

uST TRANSPORT AND INFRASTRUCTURE **SOLUTIONS**



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OUR **PHILOSOPHY**

Transport should be a solution to problems, not their source.

uST transport and infrastructure complex moves cargo and passenger flows to a separate space off the ground.

The fact that uPods move above the ground on a specially designed string rail overpass ensures a number of advantages: optimized aerodynamics, increased speed, unprecedented safety, rational use of land and resources, and minimized environmental damage caused by transport. In addition, the cost of construction and operation is significantly lower compared to the existing transport solutions.



STRING RAIL TRANSPORT: OPTIMAL, EFFECTIVE, AND SAFE.

Anatoli Unitsky

Scientist and inventor, author of more than 200 scientific papers, 20 monographs, and over 150 inventions in the field of construction, transport, mechanical engineering, electronics, and chemical industry.

Inventor of elevated and geospace string transport complexes, as well as a number of transport and infrastructure projects based on the string technology.

The head of two UN projects (1998, 2002), member of the USSR Cosmonautics Federation.

Founder of the Group of Companies on creation of eco-friendly transport and infrastructure, agriculture, energy and space technology. General Designer of Unitsky String Technologies Inc.



uST is the concept of elevated transport and infrastructure complex, which has no analogues in the world

The main components of uST transport and infrastructure complex are as follows

- Uncut pre-stressed string rail overpass.
- Unmanned rail electric vehicles on steel wheels providing high aerodynamics and equipped with an anti-derailment system and intelligent safety, power supply, and communication systems.

UNITSKY STRING TECHNOLOGIES INC.

An engineering company accredited as a scientific organization that is engaged in the designing, construction, and certification of uST transport and infrastructure complexes.

Today, on the basis of long-term developments by engineer and inventor Anatoli Unitsky, UST Inc. provides holistic high-tech transport complexes comprising the automated rolling stock and unique string tracks, as well as the infrastructure facilities and green power supply systems.

Today more

than **800**

highly qualified specialists
are employed
in Unitsky String Technologies Inc.













PRODUCTION
FACILITIES

The purpose is to develop and test the most important technological solutions and key know-hows of the string transport.

Complete production cycle of uST rolling stock

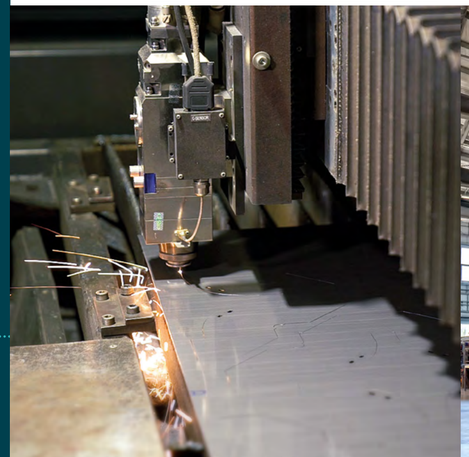
Manufacture
accessories,
devices, components

Testing
mechanical assemblies
and electronic devices

Trial run
production
prototypes











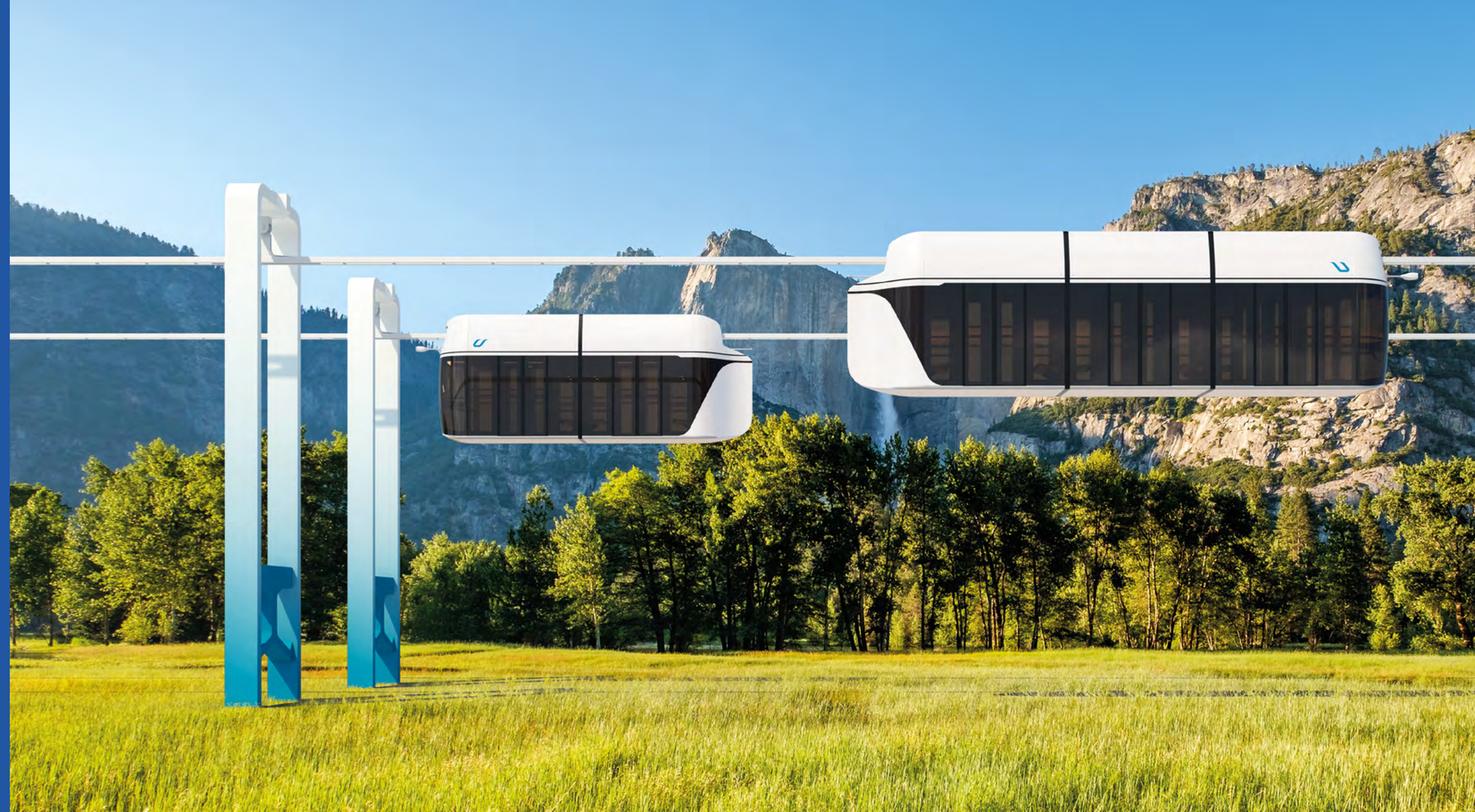
MAIN
TRANSPORT SOLUTIONS

The string transport can meet a wide range of transport and infrastructure demands while offering a possibility of highly efficient passenger and cargo transportation for any distances under any natural and climatic conditions.

All types of uST complexes are distinguished by energy efficiency, minimal adverse environmental impact, and a high safety level of passenger and cargo transportation.

uST

- Speed, safety, comfort, affordability, cost effectiveness, sustainability.
- Upswing in social activity and communication for people.
- The basis for the information, power, transport, and communications network of a new generation.



PASSENGER uPODS

Designed and produced
by Unitsky Group of Companies



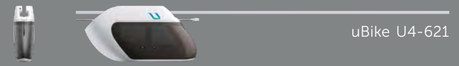
uLite U4-830



uWind U4-651



uBus U4-210



uBike U4-621



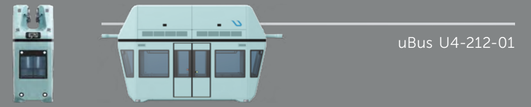
uBus U4-220



uCar U4-430



uBus U5-54304



uBus U4-212-01



uFlash U4-362

uPod – unmanned electric vehicle
on steel wheels for movement
on a string rail overpass.

CARGO uPODS

Designed and produced
by Unitsky Group of Companies



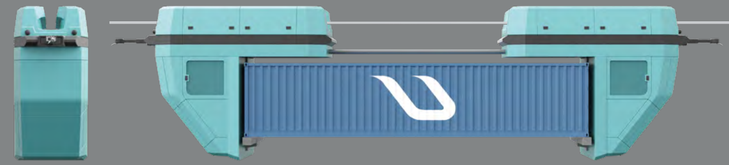
Electric rail vehicle 212
(container vehicle)



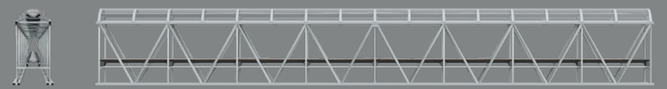
uTruck U4-131



uTruck U4-171



uCont U4-192-01



uTrans U4-100

PASSENGER
TRANSPORT

uST transport is a unique infrastructure solution for cities and suburbs. uPods are built using a principle of modular construction, that allows selecting the optimal rolling stock with minimal costs.

It is designed for city and intercity passenger transportation.

It is harmoniously integrated into the existing infrastructure of any megacity.

It solves transport problems of large cities by creating the high-rise building network interconnected with elevated (air) transport communication.



uWIND

Monorail suspended light uPod of small capacity.

Passenger capacity	2 people
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	3.3 kW·h/100 km, fuel equivalent – 0.82 l/100 km



Maximum structural functionality, simplicity of use, low cost of production, and minimum power consumption make uWind one of the most affordable solutions for transportation links in sparsely populated and remote areas, as well as in regions with challenging terrain.

The optional design of the assemblies and components allows using this uPod for passenger and cargo transportation.

uPods in the complex are connected by electric coupling.

uBIKE

Monorail suspended light passenger uPod.

Passenger capacity	2 people
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	2.8 kW·h/100 km, fuel equivalent – 0.7 l/100 km



It combines features of a highly effective electric vehicle and leisure facility.

