Precast Sidewalks

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innovation
city of san antonio

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Precast Sidewalks
Project Summary

Background

In 2016, District 1 Councilman Roberto Treviño requested city staff pilot the use of precast construction panels for sidewalks. The Transportation & Capital Improvements Department (TCI) identified the La Manda Street Project to construct half of the sidewalks using traditional cast-in-place methods and the other half of the project using precast construction. Bexar Concrete Works was the manufacturer of the precast sidewalk panels and SAC Construction Company was the construction contractor for both the cast-in-place and precast construction on this project. In July 2016, the Office of Innovation (Innovation) was engaged to analyze the use of precast concrete panels in used in this pilot project in comparison to cast-in-place construction.

Comparative Cities

Innovation contacted representatives from 11 cities to determine if they had experience with precast sidewalks. The cities contacted include Austin, Chicago, Dallas, Ft. Worth, Houston, Los Angeles, New York, Philadelphia, Phoenix, San Diego, and San Jose. Precast construction was used in other applications, such as roadways and bridges. However, this would be the first use of precast for sidewalks that we found.

Innovation Analysis

To evaluate the use of precast construction for sidewalks in comparison to cast-in-place construction, Innovation reviewed the costs of both methods and any expected lifecycle benefits for using precast construction.

When beginning the review of the precast construction project, Innovation found the pilot project was implemented through the use of a change order on an existing project. Since a change order was used for this project and not competitively bid, the comparison was of limited usefulness.

Lifecycle Benefits

Lifecycle benefits can be difficult to assess as TCI does not maintain in inventory of sidewalks that includes the dates of installation and failures. National estimates from the Federal Highway Administration states that many cities expect concrete sidewalks to last 25 years. Sidewalks constructed using precast construction molds is a new use of precast construction. Therefore, testing and information regarding the full life expectancy of the sidewalks is not available. Initial testing done by Bexar Concrete shows the precast sidewalks do tolerate a higher level of compression than cast-in-place sidewalks. Cast-in-place sidewalks typically break in testing after 28 days at 4,500 psi. By comparison, the precast panels used on the La Manda project showed the precast panels with an average strength of approximately 7,600 psi after 3-7 days.

The design strength of the precast panels considered in this report is comparable to structural concrete used for bridges. This will make precast sidewalks less likely to break by any force pressing down on the sidewalks, such as if a vehicle were to be driven over the sidewalk. However, other items that can cause sidewalks to fail such as bad soils and utility trench failures are not impacted by compressive strength.

PEPP Analysis

In October 2016, a committee of Professional Engineers in Private Practice (PEPP) performed a review of precast sidewalk construction and submitted findings. The reviewing committee did not recommend the use of precast sidewalk panels.

Conclusion

The ability to draw firm conclusions about the use of precast sidewalks is limited due to the pilot project not using a competitive process for the precast portion of the project and the lack of data on the life expectancy of current sidewalks. Innovation recommends the following:

1. Conduct a second pilot program by completing a solicitation process for a sidewalk project with precast construction as the method of construction—TCI staff has identified Tiffany Drive, extending from Marlborough Drive to Briarfield Drive, as a second pilot project to be coordinated with District 1. Bidding is expected to open August 8, 2017. Following the bidding process, additional analysis can be conducted
2. Catalog construction and longevity information on sidewalks to provide a baseline on the lifespan of cast-in-place construction; additionally, evaluate precast sidewalks on La Manda Street (as well as future precast sidewalk projects) at least annually
3. Reevaluate the cost-effectiveness of precast construction based on the results of the second pilot program, including identifying conditions that may be conducive to this method.

Precast Sidewalks
Comparative Study

In July 2016, the Office of Innovation (Innovation) was engaged to evaluate the use of precast concrete panels in sidewalk construction in comparison to current construction methods, known as cast-in-place (or pour-in-place) sidewalk construction.

