



RCC (Roller Compacted Concrete) use for Residential Roadways



Travis Attanasio, PE, CFM

NEW INNOVATIONS VS. TRADITIONAL METHODS

- The Sell
- The Execution
- The Aftermath
- The Epilogue



THE SELL



HOW RCC ENTERED MY RADAR

Cement Council of Texas Presentation to
Fort Worth Branch ASCE around 2008



Started as a City Engineer in January 2016

Presented with a PASER report
outlining over \$9M in immediate
improvements needed to bring
roads from a LOS F to LOS D

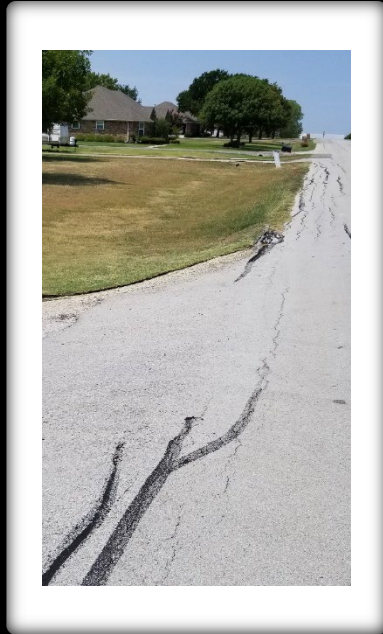
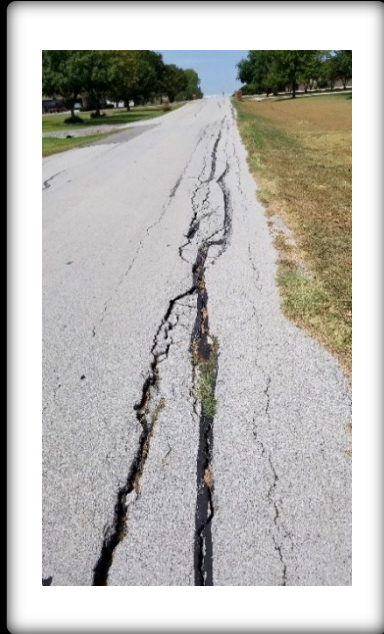
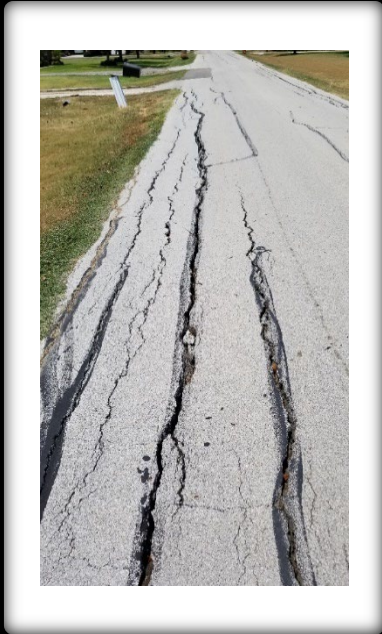
Annual City budget was less than
\$3M with most funds dedicated
to personnel

Resolution passed in 2015 to no
longer accept asphalt as an
acceptable pavement

WHAT DO YOU WANT WHEN YOU BUILD/RECONSTRUCT A ROAD?

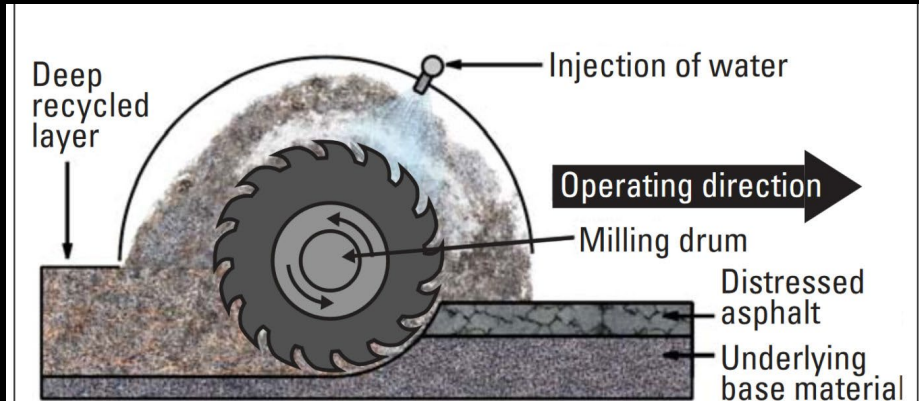
- Low cost
- Fast construction
- Minimize inconvenience to the public
- Built to last, low maintenance