In addition to the on-board (and external) energy sources, it is equipped with a bicycle generator allowing uBike to be driven by the passengers' muscle power. In the future, it can be an alternative to cars, bikes, and motorcycles.

uPods in the complex are connected by electric coupling.

uBUS

Passenger uPod.

It is designed for city and suburban transportation and has different versions (mounted or suspended, double-rail or quadrail). Its design and layout are determined by the specification and Customer's requirements.

uBus can be used as a single vehicle (like a car or a bus) and a train with different number and type of units.

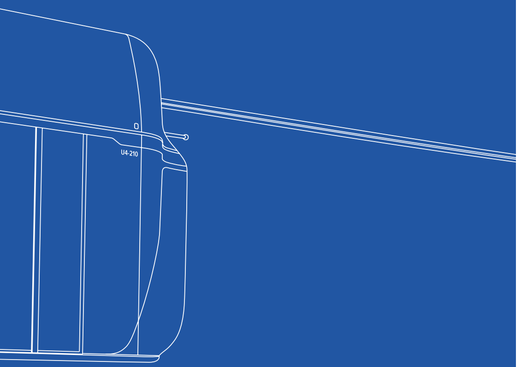
It is equipped with the climate control system, audio and video information system for passengers, and etc. The cabin has special seats for persons with disabilities.

Passenger capacity	14 people
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	9.2 kW·h/100 km, fuel equivalent – 2.3 l/100 km









uBus with its smooth easy lines combines features of the urban environment with emotional state of the modern society, while being extremly functional also has a futuristic design.

uBUS KARAT

Double-rail suspended passenger uPod.

It is designed for passenger transportation on the double-rail track of a string rail overpass on urban and suburban routes.

Passenger capacity	16 people
Design speed	Up to 120 km/h
Service speed	Up to 90 km/h
Power consumption at 100 km/h	51 kW·h/100 km, fuel equivalent – 12.75 l/100 km



uLITE

Double-rail suspended passenger uPod.

It is designed for cargo and passenger transportation on the double-rail track of a string rail overpass. uLite is developed as the most cost-efficient rolling stock in the transport range.

It can be used for different purposes, such as in public transportation, on tourist routes, and for communication between underpopulated and remote localities.

Passenger capacity	6 people
Design speed	Up to 80 km/h
Service speed	Up to 60 km/h
Power consumption at 60 km/h	4.8 kW·h/100 km, fuel equivalent – 1.2 l/100 km



uCAR

Double-rail suspended passenger uPod.

It is a stylish and comfortable vehicle intended to unclog the city streets.

uCars can ensure higher traffic flow compared to common massive, expensive and capacious railway trains and airbuses that cannot travel in trail with small intervals.

Passenger capacity	18 people
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	15 kW·h/100 km, fuel equivalent – 3.9 l/100 km

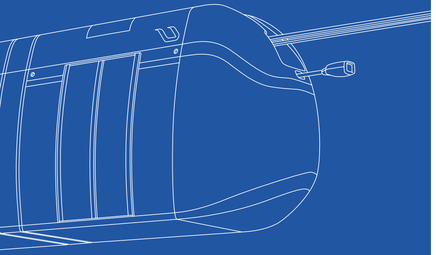


18-seat urban uCar has already passed a number of tests and certification procedures. It is one of the top efficiency performers in the category, its power consumption is 0.125 kg/passeng × 100 km (in fuel equivalent) at a speed of 100 km/h.









uCar fits the times: new look,
new proportions, new rhythm.

uCAR
(TROPICAL VERSION)

uCar (tropical version), as a modification of already existing uCar, underwent a number of improvements necessary for its operation in hot climate and upon increased humidity while providing comfortable conditions for the passengers.

- Max. operating temperature: 50–60 °C.
- Temperature in the cabin: 20–23 °C.
- Duplication of all systems: independent drive of the vehicle axles, two cooling units, two climate control units, two energy accumulators, two types of charging (manual and automatic).
- More powerful electric motors.
- Updated braking system.
- Hydraulic suspension.
- Entrance/exit doors located on both sides of the cabin.
- Improved computer vision system.
- Vip-cabine equipped with four seats (two VIP-armchairs, two collapsible seats for the personnel), folding table, TV set with 32" screen, refrigerator, cup holders, more powerful acoustical system.
- Improved door operating gear.
- Multiple glass units.

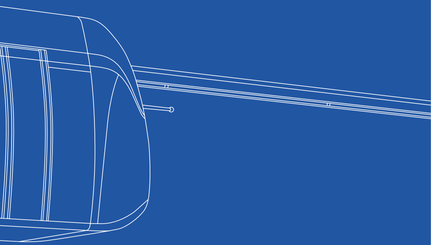


Passenger capacity	4–6 people
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	9.8 kW·h/100 km, fuel equivalent – 2.5 l/100 km









It is specially designed for operation under the tropical climate conditions of the Middle East.

uFLASH (HIGH-SPEED TRANSPORT)

Suspended passenger uPod on steel wheels. It is designed for intercity and international passenger (and cargo) transportation.

High-speed movement is provided by the specially designed string rail overpass, flowing lines of the vehicle, and its excellent aerodynamic properties.

The aerodynamic characteristics of uFlash U4-362 are close to the theoretical limit: drag coefficient C_x is equal to 0.06 (for reference: C_x of Volkswagen XL1 is 0.189).

uPods in the complex are connected by electric coupling.

uFlash is equipped with luggage compartments.

Passenger capacity	6 people
Design speed	Up to 500 km/h
Service speed	Up to 450 km/h

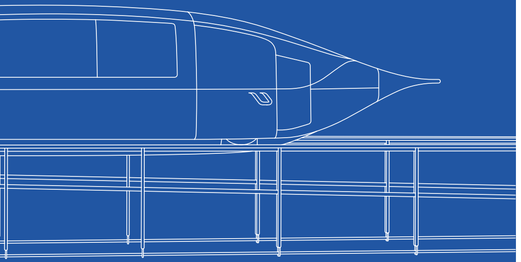








uFlash, the flagship of uST model range, was presented to a wide audience for the first time at InnoTrans (Berlin), the International Trade Fair for Transport Technology held on September 18–21, 2018.



CARGO TRANSPORT

Transport complex designed for cargo transportation for the distances of 500 km and more.

uST cargo complexes provide wide opportunities for the Customers and are able to operate all year round under various climatic conditions in remote and hard-to-reach areas, including high altitude, desert terrain, jungles, and continental shelves.

Application:

- **transportation of loose cargo** (ore, coal, construction materials, overburden rock, etc.);
- **transportation of break-bulk cargo** (containers, woods, metal, etc.);
- **transportation of liquid cargo** (crude oil and refined products, liquefied natural gas, natural drinking water, etc.);
- **transportation of special cargo** (cryogenic fluid, radioactive materials, explosives, weapons, etc.).



uTRUCK

Double-rail/quadrail suspended cargo uPod.

The model is distinguished by its audacious design solutions, outstanding visual novelty, and high functionality.

It is designed on the base of suspended urban passenger uBuses and includes traction and cargo modules. Such a modular design allows using uTruck in almost all spheres of cargo transportation.

It is intended for transportation of bulk, liquid, hazardous, perishable, and break-bulk cargo. Loading and unloading of uTruck is carried out automatically.

The automated control system ensures the movement along the rail with minimal acceptable safe time interval while providing a high performance of the complex.

If required, uTruck can be combined with uTrans in order to expand its application.

Load capacity	1,700 kg
Design speed	Up to 150 km/h
Service speed	Up to 120 km/h
Power consumption at 100 km/h	9.3 kW·h/100 km, fuel equivalent – 2.3 l/100 km

uCONT

Suspended cargo uPod designed to transport shipping containers on a string rail overpass.

Load capacity	35,000 kg
Design speed	Up to 100 km/h
Service speed	Up to 90 km/h



It ensures high performance and reliability in handling large amounts of incoming (outgoing) cargo flows in terminals integrated into automated uST complex.

Applications – logistics hubs and port infrastructure facilities.

The structure of the cargo module in uCont provides a perfect balance of ease, reliability, and performance of handling operations.

uTRANS

Non-stop cargo conveyor-type vehicle.

It is an optimal solution for the mining sites, loading-unloading terminals, and seaport terminals. It allows fast and affordable transportation of the significant volumes of bulk materials. The loading to endless belt body of uTrans is carried out from a special terminal, unloading – by tilting of the belt in vertical plane. It can operate twenty-four-hour all year round.

Design speed	Up to 10 m/s
Service speed	Up to 8 m/s
Specific power consumption	From 0.01 kW·h/t·km





SEA PORT

Main advantages of using uST cargo transport complex in the sea port:

- Delivery of loose, liquid, and break-bulk cargo for the distances of 5–10 km and more offshore;
- Mooring of large vessels does not require the creation of quay walls, dredging, or shore reinforcement;
- It is possible to deliver goods to a sea port located at a depth of up to 25 m;
- The port infrastructure and uST transport complex together form a single logistics complex for cargo delivery;
- The transportation implies cargo delivery from a mining enterprise to a bulk carrier's hold without intermediate stocking.



LINEAR uCITY:
IN UNITY WITH NATURE

uST transport and infrastructure complexes contribute to the development of linear cities – cluster-type urban settlements harmoniously integrated into the environment.

Linear uCities can be built in the mountains, in desert and flooded territories, including in areas with challenging terrain, boreal forests, and jungles, as well as on a sea shelf.

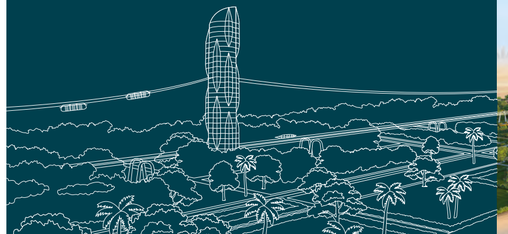
The construction of linear cities will not require cutting down forests, building motor roads and railways, or disturbing biogeocenosis within the construction area.