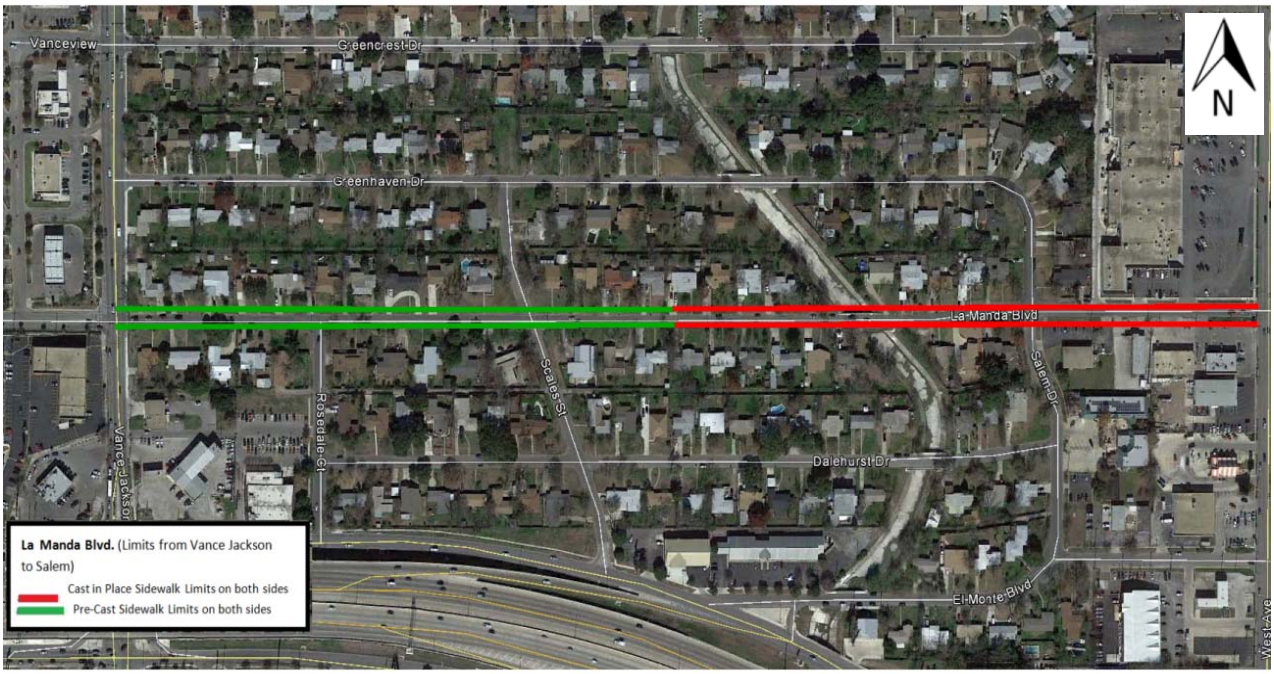
- Cast-in-place sidewalk construction involves clearing the area, placing forms and supporting material onsite, and then pouring unhardened concrete into the forms; the concrete then hardens onsite with the form acting as a stabilizing material
- In precast construction, sidewalk panels are formed, poured, and cured in a manufacturing facility, and then brought onsite and installed in the location

This report includes an assessment of the use of precast sidewalks in a pilot project in San Antonio.

Background

In 2016, District 1 Councilman Roberto Treviño requested city staff pilot the use of precast construction panels for sidewalks because a concern was raised that sidewalks crack too quickly. In theory, precast construction panels are created in more controlled conditions and are therefore stronger and less likely to crack. The Transportation & Capital Improvements Department (TCI) identified the La Manda Street Project, from Vance Jackson to West Avenue, as the pilot. This project included sidewalk replacement and new construction where sidewalks had not previously been installed. The total project length is approximately ½ mile. In order to evaluate precast sidewalk construction, TCI developed a plan to construct sidewalks from West Avenue to a point slightly east of Scales Street (the approximate midpoint) using traditional cast-in-place methods. The other half of the project, spanning from Vance Jackson Road to the midpoint was slated for precast construction. A map of the project area is shown on the next page.

Bexar Concrete Works is the manufacturer of the precast sidewalk panels and SAC Construction Company is the contractor on this project, for both the cast-in-place and precast construction.



Map of La Manda Street Project: Vance Jackson to West Avenue

Methods

In order to evaluate the use of precast sidewalk construction in comparison with cast-in-place sidewalk construction, Innovation used a number of methods. These methods included conducting interviews with project staff, researching the use of precast construction in comparative cities, observing both methods of construction and creating process maps, and conducting an analysis of the available data on cost and lifespan of sidewalks constructed with both construction methods.

Interviews

Innovation interviewed TCI staff including the following:

- Razi Hosseini, Assistant Director
- Anthony Chukwudolue, Assistant Director
- Faustino Benavidez, Sidewalks/Special Projects Manager
- Luis Maltos, Capital Programs Manager
- Mark Patterson, Contracts Administrator
- David Hernandez, Project Manager
- Pete Herrera, Construction Inspector.

Innovation staff also spoke with Jorge Garcia, Procurement Manager with the Finance Department, and corresponded with Jorge Hinojosa, an engineer with Bexar Concrete Works

who is familiar with precast sidewalk construction. The purpose of these interviews was to understand the process related to both construction methods. The interviews were used along with observations to create the process map found later in this report.

Comparative Cities

Innovation contacted a total of 11 cities to determine if they had experience with using precast construction for sidewalks. These cities include San Antonio's seven peer cities of Austin, Dallas, Fort Worth, Houston, Phoenix, San Diego and San Jose. In addition, Innovation also contacted other large cities in the U.S. including Chicago, New York City, Los Angeles and Philadelphia.