EXISTING PAVEMENT CONDITION

STAGE 1: FULL DEPTH RECLAMATION



- Existing pavement is pulverized and mixed with existing subgrade
- Material is graded to desired elevation and shape
- Cement stabilization mixtures are spread on top of material
- Normal traffic can return to surface at this point prior to final pavement placement
- Recycles existing materials
- TxDOT tested and approved method



STAGE 2: ROLLER COMPACTED CONCRETE



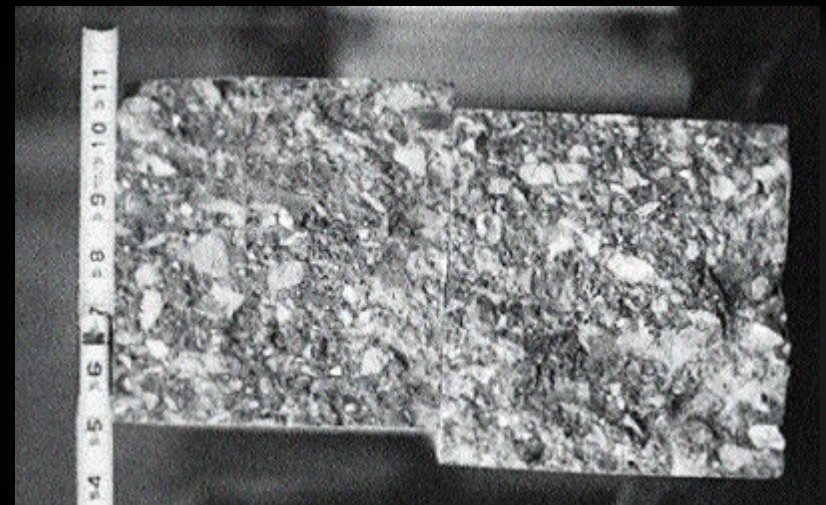
- A continuous supply of RCC material is placed in the paving machinery
- Placed directly on FDR
- Does not contain steel reinforcement
- Strong dense durable material
- Fast construction cycle (No forms or finishing)
- No costly steel and minimum labor

TEXAS – “BIRTHPLACE” OF RCC PAVEMENT IN THE U.S.

First large RCC job –
Fort Hood

1984 - 18,000 sy, 10”
thick, \$58/sy at time

1987 – Second RCC
project at Fort Hood



PORT OF HOUSTON

- By 2025, Port of Houston will have 415 acres (2M sq yds) of mostly 18" RCC
 - Collectively, largest RCC pavement installations in the U.S., maybe world



Equivalent to a 6" thick single-lane RCC road that parallels I-10 from Beaumont to El Paso

RCC PUBLIC ROADS IN TEXAS

- TxDOT
 - Multiple Safety Rest Areas
 - US83 – Leakey, TX
- City of San Angelo, TX
- City of Midland, TX
- City of Fort Worth, TX
- Liberty County, TX



THE EXECUTION



ISSUES SHOW UP BEFORE THE BID



City Engineer was informed that a Specific Use Permit would be required for use of the batch plant