Innovative approach to the construction of urban settlements in accordance with uCity logic has a number of advantages in comparison with traditional housing.

The ground surface is intended for pedestrians and plants, whereas transport, power, and information communication lines are located above the ground at the second level.

The key elements of the system are horizontal lifts (uST tracks) connecting neighboring multifunctional high-rise buildings. Comfortable low-rise buildings with all-round greening are located between the dominant towers.









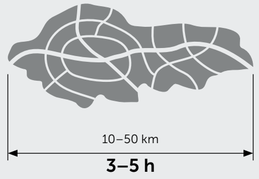
Linear uCity

- Providing a larger personal space for communication with the external environment.
- High quality of life.
- Focusing on the housing quality.
- Increasing reputation of the territory and investment attractiveness.
- Transport accessibility.
- Pedestrian city.



Traditional housing

- Low quality of living environment and living standards in general.
- Negative impact on humans and nature.
- Reduction of the inhabitants' mobility.
- Focusing on the number of square meters in the deliverable housing.
- Road accidents, traffic jams, smog.



ECOHOUSE:
HOUSE OF THE FUTURE TODAY

The time of faceless identical buildings has passed. A man needs eco-friendly architecture being a source of daily spiritual joy. The society has come to the conclusion that people should not conquer the nature, but live with it in perfect harmony.

Eco-friendly

EcoHouse is built using green technologies, as well as environmentally friendly materials that do not harm the nature. The project considers cardinal points, wind rose, landscape, human-friendly zoning of internal premises and overall geometry of building construction.



Aesthetic

The development of green technologies gives the opportunity to create beautiful, multifunctional, environmentally friendly admirable ecohouses. An original step to reproduce natural balance is roof gardening providing not only a good look of the roof, but also a sky-high part of the terrestrial ecosystem.



Cost-effective

EcoHouse is supplied with heat, electricity, and hot water using renewable energy sources – sun, ground, wind. An integrated approach to design of the buildings is naturaly based on renewable energy systems presenting its structural design elements.



MAIN TECHNOLOGICAL ELEMENTS

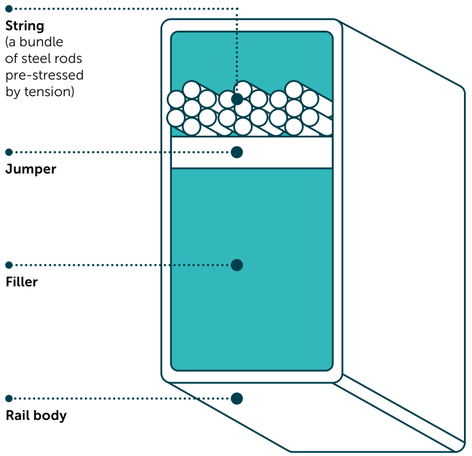
uST basis – an innovative string rail

String rail or rail-string is a conventional uncut (lengthwise) steel, reinforced concrete or steel-reinforced concrete beam or truss equipped with a rail head and additionally strengthened with pre-stressed (stretched) strings.

A string rail combines the characteristics of the flexible cable (at a long distance between supports) and rigid beam (at a small beam span – under a wheel of rail electric car and above the support).

A flat head of the rail and cylinder steel wheel ensure minimal energy consumption during the movement.

Version of semi-rigid string rail



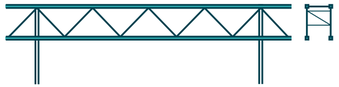
TYPES OF STRING RAILS and corresponding designs of track structure

Rigid rail (truss)

Rigid uncut track structure

Designed for the operation of heavy (weighing up to 100 tons) and high-speed uPods.

It is distinguished by a smaller number of pre-stressed elements in the composition of the rail, a higher rate of installation of supporting towers (up to 100 m), as well as the presence of additional elements forming a truss structure that reinforce the overpass design.



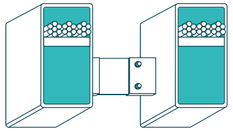
Travel speed:
from 100 to 600 km/h.

Relative structural rigidity:
1/1,000–1/10,000.

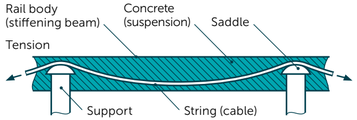
Track structure curve radius:
r = 5,000... 50,000 m.

Semi-rigid rail

Semi-rigid uncut track structure



Track structure design follows the design of a suspension bridge, combining all its main elements.



Suspension bridge



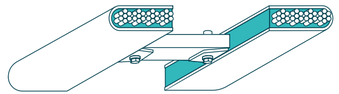
Travel speed:
from 50 to 250 km/h.

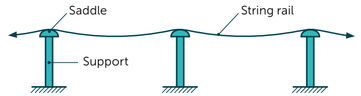
Relative structural rigidity:
1/500–1/2,000.

Track structure curve radius:
r = 500... 5,000 m.

Flexible rail

Flexible uncut track structure (variant)





uST flexible track structure is not an analogue to the cableway:

- Use of rail (lower rolling resistance);
- Lower energy consumption during the movement (by 3–5 times);
- Possibility of using a gravity engine during downward movement and gravity brake during upward movement (reduction of energy consumption by another 3–5 times);
- high durability (5–7 times longer lifetime compared to the cableway).

Travel speed:
from 30–60 (on support) to 120–150 km/h.

Relative structural rigidity:
1/100–1/500.

Track structure curve radius:
r = 100 (on support)... 2,000 m.

Rolling resistance power of a wheel of uPod with a weight of 5,000 kg at a speed of 450 km/h:

$$P_{rr} = m \times g \times C_{rr} \times v = 5{,}000\ \text{kg} \times 9.81\ \text{m/s}^2 \times 0.0015 \times 125\ \text{m/s} \approx 9.2\ \text{kW}.$$

For reference:
in the case of using pneumatic machine with $C_{rr} = 0.18$ (for $v = 450$ km/h)

$$P_{rr} \approx 1{,}100\ \text{kW}.$$

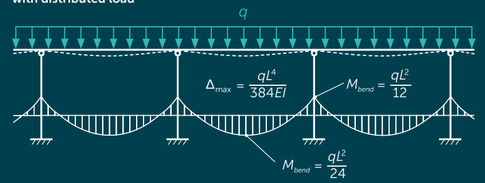
uST AND CONVENTIONAL BEAM OVERPASS



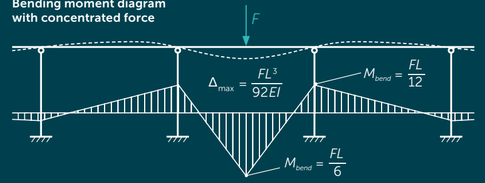


Innovative uST uncut pre-stressed string rail overpass

Bending moment diagram with distributed load



Bending moment diagram with concentrated force



10 %

of load in uST overpass is its own weight.
The overpass carries payload instead of dead load as conventional bridges do.



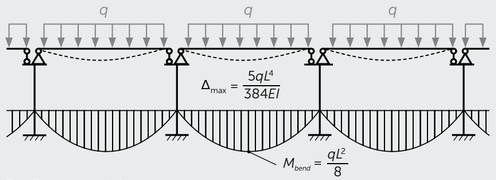
With equal distributed load, uST overpass is 5 times more rigid (smoother) and 3 times stronger than a conventional girder bridge.

With equal concentrated force, uST overpass is 1.9 times more rigid (smoother) and 1.5 times stronger than a conventional girder bridge.

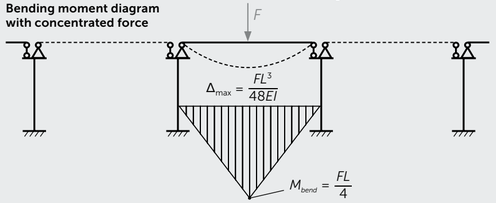
uST overpass needs less construction materials compared to a conventional overpass. As a result, the construction cost is significantly reduced.

Split overpass (conventional bridge)

Bending moment diagram with distributed load

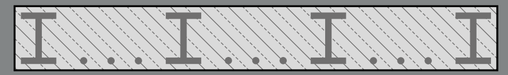


Bending moment diagram with concentrated force



90 %

of load in a conventional overpass is its own weight.
The overpass carries a dead load.



A solid roadbed puts extra load on supports and costs a lot.

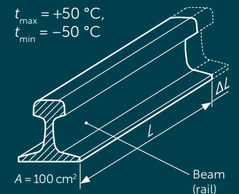
PRE-STRESSED
uST STRING TRACK –

an optimal solution to compensate thermal deformation

Under the thermal effect:

– absolute deformation
$\Delta L = \alpha \times L \times \Delta t$;

– relative deformation
$\varepsilon = \frac{\Delta L}{L} = \alpha \times \Delta t$.



For steel

linear expansion thermal coefficient (per 1 °C)

$\alpha = 0.000012$;

with Δt = 100 °C, ε = 0.0012 = 1/833
(the extension will be 1.2 m per km).

Test of a rigidly restrained beam for strength and stability under the temperature exposure (Δt = 100 °C)

Strength test:

– compression strain of longitudinal fibers:
$\sigma = E \times \varepsilon = E \times \alpha \times \Delta t \le \sigma_{02}$.

For steel

with $E = 2 \times 10^5$ MPa and Δt = 100 °C:
$\sigma = 2 \times 10^5 \times 0.0012 = 240$ MPa (ca. 2.4 t/cm²).

Stability test:

– longitudinal compression force in a restrained beam under a rapid change of temperature:

$N_{comp} = \sigma \times A = E \times \alpha \times \Delta t \times A \le P_{cr} = \frac{4\pi^2 EI}{L^2}$.

For steel

with σ = 240 MPa and A = 100 cm²:
$N_{comp} = 240 \times 0.01 = 2.4$ MN (ca. 240 t).

