GRADE SEPARATION

Description

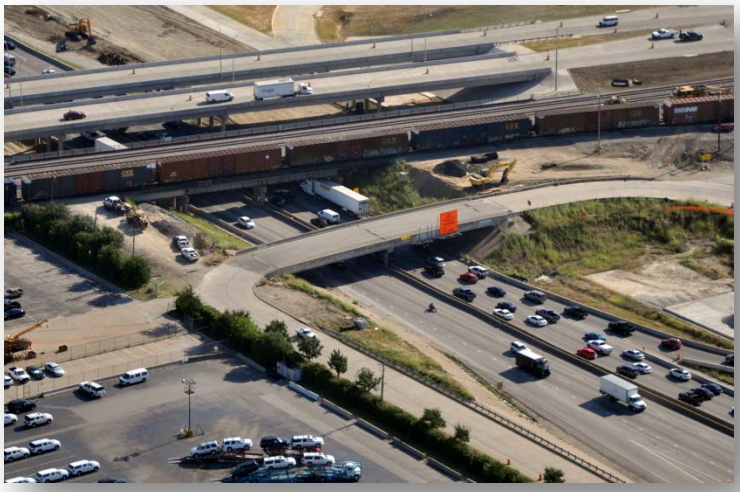
Intersections handling a high volume of traffic and pedestrians (and possibly railroads) limit the capacity of the approaching roads. Grade-separating these conflict points allow an uninterrupted flow of traffic while also eliminating the safety threat posed by trains, pedestrians, or other vehicles. Three primary roadway improvement objectives are accomplished using grade separated intersections:

- Increased capacity and uninterrupted flow.
- Increased safety.
- Reduced vehicle-train conflict and delay.

Overpasses increase the capacity of a roadway by allowing uninterrupted flow in all directions. The intersection approaches do not come in direct contact but rather bypass each other. Fewer signals are required to direct traffic, eliminating the queues caused by signals.

Grade separation increases roadway safety by reducing the vehicle-vehicle and vehicle-pedestrian conflicts. The crossing traffic is removed from the intersection, thus eliminating the possibility of collisions between those streams of vehicles. Pedestrians are given greater protection from cars, as there will be only one line of traffic to cross and more refuge points can be provided at multiple locations.

Removing at-grade intersections with railroads substantially increases speed for both trains and cars. Street traffic moves freely over or under railroad tracks, reducing wait times for a passing train and increasing travel speed and capacity of the roadway. Most importantly, the incidence rate of train-vehicle collisions is eliminated as the intersection no longer puts traffic in front of trains.



Cost:	●●●●○
Time:	**Moderate**
Impact:	**Spot**
Who:	**City/State**
Hurdles:	**Funding**

Target Market

Arterial Intersections with High Traffic Volumes

Intersections are a large cause of congestion on arterial streets. Signal time given to each direction dramatically decreases a road's capacity, increasing the possibility of congestion and queues. This planned stop-and-go condition reduces safety and increases travel time for all drivers. Elevating one of the streets will reduce the conflict caused by intersecting roadways. The reduced interference will increase the road capacity.

Railroad Crossings

Railroad crossings pose a threat to the safety of street and rail traffic. At-grade crossings, especially near intersections, create numerous conflict points for cars, trains, and pedestrians. These crossings force both cars and trains to reduce their speed, increasing travel time and congestion for cars and decreasing overall efficiency of the rail network.

How Will This Help?

Grade-separated intersections substantially increase capacity by eliminating delay caused by the previous intersection or railroad. Traffic moves freely and any needed signal timing can be increased by the lack of a traditional intersection, as signals may only be necessary for accessing the exit and entrance ramps of the interchange.

Elevating one portion of a street or rail crossing improves safety by eliminating vehicle, train, and pedestrian conflicts. Crossing traffic is minimized; trains are separated from the roadway; and pedestrians cross traffic less frequently—all decreasing the likelihood of a collision. The American Association State Highway and Transportation Officials (AASHTO) *Highway Safety Manual* reports that converting an at-grade, four-leg intersection to a grade-separated interchange reduces injury crashes by 57 percent. Converting a signalized intersection into a grade-separated interchange reduces injury crashes by 28 percent.