Three locations within the City that fit within TCEQ rules on batch plants

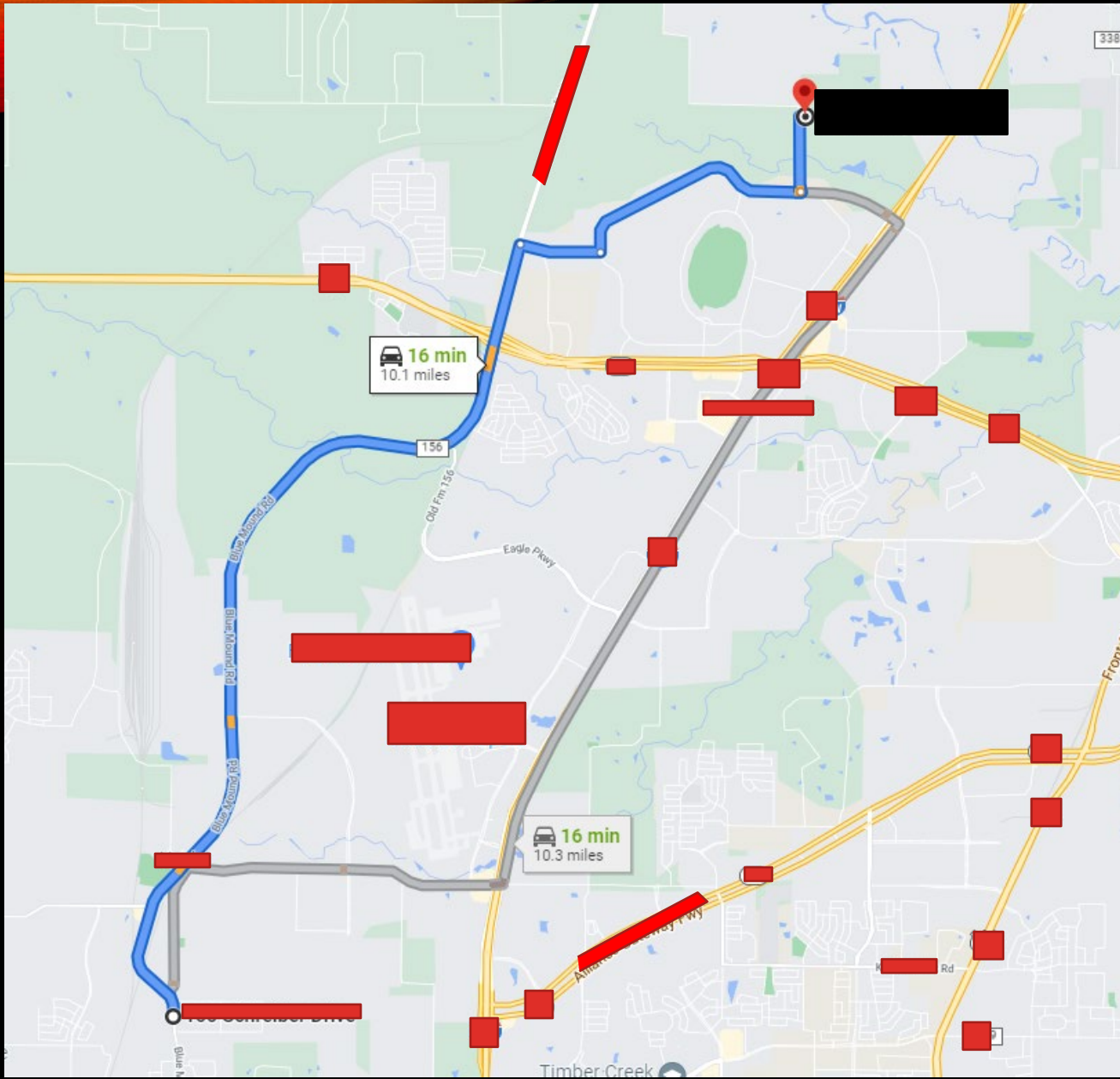
Location 1 – Inside a city park on an unpaved area

Location 2 – Vacant land near an interstate

Location 3 – Vacant land but on the opposite side of a very busy railroad track



No location was forwarded to for consideration however because of “the unsightly nature of such an industrial operation next to multi-acre estates”



LOCATION OF BATCH PLANT

SCHEDULE DELAYED

- Public meeting was held in May 2018
- Work was scheduled to start in early June 2018 to late August 2018 to coincide with school being out
- Work was delayed until after a 4th of July fireworks event by City Council
- Work started July 9, 2018



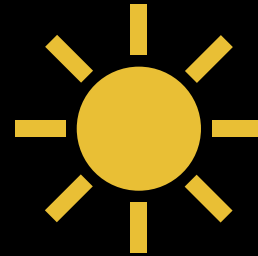
WHAT DID THIS MONTH- LONG DELAY DO?



Average temperature:

June 79.0°

July 88.8°



Max temperature:

June 101°

July 109°



NEIGHBORHOOD WATCHDOGS

- Construction was “monitored” by residents daily
- Minor complaints were occurring
 - Noise
 - Dust
 - Blocked Driveway
- Management was monitoring the comments
- Then one thing changed....





VIBRATORY ROLLERS

GOING VIRAL FOR THE WRONG REASON

A conversation thread started on Nextdoor asking if anyone noticed cracks in their walls from "the construction"

Thread took off with over 180 comments within hours

Some comments were from areas not in the same subdivision

Conspiracies started "the City did this to force us out of our homes so they can re-develop with smaller lots"

- More vocal residents appeared at a public meeting
- Normal rules are you have 3 minutes to speak on items not on the posted agenda
- Residents were allowed speak for over an hour on the "damage" they were seeing
- Several personal attacks were lobbed at the City Engineer

COUNCIL ACTION – PART 1

Council was briefed that the vibratory rollers were a normal part of road building and that if the base of the road was not solid it could cause premature failures



Council was also reminded that the product they had approved was Roller “Compacted” Concrete

- Council initially sided with the City Engineer and told the residents that any claim of damage would need to go through the Contractors Insurance
- While the residents left unhappy that the City was not going to buy in to their damage claims, Council seemed content with their decision
- Until.....

