Waste Tire Market Development Conference

USE OF “TIRE DERIVED AGGREGATE” (TDA) FOR VIBRATION MITIGATION

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RTD Denver Union Station Project Manager
West Rail Line (W Line)—Opened April 2013

Denver Union Station—Opened May 2014

East/Gold/Northwest Rail Lines (EAGLE)—75% complete Opening 2016

I-225 Line—50% in construction progress; Open 2016

U.S. 36 Open 2016

North Metro Open 2018

Southeast Rail Extension—Open 2019

LOCATION OF TDA
# Typical Levels of Ground-Borne Vibration

<table>
<thead>
<tr>
<th>Human/Structural Response</th>
<th>Velocity Level*</th>
<th>Typical Sources (50 ft from source)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold, minor cosmetic damage, fragile buildings</td>
<td>100</td>
<td>Blasting from construction projects</td>
</tr>
<tr>
<td>Difficulty with tasks such as reading a VDT screen</td>
<td>90</td>
<td>Bulldozers and other heavy tracked construction equipment</td>
</tr>
<tr>
<td>Residential annoyance, infrequent events (e.g. commuter rail)</td>
<td>80</td>
<td>Commuter rail, upper range</td>
</tr>
<tr>
<td>Residential annoyance, frequent events (e.g. rapid transit)</td>
<td>70</td>
<td>Rapid transit, upper range</td>
</tr>
<tr>
<td>Limit for vibration sensitive equipment. Approx. threshold for human perception of vibration</td>
<td>60</td>
<td>Commuter rail, typical</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>Bus or truck over bump</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rapid transit, typical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bus or truck, typical</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Typical background vibration</td>
</tr>
</tbody>
</table>

*RMS Vibration Velocity Level in VdB relative to $10^{-6}$ inches/second
SUMMARY OF TDA VIBRATION TEST MONITORING SOUTHEAST CORRIDOR

Tests conducted at five T-REX sites on Nov. 9-12, 2009
- Four TDA sites and one control site (w/standard ballast & tie)
- All sites located on southbound side of tracks and sound wall

LRT ground vibration tests at 3 positions and 3 speeds
- Distances of 15, 30 & 45 ft from SB track (30,45 & 60 ft re NB)
- Typ. 2 runs in ea. direction on ea. track at 25, 40 and 55 mph

LRT tests conducted with a dedicated 2-car train set
- Newer Siemens Model SD160 light rail vehicles (#269 & #270)
- Vehicles were empty with weight of about 89,560 each (AW-0)

Vibration propagation tests also conducted at each site
- Ground impact force generated at 11 points along a 150 ft line
- Ground vibration response measured at 15, 30, 45 and 60 ft
VIBRATION EQUIPMENT SET UP TO MEASURE VIBRATIONS
TYPICAL CROSS SECTION OF TDA

WAYSIDE APPURtenANCE (SEE NOTE 6)

BALLAST
SUB-BALLAST
BALLAST MAT

SHREDDED TIRE (SEE NOTE 2)
PREPARED SUBGRADE
GEO TECH FABRIC (SEE NOTE 3)

GUIDEWAY
TRACK
OFFSET "0" UNDERDRAIN

WALL (VARIES)
I-25 (HIGHWAY SIDE)

SHREDDED TIRE 14'-0" MINIMUM (SEE NOTE 6)

2.5% PREPARED SUBGRADE

4'-11/2"
7'-0"

2.5% GEOTECH FABRIC (SEE NOTE 3)

ROW SIDE
WALL

8'-6" TO 9'-0"

1'-0"

4'-11/2"

7'-0"

VARIES

7'-3"

(TYP)
TDA BEING PLACED ON GEOTEXTILE AT DRY CREEK
TYPICAL TRACK SECTION ON SOUTHEAST CORRIDOR (T-REX)
WRL PLACING GEOTEXTILE BLANKET ON COMPACTED SUBGRADE
OAK STREET TO KIPLING STREET
COMPACTING TDA
OAK STREET TO KIPLING STREET
WRL PLACING TDA ON GEOTEXTILE BLANKET- LEE STREET
WEST RAIL LINE (WRL) QUAIL TO KIPLING
PLACEMENT OF TDA NEAR STEELE STREET
SPREADING TDA BETWEEN NOISE WALL AND BALLAST WALL
Cross Sections of TDA (Shredded Tire) Underlayment
QUESTIONS?????