SEAMLESS SWITCH

Is it possible to make motorway interchanges cheaper to build, cheaper to maintain and less congested? The Inside Turning Left interchange design could be the answer. **Joshua Stein** reports.

Motorways are expensive. As assets near the end of their lifecycles and need replacing, the focus is always on whether new motorways, and interchanges, can offer a solid investment with efficient use of land and funding.

The Inside Turning Left (ITL) interchange design aims to tackle this by using shorter ramps, and a smaller land take, limiting costs and environmental impact. It has been developed by Goran Jovanovic who is a director of Slovenian consultant Appia with electrical engineer Rafko Atelsek who works on infrastructure projects for aluminium producer Impol.

The design was presented to the First Macedonian Congress on Roads last November as part of a study of motorway interchange designs, undertaken by Jovanovic and Atelsek.

The model has yet to be applied to a live project but, Jovanovic tells *NCE*, that it could solve many of the issues which hamper the use of classic interchange layouts, like the cloverleaf or the stack.

"Our challenge was to find a method of building interchanges where the length of the ramps and overpasses can be shorter," he says. "This is highly connected to the level of investment – if you have a lot of long ramps and overpasses, this will increase the price of construction significantly."

Jovanovic and Atelsek's study compared the ITL system with more commonly used stack, pinavia, turbine and cloverleaf interchange designs looking at average vehicle speeds, carriageway lengths for slip roads and overpasses, and the number of levels. The ITL model was created

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INSIDE TURNING LEFT INTERCHANGE

On conventional interchanges vehicles often turn through at least 140° to get from one motorway to the other. Such junctions often take up more space than the thinner, elongated ITL design.

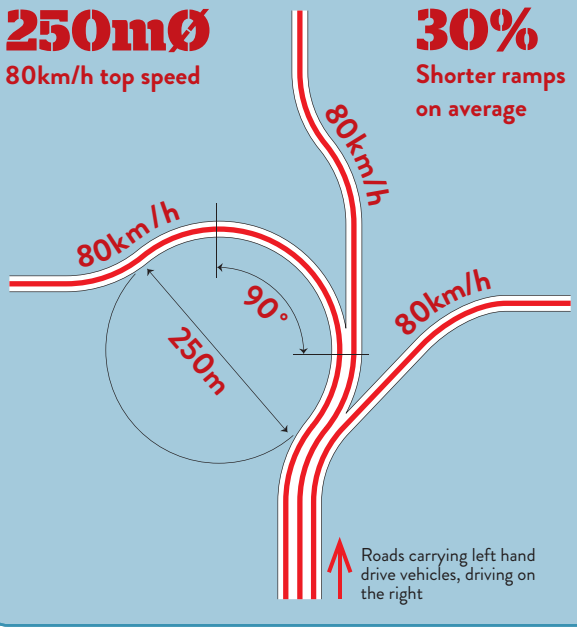
The ITL design includes a left directional ramp which turns gradually through 90°. This makes the length of the left directional ramp significantly shorter than traditional interchanges