CUE THE INVESTIGATIVE REPORTER

_____ engineer told Consumer Justice that _____
"I came in the kitchen and _____ was "following standard guidelines," and stopped
_____ His father _____ using the vibratory function after the complaints. Neighbors
the time. "He says 'it's vibr _____ who went to the city about the damage were told to file a claim
chair, in the recliner and _____ with _____ but they say reaching someone at the company was
not easy. "I called, I never got an answer," said _____.

Her neighbor, _____
hear it back there rattling, you could feel the shaking," he said.

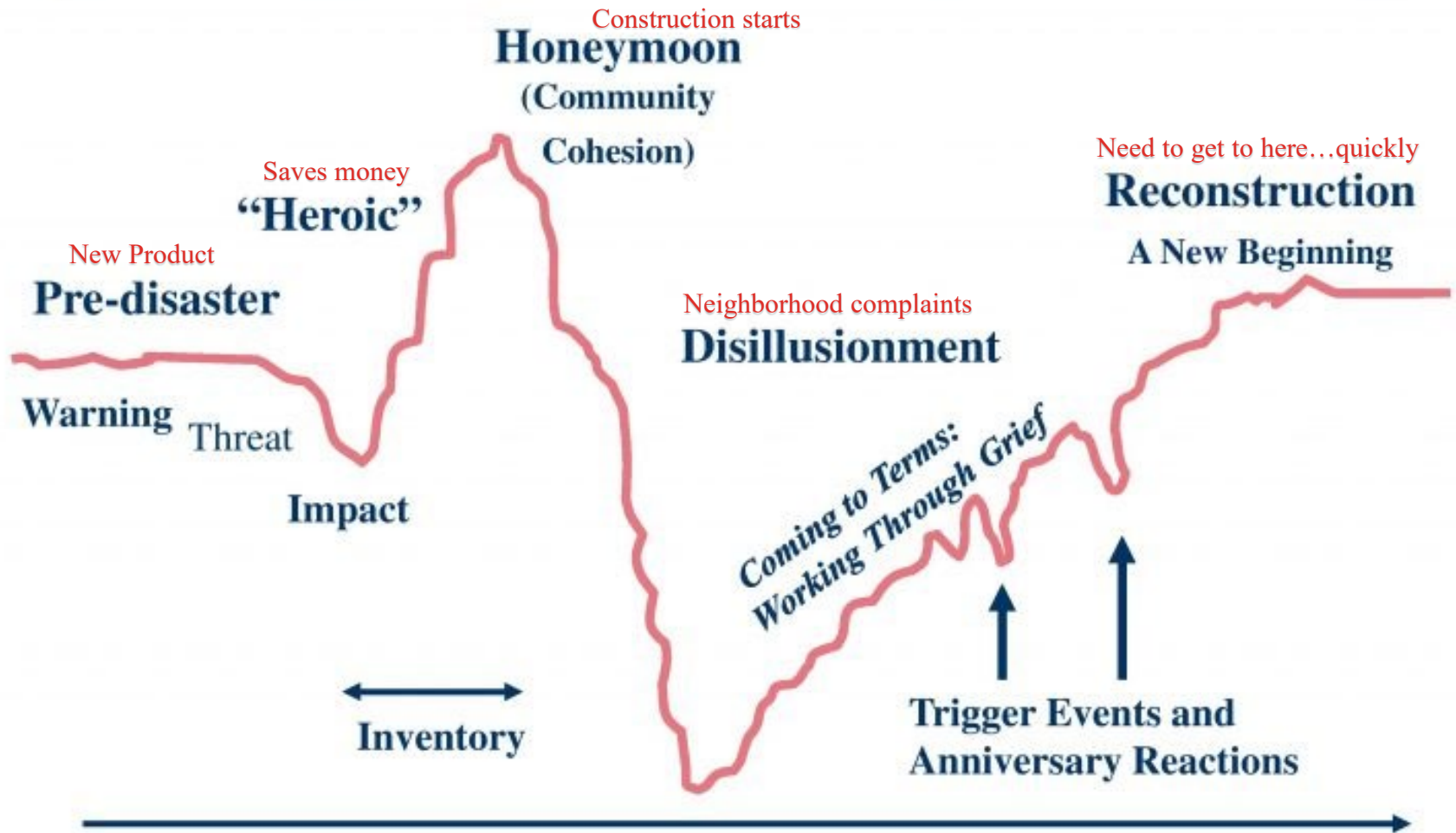
'You Could Feel The Shaking': Neighbors Say Road Construction Damaged Homes

