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SIAMS'S NATIONAL TUNNEL & UNDERGROUND SPACE PROGRAM

SINTUS - SCIENCE & TECHNOLOGY CENTER

PRELIMINARY CONCEPT

1. Preface

On the occasion of ITA's World Tunnel Congress 2012, which happened to take place in Bangkok, Dr.Chatchard, Minister of Transport, has mentioned in his Opening Address the needs and chances for further development of Thailands Underground Infrastructure.

It has been deliberated, that more use shall be made of existing scientific facilities with the implementation of science & technology competence centers addressing particular programs of tunnel and underground space technology.

Such stimulation has later been taken up in the discussions with Prof.Suchatvee Suwansawat, President of the Engineering Institute of Thailand, and Dr.Harald Wagner, resulting in the present concept ideas.

The "SINTUS – SCIENCE & TECHNOLOGY CENTER, SIAMS'S NATIONAL TUNNEL & UNDERGROUND SPACE PROGRAM" intends to create a non profit Institute to serve both the Academic World of Geotechnical Engineering and the Construction Industry predominantly working in the field of Underground Infrastructure by providing advanced Facilities for the Tunneling Technology and enhancement of graduates the knowledge through lectures, seminars and workshops to be conducted in close collaboration with highly competent International Institutes and Associations (e.g. ITA-AITES, PIARC, etc).

To enhance Transportation and Energy Infrastructure in Thailand, Tunneling is frequently required. Also Water Works for Irrigation require more often Tunneling in different terrain. Obvious it became necessary to apply advanced Tunneling Technologies. At present, Thailand may consider to improve facilities to transfer Know How resulting from programs of advanced tunneling technologies to industry and universities.

The concept of SINTUS is initiated with the objective to match the center with existing facilities to become a strong and prestigious Science & Technology Center in the field of Transport, Energy and Communication in Thailand.

Provided acceptance and support by the Royal Thai Government, the SINTUS could be started soon. It could offer advanced Education in Construction of Public Works in the context of Tunnelling and Underground Space Use for Roads, Railways, Mass Rapid Transit, urban and rural public works, Design and Technology, Project Management, Material and Technology for Construction, and all related Underground Infrastructure Construction Methods.

SINTUS Science Center considers itself as a non profit industrial infrastructure innovator that creates value for Thailand by developing required innovative and sustainable infrastructure solutions. SINTUS would contribute to urban land optimization, promoting cutting-edge projects and sustainable development initiatives, to develop a dynamic and future-ready industrial infrastructure landscape in Thailand.

2. Objectives

- Improve Quality and Efficiency of education in Tunneling Technology
- Enhance managerial skills of Graduates for Public Agencies and Private Sector
- Take active part in Social Economic Development.
- Assist students and graduates to increase skills, productivity and professionalism
- Support students by providing facilities, master tailored lessons and seminars.
- Assist Construction Industry by providing skilled, reliable graduates in tunnels.
- Enhance research and development capability of Graduates and Research Staff.
- Increase the capability of Graduates in Tunnel Construction Management.

3. Multiple Disciplinary Approach

The challenge is a multi-disciplinary approach that bring together groups of practitioners from universities and public agencies, from the industry, and students with diverse academic backgrounds to brainstorm and experiment with new urban planning concepts and to develop fresh paradigms for the built environment.

As part of this challenge, SINTUS shall establish teams with creative ideas. This teams shall then fulfill the aim of promoting synergies between underground industry and the academic community.

Teams shall be tasked to brainstorm and develop planning concepts that shall potentially be integrated into full masterplans. It shall provide practitioners and students with opportunities to learn about cutting-edge industrial developments through site visits to underground infrastructure projects to experience the process of idea generation and development. Interdisciplinary teams will then work creatively on the various programs and tasks, and present their innovative concepts.

4. Beneficiaries

Beneficiary are the Construction Industry as well as federal and local Government Agencies, evolved in the construction of underground infrastructure facilities taking the results and professional advice of the Science & Technology Center in their works and undertakings.

Technology results will benefit to public agencies and to the private sector, in Thailand and abroad, when exported. It shall enhance professionalism in the field of underground Infrastructure Projects at present and in the future.

5. Technology Program

As an industrial infrastructure innovator, SINTUS would be exploring creative ideas and innovative solutions to intensify land use and meet the country’s evolving needs.

This allows to meet the demand for industrial land while supporting sustained economic growth.

5.1 Multiple Drift Technology

Multiple Drift Technology shall be used to maintain and eventually increase cross section size in clayey/silty and sandy soils in particular in soft urban underground. Mined metro stations and shafts shall be one of the major alternatives for construction of underground mass rapid transit infrastructures.

Multiple levelled metro stations may penetrate through various materials, such as residuals soil and weathered rock. Structural design and ground support in the cross section are crucial in ensuring stability and integrity of the station.

