 m (the optimal span is 25 m). The minimal vertical load upon the support (together with the moving vehicle weight) is 10 tf (the span is 10 m), the maximum load is 35 tf (the span is 100 m).

The terrain relief and the longitudinal route profile and the layout will determine how tall the supports should be. Table 2 is a guide for practically any terrain relief showing that they should be on the average 15 m tall.

Table 2

Determination of Average Height of Supports

Tallness of supports, m	Proportion of the supports in their total number, %
10	70
20	20
30	5
40	3
50	1.5
100	0.5
Total: average tallness of supports -15 m	100

The supports are described in more detail in [1].

The alternatives of one-track STS routes and their supports to suit various geographic conditions are shown in Fig. 5,6.

Fig. 5 - 6. Variants of signle-track STS routes for various geographical conditions

The carrying supports experience slight vertical, transverse and longitudinal loads (for example, the transverse loads appear during braking, they are transmitted by the rail-strings to the anchored supports. Therefore, the supports have typically small cross-sections, light foundations, they occupy little area and require little earthwork. It is specifically significant not to encroach upon the proprietary rights of land owners which may create serious problems. The STS can be run in a single span (up to 2,000 m long) 50...100 m high over expensive land plots with economical land use. Since the STS is a "transparent" structure (almost without shadow) it will be ecologically clean, with a low noise level, it can run over residential areas, game preservations, parks, etc.

Designs of unified modular STS supports have been developed: short (5...15 m), average (15...25 m), tall (25...50 m) and supertall (50...100 m) which are unique in their little consumption of materials and they are highly easy to fabricate and erect.

1.5. Vehicle

The passenger vehicle accommodates 10 persons (during peak hours), a cargo vehicle can carry 4,000 kg load, the motors are 80 and 40 kW, respectively, with the energy delivered through wheel which contact the current conducting rail heads (the right and the left) allowing to reach the speed 300 km/h. The drive can be designed as two motor wheels 40 kW each. A perfect shape of the vehicle body has been selected with the aerodynamic resistance factor C_x=0.075 (the model was tested in the aerodynamic tube) allowing to minimize the aerodynamic losses and noise at high speeds. Further work on the vehicle body shape provided reduction of the aerodynamic resistance factor C_x to 0.05...0.06.

To reach 400 km/h the power of the motor of the passenger vehicle should be increased to 200 kW and to 400 kW to reach 500 km/h. For the cargo vehicles to reach the same speeds it is enough to have a motor which is twice less powerful than that of the passenger vehicle (the front surface area of the cargo vehicle is two times less).

The vehicle can operate as a routed taxi from the boarding station to the destination without any driver being steered by the on-board computer. The latter is controlled and guided by line computers and central computers. The vehicle is described in [1] in more detail.
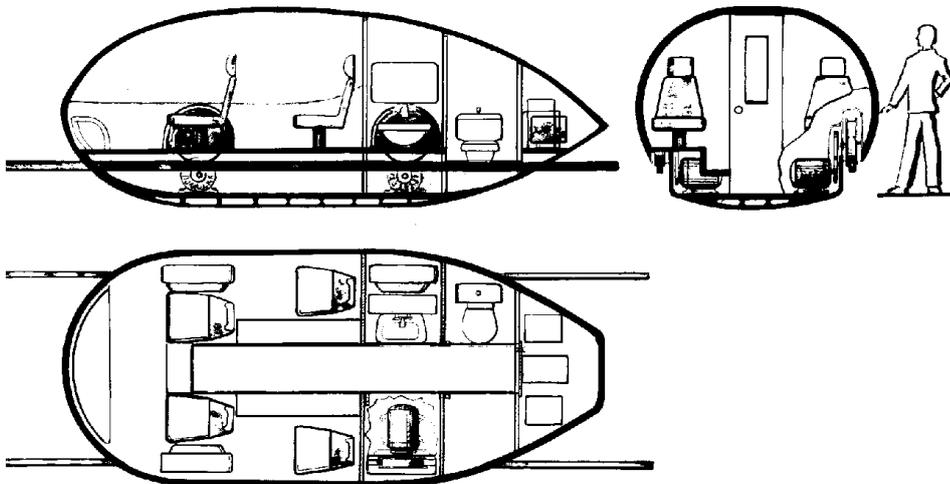
Fig. 7. Long distance travel vehicle for four passengers

1.6. Passenger, Cargo Terminals and Stations

Terminals will be circular with moving (rotating) platforms (Fig. 8) or floors. The terminal diameter is about 60 m which can be increased up to 100 m or more where passenger traffic is heavier (over 100 thous. passengers during 24 h).

Fig. 8. Station.
1 - Station building; 2 - Garage-workshop; 3 - ring-way; 4 - ring-way mobile platform; 5 - switch point; 6 - end anchored support; 7 - vehicle; 8 - entrance (exit) to the station.

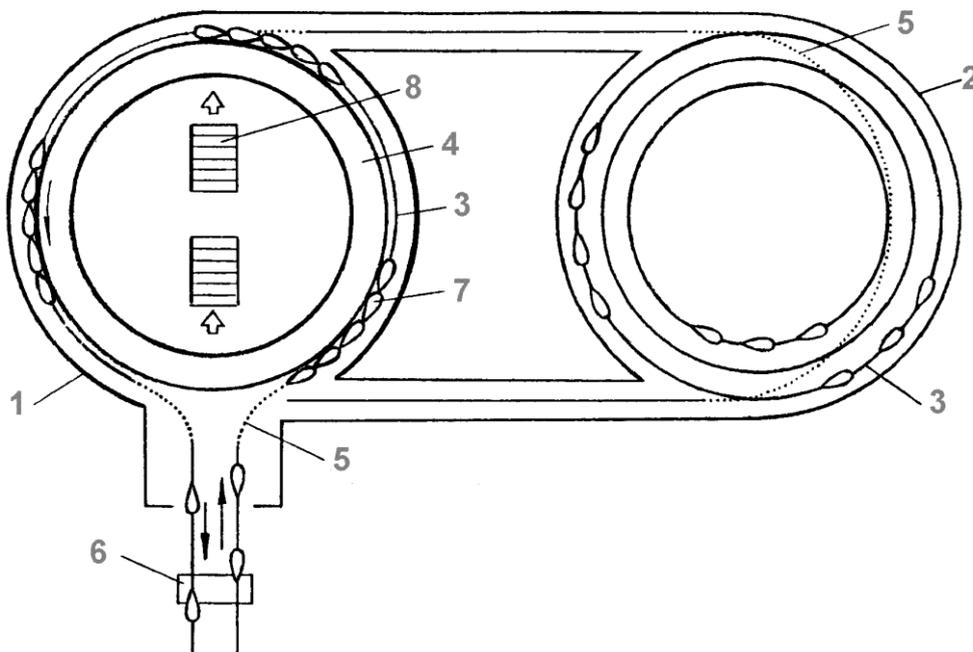Intermediate stations with significant passenger traffic will have switches and sheds to pass the vehicles irrespective of the main schedule (Fig. 1). The stations with lighter passenger traffic are made as open platforms along the route. The boarding (unloading) of passengers is effected after braking individual vehicles with vacant seats.