© CBS NEWS
DFW

SEPTEMBER 13, 2018

_____ says he recognized it from his days as a construction equipment salesman. "They're not supposed to be used near home. I know what they do," he said. "I understand on a highway, I understand that. But you're up here 30 feet from somebody's home?"

Typical Phases of Disaster



LEARNING SOMETHING NEW



TRANSIT NOISE AND VIBRATION IMPACT ASSESSMENT

FTA-VA-90-1003-06

May 2006



Office of Planning and Environment
Federal Transit Administration

- City Engineer had to become educated very quickly
- First question...How do vibratory rollers work? What the wave looked like underground? What was a reasonable level of vibration vs. what could cause damage?
- Luckily, the issue had been researched extensively

VIBRATION IMPACT ASSESSMENT

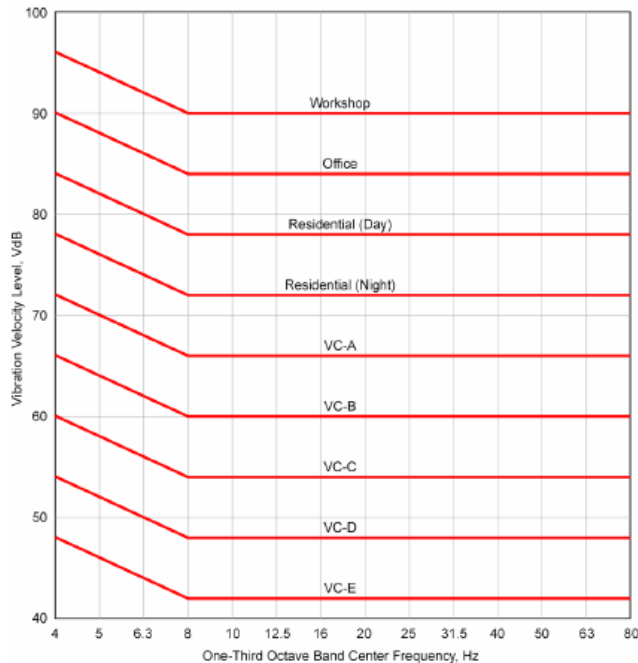


Figure 8-1. Criteria for Detailed Vibration Analysis

Table 8-3. Interpretation of Vibration Criteria for Detailed Analysis

Criterion Curve ¹ (See Figure 8-1)	Max L_v (VdB) ²	Description of Use
Workshop	90	Distinctly feelable vibration. Appropriate to workshops and non-sensitive areas.
Office	84	Feelable vibration. Appropriate to offices and non-sensitive areas.
Residential Day	78	Barely feelable vibration. Adequate for computer equipment and low-power optical microscopes (up to 20X).
Residential Night, Operating Rooms	72	Vibration not feelable, but ground-borne noise may be audible inside quiet rooms. Suitable for medium-power optical microscopes (100X) and other equipment of low sensitivity.
VC-A	66	Adequate for medium- to high-power optical microscopes (400X), microbalances, optical balances, and similar specialized equipment.
VC-B	60	Adequate for high-power optical microscopes (1000X), inspection and lithography equipment to 3 micron line widths.
VC-C	54	Appropriate for most lithography and inspection equipment to 1 micron detail size.
VC-D	48	Suitable in most instances for the most demanding equipment, including electron microscopes operating to the limits of their capability.
VC-E	42	The most demanding criterion for extremely vibration-sensitive equipment.