With the pre-stressing force of more than 2.4 MN, there will be no compression forces in the structure and it will remain stable.

Without tension

Compressive buckling.



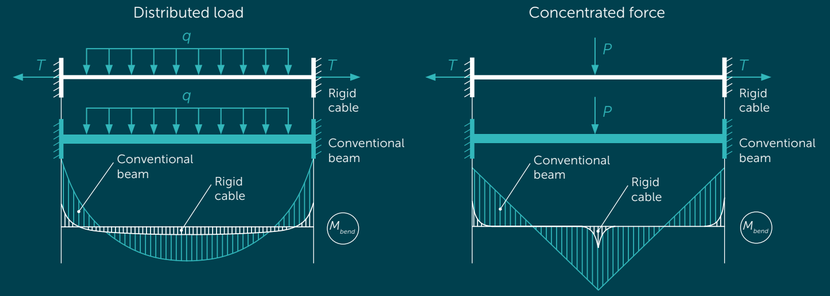
With tension

The beam is not subject to compressive buckling (with $N \ge R$).





Bending moment diagrams for a restrained beam (conventional structure) and pre-stressed rigid cable (uST)



Bending moments in a rigid cable are 10 times lower than in a conventional beam (with the same spans and loads).

Conclusion

The most dangerous phenomenon is that heating of a rigidly restrained beam results in its stability loss.

Solution

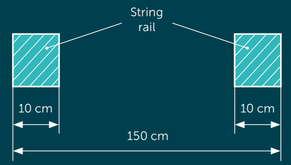
A pre-stressed beam with calculated force of $T \ge N_{comp}$ ensures that even temperature difference of Δt = 100 °C will not cause compression forces in longitudinal fibers of the beam.

HIGH EVENNESS OF THE TRACK

is achieved due to using an uncut string rail between anchoring structures

- Supporting towers installed at a span from 50 m to 3,000 m (to ensure rigidity of the uncut track structure) allow using light structures.
- The amount of materials required for the support construction can be reduced by 8 times resulting in the respective cost reduction.
- The uncut structure of the string rail and the design of the relevant overpass reduce the amount and cost of building materials by 15 times and more compared to the conventional beam overpass.
- Fixing of the track structure to the support top additionally increases its load-bearing capacity by 8 times.

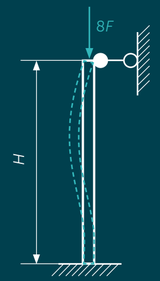
uST track structure



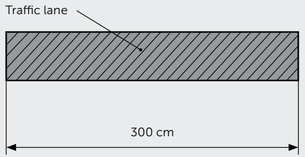
Construction cost of uST double-track overpass:

- low speed – **from 2 mln USD/km;**
- medium speed – **from 5 mln USD/km;**
- high-speed – **from 10 mln USD/km.**

uST support stability loss



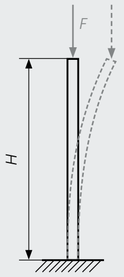
Roadbed of conventional overpass

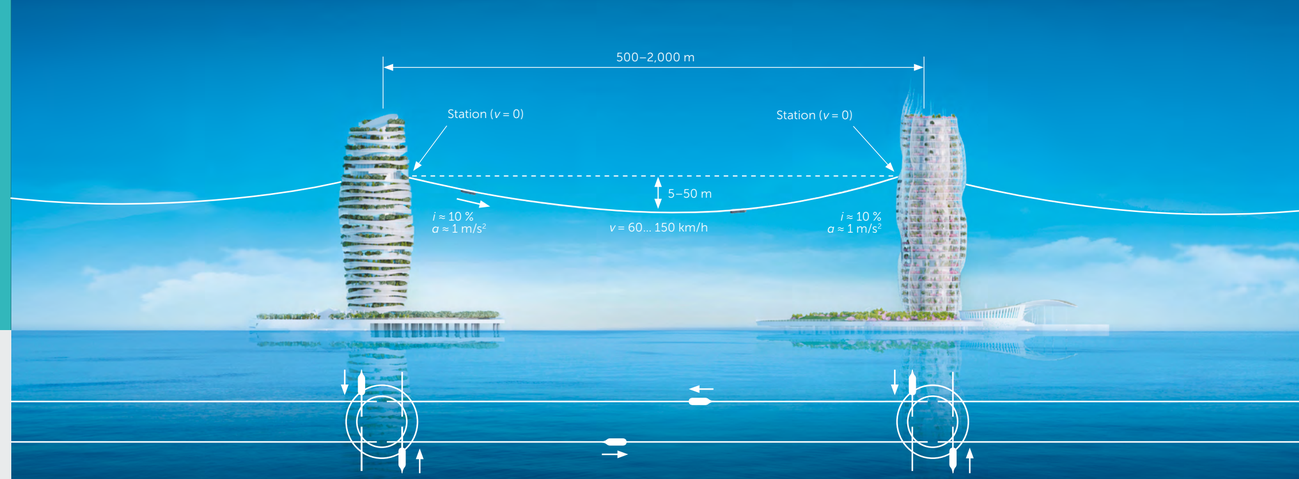


Cost of the conventional overpass construction –

from 100 mln USD/km.

The ordinary support stability loss





APPLICATION OF **ENERGY CONSERVATION LAW** IN uST TRANSPORT

In terms of energy consumption, an overpass with a sagging track structure is several times more efficient than a road with a straight track structure.

The drive in uPod for a sagging track structure is only required to compensate for aerodynamic losses and overcome steel wheels rolling resistance on a steel rail (about 10 kW for a 50-seat vehicle). That's why the engine is not used at a downhill section of the track while the vehicle is accelerated by gravity (gravity engine).

uPod does not need brakes at an uphill section because it is slowed down by gravity (gravity brakes).

Energy recuperation according to the scheme "potential energy at the station ➞ kinetic energy of motion through the overpass span ➞ potential energy at the next station" occurs without using a recuperator in accordance with laws of physics. The efficiency of such recuperation is 100 %.

SMOOTHNESS OF MOVEMENT

Passenger comfort is estimated by the smoothness of movement *W*:

$$W = 2.7k\sqrt[10]{A^3 \times f^5},$$

where *k* – coefficient, which depends on vibration direction and frequency;
A – oscillation amplitude, cm;
f – oscillation frequency, Hz.

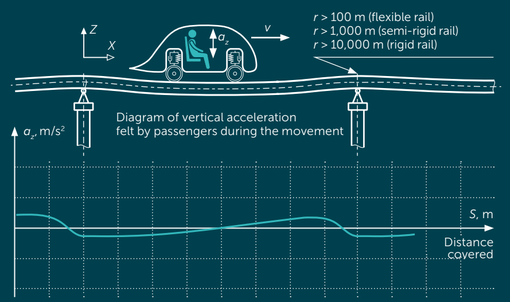
Evaluation	Index of movement smoothness, *W*
Very good	Less than 2
Good	2–2.5
Satisfactory for passengers	2.5–3
Impermissible for passengers	3–3.25
Permissible for cargo	3.6–4.25
Physiologically unsafe for passengers	4.5

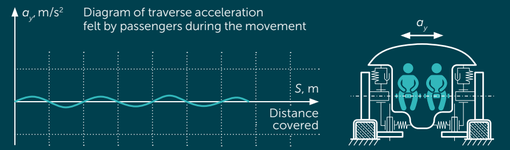
uST

Automobile and railroad transport



uST uncut pre-stressed overpass

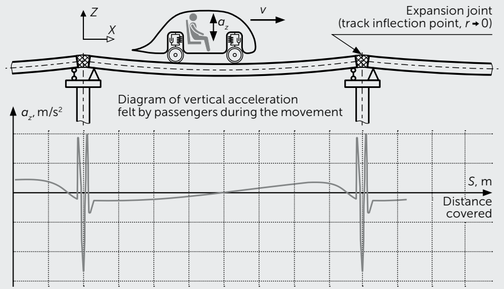


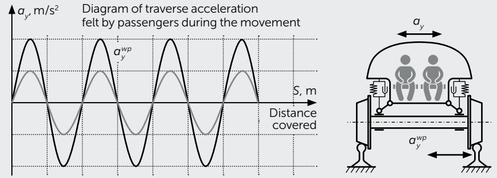


Advantages:

- smooth change of acceleration when moving through supports;
- simpler design of the supporting node.

Split overpass (conventional bridge)



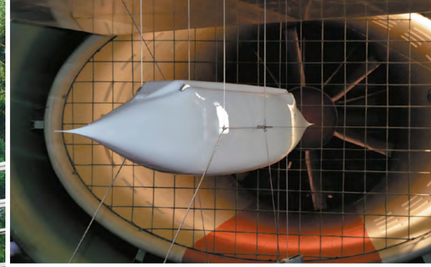


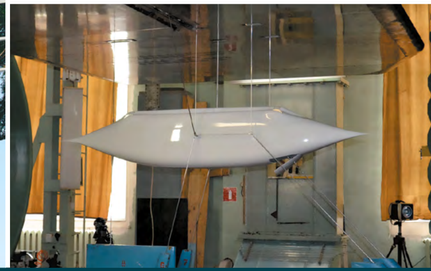
Disadvantages:

- peak values of acceleration when moving through supports;
- complicated design of the supporting node with an expansion joint.

uPOD
AERODYNAMICS







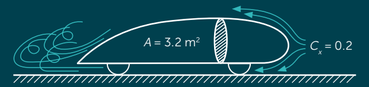
Testing of uFlash model (scale 1:5)
in the wind tunnel, 2017

The location of the track structure above the ground and the absence of a solid roadbed eliminate the main problem of high-speed transport – ground effect. This increases aerodynamics of a wheeled vehicle by two times.

The operation of one uFlash during 25 years will allow saving about 22,000 tons of fuel with a cost of 20 mln USD.

