DIFFERENT TYPES OF JUNCTION BEHAVIOUR FROM ROAD SAFETY POINT OF VIEW. SPANISH EXPERIENCE IN STATE ROAD NETWORK

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**TYPE OF INTERSECTIONS**

- **By separation**
  - At grade (JUNCTION)
  - Grade Separated (INTERCHANGE)

- **By signalization**
  - Signalized
  - Not signalized

- **By channeling**
  - Canalize
  - Without channeling

- **By shape (JUNCTIONS)**
  - “T” junction
  - “Y” junction
  - “Cross“ junction
  - “X“ junction
  - Roundabout

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### 1- Inventory

<table>
<thead>
<tr>
<th>Kilometres</th>
<th>R.C.E.</th>
<th>INTERSECTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>26.051 Km</td>
<td>2.839 Km (11%)</td>
</tr>
<tr>
<td>Injury Accidents</td>
<td>85.367</td>
<td>20.146 (23.6%)</td>
</tr>
<tr>
<td>Accident Rate</td>
<td>21.4</td>
<td>34.4</td>
</tr>
<tr>
<td>Fatal Accident Rate</td>
<td>1.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Death Rate</td>
<td>2.1</td>
<td>3.2</td>
</tr>
</tbody>
</table>

(AVERAGE IN LENGTH: 490m)
2- Sample

<table>
<thead>
<tr>
<th>NO OF JUNCTIONS: 5.754</th>
</tr>
</thead>
</table>

### SAMPLE COMPOSITION

<table>
<thead>
<tr>
<th>BY SHAPE OF JUNCTION</th>
<th>BY AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T</strong></td>
<td><strong>RURAL</strong></td>
</tr>
<tr>
<td>3.078</td>
<td>3872</td>
</tr>
<tr>
<td>53,5%</td>
<td>67,3%</td>
</tr>
<tr>
<td><strong>Y</strong></td>
<td><strong>URBAN</strong></td>
</tr>
<tr>
<td>472</td>
<td>1244</td>
</tr>
<tr>
<td>8,2%</td>
<td>21,6%</td>
</tr>
<tr>
<td>Cross (+)</td>
<td><strong>CLOSE TO URBAN</strong></td>
</tr>
<tr>
<td>668</td>
<td>638</td>
</tr>
<tr>
<td>11,6%</td>
<td>11,1%</td>
</tr>
<tr>
<td><strong>X</strong></td>
<td><strong>WITH LIGHTING</strong></td>
</tr>
<tr>
<td>49</td>
<td>1.706</td>
</tr>
<tr>
<td>0,9%</td>
<td>29,7%</td>
</tr>
<tr>
<td>Opened roundabout</td>
<td><strong>WITH TRAFFIC SIGNALIZATION</strong></td>
</tr>
<tr>
<td>334</td>
<td>188</td>
</tr>
<tr>
<td>5,8%</td>
<td>3,3%</td>
</tr>
<tr>
<td>Roundabout</td>
<td><strong>UNTREATED</strong></td>
</tr>
<tr>
<td>358</td>
<td>1.910</td>
</tr>
<tr>
<td>6,2%</td>
<td>33,2%</td>
</tr>
<tr>
<td>Interchange</td>
<td></td>
</tr>
<tr>
<td>555</td>
<td></td>
</tr>
<tr>
<td>9,6%</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td></td>
</tr>
<tr>
<td>4,2%</td>
<td></td>
</tr>
</tbody>
</table>

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2- Junctions vs. other road sections

Junctions represent 10.9% of the total length of the network, but they concentrate about 24% of injury accidents.
3- Junctions vs. other road sections

Both Accident Rate and Fatal Accident Rate are higher at junctions than in the rest of the network. If we calculate a ratio with Fatal Accident/100 Injury Accident, in this case the results are that the index is lower at junctions.
4- Junction by type analysis

a) Accident figures considering type of junction

Interchanges have the lowest Accident Rate, followed by roundabouts.

X-junction shows the highest Fatal Acc and Injury Acc rate, while roundabout has the lowest rate value.

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c) Interchange by type analysis

- **Diamond**
  - Accident Rate: 1.9
  - Fatal accident rate: 19.1
- **Clover-leaf**
  - Accident Rate: 1.5
  - Fatal accident rate: 19.9
- **Trumpet**
  - Accident Rate: 24
  - Fatal accident rate: 27.9

**Legend:**
- Blue: Accident Rate
- Red: Fatal accident rate
- Green dashed line: Average Accident Rate
- Purple dashed line: Average Fatal accident rate
When AADT<10,000 veh/day the T-junction shape with better results regarding Accident Rate is the one that has a left turning lane.

When AADT is over 15,000 veh/day, the T-junction shape with better results regarding Accident Rate is the one that has a left turning lane and merging lane.
In general, Y junctions behave worse than T-type
f) Cross-type intersection

Is the type of junction with the highest values of accident rates together with opened roundabouts, especially when considering rural area.

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g) X-Type junction:

- X-Type present a high Accident Rate (AR=42).
- However, this type of junction is more secure than opened roundabouts (AR=59.2) and cross-type intersections (AR=45.1). These results confirm that the orientation of the branches of the junction has a positive effect on road safety.
- Not statistically significant sample (0.85%)
h) Roundabouts

Good results for traditional roundabouts but high Accident Rate results for the opened type.
5- Accident data vs. AADT

a) AADT in main road

In general, when the AADT increases accident rates tend to improve (lower values).
INTERSECTION ACCIDENT ANALYSIS AT THE STATE ROAD NETWORK OF SPAIN (R.C.E)

6- Analysis by area

- Intersections in Urban areas show the lowest accident rates.

- In rural areas, both Accident and Severity rates are very high (as car speed is above urban areas).
7- Analysis considering Lightning requirements and type of area

- Significant results only when considering urban areas.
- Outside urban areas, the death rate decreases but the values recorded of accident rate increases.
DESIGN RECOMMENDATIONS:

On behalf the results of the present Intersection Accident Analysis, the main recommendations (considering the type of junction) to incorporate the current knowledge on the safety performance are:

a) Outside urban areas:
   
   Four branches junction:
   
   The best type of junction, regardless AADT values, is the interchange. Among this, the clover-leaf type present the lowest accident rates.

   Three branches junction:
   
   ✓ AADT< 10.000 veh/day: T-type, channelized and with middle turning lanes.
   
   ✓ AADT>10.000 veh/day: T-type, channelized and with middle turning lanes and merging lanes.

b) Urban areas:

   The type of junction with better results regarding accident rate are illuminated roundabouts and interchanges.
CONCLUSIONS:

• Roundabouts and Interchanges are the two types on intersections that better comply with safety standards (lower accident rates). In the other hand, the worst results are for opened roundabouts, Cross-type and X-type junctions.

• Regarding AADT, accident rates decreases when the AADT of the main road increases.

• When two roads merge into a cross-type intersection and one of the roads has an AADT of 8,000-10,000 veh/day, it is recommended to adopt an interchange type design.

• Roundabouts are a good solution for urban areas but not for rural areas. Opened roundabouts do not behave well in general, but work better in urban areas if they have traffic lights to control the movements allowed.
CONCLUSIONS:

• T-junctions can be used for a wide range of AADT. However, for AADT<8,000 veh/day, the accident rate is lower in Y-type.

• In general, Cross type of intersections are quite unsafe. The main problem is the length of the turning lane (too short), when it is recommended to be over 100 metres.

• Lightning has effects on safety only in urban areas.
THANK YOU VERY MUCH FOR YOUR ATTENTION!