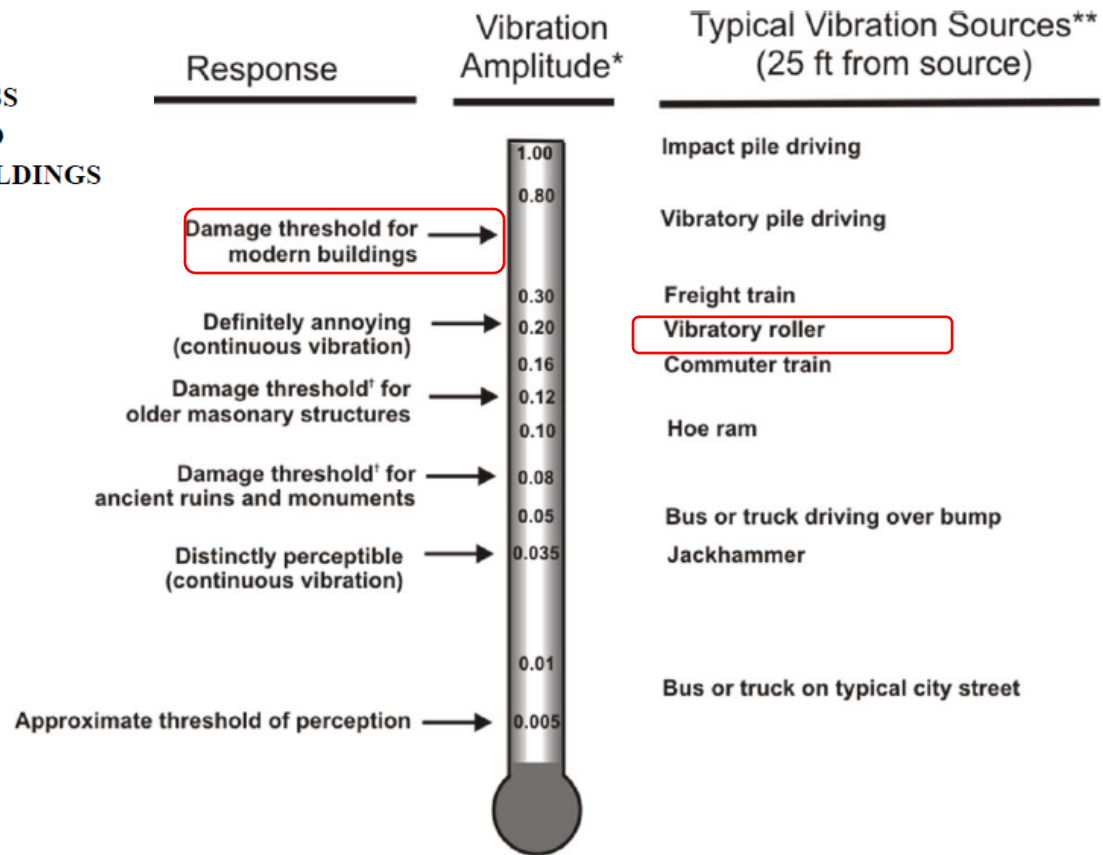
¹Descriptors on curves are those provided by References 2 and 3.

²As measured in 1/3-octave bands of frequency over the frequency range 8 to 80 Hz.

NATIONAL COOPERATIVE HIGHWAY RESEARCH

NCHRP 25-25/Task 72

CURRENT PRACTICES TO ADDRESS
CONSTRUCTION VIBRATION AND
POTENTIAL EFFECTS TO HISTORIC BUILDINGS
ADJACENT TO
TRANSPORTATION PROJECTS



* Peak particle velocity (inches/sec)

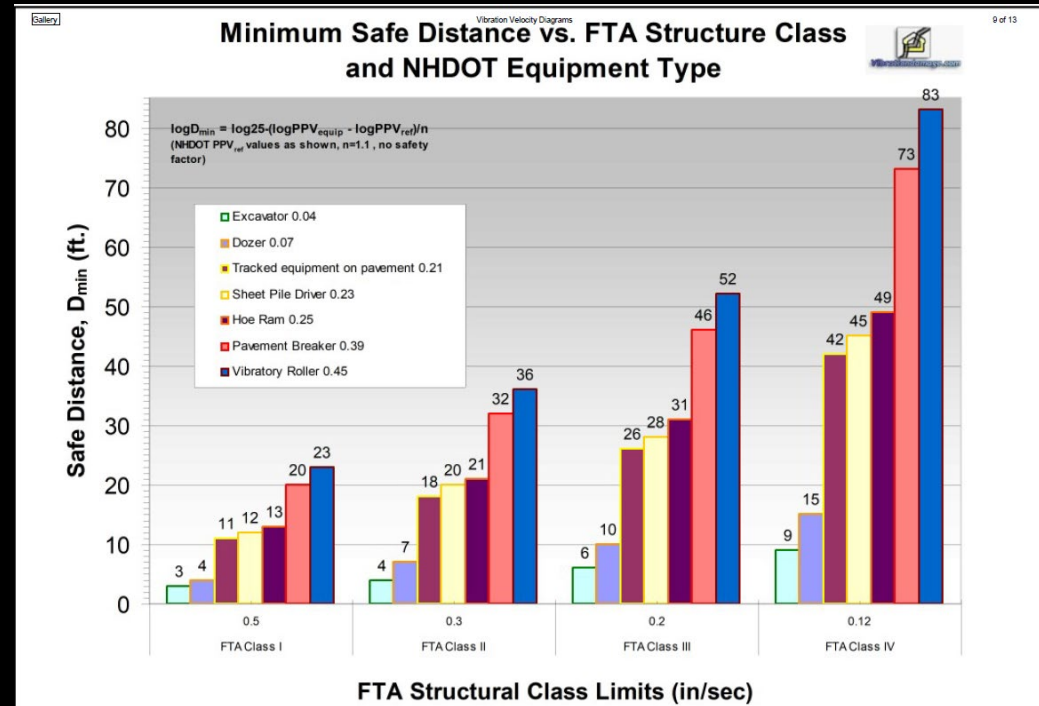
** Actual vibration levels are dependent on many factors