The route is designed to have 4 terminals and 11 stations.

Circularly shaped cargo terminals will be equipped to load and unload automatically cargo modules. They will be compact with extensive handling facilities employing a unique process of handling operations and specially designed containers for fluid, bulk and piecemeal cargo. For example, a terminal 100 m in diameter will be capable to handle about 100 thous. tons of oil (or oil products) a day (36.5 mln tons a year) or much smaller in size than a sea harbor of the same handling capacity.

Individual cargoes, such as passenger cars, can be transported on open platforms, though it may require to increase the power of the motor of a cargo module 3...5 times. Thus, passengers can get from one city to another during highway rush hours and with unfavorable weather conditions (glass ice on the ground, snow storm, etc.) without leaving their cars.

1.7. Management of Passenger and Cargo Traffic

1.7.1. Boarding and Unloading

Upon entering into the terminal the passenger sees a lighted sign on each vehicle (the sign can either be on the vehicle wall or on the terminal wall as a running string of information) indicating the destination name, for example, "the terminus". If the required destination is not indicated the passenger can board a vacant vehicle and press the "terminus" button (inside the vehicle). Passengers will have 0.5...2.5 min. to board if the moving platform with the vehicle on it has the speed 0.5 m/s and the circular route is 50 m in diameter. After the door is shut (automatically or manually) the vehicle is released from the moving platform, the switch transfers it to the track line. In case the door has not been shut or the boarding has not been completed or there are no passengers the vehicle is returned to the second round on the platform. Similarly the passengers land at their destination in reverse order. In its general implementation it resembles the handling of baggage along circular conveyers at modern airports. If necessary, some vehicles may be directed to workshops in a separate building or at another floor of the terminal.

1.7.2. Cargo Handling

Cargo is handled automatically at cargo terminals. Consignments are delivered to the terminal and forwarded to a consignee by other means, such as an oil pipeline. Large consignees and consignors, such as oil refineries, will have their own terminals.

Full containers are loaded into the cargo modules which are then marshaled into trains and directed to the transport line. At destinations containers are removed from modules and directed for unloading, their places are occupied by empty containers or containers with other cargoes. The capacity of a container is 1000...4000 kg. Each container is accompanied with an electronic card to be read by the on-board computer to enter the nature of a consignment, its weight, conditions of transportation, destination, consignee, etc.

Passengers can continue to travel in their cars on a special open platform or they can forward to dispatch their cars ahead of them or behing them in an open cargo module and travel in the passenger vehicle.

1.7.3. Traffic

Vehicles are grouped together electronically, for example, into trains of five vehicles with the space between them 100...500 m. The control system along the entire route maintains the same speed of the vehicles in the train and the spacing between them. To maintain the traffic of 1,000 passengers per hour one train of five vehicles should leave the terminal every three minutes. The average spacing between the trains will be 14 km at a speed of 300 km/h. This spacing is sufficient for maneuvering when passengers board or unload at intermediate stations. The running trains will be grouped at boarding stations and by adding vehicles at intermediate stations (at the head or at the tail). Therefore, the control system will both send vehicles and control their location coordinating their "synchronization" in time. Some stations may have special marshaling facilities to accumulate vehicles. The speed will be set from 200 km/h (along the ascents) to 300...350 km/h along horizontal stretches and descents. The line and central computers will control traffic by accumulating information about the location, speed, destination and condition of all major units (the running gear and the drive, in the first place) of each vehicle. Modern control software allows to arrange the transport traffic of STS vehicles with 100-percent safety without human involvement.

A system similar to the one developed in Japan for the self-controlled Mitsubishi car can be employed to control the STS vehicles. Each vehicle will have three on-board TV, infrared and ultrasound systems running

simultaneously. The on-board computer will receive signals from the vehicles ahead to analyze and adjust the proper speed and the spacing. Also, there will be mutual information exchanges and with the line and central computer systems to check the location, speed, condition of the route structure, supports, switches, irregularities, track defects, etc. The on-board computer system will employ microprocessors to process the data from built-in sensors, TV and IR cameras, mechanical means. Relevant commands will be issued for various executive mechanisms. The maneuvering operations are automatically coordinated with the route on-line computer system in order not to affect the transport traffic.

1.7.4. Route Traffic Capabilities

When trains comprise 10 ten-seat vehicles moving with the speed 300 km/h with the interval 30 seconds, the traffic along a single line during peak hours will amount to 12,000 passengers/h and 24,000 passengers along the route (with two oppositely directed lines) or 576,000 passengers every 24 hours pr 210 million passengers a year. There is still a margin to increase the traffic without adding more lines.

The minimal distance between cargo modules along the line is 50 m (50...100 m is the minimal urgency deceleration by throwing out a braking parachute), hence the ultimate traffic capacity of a single line at a speed 300 km/h is 24 thous. t/h or 576 thous. t/day (210 million t/year). The maximum traffic capacity of a double-track line is 48 thous. t/h. 1,150 thous. t/day, 420 million t/year.

The actual scope of cargo and passenger traffic will be one order of magnitude less because the route will operate at its 10-percent capacity, it will promote the reliability and safety of the transport system in operation, in the long run.

1.7.5. Traveling Time

Table 3

Time spent by passengers for travel
from downtown Quebec to downtown Toronto (760 km)

№	Transportation process	Time, min. at the speed of	
		300 km/h	400 km/h
1	Waiting for a vehicle to arrive	1	1
2	Boarding	2	2
3	Waiting for start	1	1
4	Joining the main traffic	1	1
5	Acceleration to the calculation speed	2	3
6	Traffic along the route	150	111
7	Deceleration	2	3
8	Driving into the terminal	1	1
9	Unloading of passengers	1	1
10	Unforeseen time losses	4	6
	Total:	165 (2 hrs 45 min.)	130 (2 hrs 10 min.)

Time spent for traveling to other communities is shown in Table 4.

Table 4

Time spent by passengers for traveling from Quebec at the speed of 300 km/h

Station	Distance between stations, km	Time en route with incrementation
Quebec		
	240	58 min.
Montreal		
	160	1 hour 31 min.
Ottawa		
	360	2 hours 45 min.
Toronto		
Total:	760	2 hours 45 min.