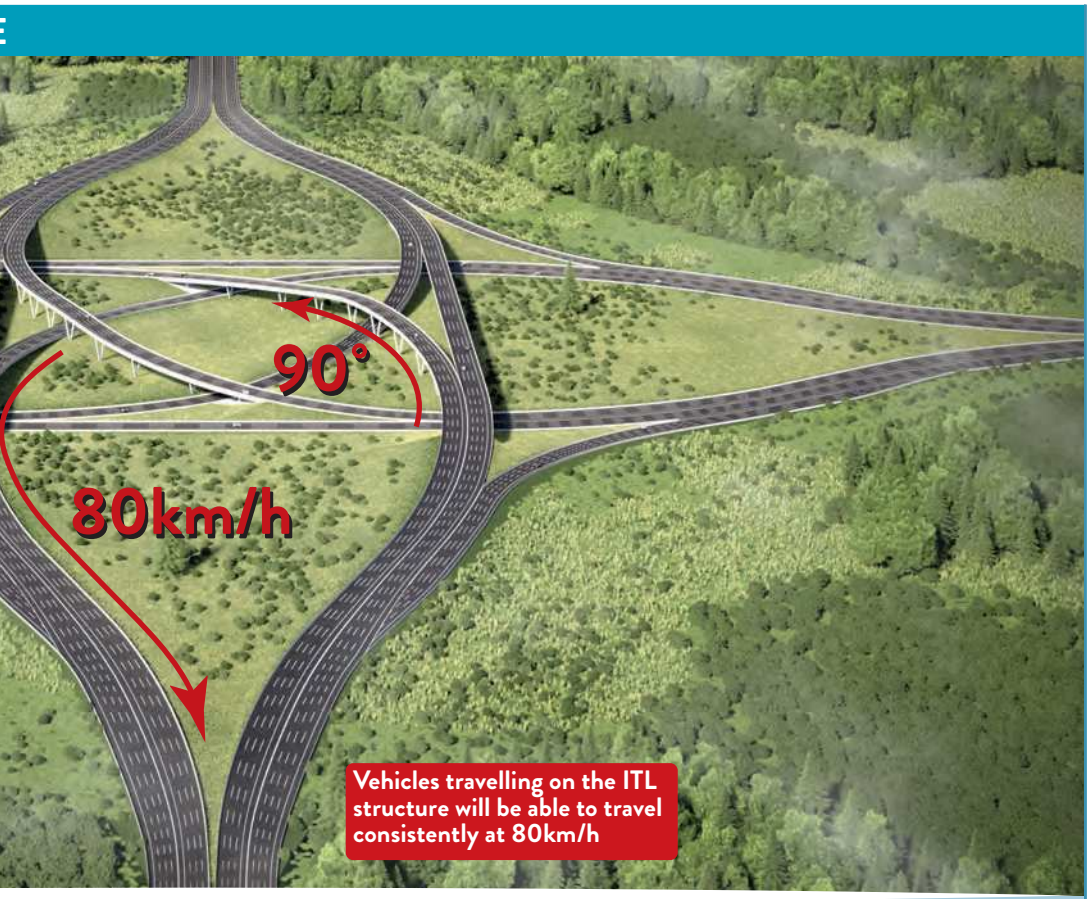
The ITL interchange design uses shorter ramps and builds on a smaller land area to limit the cost/environmental impact

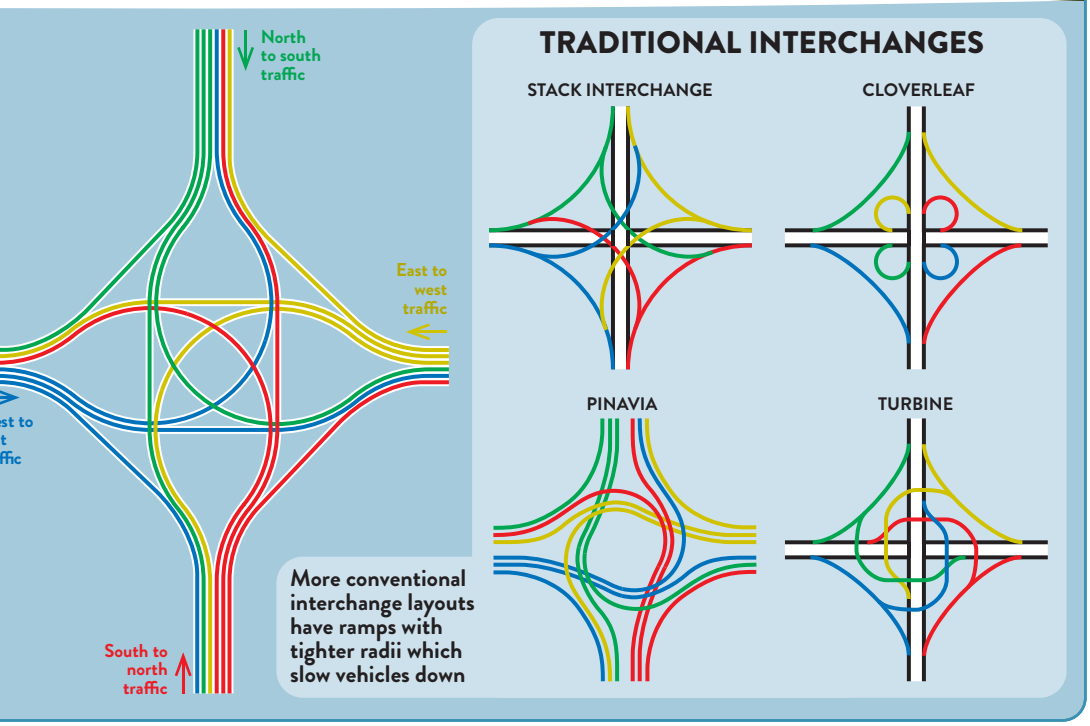
ITL INTERCHANGE

250mØ
80km/h top speed

30%
Shorter ramps on average







“Overpasses and underpasses are always more expensive compared with roads, because they include steel or extra concrete

using software firm PTV Group’s Vissim traffic simulator, which compared traffic data with real-time data from other motorway interchanges. ITL, the study claims, “represents the best compromise between the traffic capacity, the land area used and construction cost”.