† Approximate threshold for cosmetic damage

Figure 1. Typical Vibration Amplitudes and Thresholds

HOW ONE WEBSITE HELPED ACCIDENTLY

- One of the residents pointed the City Engineer to a website that was seemingly design to sell a book on vibratory roller damage
- Within that website were several charts that plotted safe distances
- The homes that reported damage were further away than the “safe distance”
- Residents were told this and suddenly the website and the science was “bunk”



COUNCIL ACTION – PART 2

- Despite the evidence presented the decision was made that demanded all vibratory rollers stop work
- Information given that this action could invalidate the maintenance bond
- Decision was made to reduce density requirements for subgrade and for the RCC, negating rollers



WORK RESUMES – WITH NEW RULES



ACTUAL SCHEDULE

- Work started: July 9
- Back to School Date: August 27
- Auger Broke: August 25
- Streets fully opened (complete with concrete): September 10
- Final Inspection and acceptance: October 30



FINAL PRODUCT





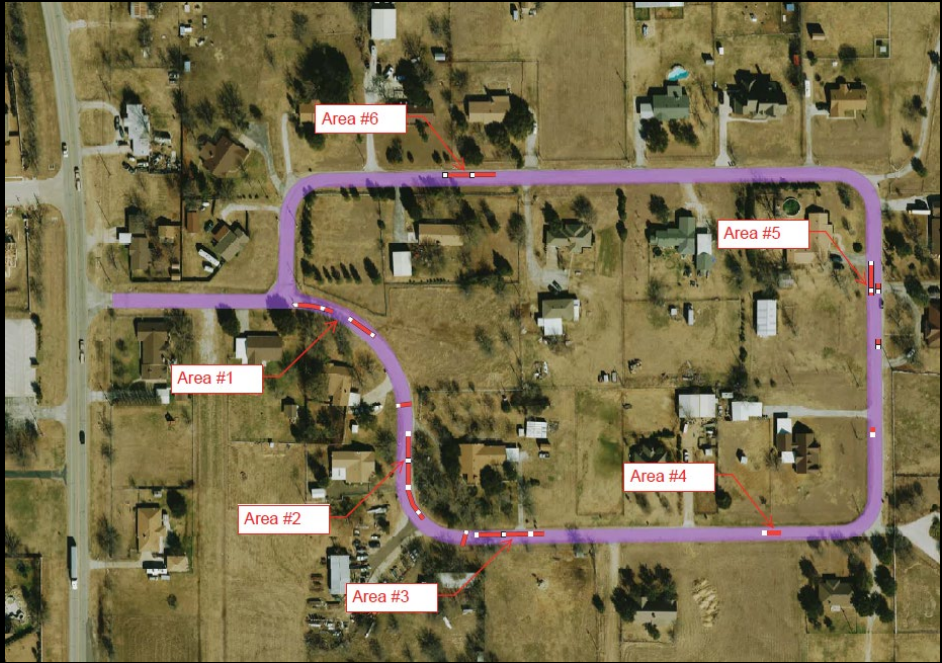
THE AFTERMATH

Unfortunately, that is not the end of the story

CRACKS START TO DEVELOP

- City Engineer notified in early 2019 that some cracks had started developing
- Minor cracking was expected as the product cured
- What was found however was longitudinal cracks that ran through several panels
- City Engaged Cement Council and a geotechnical firm
- Street cores showed 7.5" of FDR (8" specified) and 6" of concrete (6" specified)
- Areas of cracking were isolated indicating that it was not a widespread problem