Thus, a thousand uFlashes with the unique aerodynamic properties can save over 20 mln tons of fuel, at the cost of more than 20 bln USD. At the same time, more than 70 mln tons of atmospheric oxygen would not be burned and more than 100 mln tons of pollutants would not be released into the atmosphere.

Wind tunnel tests of the models of innovative uFlash in 1994–2009 gave the result $C_x = 0.075$.

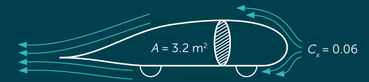


The ground effect causes turbulence.

For this reason, one uFlash is capable of saving about 600 kW of drive power compared to the most advanced alternative ground high-speed vehicles having a minimum value of $C_x = 0,2$.

The wind tunnel tests of high-speed uPods in 2017 improved their C_x to 0.06:

$$\Delta C_x = 0.2 - 0.06 = 0.14.$$

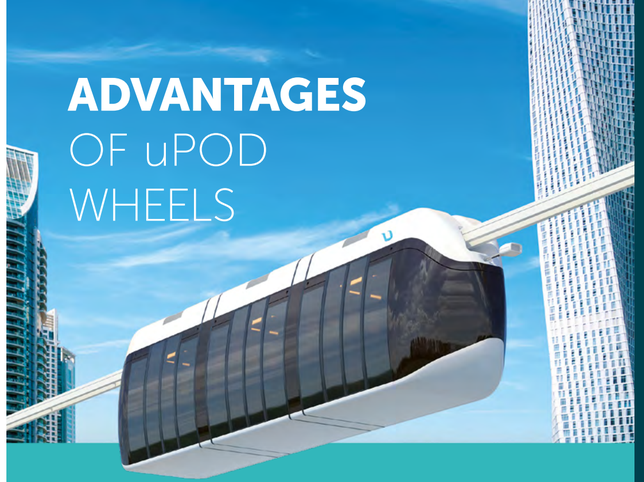


Power saving due to aerodynamic resistance (at a speed of 450 km/h):

$$\Delta P_{ar} = \frac{1}{2} \rho \times v^3 \times \Delta C_x \times A \times k = \frac{1}{2} \times 1.25\ \text{kg/m}^3 \times$$

$$\times (125\ \text{m/s})^3 \times 0.14 \times 3.2\ \text{m}^2 \times 1.1 \approx 600\ \text{kW}.$$

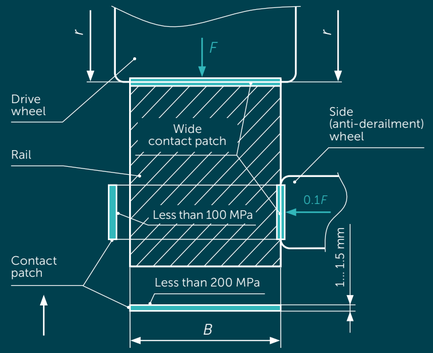
ADVANTAGES OF uPOD WHEELS



Advantages of uPod steel wheels:

- no slipping in the contact patch (cylinder rolling along the plane);
- insignificant contact stress (less that 200 MPa) due to a wide contact patch (according to the rail head);
- small wheel load and absence of joints on the track;
- minor wheel rolling resistance due to narrow contact patch (in direction of rolling);
- symmetrical rail head wear (in vertical and horizontal planes);
- disk brake mechanisms and ABS preventing wheels locking.

Innovative uPod wheel



Calculation of contact stress for a uPod with gross weight of 5 tons:

$$\sigma_c = 0.418\sqrt{\frac{F \times E}{B \times q \times r}} = 0.418\sqrt{\frac{0.0125\ \text{MN} \times 2.1 \times 10^5\ \text{MPa}}{0.08\ \text{m} \times 0.8 \times 0.26\ \text{m}}} =$$

$$= 163\ \text{MPa (ca. 1.7 t/cm}^2\text{)}$$

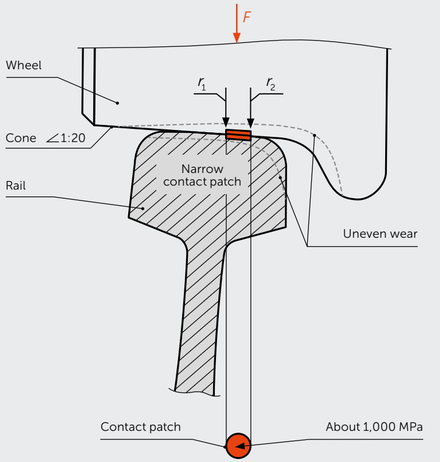
where F – wheel load;
E – effective elastic module;
B – width of wheel supporting part;
r – wheel radius;
q – coefficient of contact irregularity by length.

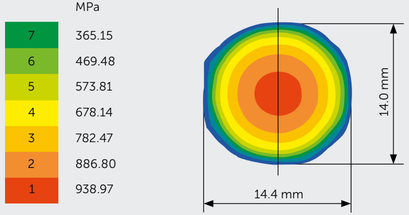


Increased wheel wear and noise of conventional railway wheel are caused by the following:

- high loads on the wheel and presence of rail joints;
- slipping in contact patch, caused by difference of seating diameters in conical surface of the wheel;
- a rigid wheel pair prone to self oscillations, that increases wear and noise;
- big static and dynamic wheel loads combined with inevitable track irregularities;
- operation of brake mechanisms (brake shoes cause additional wear to the wheel tread);
- big contract stresses (1,000 MPa and more) caused by a small size of the contact patch;
- asymmetrical load application onto the rail head.

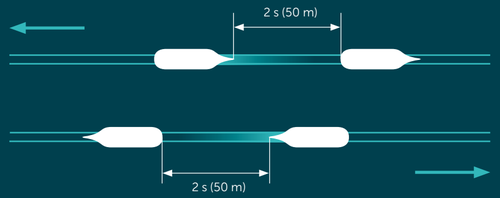
Conventional railway wheel







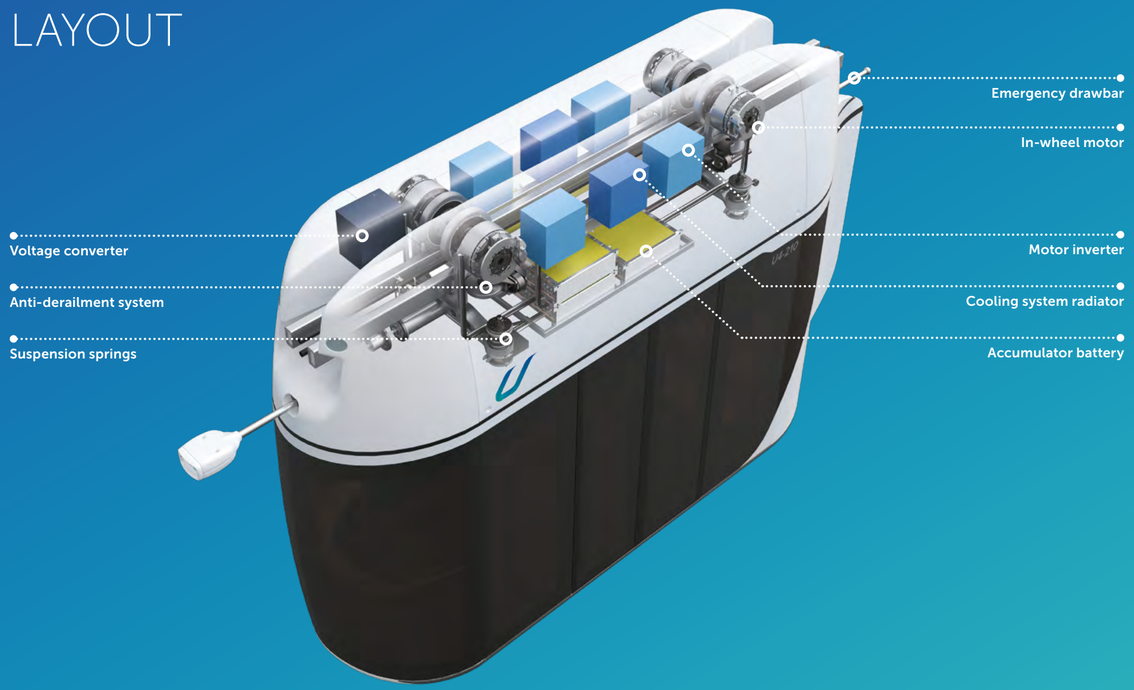
TRANSPORTATION CAPACITY
OF uST TRANSPORT AND INFRASTRUCTURE COMPLEX



A safe time interval between uPods is 2 s (or 50 m at a speed of 90 km/h), in real life – 35 s (more than 500 m). Minimal safe interval between vehicles of 2 s (50 m) is recommended by the American Automated People Mover (APM) Standards Committee.

Maximum passenger flow will be 30,000 passengers per hour (round trip) for the trains consisting of seven 25-seat uBuses.

CHASSIS
LAYOUT



AUTOMATED CONTROL SYSTEM OF uST TRANSPORT COMPLEX

Automated control systems of uST transport complex are a well-balanced combination of the known and proved effective technologies and advanced methods related to neural networks, digital intelligence, big data, and blockchain.

The automated control system covers all the aspects of uST transport complex operation. It collects data from all uST components and allow making the effective management decisions automatically without an operator.

The use of automated control systems in uST will make it the safest mode of transport, improve the logistics of passenger and cargo transportation, and raise the information space on the planet to a new level of development.