1.8. Safety and Reliability

1.8.1. Safety at Terminals
The safety of passengers is achieved by the synchronization of speeds and the circular terminal platform, for example, by joining them with mechanical means. The platform should move with the speed 0.4 m/s for the passenger traffic of 2,000 passengers per hour with a full turn during 6.5 min. (when the outer diameter is 50 m). Electrical safety is achieved by using safe electrical voltage (12 or 24 V) or batteries in vehicles, or electrical current of the same voltage supplied through the rail track to exclude shock hazards.

1.8.2. Transport Line Electrical Safety and Reliability
Safety is ensured by a relatively small voltage in the line (about 1,000 V), insulation of current carrying rail heads and supports and by non-conductive vehicle bodies made from composite materials. Hence, in case a vehicle misses the rail track it will not produce any short-circuiting between rail heads.

When the traffic reaches 1,000 passengers per hour (24 thous. passengers a day and cargo traffic 2 thous. t/h or 17.5 million t/year) along a leg 100 km long, 35 passenger vehicles and 170 cargo vehicles will run simultaneously with the total power of motors 9,600 kW. No additional transmission lines to supply the STS and its infrastructure are needed, because the rail-string will allow to transmit the electrical power over 10,000 kW (up to 100,000 kW, if it has a special design). Therefore, the STS should be connected to the existing grid every 100...300 km and more.

1.8.3. Traffic Safety
Traffic safety is achieved by failure-free operation of all the systems effective to maintain the routine mode of traffic: the computerized control means, reliable electronic systems, communication lines and measuring instruments, executive mechanisms of switches and drive controls and the braking system, reliable mechanical members of the route structure, STS supports, etc. A hundred-percent safety of the traffic processes is evidenced by the experience of operation of high-speed railways in the world. For example, high-speed railways in Japan have transported over 5 billion passengers during 20 years of operation without any accidents or casualties.

The STS employs four vehicle braking modes: routine (acceleration is 1 m/s^2, the braking path is 3,500 m), urgent (2.5 m/s^2, the braking path is 1,400 m), emergency (10 m/s^2, 350 m) and extreme (50 m/s^2, 70 m). The emergency an extreme braking are achieved by actuating all the braking systems, including parachutes provided in each vehicle. Once the explosive charge ejects the parachute, safety air cushions are inflated in the passenger salon to exclude lethal traumas under the above loads (the peak overloads will be approximately equal to those experienced by car passengers in collisions with immovable obstacles at a speed 25 km/h.)

 In case of power failure each vehicle is equipped with a battery and an emergency starting motor which will deliver the vehicle at a slower speed to one of the stations or emergency stop platforms on each anchored support, i.e. after every 1...2 km. If necessary, the route portion with power failure can be run through solely on batteries which can be recharged en route over the route portions with normal power supplying.

1.8.4. STS Structural Reliability and Functioning
STS cable and string elements of rails and carrying structures are exposed to the utmost strain. Since they are in the corrosion resistant medium in the special sheath and in a mechanically strong body protecting them against external effects, their service life can amount to hundreds of years and longer. Also, the traveling load alters the stress-strain state of these elements only by one per cent (see [1], p. 8) and this state remains basically unchanged during the entire period of operation extending the service life and saving operation costs. Since the string elements are located in different remote places (mutually isolated wires in the strings of the left and right rails, the one-way and return lines, the upper and lower strings, etc.), the probability that they snap simultaneously is close to zero, even in case of disasters, such as earthquakes, floods, landslides, hostilities, etc.). Even in case 90% of carrying wires snap, the structure will not collapse, unlike other structures, such as bridges, highway loops, viaducts, modern skeleton buildings, etc.

The STS route structure remains highly durable even when destroyed by terrorists. A support is secured to the route structure with a special unfastening mechanism which releases it making just the rail-string span longer and increasing its corresponding deflection. It will not destroy the integrity of the route even in the case when several supports in line are destroyed.

The results of a model of the STS vehicle tests in the aerodynamic tube at a speed 250 km/h at the Central Research Institute named after the Academician A.N. Krylov (Saint-Petersburg) have manifested that lateral winds

blowing with the speed within 100 km/h produce lateral capsizing forces within 100 kgf. They will not affect the functioning of the transport system, the more so they will not derail vehicles.

1.8.5. Ecological Safety

The STS transport system is highly safe ecologically both during erection and in operation.

The STS can be erected without any special equipment (such as platforms or construction power shovels) without using road approaches because the necessary materials and structural members will be delivered along the erected route stretches. Also, erection may obviate the need of earthwork destroying the soil level or the humus accumulated during millions of years, because the supports will be erected on posts driven into land as foundations. these features are extremely essential when the route runs over fertile or most valuable plots of land.

The STS will consume electricity for its operation as an ecologically clean source of energy. Passenger vehicles and transport modules will be airtight and they can stop only at special stations, it will eliminate contamination of the environment by passengers or any sorts of industrial waste. The containers are designed to exclude leaks (they will have no pumps, valves, seals and other joints which may leak) or losses of bulk cargoes. Any crush along the route may cause derailing of just a single module (the extreme braking path of the next module will be less than the distance between the two), also a parachute will be activated to decelerate the container so that it does not disintegrates when it drops on the land surface.

The STS needs no embankments, cuttings, tunnels , bridges or conduits. One carrying support occupies just one square meter, the anchor support occupies 10 square meters. Hence, one kilometer will require the area less than 100 square meters, i.e. 0.01 hectare, therefore the conventional land alienation will be within 10 cm. It is much less than the area occupied by a walking path.

The length of a span is not critical because both forests or individual trees along the route may remain because any support can be shifted this or that way straight during construction.

The STS route will not interfere with the migration of soil and surface water, animals, reptiles, crop growing or any other land use.

The STS will be a low-voltage line, so it will not create any electromagnetic interference and it can pass quite high (up to 100 m) over residential buildings, crop land, over game preservations and parks. Absence of sliding electrical contacts in the vehicle-contact grid couples (unlike railways) and the power of the motors exclude radio noise.

The STS requires extremely few materials for its erection, therefore it will be ecologically clean in this respect. For example, a single-track route as long as a railway can be erected from the materials of just a single rail and each third sleeper (the railway has still the second rail and 2/3 of sleepers, the contact grid, rail conduits, viaducts, etc.). Hence, the STS for its erection will not require as many blast furnaces, ore, mines (to produce steel, copper), cement and reinforced concrete plants , earth, sand and gravel quarries, the scope of deliveries by trucks and by railway cars of the materials, special approaches, etc., which would incur an additional, sometimes irreversible ecological damage.