The ITL design has been developed for roads carrying left hand drive vehicles, driving on the right.

It works on the basis that, at the interchange of north/south and east/west motorways, the two carriageways of each highway are separated, creating space between them for slip roads.

These would take northbound traffic onto the westbound route of the other motorway and southbound traffic to the eastbound carriageway.

The layout is identical for traffic moving from the east/west motorway to the north/south one.

Shorter slip roads would connect the northbound and eastbound carriageways and the southbound and westbound carriageways as well as the westbound and northbound carriageway and the eastbound and southbound carriageway .

“[Having the sliproads between the carriageways] is the major advantage in comparison with the other designs,” says Jovanovic.

On conventional interchanges vehicles must often turn through at least 140° to get from one motorway to the other. Such junctions often take up more space than the thinner, elongated ITL design.

The ITL design includes a left directional ramp which turns gradually through 90°. This makes the length of the left directional ramp significantly shorter than traditional interchanges which incorporate longer curves as vehicles must turn back on themselves and loop around to join the other

> **With the ITL system, the ramps are an average of 30% shorter than other, conventional systems**

motorway.

The left directional ramps have all been designed to cross over or under a combination of carriageways – two central slip roads and two main carriageways. This presented the biggest challenge to the designers.

"The biggest challenge is the level change of the slip roads," says Jovanovic.

"Those in the space between the carriageways must go over or under slip roads and main carriageways. This means in a very short length of road you have to change the vertical alignment of the interchange very quickly. That is very tricky to pull off."

COST-CUTTING INNOVATION

An ITL interchange will, according to the designers, have around 1.4km of overpasses, a fraction of the 3.3km average for stack interchanges.

Some existing interchanges have overpasses which are five times the length of the ITL design. That, Jovanovic explains, is a critical difference. Constructing overpasses is the costliest element of a motorway interchange. "Overpasses and underpasses are always more expensive compared with roads, because they include steel or extra concrete, which is much more expensive to build if you compare with standard roads," he says.

"The structure needs some foundations as well." Therefore, keeping the length of the overpasses as short as possible reduces the costs.

Additionally, the ITL model's slip roads are shorter when compared to traditional interchange designs – again making them cheaper.

"With the ITL system, the ramps are an average of 30% shorter than other, conventional systems," Jovanovic adds.

Slip roads on a typical turbine structure, are according to the study, 75% longer than the ramps on the ITL model.

"It is always hard to talk about the specific amount of money you will save on one project in comparison to another, because there are many factors, some of which you cannot predict," says Jovanovic. "But if the ramps are between 20% and 75% shorter, you get an idea of how much money you will save using the ITL system."

The ITL interchange system incorporates a slightly longer total road length than the stack and turbine interchanges, but should cost less when the length of the overpasses is considered, the study suggests.

PUSHING EFFICIENCY

One of the most easily recognisable interchange structures is the cloverleaf, seen in Germany and the United States since the 1920s. This is the only design with shorter overpasses than the proposed ITL, but falls short because the tight curves on the cloverleaf require a dramatic reduction in vehicle speed.

"Safety is always a concern when you are building interchanges," says Jovanovic. He says that with alternative models to ITL, vehicles have to slow down more than they would on the ITL.

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"The [100m] radius of the curves on the cloverleaf is very small, so designers decide to lower the maximum speed, to keep the interchange safe."

Vehicles moving through a typical cloverleaf junction are forced to slow down to 40km/h as they negotiate the bends. Invariably, this leads to delays and congestion on the roads.

In comparison, the 250m radius of the ITL curves means vehicles can travel at a more constant speed. Atelsek and Jovanovic's microsimulation calculates the ITL would slow vehicles down less than other interchanges, especially when traffic is busy.

In a "highest volume traffic scenario", the designers say an average vehicle on the ITL interchange would be delayed by 10.2s, in comparison to 13.6s on pinavia interchanges.

FINE-TUNED DESIGNS

Jovanovic and Atelsek are braced for some difficult pitches as they seek to have the ITL design adopted. "[The industry has] got used to using the same models for so long," Jovanovic explains.

"Now the goal is to promote the design and to show potential investors what we would achieve with the ITL model." **N**