New York and Los Angeles reported using or considering precast materials to construct roadways, but not sidewalks. Austin and Los Angeles reported having used or considered a flexible, rubberized product as an alternative to concrete, but do not currently use it. Dallas is currently considering a flexible product called Capitol Flexi-Pave[1]. All of the cities surveyed reported that they currently rely on cast-in-place methods to construct sidewalks.

Observations & Process Mapping

Over the course of the project, Innovation observed the construction of sidewalks using both methods of construction. The purpose of the observation was to assist in the creation of the process maps, while also identifying any issues with the construction process. The pictures included in this report are from the construction of the La Manda Project.

During the observation process, staff identified that many of the processes and methods employed in cast-in-place sidewalk construction will be used in precast construction. For example, demolition and excavation are required for both methods. Additionally, while the intention of the precast construction process is to use the pre-made panels for the entirety of the work, that was not possible in the La Manda project. The section completed using precast construction still required some cast-in-place concrete for driveways, transitions, and other sections that do not accommodate a rectangular precast panel due to curves, angles and driveway transitions.

[1] See http://capitolflexipave.com/. Accessed 26 September 2016.

Above: demolition and removal of a commercial driveway on La Manda Street near West Avenue

Above: demolished sidewalks in front of residential properties on La Manda Street near Scales Street, in preparation for precast sidewalk construction
Above: forms installed for a driveway, transitions, and a corner with grading—elements that are not conducive to precast construction



Above: footing construction and base preparation prior to precast panel installation

Innovation developed a process map based on interviews with staff and onsite observations. The map is included as Appendix A to this report.

The process map identifies potential challenges related to the use of precast construction molds for sidewalks. In projects where these challenges are present, the contractor will likely need to use cast-in-place construction for portions of the project, limiting the effectiveness gained from using precast construction.

1. Relocate utility access & meters
   Utility access points and meters are commonly located within or near sidewalks. While cast-in-place sidewalk construction may require these items to be adjusted, it often allows the sidewalk to be constructed around them. Because the sidewalk panels are cast ahead of time for precast construction, the access points or meters need to be relocated to accommodate the panels. This is generally more costly and time-consuming than the adjustments possible with cast-in-place construction. San Antonio Water System made the required relocations to water meters on La Manda Street. However, a long-term agreement on who will pay for the relocations was not been reached. Additional cost and time may be required to complete this step in the future.

2. Pour sidewalk transitions and approaches
   Precast panels cannot replace the need for all cast-in-place work which will be required wherever curves, non-square angles, and driveway transitions are present.

Innovation Analysis

To evaluate the use of precast construction for sidewalks in comparison to cast-in-place construction, Innovation reviewed the costs of both methods and any expected lifecycle benefits for using precast construction.

When beginning the review of the precast construction project, Innovation found the pilot project was implemented through the use of a change order on the existing contract for the La Manda Street Project. Since a change order was used for this project and not competitively bid, the comparison was of limited usefulness.

Lifecycle benefits

Lifecycle benefits can be difficult to assess as TCI does not maintain in inventory of sidewalks that includes the dates of installation and failures. National estimates from the Federal Highway Administration states that many cities expect concrete sidewalks to last 25 years. Sidewalks constructed using precast construction molds is a new use of precast construction. Therefore, testing and information regarding the full life expectancy of the sidewalks is not available. Initial testing done by Bexar Concrete shows the precast sidewalks do tolerate a higher level of compression than cast-in-place sidewalks. Cast-in-place sidewalks typically break in testing after 28 days at 4,500 psi. By comparison, the precast panels used on the La Manda project showed the precast panels with an average strength of approximately 7,600 psi after 3-7 days. The design strength of the precast panels considered in this report is comparable to structural concrete used for bridges. This will make precast sidewalks less likely to break by any force pressing down on the sidewalks, such as if a vehicle were to be driven over the sidewalk.

Compressive strength is not the only factor that can affect the lifespan of a sidewalk. Items such as bad soils and utility trench failures can cause sidewalks to fail and are not impacted by compressive strength. Innovation's research found the following recommendations from FHWA on how to improve the lifespan of sidewalks[2]:

- Thickness of concrete—four inches for light axle loading over sand/gravel; five inches for light axle loading over silt/clay
    - The Standard Specifications and Details published by TCI requires four-inch concrete thickness
- Use of reinforcing bars or mesh use of aggregate base

[2] U.S. Department of Transportation, Federal Highway Administration (FHWA). "A Guide for Maintaining Pedestrian Facilities for Enhanced Safety." http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa13037/chap6.cfm. Accessed 19 September 2016.