The STS vehicle has no projecting parts, excepting narrow wheels protruding for 10 cm from the body. It needs no windshield wipers or lights (because there is no driver) which produce noise at high speeds. The wheels can be fabricated from light alloys (the load per wheel is 500...1500 kgf), therefore they can weigh within 10...20 kg. Hence, a STS train weighs hundreds of times less than a railway train, it is tens of times shorter and runs much smoother because of the track smoothness (what can be more straight than a strongly tensioned string?). Therefore, the STS train will produce hundreds of times less noise and vibration than high-speed trains.

1.9. Communications Infrastructure

The STS will be not only ecologically safe transport system providing comfortable, cheap and quick delivery of passengers and cargo. It will also be a very important demographically oriented factor and major communications system supplying power and information for other transport types because power lines, power plants using ecologically safe power sources and telecommunications lines (wired and fiber optic) may be easily combined with it.

1.9.1. Autonomous power supplying

At present the nature is effected in the most negative way by modern power plants. That's why it is more efficient to use autonomous power supplying in the STS that is based on the natural power sources - sun and wind. With consideration of the direct environmental effect wind based power supplying is one of the most safe power sources. It does not contaminate the atmosphere and water with hazardous substances, it does not reduce the limited

amount of unrestorable mineral resources, it does not change the normal regime of water supplying.

The basic elements of the wind based and helios power units that may be combined with the supports and other elements of the STS were worked out. It allows to decrease the cost of their construction radically. For example, the cost of the mass produced air unit will be within 1000 US$ per 1 kW of the power while the cost of atomic power plants, for example, has increased from 300 US$/kW in 1960 to 4000...5000 US$/kW at present time. Such price increase in for atomic energy is basically determined by the increased safety and ecological requirements. Considering that the wind units completely meet these requirements, in the future they may be even more preferred than traditional sources of electrical power.

The wind units can work at the wind speed over 2 m/sec. and will generate the power of 5 kW at the wind speed of 5 m/sec., 50 kW - at 10 m/sec. and 150 kW - at 15 m/sec. They will be easily starting due to high torque, provide noiseless work and create no danger for birds due to the low turning speed. Wind based power stations placed on a height level will not require additional land space and allow to conduct agricultural and other activities under them.

The STS will need power source with 100...200 kW/km power or two wind based units with the power of 50...100 kW at each kilometer of the route. The maximum number of the units corresponds to the number of supports, i.e. 20...50 supports/km, and their total power may be 1000...5000 kW/km. Thus the total power of the STS power units may be 1...5 mln. kW per 1000 km of the routes (at the average wind speed of 10 m/sec.) and the cost of the power generated by them will be about 0.02 US$/kW with the pay back term of 6 years. That's why the STS, in addition to the autonomous power supplying, will be a major power plant supplying electric power to the adjacent areas. There will be no need in expensive and ecologically unsafe power lines because the STS will transmit the necessary power directly to the consumers.

If the erection of an equivalent power potential with assistance, for example, of atomic power will require major centralized investments, in billions of US$, the STS wind based stations may be erected locally with fairly small local investments contributed by individual investors, residents of distantly located villages, small towns, etc.

Construction of the STS may help to resolve the problem of power supplying especially for almost undeveloped and hardly accessible areas (mountains, desert, tundra, etc.) with no industrial electrical power lines.

Distribution of the wind based units along the STS route will have its positive effect because windless areas will be permeated with areas with very strong wind that will basically supply the necessary power for the entire route.

1.9.2. Towns along the route

The STS routes also help to solve many demographic problems. New towns harmonically co-existing with the nature may be constructed along the routes within pedestrian access distance with consideration of ecologically safe transport infrastructure and noiseless vehicle traffic. It will not be required to cut forest, erect automobile roads or violate natural balance in the area in any similar way. It will be easy to develop agriculture and ecologically safe industry. Such areas will be examples of rationally organized community. The erection of such towns along the route will cost considerably less than with traditional erection. It will be just beneficial because living in the normal environmental and social conditions will become more important for people than just having something in personal possession. It will be the beginning of the future life of the society in harmony with the nature and not in opposition to it.

1.10. Attractive Appearance and Comfort

The majority of people spend their active time within a closed, limited space. Due to the ergonomics the common transport means allow to see some land surface, a portion of the road, etc.

The STS both solves the problems of comfort and its functional objective to fast deliveries of passengers to their destinations. Large windows, comfortable seats, soft silky tracks transform a common trip into the delight of enjoying the sights of nature from the birds' flight.

The appearance of slim route structures, support and stations will fit into the natural landscape without impairing the ecology or destroying even fine natural components and the historical architectural styles along the route adding islands of modern architectural shapes.

Each vehicle will be air conditioned, passengers will enjoy a broad variety of other services, multichannel music and TV, world telephone communications, special services for businessmen, passengers with children, disabled people. The STS vehicles are airtight equipped with a system of pressurized or chemical water closets to accumulate waste.

Passengers can command vehicles to stop at any intermediate station, i.e. after every 10...20 minutes.

1.11. Construction Process

The string prepared in advance is stretched to a certain tensioning (the force of tensioning or elongation in tensioning serve as a reference parameter) and its ends are secured rigidly, for example, by welding, to anchor supports. The intermediate supports are erected beforehand or in the process of tensioning or after. A platform is sent along the intermediate supports and the string which can travel independently and fix its position rigidly in respect to the supports. The hollow rail body is mounted with the help of the platform span after span, then it is fixed in the specified position and filled with a filler the rail head, the cross plank are erected and other necessary operations are performed to erect the route structure. All these operations are easily mechanized and automated, they can be performed during 24 hours every day in any weather to expedite construction reducing labor consumption and cost. To eliminate microroughnesses and microwaviness of working surfaces after the rail head is erected and to remove gaps between its joints the system can be polished throughout its length.