Implementation Examples

Texas: Two examples of grade separations can be found on US 281 north of San Antonio, at the intersections with SH 46 and FM 1863. Aerial images of these locations are provided in the figures below.

These two locations provide mobility for through traffic on US 281 while still permitting access to and from other roads on the state highway system.

A project to install grade separations at railroad crossings has been proposed for FM 306 in New Braunfels. A local citizens group[1] states that there are 32 daily trains that cross FM 306 at grade, and these trains often cause significant delays, sometimes blocking the crossing while they stop or back up. The FM 306 corridor not only serves local traffic, but it also is a school bus route that includes 98 daily school bus crossings over the tracks. Additional crossings by emergency response vehicles are also affected by the railroad tracks. Local citizens worked with elected officials and TxDOT to propose two grade separations at railroad crossings on this corridor; the project is tentatively scheduled to let in August 2012.[2]

Application Techniques and Principles

Grade separated intersections should be used when other techniques (e.g., signal timing, lane additions) are unsuccessful in reducing congestion to an acceptable level or were impossible due to external constraints. Grade separation works well when one or more directions experience heavy volumes and high levels of congestion even after other methods (such as signal optimization or additional turn lanes) have been exhausted.

The congestion on all approaches of an intersection should be examined to find the best grade separation solution. For example, if congestion primarily occurs on one cross street, a two-level interchange is recommended.

US 281 @ SH 46 (Google Earth)

US 281 @ FM 1863 (Google Earth)

For more information, please refer to: http://mobility.tamu.edu/mip/strategies.php.

If congestion is significant on all approaches, a three-level interchange better provides the desired capacity. If the adjacent intersections are also congested, a grade separation may only move the problem, rather than solving it.

For road/rail intersections, a simple overpass reduces the delays felt by both traffic and trains. Cars and trains lower their speeds when approaching at-grade intersections. The lack of interaction will increase speeds through these intersections and eliminate the possibility of collisions.

The AASHTO *Green Book*[3] describes six conditions, or warrants, that should be considered when determining if a grade separation or an interchange is justified at a particular site:

1. **Design designation –** The determination to develop a highway with full access control between selected locations becomes the warrant for providing grade-separations or interchanges for all intersecting roadways crossing the highway.
2. **Reduction of bottlenecks or spot congestion –** Insufficient capacity at the intersection of heavily traveled routes results in intolerable congestion on one or all approaches.
3. **Reduction of crash frequency and severity –** Some at-grade intersections have a disproportionate rate or frequency of serious crashes. If inexpensive methods of reducing crashes are likely to be ineffective or impractical, a grade-separation or interchange may be warranted.
4. **Site topography –** At some sites, grade-separation designs are the only type of intersection that can be constructed economically.
5. **Road-user benefits –** The road-user costs from delays at congested intersections are large. Road-user costs, such as fuel and oil usage, wear on tires, repairs, delay to motorists, and crashes that result from speed changes, stops, and waiting, are well in excess of those for intersections permitting uninterrupted or continuous operation.
6. **Traffic volume warrant –** A traffic volume warrant for interchange treatment may be the most tangible of any interchange warrant. Although a specific traffic volume at an intersection cannot be used as the sole criterion to warrant an interchange, it is an important variable, particularly when combined with the traffic distribution pattern and the effect of traffic behavior.

Not all warrants for grade separations are included in the warrants for interchanges. Additional warrants for grade separations include grade separations that would:

- Serve local roads or streets that cannot practically be terminated outside the right-of-way limits of freeways.
- Provide access to areas not served by frontage roads or other means of access.
- Eliminate a railroad-highway grade crossing.
- Serve unusual concentrations of pedestrian traffic (for instance, a city park developed on both sides of a major arterial).
- Serve bikeways and routine pedestrian crossings.
- Provide access to mass transit stations within the confines of a major arterial.
- Provide free-flow operation of certain ramp configurations and serve as part of an interchange.