Another aspect is how to prevent/reduce, control water inflow into underground structures and provide a safe, comfortable and cost-effective construction and operation environment.

The concept would look into optimization of station design in terms of structural design, water seepage control, ground support, dimensions, cost and time for construction, as well as cost efficiency and safety during operation.

5.2 Multipurpose Tunnels

Multiple Purpose Tunnels are combining different tunnel usages in one tunnel structure, independent from the applied tunnel technology, for better ecologic service. The Smart Tunnel in Kuala Lumpur is a good example. It is the longest multipurpose tunnel in the world, acting as storm drainage and road structure.

The multipurpose objective of this tunnel is to solve the problem of flash floods in Kuala Lumpur and also to reduce traffic jams during rush hours. There are two components of this tunnel, the stormwater tunnel and motorway tunnel.

Similar concepts shall be used for tunnels acting among others as combined tunnels e.g. for roads and bycicles, utility tunnel for combined communication and water supply or water discharge tunnel.

5.3 Multiple Baseline Contracting

Contracting Technology with GBR (Geotechnical Baseline Report) and RMP (Risk Management Plan) – Contracting Baseline Framework for design and construction of Tunnels using various Tunnel Technologies (see recomendations from ASCE, BTS, ASG, et.al.).

5.4 Hybrid NATM / Ribbing Tunnel Technology

Hybrid Technology for Conventional with Traditional Tunnelling – Enlarged X-sections by combining Ribbing Methods with Conventional Tunnelling (NATM). Ribbing Method is a reliable method making use of a concrete arch pre support (therefore also named CAPS Method) for large tunnel cross sections in soils under shallow cover.

The ribs reduce the probability of collapses and the magnitude of surface settlements as well. Future studies with different ground properties and overburden thickness shall contribute to the optimization of rib design.

With the present of high degree of manual work and low degree of mechanization the method is offered the chance, to develop simple mechanized excavation and support measures (e.g. mini excavators integrated into micro tunnelling TBM's) such increasing productivity, economics and labor safety.

5.5 Hybrid CIP/TBM Technology

Hybrid Technology for TBM Tunnels with Cast-in-Place (CIP) Linings (SFR Shotcrete & sprayed membrane) – Concept for CIP onepass tunnel linings in various ground conditions (see ITA publications on Steel Fiber Reinforced Shotcrete).

On the subject of water tight tunnels, recent developments are promising improvements in time, quality and cost. However, more studies shall be undertaken on the latest technology of in situ sprayed waterproofing layers, replacing prefabricated waterproofing membranes.

5.6 Civil & Architectural Team Planning Program

Planning team work in design and construction for Urban environment between Tunnel Engineers and City Planners/Architects in order to provide comprehensive solutions in balancing priorities for infrastructure implementation under border rural until urban center conditions.

5.7 Construction Speed up Program

SINTUS shall be looking for innovative solutions to accelerate the construction speed by exploring new technologies or creative methods to reduce construction time and improve efficiency and cost effectiveness to meet the industry needs.

Using conventional methods, the typical all inclusive construction of tunnels takes about 18 months per km. The tunnel works involve the excavation and support installation of initial and final linings, construction of tunnel drains, pavement and safety installations.

SINTUS seeks innovative concepts to accelerate the works by integrating different construction activities so the construction process involves only a limited number of stages. The concept should reduce the construction works and construction time by at least 30%.

5.8 Construction Risk Assessment

Underground facilities have been widely used for urban transportation (e.g. MRT) and storage facilities for oil, chemicals, etc. over the world, because they result in land savings and offer benefits of enhanced safety and security.

Due to limited availability of land, underground facilities show high potential values, since construction of underground facilities is costly. It is exposed to various risks.

In order to manage risks associated with underground facilities construction, risks will be identified according to phases of project life-cycle. The identification of risk will be carried out through reviewing existing literatures, interviewing experts, and studying actual projects.

Then, they are assessed quantitatively, qualitatively or the combination of both, particularly using computer simulation on the impact of risk factors.

These risk analysis will lead to a higher confidence in the estimation of construction duration, project investment cost and contingency budget required. Based on the results of risk assessment, risk management strategies will be suggested.

These research findings will thus enhance the project's constructability and viability and will bring about a higher level of certainty in the successful implementation of the project.

5.9 Underground Openings - Impact on Public

Concepts have been developed for the construction of underground caverns in order to provide space for storage and other industrial purposes. Urban environment needs new dimension and space for urban expansion and development as well; such demand could be met by creating new space by going underground for residential, commercial as well as complex industrial facilities and related infrastructures, e.g.car parks.

Underground infrastructure can be categorized as a complex system that involves not only sophisticated technical structures but also extensive social organizations, whose resilience relies on smooth integration between technical and organizational apparatuses embedded in the system.