The STS construction process is shown in Fig. 9.
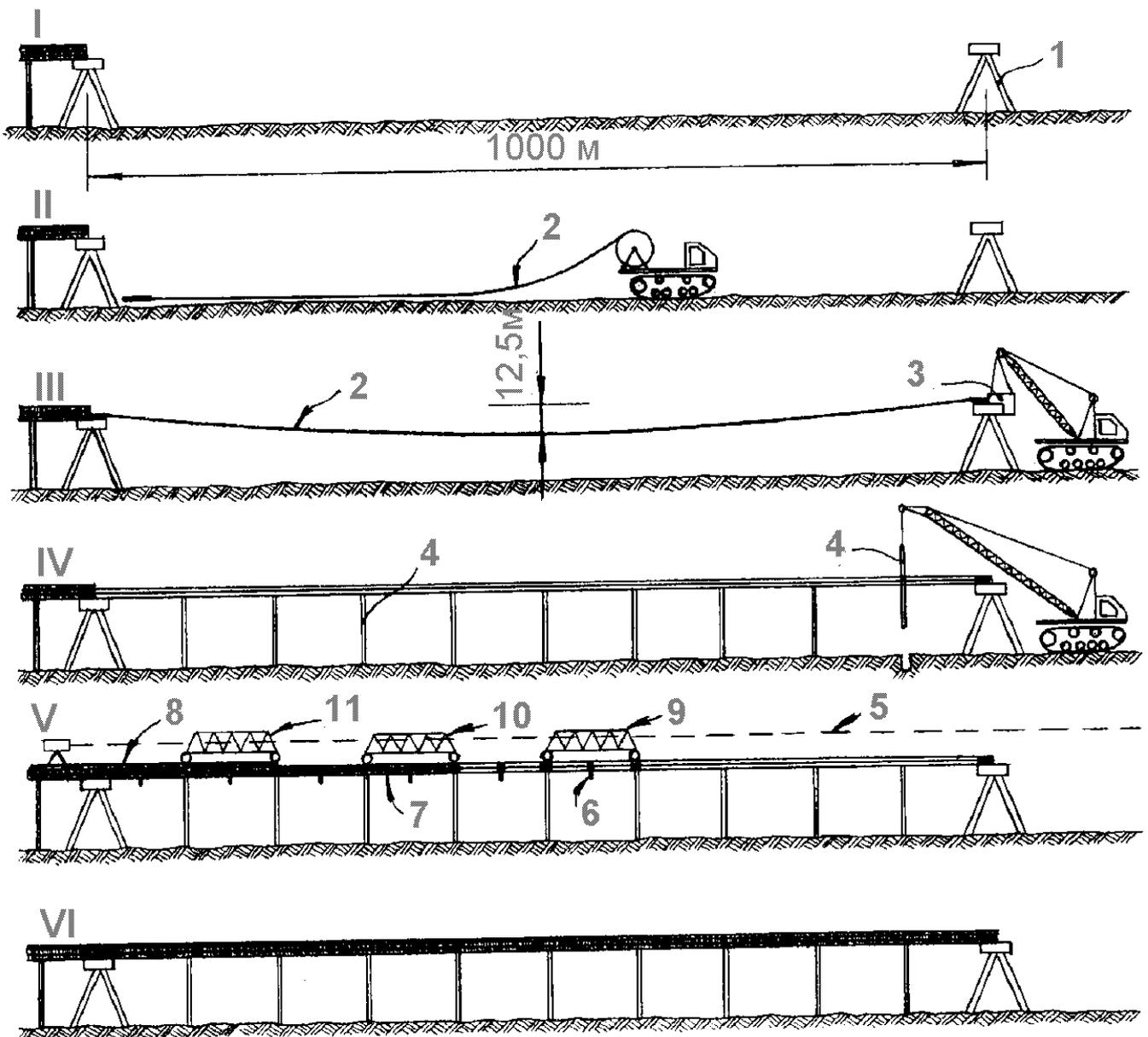
Fig. 9. STS construction process.

1 - anchored support; 2 - rope (string element); 3 - string tension mechanism; 4 - intermediate support; 5 - sight line; 6 - cross board; 7 - rail body; 8 - rail head; 9, 10, 11 - technological platforms for installation of, correspondingly: crorss planks, rail body and rail head;

I - anchored support construction; II - placement of string ropes along the route; III - string stretching and anchoring; IV - installation of intermediate supports; V - erection of rail parts and route structure; VI - constructed part of the route.

The STS can be erected with a special erection combine which tensions the string and other tensional rail members over the combine rather than over the anchor support. The combine moves along the route on its walking legs and places assembled intermediate supports with the ready rail track, once it reaches the anchor support it fastens them together securely.

1.12. Feasibility Parameters

Table 5 introduces the feasibility parameters of a double-track route 1 km long, respectively, Table 6 shows its total cost.

The following aggregate prices were used to evaluate the cost of structures: metallic structures depending upon their complexity and steel grade - 1,500...5,000 US$/t; aluminium structures - 5,000 US$/t; reinforced concrete structures - 750...1,000 US$/m^3, US$ 500 per cubic meter of monolith reinforced concrete. Eleven intermediate stations have been projected each US$ 5 million. The cost of terminals (4) and service buildings was estimated 3,000 US$ per m^2 of the area (general construction works plus engineering and technological equipment), 1,500 US$/m^2 of the area of garages (workshops) and 1,000 US$ per m^2 of the territory of cargo terminals (4).

The cost of a double-route track will be US$ 1.1 million per km, the total of the complete 760 km route together with its infrastructure is US$ 1,400 millions, including 1,085 million for the STS and 315 million for the infrastructure.

Table 7 lists the major feasibility indicators, Table 8 lists the costs of transportation (the cost of transportation of one passenger and a ton of cargo). The following parameters unlisted in the Tables were used for the estimates: cost of electrical energy - 0.05 US $/kW·h; returns yielded by the transport system: 80% from the passenger traffic and 20% from the cargo traffic.

The cost of transportation of a passenger over a distance of 760 km from Quebec to Toronto with an average passenger traffic of 50,000 passengers during 24 hours will amount to 8.29 US$, one ton of cargo (with 100,000 tons during 24 hours) will cost 2.98 US$. The transport system will yield a profit of 80 mln US$ a year. The profit can be increased significantly by raising the price of tickets to 20 US$ per passenger (the price of railway tickets). It will yield an additional profit of 210 mln. US$ (with 50,000 passengers during 24 hours). The transport system will pay back its cost during 4.8 years. With passenger traffic of 100 thous. per day the route will pay back within 2.2 years.

Cheap traffic along the transport system is due to its low cost (below the cost of a railway of the same length) and insignificant specific energy consumption for traction (for example, a STS vehicle, under other equal conditions, is 12 times cheaper than a car when estimated per passenger, including 3 times due to improved aerodynamics, 2 times due to a greater efficiency of the motor and 2 times due to a greater passenger capacity) because a 10-seat vehicle can reach the speed 300 km/h with a motor just 80 kW. Also, it has been projected that the entire route will be self-sufficient for 80% from passenger traffic, therefore to deliver a ton of oil from Quebec to Toronto will be cheaper than along a pipeline. The cost of transportation can be reduced even more if individual power plants are erected along the route which can generate energy cheaper than 0.05 US$/kW envisaged by the project.