Automated control systems

- Traffic control system (upper level of control, adaptive system of route assignments)
- Interactive system for interaction and communication with the user
- Positioning system
- Technical vision (cameras,radars, sensors)
- Onboard automated control system

Onboard automated control system

- Onboard automated systems intended to manage uPod equipment and connect with the upper level control system
- Traffic control system (automatic)
- Functional equipment control system (hydraulics and internal automated systems)
- Positioning system (inertial)
- Energy supply systems

Security systems

Communication systems

- Internal vehicle network
- Inter-vehicle communication (V2V, C2C)
- Data exchange and communication with external objects of the complex (V2X, C2X)

SAFETY
OF TRANSPORT COMPLEXES

The technogenic character of conventional roads in linear embankments causes environmental disorder:

- open and ground water movements, natural habitat and migration ways of birds and animals are violated;
- many hectares of land are taken out from the biospheric use;
- noise, vibration, and electro-magnetic emission, as well as pollution of the atmosphere and hydrosphere with exhaust gases, tire and asphalt wear chips, deicing salts and other reagents increase the morbidity and mortality of the population;
- railway wrecks and incidents on oil pipelines are accompanied by substantial emissions of chemicals into the environment.

According to statistics, the crashes and accidents annually cause death of about 1.5 mln people (including post-accident deaths), more than 10 mln get into accidents and become disabled.

The construction and operation of expensive and material intensive conventional transport infrastructure require significant amounts of financial and natural resources.



uST is the safest transport

The measures preventing uST transport complex from accidents are described in details in operation manuals, as well as technical and project documentation on individual components. The design of string rail overpass is based on the main principles of the structure reliability in accordance with ISO 2394 General principles on reliability for structures, IDT.

- High resistance to vandalism and terrorist attacks.
- Location of the track structure above the ground enhances traffic safety by approx. 100 times.
- uPods moving at the second level and absence of the crossroads or other intersections eliminate collisions with ground transport, pedestrians, domestic and wild animals. The minimal distance between the vehicle bottom and ground surface is 4.5 m, as for the non-accessible roofs and tops of the buildings – 2.5 m, and motor roads – 6.5 m.
- Anti-derailment system increases traffic safety by another 10 times.

Safety of uST transport complex

Transport safety
(safety of the structural elements)

1. Overpass components safety
2. uPod components safety
3. Safety of passengers at the station

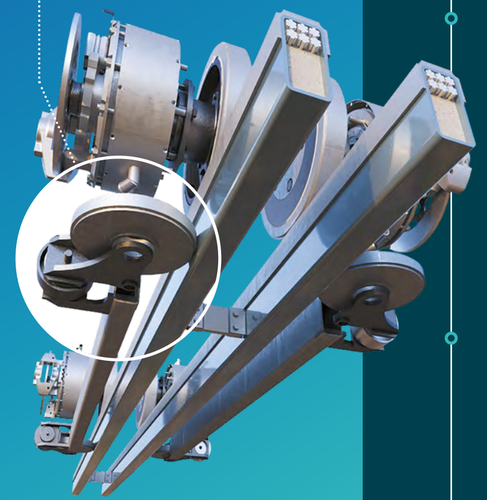
Information security
(automated control system)

Environmental safety
(eco-friendly technology)

TRANSPORT ASPECT
OF SAFETY

Second-level uST electric car on steel wheels with anti-derailment system is the safest of all known transport vehicles.





1 Overpass components safety

Durability of the rail-string overpass

The pre-stressing of a string rail by tension allows us to:

- significantly improve stress strain behaviour of the track structure, reduce the range of tension from cyclic-repeated rolling dynamic loads in order to increase durability of the structures;
- eliminate employment of the formed contraction joints, increase durability and safety of the overpass;
- optimally compensate internal forces and deformations of the track structure caused by the thermal impact, eliminate the impact of climate factors on its durability and buckling of the uncut string-truss overpass caused by its heating by the sun;
- effectively use high-strength materials, due to the high design resistance of the string material regardless of the geometric shape of a string section.

The design solutions used for uST transport overpasses provide reliable protection for the key components against the impact of external factors (a string is hidden into the rail, the anchored assemblies are protected by the construction of anchoring structures, etc.)

uST transport complex is resistant to floods, landslides, earthquakes, seismic sea waves, and other natural disasters, as well as terrorist attacks.

High smoothness of the track

uPod moves not on a string (cable), but on a steel rail, which flexural rigidity is higher compared to the railway rail due to tension (stretching). Thus, under the vehicle wheel, the string rail will behave not as a flexible cable, but as a rigid beam: under concentrated force of the wheel the local bending radius (bending) of rail-string will be 1 km. This means that the wheel will roll smothly, without strikes both between the supports and over them.

The continuous rail-string track, absence of contraction joints, damped design of the wheel, rail-string and concrete anchoring structures make rolling of uPod steel wheel on a seamless rail quiet in the whole range of speeds, without creating vibrations of the supports and, accordingly, the soil.

2 uPod components safety

The anti-derailment system includes the following subsystems duplicating each other:

- a subsystem to guide the side wheels with wheel safety flanges protecting against vertical derailment and roll-over of the transport vehicle;
- a subsystem of retaining bottom wheels for suspended vehicles. It allows increasing stability against vertical separation from the rail and rolling over of the transport vehicle;
- a duplicating subsystem: the construction of support wheels has safety flanges;
- uPod framework design, which encloses the rail, prevents it from falling from the rail track. The safety is ensured by the geometrical shape of the structure (horseshoe-shaped);
- an emergency restraining device, equipped with friction elements – "rail" brake.

The braking system of uPod has two braking circuits: main and auxiliary ones.

The auxiliary system provides braking force which is not less that 50 % of maximum braking force of the main braking system.

Rail parking brake can be used as emergency brake. In case of emergency, uPod is lowered onto the rail brake and slides on the rail, that provides its slowdown.

2 Vehicle components safety

Safety of uPod power supply system

- Distributed (multiple) electric drive.
- Accumulation of electric power in order to maintain the operation of the critical functions.
- Availability of the backup batteries on the electrified tracks.
- Passenger uPods have the equipment with a supply voltage of 24 V.

Safe time interval between uPods

Safety interval depends on uPods coupling system (mechanical or electronic) and their capacity.

During train traffic (several uPods in a mechanical or electronic coupling), the specified safety interval is 30–50 s; between uPods in electronic coupling – not less than 2 s.

Other measures to prevent and eliminate emergency situations

- Double electric insulation of the passenger module.
- Protective structures for moving and electrical parts.
- Use of non-flammable (fire-resistant) materials in passenger uPods.
- Availability of the automatically coupled emergency and towing device.
- Individual means for evacuation of passengers.
- Joint units and fairings providing an emergency crumple zone upon collision of uPods.
- Emergency exits.
- Duplex audio and video communication with an operator.
- Automated fire-extinguishing system of the drive module and equipment compartments.
- Fire-extinguishers in passenger module.
- Emergency ventilation.

3 Safety of passengers at the station

- Door opening/closing sensors
- Functional equipment control system
- Optoelectronic and radioelectronic surveillance system
- Video cameras at the station
- Sluice doors



INFORMATION ASPECT OF SAFETY

uST automated control system minimizes the impact of human factors, providing unprecedented safety of the whole transport complex.

Capabilities of automated uPod control system:

- duplication of uPod communication system with the central control system (using two different channels);
- evaluation of threats and obstacles on uPod way by means of technical vision and sensing system;
- automatic reporting to the central control system on any failure and emergency on board;
- automatic evaluation of destructive actions of passengers in the cabin by means of technical vision and sensing system.



ENVIRONMENTAL ASPECT OF SAFETY

uST is based on careful integration of the new-generation transport and infrastructure complex into the environment.



- uPod with its high aerodynamic properties is the most economical vehicle with minimal environmental impact.
- uST transport vehicle uses alternative sources of energy (electric drives, batteries, energy storage devices) that does not pollute the atmosphere.
- The construction of uST elevated tracks preserves the natural landscape, biogeocenosis, and biodiversity of the surrounding area.
- Due to the absence of embankments and excavations, there will be no obstacles to natural movement of ground and surface waters, as well as movement of equipment, people, and animals.
- Low volume of earthwork and small area of land necessary for the construction of uST routes will minimize removal of fertile soil land (humus) from the surface.
- Operation of uST vehicles does not require the use of anti-icing salts with their by-products contaminating the environment and human body as well.
- The track structure and supports of uST overpass have extremely low material consumption.

uST AND **ECOLOGY**



Reduced resource consumption – saving of raw materials, land, power, labour, and finances

Reduced amount of hazardous emissions into the atmosphere (by times) due to lower power consumption

Preservation of natural ecosystems and geobiocenosis

Increased electrical, vibration and noise safety (by 10 times)

Minimal local land allocation (reduced by 20 times)

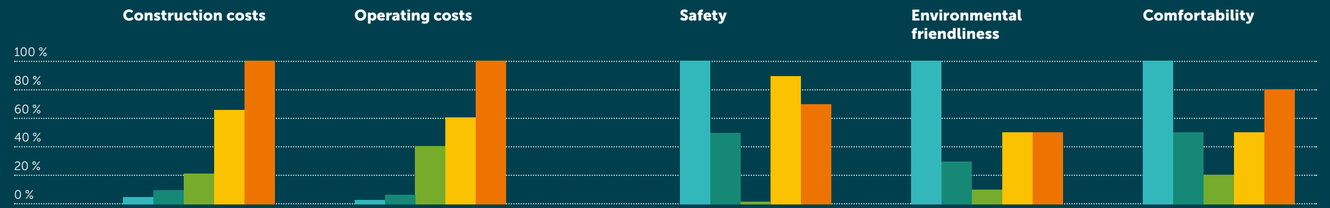
No earth embankment (low head dam)