Along with the construction of those underground caverns, the social issues become more and more critical because people need to spend longer time daily underground for longer time periods.

The societal impacts include benefit analysis and stakeholders' response towards underground facilities together with health assessment. The consideration of social impacts early in the planning of a development can lead to sustainable environmental development; improved relations between the developer, the planning authority and the local communities; a smoother planning permission process, and a viable economic return on the extra expenditure incurred.

The study shall provide comprehensive information for the decision making process and project management of the underground cavern developments.

5.10 Shaft Design Optimization in Construction & Operation

Vertical shaft shall be one of the major alternatives for accessing underground infrastructures. The shafts will be used in construction, installation and operation phases and will cater for different modes of transportation. Shafts may penetrate various materials, such as residuals soil and weathered rock before reaching the solid bedrock.

Structural design in the overburden (diaphragm walls or piling) and rock support in the bedrock section are crucial in ensuring stability and integrity of the shaft. Aspects how to prevent or reduce the water inflow into shafts and provide a safe, comfortable

and cost-effective construction and operation environment shall be considered.

The concept shall look into optimization of shaft design in terms of structural design, water seepage control, rock support, dimensions, means of shaft transportation, cost and time for construction, as well as cost, efficiency and safety during operation.

6. Role of National Universities

In continuation of the geopolitical changes of the 20th century, there are further geopolitical changes to be expected during the 21st century. In consequence of said changes, Iran is supposed to play an increasing important role on the geopolitical stage, such being forced to strengthen its economy on the basis of expanding infrastructure in the agricultural, transportation, and energy sectors.

SINTUS is meant to make use of the Asian Tradition in Underground Technology in combination with global Advanced Tunnel Technologies, and to such provide results which should benefit to the environment, ecology and economy of future infrastructure of Thailand.

The role of Thai Universities is of significant importance for the successful development of **SINTUS**, as **SINTUS** is meant to be a National Program for the implementation and further improvement of Underground Infrastructures in Thailand. In order to make **SINTUS** a success, the cooperation with the National University Network will be asked for (see attached graph).

While it shall be looked for International Research Cooperations on University levels, the role of International Experts shall be limited to advisory services, which shall be asked for on a project by project basis respectively on a research topic by topic basis.

6.1 SINTUS – Ministry supported NGO

SINTUS is meant to be an **Association** of University Institutes and Research Laboratories, sponsored by construction and manufacturing industry under the umbrella of Ministry of Science & Education. Research results shall be available to the public.

SINTUS shall be registered following actual Thai laws as an NGO having the structure of a Non Profit Organization. The acting management shall be supervised by the Ministry for Science and Education (or as adviced). Its actual Statutes and By Laws shall correspond to best practice of Thailands corporations.

6.2 Short Term Activity / Long Term Scope of Work

Due to the importance of **SINTUS** on the long run of Thai infrastructure development, and such in the best interest of Thailand, short and long term activities shall be annually phased and closely coordinated within Stakeholders.

Starting with the development of the business model, further considerations shall show results of short term activities based on long term scope of work, as well as outcomings to users including detailed national published information.

6.3 BUSINESS MODEL

SINTUS shall develop the **Business Model**, whereas advisors will be honored and pleased to assist, starting with the **Budget** for the next 5 years. The budget shall include **Funding** and best estimate of cost such reflecting both the **Short Term Activity** and the **Long Term Scope of Work (Schedule chart to be developed)**.

The budget for the entire team and the first 5 year term shall include

General Expenses for Office, Personnel, Consumables, Travel Expenses, Equipment, Overhead and Risk.

Key Professional Personnel shall include Management, Principle Researchers, Assistants, Fellows

Equipment shall include a.o. Laboratory and Survey Equipment, Computers, Cameras, etc

Funding shall be seeked from private companies and banks as well as public institutions, such becoming optional shareholders. While it is accepted to make profit, any such profit shall remain in the company for further techno-scientific investment in research projects.

6.4 ORGANIZATION

There shall be an Organization Chart developed, in order to show founders, position and role of the Government, associations with other NGO's, e.g. ITA-Aites, Universities, private Institutes, Contractors, Consultants and Manufacturers.

6.5 CC - CENTERS OF COMPETENCE

The centers of competence (organization chart to be developed) consists of

CC1 HIGH TECH LABORATORY (Geotech and Material)

CC2 HOLISTIC LIBRARY (Enhancing a.o. Literature Review)

CC3 TECHNOLOGY PROGRAM (10 Research Program Proposal)

CC4 TEACHING PROGRAM (Cooperation with Universities)

CC5 FIELD SURVEYANCE (Cooperation with Consultants & Contractors)

Bangkok, in January 2014