A high passenger and cargo traffic is possible along the route because it will link the regions of Canada inhabited with millions of people, short traveling time (with the average distance between the cities along the route 200 km, the average traveling time between them is 40 min.), cheap trips allow to make one-day business trips and mutual visits of tourists, businessmen, shoppers, etc.; it will allow many people to go to jobs from one communities to another along the route. It will make car tourism cheap, because personal car can be delivered, for example, from Quebec to Toronto (760 km) just for US $ 5 within 3 hours.

Table 5

Consumption of materials and cost of one km of a double-track route

Structural element	Material	Consumption of materials per km		Tentative cost, Thous. US$ per km
		mass, tons	volume, m^3	
1. Rail-strings, total				450
Including:				
1.1 Heads	Steel	96	-	190
1.2. Body	Al sheet	5	-	25
1.3. String	Steel wire	79	-	160
1.4. Filler	Composite	-	45	20
1.5. Gluing wax	Composite	1	-	10
1.6. String protective sheath	Polymer	4	-	20
1.7. String water insulation	Polymer	2	-	10
1.8. Others		-	-	15
2. Cross plates		-	-	20
3. Intermediate supports (15 m tall), total		-	-	190
Including:				
3.1. Posts	Reinforced Concrete	-	96	70
3.2. Cross pieces, stay guys	Reinforced concrete	-	46	35
3.3. Support upper structures	Steel	8	-	20
3.4. Pile foundation	Reinforced concrete	-	48	48
3.5. Others		-	-	17
4. Anchored supports (15 m tall), total		-	-	105
Including				
4.1. Support bodies	Reinforced concrete	-	50	38
4.2. Pile foundation	Reinforced Concrete	-	36	36
4.3. Metallic structures	Steel	2	-	5
4.4. Anchor fixtures	Steel	2	-	10
4.5. Others		-	-	16
5. Earthwork		-	-	20
6. Rail power supply system		-	-	40
7. System to monitor the conditions of supports and route structure		-	-	10
8. System to monitor transport traffic		-	-	20
9. Emergency power supply system		-	-	20
10. Transport traffic control system		-	-	30
11. Emergency stop points		-	-	20
12. Surveying and mapping		-	-	50
13. Cost of land and its preparation		-	-	50
14. Other tasks		-	-	25
15. Unforeseen expenses		-	-	50
TOTAL:				1100

Table 6

Cost of double-track STS transport line "Quebec - Toronto" (760 km)

No.	Description of route elements	Quantity (volume of work)	Item cost, thous. US$	Total cost, mln. US$
1	Way structure	760 km	470	375
2	Supports	760 km	295	244
3	Terminals	4	30000	120
4	Intermediate stations	11	5000	55
5	Garages and workshops	4	15000	60
6	Earthwork	760 km	20	15
7	Rail power supply system	760 km	40	30
8	System for monitoring the condition of the supports and the way structure	760 km	10	8
9	Transport traffic control system	760 km	20	15
10	Emergency power supply system	760 km	20	15
11	Transport traffic control system	760 km	30	23
12	Emergency stop platforms	760 km	20	15
13	Surveying	760 km	50	38
14	Cost of land and its preparation	760 km	50	38
15	Research and development	-	-	25
16	Pilot double-track STS leg	20 km	2000	40
17	Other elements of the route infrastructure	-	-	50
18	Cargo terminals	4	20000	80
19	Other tasks	-	-	50
20	Unforeseen expenses	-	-	142

TOTAL: 1,400

Table 7

Engineering and Economic Indicators of the STS double-track
"Quebec - Toronto" Line

Parameter	Magnitude
1. Transport line characteristics	
1.1. Total cost, million US$	1400
1.2. Depreciation deductions, %	5
1.3. Annual operation cost & cost of maintenance and routine repairs, thous. US$	20
1.4. Term until fully repaid, years	20
1.5. Route stretch, km	760
2. Vehicle characteristics	
2.1 Cost, thous. US$:	
- passenger	30
- cargo	10
2.2. Number of seats:	
- business class	10
- first class	5
- deluxe	1
2.3. Carrying capacity, kg:	
- passenger	2000
- cargo	4000
2.4. Transport module weight (net), kg	1500
2.5. On-line utilization factor	0,75
2.6. Reserve park of vehicles, %	20
2.7. Average annual speed, km/hour	300
2.8. Engine power. kW:	
- passenger	80
- cargo	40
2.9. Vehicle annual run along 2,880 km leg, thousand km:	
- passenger	1510
- cargo	1510
2.10. Annual transportation volume by one transport module (along a 760 km leg):	
- passengers	19900
- cargo, tons	7960
2.11. Specific power losses for traction:	
- passenger, kW·h/ passenger·km	0.027
- cargo, kW·hour/ton·km	0.033
2.12. Depreciation deductions, %	10
2.13. Annual operation cost, %, versus vehicle cost	10
2.14. Term until repaid, years	10

Table 8

Cost of Transportation along "Quebec - Toronto" Line (760 km)

Parameter	Scope of transportation (both ways)					
	passengers, thousands/day			cargo, thous. tons/day		
	20	50	100	50	100	200
1. Reduced costs 760 km leg):						
- US$/pass.	18.94	8.29	4.87	-	-	-
- US$/ton of cargo	-	-	-	3.35	2.48	2.06
1.1. Costs along the transport line, total	17.01	6.81	3.39	1.71	0.84	0.42
Including:						
- depreciation deductions	7.67	3.07	1.53	0.77	0.38	0.19
- operation cost	1.67	0.67	0.33	0.17	0.08	0.04
- deductions for profit	7.67	3.07	1.53	0.77	0.38	0.19
1.2. Cost of vehicles, total	1.48	1.48	1.48	1.64	1.64	1.64
Including:						
- depreciation deductions	0.15	0.15	0.15	0.13	0.13	0.13
- operation cost	0.15	0.15	0.15	0.13	0.13	0.13
- deductions for profit	0.15	0.15	0.15	0.13	0.13	0.13
- energy cost	1.03	1.03	1.03	1.25	1.25	1.25
2. Number of vehicles for the entire route, at average transportation stretch 760 km, pcs	370	920	1,850	2,290	4,580	9,160
3. Rolling stock cost , US$ million	11	28	56	23	46	92
4. Average traffic interval between vehicles (single vehicles along one line)						
- seconds	86.4	34.6	17.3	13.8	6.9	3.4
- spacing, km	7.2	2.9	1.4	1.15	0.58	0.29

2. Comparison of the STS Performance and Economics with other High-Speed Route alternatives

2.1. General

The STS performance is better to compare with railway, automobile, air transport means and magnetic suspension trains, since the major competitors of the STS will be automobiles and traditional high-speed railways.