uST COMPARED TO THE EXISTING ANALOGUES



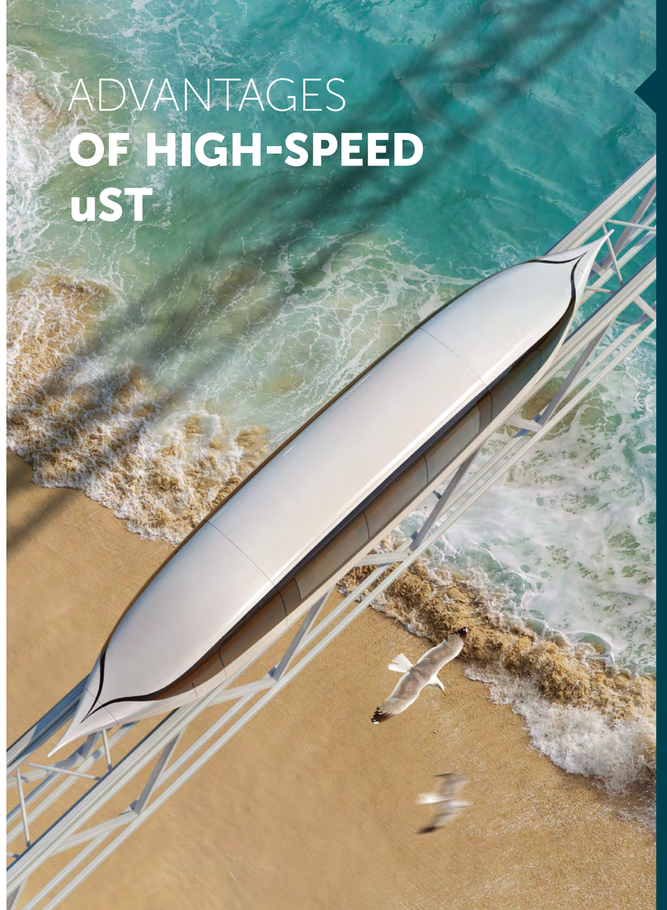
* The data is based on the studies of the Solomenko Institute of Transport Problems of the Russian Academy of Sciences in percentage correlation of integral index by types of transport.

As estimated by the Russian Academy of Sciences, the innovative uST transport technology is the most cost-efficient, sustainable, and safe compared to all known and prospective transportation systems.

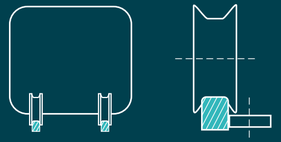


uST
Monorail
Railway transport
Maglev
Automobile transport

ADVANTAGES OF HIGH-SPEED uST



High-speed uST



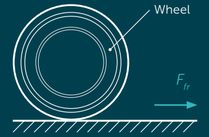
Compared to maglev vehicles, uST track structure is more openwork, significantly less material-intensive, and therefore less expensive. It does not require the installation of electric coils and magnets and has a simple anti-derailment system.

The track structure operation does not require any additional machinery as it is capable of selfcleaning (e.g. from snow and icing) and has no complicated technical elements (electric coils, etc.).



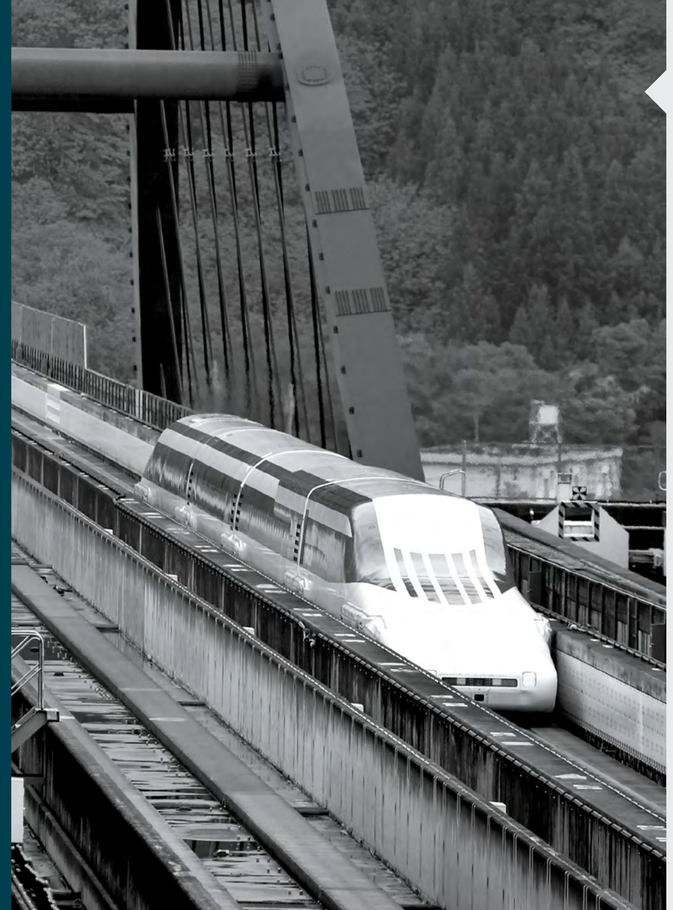
Cost of high-speed uST overpass –

from 10 mln USD/km.



The use of steel wheels gives propulsor performance greater than

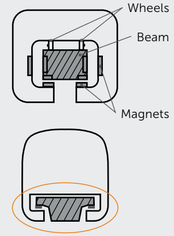
99.8 %.

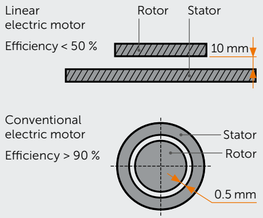


Maglev

The track structure operation is more labour intensive due to its complicated configuration and technical components (electric coils, switching devices, etc.), and requiers constant maintenance and using machinery to clean the track from snow and icing.

This track structure is expensive as it has a massive roadbed and requires the installation of electric coils and a complex anti-derailment system.





The use of a linear electric motor provide the efficiency of no more than 50 % as the clearance between a rotor and stator (for example, in Transrapid) cannot be less than 10 mm while the effective electric motor should have the clearance of no more than 0.5 mm.



The overpass cost –

from 50 mln USD/km.

uSKY TEST & CERTIFICATION CENTRE

The uSky Test & Certification Centre in Sharjah (UAE) is a research and production cluster, which demonstrates monorail passenger and cargo uST transport and infrastructure complexes on flexible and semi-rigid track structures.

The Centre is part of the SRTIP infrastructure - the Sharjah Research Technology and Innovation Park. In uSky they demonstrate the rolling stock that has already been tested in the Belarusian EcoTechnoPark, as well as new ranges of rail electric cars. On a 400 m long flexible track structure there are vehicles capable of travelling at speeds up to 150 km/h: four-passenger uCar and cargo uCont designed to carry 20-foot containers.

The first transport complex has already been built with a flexible track structure, two anchoring structures, stations, repair shop, service station, control room, and other auxiliary facilities. The passenger station of the complex is equipped with perrons for safe embarkation/disembarkation of passengers, microclimate systems, automatic doors, firefighting systems, and information systems for passengers and staff.

Besides, on the territory of the Centre they work on the design and construction of two more transport and infrastructure complexes.

Test Section No. 2 built as the semi-rigid string rail overpass is intended for testing design and technology solutions. By now, the anchoring structures and supporting towers have been installed, and the fifth-generation track structure is in the active design phase. This 2,100 m long test section will enable us to demonstrate the operation of the new generation of cargo and passenger uPods (up to 150 km/h).

The installation of the track structure for Test Section No. 4 is in progress, where innovative solutions for passenger and cargo transportations will be tried out.





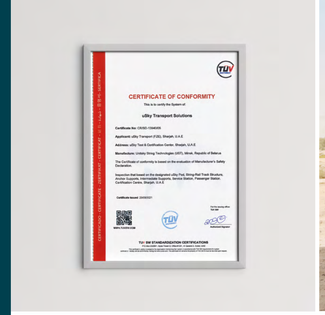




In 2021, in the UAE, uST Transport & Infrastructure Complex in tropical version (uSky) with all of its key structural components was certified for the first time in accordance with international regulations:

- pre-stressed string rail overpass;
- urban uPod (steel-wheeled electric car with an onboard component of the automated control system of the complex);
- anchoring structures (combined with the station facilities, repair shop, and control room);
- supporting towers;
- passenger stations;
- service station (includes the control room and repair shop).

The certificate of conformity from TUV SW is another indication of the safety of uST transport and infrastructure technology. This means that we have found the optimal parameters of uST transport and infrastructure solutions and their structural components in tropical version for their further commercialization.


CERTIFICATE OF CONFORMITY

This is to certify the System of

uSky Transport Solutions

Certificate No: 0193/01.1594/05

Applicant: uSky Transport (TOO), Sharjah, U.A.E

Addresses: uSky Test & Certification Center, Sharjah, U.A.E.

Manufacturer: Unisky Strong Technologies (UST), Minsk, Republic of Belarus

The Certification of conformity is based on the evaluation of Manufacturer's Safety Declaration.

Inspection that based on the designated uSky Rail, Strong Rail Track Structure, Anchor Supports, Intermediate Supports, Service Station, Passenger Station, Certification Centre, Sharjah, U.A.E

Certificate issued: 29/09/2021

TUV SW STANDARDISATION CERTIFICATIONS









About

10 ha

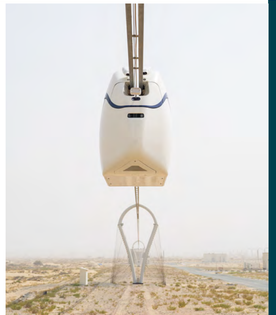
is the area of the territory, where a light overpass with a flexible track structure and all the necessary transport and logistics infrastructure have already been constructed (the total area of the site is 28 ha).











Along with the functional testing sites, it is planned to deploy in the Centre a full-fledged infrastructure of urban complex with its boarding stations, turngates and ticketing systems.

In order to expand development of the string rails network in the region and around the world, the research and production cluster will become the base for research and development. American University of Sharjah, together with the Innovation Research and Technology Park, plan to establish the Competence Center where the specialists in design, construction, and operation of the string transport will be trained.



ECOTECHNOPARK

EcoTechnoPark is the center for practical implementation of uST solutions, their international expert evaluation and certification.

EcoTechnoPark is located near Maryina Gorka, Belarus, within the area of 35.9 ha.

