University of Pisa

MODERN ROUNDABOUTS AND HISTORICAL TOWNS: THE AREA OF PORTA S.ANNA IN LUCCA (Italy)

Comune di Lucca

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ABSTRACT

Lucca is a historical town and there are no spaces available for new roads. Therefore, the main task of our applied research has been related to gain some local congestion reductions and traffic impacts mitigation, especially during peak hours, through implementing and optimizing the present road network facilities.

"Porta S.Anna" is a crucial part of the urban road network in its whole, and among the new set of proposed planning actions there are two roundabouts. The first one is the roundabout placed at the intersection of two main arterials, namely Viale Carducci and Viale Europa, which has been analyzed under different traffic conditions and evaluated in respect to some design changes of its geometrical characteristics. This way, the best shape and size have been set up, under many and various constraints superimposed compatibility. The roundabout has been built on 2006 and today operate efficiently and with lower delays and shorter queues than during its previous arrangements.

In similar way, we have carried on the design of a second large roundabout in order to improve the road node of Piazzale Boccherini. Nowadays, the roundabout project have passed both the "administrative commission" and the "landscaping & environmental committee" and its construction is expected to start no later than Fall 2008.

Due to the presence of several constraints both the two roundabouts quoted above result in an elliptic shape with semi-axial ratios of 0,87 ("Europa") and 0,90 ("Boccherini"). Moreover, they are studied and designed considering three main groups of design factors:

a) Road safety factors: referred to accident risk reduction as many as their severity. Among these factors there is the special attention paid to pedestrians and cyclist flows operations. The roundabout layout designed for "Piazzale Boccherini" takes explicitly into account of special detached works spanning from improved pedestrian crossings by suggesting an underground passage on the main arterial branch (NB).

b) Circulation efficiency factors: the two roundabouts are replacing of two signalized intersections and lesser average delays are expected. The roundabout arrangement of Piazzale Boccherini it is also conceived into a local network study and its related traffic flow simulations have shown benefits and improvements not only limited to the intersection itself.

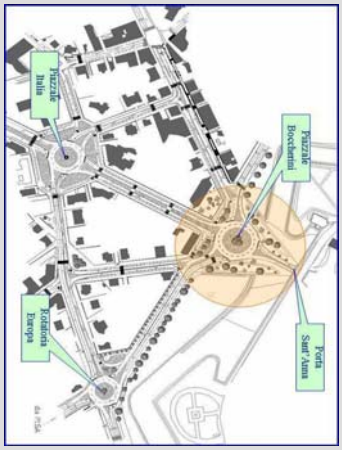
c) Central island furnishing and road space upgrading factors: it is well-known and world-wide accepted that a roundabout consists of a better road space marking element, especially for urban areas, than a signalized intersection. From an architectural point of view, the roundabout can be resembled to a "*check point*" and should be furnished in a way enhancing its visibility and perception by drivers. Public lighting has an important role and becomes a distinctive item, often beyond the mere road safety. Central island can be set up with lawn and/or trees enhancing the surrounding landscape, as much as with remarkable arrangements or statues.

The main tackled problems are the following:

• *High traffic flows*: the arterials surrounding the Historical City form the so-called "Urban Ring" and it is the crucial element of the road network. Therefore, high peaks of traffic flows are daily recursive on the "Urban Ring", in addition with high flow percentages of heavy commercial vehicles. Due to its primary access function for the city centre, there are also considerable flows of pedestrians and cyclists traversing and crossing the "Urban Ring".

• *Proximity to Renaissance Walls*: our roundabout design processes have been deeply influenced by the proximity to the monument of Renaissance Walls, surrounding all the historical city. Such a proximity acted as a special constraint both on the selection of geometry, subject to require the longest distance from the monument, as much as on the choice of the central island landscaping which has been furnished taking into account both the preservation of present higher trees and the roundabout landscape integration.

Layout of the local road network under study



Satellite view of the present condition

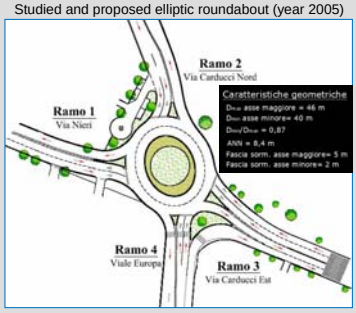
1) "VIALE EUROPA" Roundabout

Evolution across the time

Signalized control (from 1960 to 2004)

Experimental roundabout arrangement (years 2004-2006)

Studied and proposed elliptic roundabout (year 2005)



Satellite view of the present condition (built on year 2006)

2) "PIAZZALE BOCCHERINI" Roundabout

Present condition (intersection layout)

Present condition (aerial view)

1st hypothesis of layout (circular shape)

2nd hypothesis of layout (elliptic shape + shunt lanes)

Passed layout (elliptic shape without "shunt lanes" for sake of a better landscape insertion)

Average delays at comparison

PRESENT condition (signalized)

	Average delay (s/veic)		Level-of-Service
Porta S.Anna	WB-R	36,4	D
	WBT	22,4	C
	WB-L	31,5	C
Viale Carducci	17,6		B
Via Catalani	49,8		D
Viale Papi	29,2		C

DESIGN layout (roundabout)

	Average delay (s/veic)	Level-of-Service
Porta S.Anna	6	A
Viale Carducci	45	E
Viale Luporini	24	C
Viale Papi	34	D

Design solution geometry

Major semi-axis	27,75 m
Minor semi-axis	24,85 m
Circle width	9,00 m
Minimum distance to the Walls	81,15 m

Traffic induced vibrations in the Reinassence Walls

The vibration levels induced in buildings by dynamic actions existing among vehicles and road pavement can be described through the values of the peak point velocity, or PPV.

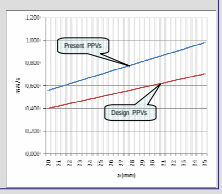
One can use the so-called Watts Model measuring the expected value of PPV on building foundations related both to different soil compositions and to vibration waves deadening as the distance grows (Watts G.R., "*Traffic induced vibrations in buildings*". TRRL - Transport and Road Research Laboratory, Report n.246, 1990).

The Watts Model is based on the following expression of the peak point velocity at 12Hz vibrations:

$$PPV = 0{,}028a\left(\frac{v}{48}\right)tp\left(\frac{r}{6}\right)^{x}$$

where: *a* is the maximum height or depth of surface faults (mm); *v* is the maximum speed of heavy vehicles (km/h); *t* is a scale factor related to the specific soil type; *p* is equal to 0,75 if the surface fault is placed on the path of one wheel only, 1 otherwise; *r* is the measure point distance (m); *x* is the value of the power function of wave deadening while distance growing and it is exhibited.

Referring to our own design condition, we have the value of 0,52 mm/s for PPV at 12Hz traffic induced vibrations in Walls foundations. Such a value is very much below the feasible value of 3,6 mm/s set up for high importance buildings by National standards (Norma UNI 9916 per "*Strutture di grande valore intrinseco*"). **Our designed solution even shows its capability in lowering to a great extent the traffic induced vibrations nowadays in foundations of the Renaissance Walls due to the traffic flows on Urban Ring in front of Porta Sant'Anna (about 40% less of PPVs).**



Daylight 3D simulation (Northbound view from an aerial viewpoint)

Daylight 3D simulation (Eastbound view)

3D simulation by night (Westbound view from a viewpoint placed on the Walls)