In all these cases a great significance should be attached to the specific consumption of electrical energy for transportation. STS transport modules have a comparatively small specific energy consumption in motion. For example, at speeds 300 km/h: 0.027 kW·pass/pass·km for passenger and 0.033 kW·h/t·km cargo traffic. High efficiency of STS motors, small energy losses in motion (good aerodynamics and low mechanical losses when a rigid wheel runs over a rigid track) make the STS transport the most economical among the existing types of high-speed transport means running with the same speeds. compared with high-speed railways in the same measures the consumption of energy is reduced 5 times, compared with magnetic suspension trains 10 times and compared with jet planes 20 times.

The STS route requires less materials, therefore it is cheaper. For example, to erect the carrying portion an insignificant amount of reinforced concrete is required - 280 m^3/km for a double-track route with supports 15 m tall. About 500 m^3/km is required if its consumption for stations and auxiliary systems is added. For comparison: consumption of reinforced concrete just for enclosures high-speed railways and routes of magnetic suspension trains is 750 m^3/km.

Since the scope of earthwork is little, so are the expenses. The STS route can run without embankments or excavations along any terrain. Earthwork will have a localized nature (drilling of holes for supports totally 100...200 m^3/km, or not earthwork is required at all in case the foundation is erected on piles. For comparison, to construct a kilometer of a modern motorway or railway requires to 10,000...50,000 m^3, 100,000 m^3 in cross country or mountainous places.

The consumption of other structural materials for the route and supports is small because cheap, available, mass-produced materials will be used.

The STS rolling stock cost can be estimated in comparison with passenger cars which are the closest analogs in dimensions and designs.

25.50 kW electric motors mass produced for the STS will be 1.5...2 times cheaper than internal combustion engines of the same power, and also more reliable, durable, easier to operate and maintain.

The STS transport module body will be cheaper than a car body of the same size because of its simpler design (absence of radiators, doors, baggage space, front hood, lights, dimensional, braking and other warning lights, windshield wipers, windows lifting mechanisms, etc.).

The STS vehicle will have a cheaper and simpler running gear and suspension (no unreliable and expensive tires, wheel turning mechanisms, simpler torque transmission to stationary wheels, no problems with tractability, etc.).

The costs of r.p.m. and torque control systems of these two transport means cost are approximately similar and are as intricate (it is a motor r.p.m. control unit in the STS and the gear box, clutches, fuel injection system, etc., in cars).

The vehicle steering system is much simpler and cheaper than in cars, because there will be few parameters: the speed, spacing between vehicles and location (the coordinate) of a vehicle along the line. Irrespective of the computer technology progress it is still complicated to steer a car, so far only human brain can tackle the problem (the driver factor should be considered when evaluating the cost of running a car: at present millions of people have to drive cars daily for hours and that with their daily shortage of time). A cheap controller with its own control software will tackle the problem with the STS controlled and guided by on-line computers integrated into a net. To control a car, in addition to servomechanisms (the steering wheel and its mounting, wheel turning mechanism, gas, brake and clutch pedals, gear mechanism, etc.) a whole system is required to visualize information for steering which is unnecessary with the STS, such as windshield wipers with their actuating mechanisms and detergent delivery system (to keep the windshield clean and to ensure proper visibility), main and auxiliary lights, instrument panel, mirrors, horn, etc..

The STS vehicle will have about the same exterior and interior as a car and can be widely variable in response to individual tastes.

Also, the STS vehicle has no fuel tank (thus, no gas filling stations along the route, refineries providing gasoline and diesel fuel, oil wells are required); it does not require any system of removing and additional

combustion of exhaust (for example, more strict ecological norms in many countries have recently made cars much more expensive).

Considering the above argumentation it can be predicted that mass produced STS vehicles will be 1.5...2 times cheaper than passenger cars of the same capacity, thus, it will be easier available (in future the STS advantages may lead to the creation of a wide string transport net comparable with the current network of motorways).

2.2. High-Speed Railway

High-speed railways (HSRW) designed for speeds 250...300 km/h are becoming more and more popular in the world. Their extension has gained priority in the transport, for example, the Council of Ministers of the European Community projects to invest about 300 billion ECU (until the year 2010) into their construction.

The common railway transport is not suitable for high speeds. Moreover, the earth bed subsidence should not exceed 1 mm, hence loose soil should be removed to a depth of several meters to erect such railways. As a rule, loose soils occupy lowlands, flooded lands, marshy land, which are a natural water system accumulating and distributing moisture among rivers. Back-filling (and compacting) in great volumes will impair the natural water flow with a serious risk of dehydration of some territories, swamping of others, losses of forested lands, arable and crop fields, etc. In fact, the high-speed route embankments will become a dike (a dam) for soil and surface water. Also, such lines will require a special enclosure (from both sides) and noise screens to fence off wild and home animals, agricultural activities, etc. In general, a high speed line will require 3.2 hectares/km (the data for Germany), the entire route "Quebec - Toronto" will require 2430 hectares of rather expensive land to be vacated.

A high-speed train is a rather strong source of noise and soil vibrations, which is not surprising with its weight of hundreds of tons, its length of hundreds of meters and locomotion consuming thousands of kilowatts. The train has a great variety of projecting pieces, connectors, joints each acting as a noise source. One wheel pair weighs about a ton, it would sure hit against microroughnesses, letting alone macroroughnesses of rail joints, for example.

The major disadvantage of high speed railways is their cost. For example, experts of the European Bank of Reconstruction and Development have evaluated that a high-speed route between Saint-Petersburg and Moscow (660 km) will cost 6...8 billion US$, transportation of a single passenger will cost 123 US$ (approximately as much as along European high-speed routes). The estimated cost of the route "Quebec - Toronto" may be 8...10 billion US$, the cost of transportation over 760 km will be 140 US$. These figures 5...10 times exceed those for the STS. The means required for erection of high-speed railway route "Quebec - Toronto" would be sufficient to construct complete STS routes over 5 thousand kilometers long.

2.3. Analysis of Motor Transport Capabilities

The automobile transport is known to be unable to compete with railways and air transport at distances above 200...400 km and more serving as a complement of the integral transport system.