EcoTechnoPark:

- demonstrates the ecological potential of uST – minimal land allocation for the track, reduced material and power (fuel) consumption in the course of the complex construction and operation, etc;
- facilitates the certification process for every complex and its components – a transport overpass, rolling stock, infrastructure, etc.;
- represents current industrial models of uST passenger and cargo transport and infrastructure complexes;
- represents an accompanying communication infrastructure, including ecogenic biotechnologies and agricultural solutions;
- contributes to the constant development and modernization of uST.

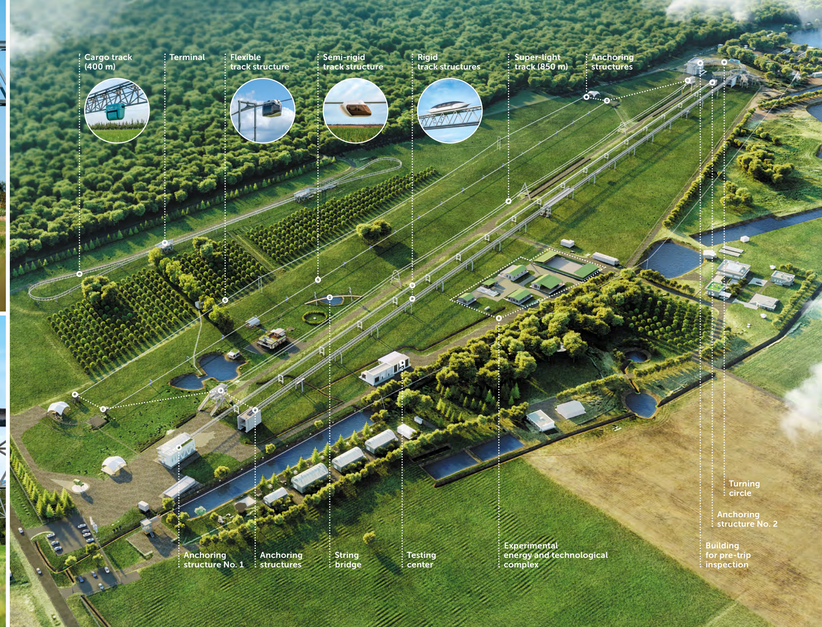














The operation of passenger, cargo, and high-speed vehicles moving along six types of track structure (rigid, arched rigid, semi-rigid, flexible, super-light, and cargo) is demonstrated in the EcoTechnoPark. There are also options of supporting towers and anchoring structures for the string rail transport overpasses and other infrastructure components (stations, depots, turnouts), as well as two types of cargo terminals.

The center presents 12 unmanned uPods, which are essentially different in design, driving speed, and capacity: passenger (uBike, uCar, uBus, uLite, uWind, uFlash) and cargo (uTruck, uCont, uTrans) vehicles.













An ecohouse was built in the EcoTechnoPark based on green technologies and sustainable materials. All the infrastructure and logistics facilities of uST are surrounded by wildlife on fertile soil.

More than

15,000

fruit trees have been planted in the EcoTechnoPark gardens.



uTERRA

Organic farming means no use of chemical fertilizers, pesticides, herbicides, and other toxic substances, as well as application of gentle methods of soil treatment.

uTerra is the project providing organic farming together with greening of sites along uST tracks, the creation of green roofs and floors in buildings and structures of transport and infrastructure complexes.

Social and economic possibilities provided by the uTerra project

- Provision of rational and efficient functioning of land resources and land conservation
- Restoration of the territories suffered from human activities
- Preservation of the natural balance
- Creation of favorable living environment
- Development, greening, and settlement of desert areas

On the way to preserve the environment

Humus is one of the important means for replenishment of the biological resources of our planet; it is favorable for the growth and development of plants.

The fertility of soil depends on this unique microbiological fertilizer. It is the source of nutrients for green plants. Humus contains many macro- and micronutrients (nitrogen, phosphorus, potassium, etc.), becoming available to plants after mineralization.



uTerra biohumus is produced from brown coal, ash, inoculum, aerobic microorganisms and used for restoration of soil fertility and improvement of soit characteristics.



Purposes of using biohumus:

- restoration of soil fertility, even if soil is completely depleted;
- increase in crop yields, growth of plants and development acceleration;
- natural soil detoxification;
- reduction in the cost of agricultural products;
- exclusion of chemical fertilizers, pesticides and herbicides;
- improving the taste of products;
- obtaining environmentally friendly crop, reduction of nitrate levels, radionuclides and heavy metals in plants.

Fundamentally new approach to land use

uTerra biohumus was tested on the experimental land plot of the EcoTechnoPark, created on a former tank training range.

Today, the EcoTechnoPark is also an illustrative example of the ecological potential of uTerra and demonstrates the rational use of natural resources, implementation of modern agricultural ecological technologies, and creation of organic farming zones.



Composition of uTerra biohumus

80–90 % – specific organic (humus) substances. They consist of humic acids, fulvic acids, and humine.

10–15 % – organic substances of individual nature that are represented by plants residues compounds. They include proteins, amino acids, fats, carbohydrates, waxes, etc.



User guide for uTerra biohumus

uTerra biohumus is an universal soil improver, as it is suitable not only for all plants, but also for various types of soil.

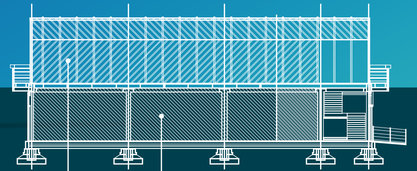
Open ground:
not less than 15–100 g of humus per 1 m^2 of surface depending on agroclimatic conditions and type of cultivated plants.

Indoor ground:
not less than 0.5–2 g of humus per 1 l of soil.

The use of uTerra biohumus increases crop yields by 20 % and more.

Modular greenhouses are the future of greenhouse facilities:

- affordable;
- cost-effective;
- easy to install and use;
- universal;
- allow expanding the area of a greenhouse facility within the shortest possible time.



1st floor – Light-proof module. It is intended to cultivate products under artificial lights.

2nd floor – It is intended to cultivate products under daylight with partial supplementary lighting (if required).



Raised vegetable beds



- Active heating by the sun
- Protection of plants from negative impact
- Reduction of the cultivated land space
- Increase in crop yield
- Absence of excessive moistening and drought
- Individual soil for each vegetable bed
- Good drainage
- Reduction of labor costs
- Aesthetic appearance









Cultivation of microgreens: one of the directions within the uTerra Project

Microgreens are young plants having two true leaves. It is the time when plants contain maximum concentration of the useful substances (6–40 times more than in adult plants): minerals, vitamins, and bioactive compounds.

The germs are cultivated from the seeds of the following crops: lettuce, flavoring herbs, sunflower, wheat, etc.

The microgreens are cultivated in the territory of the EcoTechnoPark using uTerra biohumus and technology excluding chemical fertilizers. Wheat germ juice production is launched.

Microgreens are a powerful activator for immune system, natural source of proteins, fibers, antioxidants, minerals, vitamins, amino acids, including irreplaceable ones. It possesses anti-inflammatory, antibacterial, antiviral, antioxidant, wound healing, anti-sclerotic, detoxification and immunomodulatory properties.



PROSPECTS FOR uST IMPLEMENTATION

- Integration of countries into international transport corridors, creation of a fundamentally new logistics of the 21st century.
- A qualitative change in the economic structure and increase in the countries' gross domestic product (GDP).
- Maximum reduction in capital and operating costs of transport and infrastructure construction.
- The development of underexploited and inaccessible territories, creation of a unified network of cargo, passenger, and high-speed intercity roads.
- The development of related industries for the production of rolling stock and track structures (metallurgy, chemical, petrochemical, radioelectronic, engineering, and construction industries).

All innovative uST components can be produced at the project locations using the existing technological capabilities.

Track structure

Rolling stock

Infrastructure

PATENTS

INVENTIONS





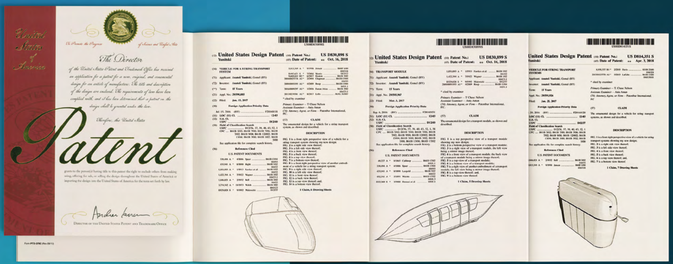




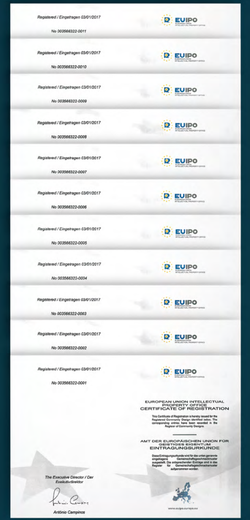


INDUSTRIAL DESIGNS

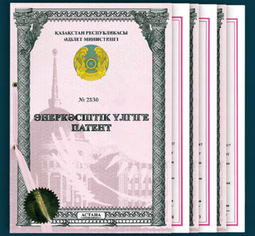




CERTIFICATES

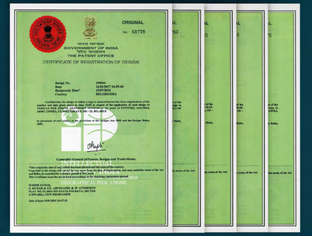






























CONTACT DETAILS

33, Zheleznodorozhnaya Str.,
Minsk, 220089, Republic of Belarus

Tel.: +375 17 388-20-20

ust.inc
info@unitsky.com



The presentation brochure materials review and describe the theoretical foundations of Unitsky String Transport, and may not correspond to the current stage of development of uST transport and infrastructure solutions, which are constantly being improved.

Unitsky String Technologies Inc.
ust.inc
info@unitsky.com

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