Issues

Funding these relatively large projects remains the single biggest implementation issue, though the benefits are often well worth the cost. Finding locations with available right-of-way and public approval sometimes proves difficult, especially in densely-developed areas. Sufficient right-of-way should be acquired as the intersection is first built; acquiring additional land dramatically increases cost.

The acquisition of needed rights-of-way and construction costs represent significant hurdles that must be overcome, even though the benefits may be dramatic. If planners recognize that an intersection may eventually benefit from grade separation, the needed rights-of-way may be purchased during the intersection's initial construction when the land is typically cheaper.

The accommodation of traffic during construction of a grade separation is also an important consideration. Rarely is an intersection completely closed when a grade separation is constructed. The needs of drivers who use the intersection must be accounted for when scheduling the various phases of the project to allow traffic to proceed through the area as safely and efficiently as possible.

Who Is Responsible?

City and state officials are responsible for designing, constructing, and maintaining the overpasses and other features of the grade separated intersection, depending upon road jurisdiction. Cities should follow state codes for construction.

Project Timeframe

The timeframe of a grade separated intersection project depends on the size of the constructed overpasses. A project that includes only constructing a two level roadway interchange, or a railroad overpass, will have a shorter timeframe compared to a three-level interchange. The timeline for a grade separation project typically takes place over multiple years, to allow for appropriate design, right-of-way acquisition, any needed environmental clearance, securing necessary funding, and construction phasing. As mentioned above, the FM 306 project is tentatively scheduled to let in August 2012,[2] and the duration of the construction period has not been specified. The concept of the project has been discussed since 2008, and design work took place in 2010.[1]

Cost

The project cost depends on the type of interchange being constructed. A project to construct a two-level interchange or overpass will typically cost in the range of $10 to $30 million. This is low when compared to the costs of more than $100 million to construct a larger three-level interchange. Additional right-of-way requirements may increase the cost dramatically. The entire FM 306 project is estimated to cost almost $40 million for two railroad grade separations and widening two miles of the highway from two lanes to four; the two railroad grade separations have estimated costs of about $10 and $15 million.[2]

Data Needs

Designing and constructing an adequate grade separated intersection requires a significant amount of information regarding the current interchange. Traffic counts are needed for all directions approaching the intersection. Current information regarding signal timing and preemption is also needed to be sure no other methods of re-signalization are possible.

Useful data also include peak hour volumes for each intersection approach, intersection geometry, available right-of-way, topography, proximity to other intersections, turning movements, and pedestrian volumes. Should the grade separation be due to a railroad crossing, the average delay to either traffic or trains should be reported, as well as the frequency of trains and the number of train-car collisions.

Grade Separation Best Practice

- Type of Location: High volume and/or high-speed major streets, particularly at intersections with substantial left-turn volumes.
- Agency Practices: Coordination between planning, design, safety, and operations.
- Frequency of Reanalysis: After substantial land use changes or development; as travel increases or trips change in the area; at time of roadway widening or reconstruction.
- Supporting Policies or Actions Needed: Capability to fund improvements, multi-agency agreements, and policies where roadways cross jurisdictional boundaries.
- Complementary Strategies: Intersection pedestrian treatments, access management.

For More Information

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Mobility Improvement Checklist: Adding Capacity, Vol. 3, Texas Transportation Institute, Texas A&M University, College Station, TX, September 2004.

A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, Institute of Transportation Engineers, Washington, D.C., 1997.

References

1. Project Background. The FM 306 Improvements Coalition. New Braunfels, TX. http://www.fm306.org/Background.html. Accessed: November 4, 2011.

2. Detail Letting Schedule for Comal County (FY 2012) -- CCSJ: 1728-02-037. Texas Department of Transportation. Austin, TX. http://www.txdot.gov/insdtdot/orgchart/cmd/cserve/let/2012/comal.htm. Accessed: November 4, 2011.

3. American Association of State Highway and Transportation Officials. A Policy on Geometric Design of Highways and Streets. AASHTO. Washington, DC. 2011.