Lack of competitiveness of the automobile transport as a major means of the future passenger and cargo traffic along "Quebec - Toronto" route is apparent due to the following reasons:

- even erection of a new multilane motorway will not truly increase the speed and the comfort of the automobile transport which will be much less than that of the STS with an average speed of a passenger car being below 100...110 km/h, the buses will be still slower. It means that the time needed to reach from downtown Quebec to downtown Toronto will be at least 6...8 hours, while an STS vehicle covers the distance within 2 hours and 45 minutes (within 2 hours and 10 minutes at 400 km/h speed);

- erection of such motorway (with the account of dividing strips, multiple loops at various elevations of the "clover leaf" types, acceleration and deceleration strips, parking lots for rest, etc.) will require a strip 2.5...3 times wider than a high-speed railway for the same passenger traffic or 750...900 (!) than for a STS;

- exhaust into the atmosphere by the STS will be less than the HSRW with its 0.6 grams per passenger-kilometer, or automobiles with their more than 10 grams per passenger kilometer;

- the STS vehicles will be airtight with all the waste collected and dumped at depots. Experience manifests that the strip along motorways is most exposed to waste disposed by car passengers;

- erection of a multilane motorway across will be rather costly, 5...8 billion US$, while the same STS route will cost just 1.4 billion US$.

2.4. STS versus Aviation

The STS is advantageous when compared with the air transport due to the following considerations.

Research of transport means has allowed to discriminate clearly between the competitiveness of the air and railway transport. The so-called "transport niches" are implied defining the range of distances and speeds at which a transport means provides passengers with the utmost comfort and speed all with the least energy losses.

The analysis includes whether the absolute speed of transport means is essential for passengers or the time to reach an airport or a railway station, waiting until departure, baggage handling or the actual time of traveling. The distance is estimated between destinations as the so-called "zones of equal accessibility" located downtown. Hence, for example, an air passenger needs 3...4 hours to travel from Quebec to Toronto (760 km), i.e. longer than with the STS traveling at 300 km/h (2 hours 45 minutes) or 400 km/h (2 hours 10 minutes).

However, the ecological safety is the governing factor in all these comparisons. Modern airplanes release totally 300...400 g/passenger-kilometer or 500...600 times more harmful substances into the atmosphere than the high-speed railways or the STS, respectively. Actually, this parameter is expected to reduce 3...5 times when aviation switches over to the double-contour turbojet engines.

The major share of the exhaust accumulates exactly in the vicinity of airports, i.e. around large cities when planes fly low and the engines are boosted.

At low and medium altitudes (up to 5,000...6,000 m) the atmospheric pollution with nitrogen and carbon oxides persists for several days, after that they are trapped by moisture and produce acidic precipitation.

Aviation is the sole pollutant at higher altitudes with the harmful substances persisting in the atmosphere much longer, about one year. Even conversion to hydrogen engines fails to solve the problem. Harmless releases of the engines as water vapors close to the land surface convert into ice crystals shielding land.

During multihour flight every passenger is exposed to additional irradiation of several thousand mRh/h due to natural space gamma-radiation (irradiation doze on board is 300...400 mRh/h in comparison with the normal level of 20 mRh/h).

Moreover, the noise effect is specifically strong around airports and electromagnetic noise around radar stations.

It is an important factor to consider that airports require land areas comparable with those for high-speed railways, yet these areas are located straight near cities implying that they are more valuable.

A significant disadvantage of the air transport is that passengers and cargo are delivered exceptionally to one terminal, while STS train can deliver them to any intermediate station.

The major factor is the travel cost which will exceed many times that of the STS when the cost of traveling to the airport and back is added.

Thus, "Quebec - Toronto" future passenger and cargo traffic lines manifest obvious advantages of the string transport routes.

2.5. Applicability of Transport Means with Magnetic Suspension

Magnetic suspension transport (MST) requires solution of sizable scientific and engineering problems. Actually, the MST is still being experimented upon, though a number of countries have erected separate short stretches. Alternatives of implementation of the "Transrapid" System (FRG) and electrodynamic suspension and linear synchronous motors have been evaluated, they require to employ the effect of superconductivity. The MST requires 4...5 times more investment than high-speed railways and 30...50 times more than the STS. For example, the projected Transrapid route Berlin-Hamburg (Germany) 300 km long is estimated to cost 19 billion DM. Hence, MST "Quebec - Toronto" may be estimated to cost 30...40 billion US$.

This amount is enough to erect complete STS routes over 20 thous. km long.

3. Stages of Implementation of the STS Project

The primary objective is to complete research and development (25 million US$) to select, optimize and adapt to the terrain relief and operation conditions of design, technological, engineering and other solutions, the know-how accumulated by the author during 15 preceding years and the specialists which he attracted to cooperate and then at the "NTL Transportlinien GmbH (Germany) and since 1997 at the Research Center "YUNITRAN" (Belarus), because it received the non-material assets accumulated during this period: patents, know-how, engineering knowledge, designing, technological and other achievements and their cost exceeds 1 billion US$, according to the estimate of the Institute of Independent Assessment of Investment and Credited Projects (Minsk). The program had been elaborated to develop the design of the transport line and the vehicle (with all their components) with the account of wages of designers and other staff, the cost of materials and standard pieces,

equipment, expenses to attract contractors, etc. The program is for the conditions in the Republic of Belarus, but it can be easily adapted to the conditions of any other country with the help of correction factors.

A special designing bureau should be created together with several laboratories (to investigate motion dynamics; control, communications and safety systems; electric motors and power supply and reliability of structures) and major services (the general designer, the chief economist, the chief process engineer, the chief engineer, the chief construction engineer, the chief power engineer, the chief communications expert). This stage can be accomplished within 2...3 years providing the corresponding finances become available and 100...120 designers are recruited. Research and development can be combined with the erection of a pilot STS leg 10...20 km long.

Then the pilot route leg (40 million US$) should be erected and pilot vehicles should be produced (2 million US$). With sufficient finances it can be accomplished within 2...3 years. The pilot leg can be erected in any country where investors believe their investments can enjoy protection and the inventor and designer can be sure of the proper protection of the intellectual property and the copyright. A special research and designing center should also be established in this country.

The route survey can be started simultaneously with to the erection of the pilot leg as well as the survey of other transport lines if there are clients for such projects. It will allow to become leaders of the world super high speed transport market in the 21-st century.

Development, designing and erection of the STS "Quebec - Toronto" can be started as implementation of the national transport program in Canada. In the process of implementation of the national program it will be possible to negotiate about further construction of the route in the United States, elaborate the unified design, technological and operational standards. Then each country can independently erect its own portion of the transcontinental route with its ramification (if necessary). After that, in the future, the route may be extended to the Western US border (for example, "Ottawa - New York" or "Toronto - Detroit - Chicago") and on the other side to the south, to Mexico.

The STS, due to its strong competitiveness, will be able to conquer the markets of high-speed communications. It will create a new economic niche by forcing out high-speed railways, trains with magnetic suspension and aviation.

Appendices:

[1] "*String Transport Systems on Earth and in the Space*" / A.E. Yunitsky, 337 pp., ill., Gomel, 1995.
[2] Information Materials on ____ pages.

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