ASSESSMENT

- Streets were assessed panel by panel by the City Engineer
- Overall, 90.8% of the RCC showed no signs of distress
- Most cracking occurred within three places:
 - Edges
 - Where side slopes exceeded 2:1
 - Near large vegetation
- Ground outside the limits of paving showed signs of movement
- Unusual level of foundation repair permits in 2019

CONTRACTOR CONTACTED

- Contractor was contacted in late 2019 concerning cracks forming
- Contractor initially pointed to the changed parameters of construction invalidating the maintenance bond but still came out for a site visit
- Contractor and City eventually came to an agreement that most cracks would be routed and sealed and one area that showed severe stress would be replaced with traditional concrete

WHAT'S IT LIKE TODAY?



Continued ground movement and
crack spreading

WHAT'S IT LIKE TODAY?



Limited new cracking has developed
but not outside the initial areas

WHAT'S IT LIKE TODAY?



Some cracks continued to widen (note joint sealant)

WHAT'S IT LIKE TODAY?



Even the replacement (traditional) concrete cracked



THE EPILOGUE (LESSONS LEARNED)

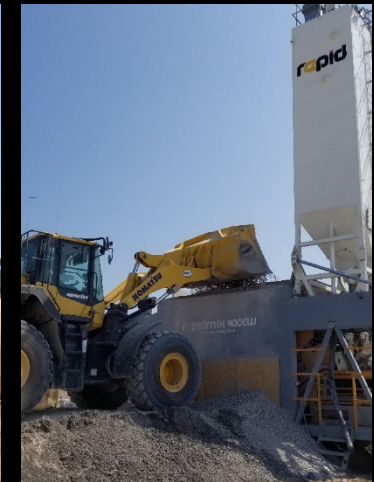
INSPECTIONS

- Recommend a full-time inspector on the job
- Recommend retaining control of the testing firm
- Recommend performing a test strip to train inspectors



LOCATION OF BATCH PLANT

- Batch plant needs to be near the project
- Adjustment to the mix was null with such a long drive
- Manage citizen expectation early that the batch plant is temporary



ALTERING SPECIFICATIONS

- Don't allow non-engineers to modify specifications
- If you do, get buyoff from Design Engineer, Geotechnical Engineer, and Testing Inspector

PORTLAND CEMENT COMPACTED CONCRETE

DESCRIPTION.

govern for the construction of Portland Cement Concrete (RCC) on a prepared subgrade or on a prepared subgrade or on a prepared subgrade as shown on the Plans, the lines and grades shown herein.

METHODS.

The following American Society of Testing and Materials (ASTM) specifications are referenced in this Item and are modified as follows:

ASTM C 31 – Practice for Making and Curing



SOIL ALL DEPTH RECLAMATION

The soil shall consist of pulverized soil with Portland cement, soil and aggregate, proportioned, mixed, placed, compacted to the lines, grades, thicknesses

American Society of Testing and Materials (ASTM) specifications are modified as listed:

ASTM C 150 – Standard Specification for Portland Cement

ASTM D 1557 – Standard Test Methods for Liquid Limit, Plastic Limit, and Shrinkage Limit of Fine-grained Soils





CORNERS

- Paver works well on straight runs or sweeping curves
- Residential curves pose a challenge
- One solution: Over pave and sawcut the radius

EDGE CONDITION

- Unconfined edge may have been a contributing factor to edge failures
- Consider a thickened edge or tied curbs



DESIGN CONSIDERATIONS

- Though this was a residential street several large vehicles will access the street over time.
 - Ladder trucks – 80,000 lbs, spread over 4 point loads
 - Garbage trucks – 33,000 lbs empty, 51,000 lbs full
 - School Bus – 44,000 lbs
 - Amazon truck – 18,000 lbs
- Consider adding extra depth to the concrete over design minimum



OVERALL IMPRESSION

- RCC takes the most expensive component (steel) out of the concrete promoting cost savings
- Ideal for residential construction due to the time that residents can access their property being sooner

100% I would recommend RCC again

Take all lessons learned into account

Take a “concrete” stance and have solid backing

Conduct several public meetings to show this is a proven product



Questions?

Travis Attanasio, PE, CFM

City of Burleson

Tattanasio@burlesontx.com

(817) 426-9614

Thank You!