- Depth of sub-base below the sidewalk—four to six inches of free-draining granular material
    - The Standard Specifications and Details published by TCI requires a minimum of two inches of gravel, crushed rock, or flexible base material
- Placement and selection of trees

Additional Analysis Conducted

TCI conducted an assessment of the costs of precast construction compared to cast-in-place construction. Additionally, at the request of the City Manager's Office, a review of precast sidewalks was performed by the Professional Engineers in Private Practice (PEPP). PEPP is a practice group and member of the National Society of Professional Engineers and the Texas Society of Professional Engineers. San Antonio's chapter of PEPP offers expert consultation services and they include the following engineering firms:

- A-1 Engineering, LLC
- CNG Engineering, PLLC
- Fire Protection Consulting Group, LLC
- HMT Engineering
- Intelligent Engineering Services, LLP
- James T. Rodriguez Consulting Engineers
- Jones & Carter
- Pape-Dawson Engineers
- Poznecki-Camarillo, Inc.
- Raba Kistner Inc.
- Vickrey & Associates, Inc.

The results of each of those assessments are included in the following sections.

TCI Analysis

TCI prepared a document entitled, "Sidewalk Alternatives: Cast-in-place vs Precast." A copy of the document is included as Appendix B to this report and provides the following cost comparison of four-foot wide sidewalks:

Description *All costs shown are per linear foot (LF)	Cast-in-Place ("CIP")	Precast
Construction materials and labor	$66.28	$98.00
Construction related costs: inspection, construction contingency, material testing (same for CIP & Precast)	$9.34	
Design and project management (same for CIP & Precast)	$12.66	
Total cost per linear foot	$88.28	$120.00
Total cost per linear foot (rounded)	$90.00	$120.00

The TCI analysis includes construction related costs as well as design and project management in the total cost per linear foot.

TCI identified three criteria for evaluating precast sidewalk construction:

1. Cost-benefit analysis—including capital investment and projected maintenance costs;
2. Construction quality—anticipated benefits of precast construction include reduction of trip hazards, fewer ADA violations, and improved overall safety; and
3. Time of installation—precast construction time expected to be less than cast-in-place, reducing inconvenience to property owners and reducing time required of construction inspector and field engineer.

PEPP Review

A committee of PEPP reviewers received a description of the La Manda project, financial information, technical drawings, and photographs. Members of the committee included Frank Jaster of Civil Engineering Consultants, Cara Tackett of Pape-Dawson Engineers, and Chuck Gregory of Terracon Environmental & Materials Testing. Findings were provided via email to TCI and include:

1. Based upon this project, it does not appear that the cost of pre-cast panels is feasible. The bid for conventional sidewalks (see attachment) was $42.00 per SY and the curb was bid at $12.00 per LF. The bid for the pre-cast panels was $85.00 per SY and the curb was $45.00 per LF. That's more than a 50% increase on the conventional sidewalk price per SY and over a 73% increase in curb price per LF.
2. We do not have a performance history on these panels. When panels are set on bridge decks, many panels are spalled or have cracks in the panel, which adds to the cost of the units (see bullet No. 1).
3. During our discussion it was pointed out that there is some specialty equipment that is needed to properly set these panels. The additional loading on the street and in property owner's yards has the potential to cost in pavement repairs/maintenance and impact public relations during construction. It has been our experience on construction projects that contractors find ways to expedite construction processes, which can lead to damages to the individual units (see bullet No. 2).
4. Contractor has stated that the installation of the panels did not save any time.
5. In summary, the members of the COSA Construction Subcommittee do not see a benefit to utilizing pre-cast sidewalk panels.

Recommendations

Innovation recognizes the potential benefits of new sidewalk construction methods such as precast construction. However, the ability to draw firm conclusions about the use of precast sidewalks is limited due to the pilot project not using a competitive process for the precast portion of the project and the lack of data on the life expectancy of current sidewalks. Innovation recommends the following:

1. Conduct a second pilot program by completing a solicitation process for a sidewalk project with precast construction as the method of construction— TCI staff has identified Tiffany Drive, extending from Marlborough Drive to Briarfield Drive, as a second pilot project to be coordinated with District 1. Bidding is expected to open August 8, 2017. Following the bidding process, additional analysis can be conducted to determine if precast construction is a viable alternative to cast-in-place
2. Catalog construction and longevity information on sidewalks to include:
    a. Location
    b. Date of construction
    c. Construction method (i.e. cast-in-place vs. precast)
    d. Date of failures
    e. Description of failures

    The purpose of this data will be to provide a baseline on the lifespan of cast-in-place construction for comparison to precast construction. Additionally, regular evaluation of precast sidewalks installed on La Manda Street (as well as any future precast sidewalk projects) should be conducted at least annually
3. Reevaluate the cost-effectiveness of precast construction based on the results of the pilot program, including identification of circumstances that may be more conducive to precast sidewalk construction such as:
    a. Predominantly straight construction
    b. Minimal transitions required (i.e. driveways, grading, etc.)
    c. Design enhancements (i.e. color, wayfinding, stamping, etc.)

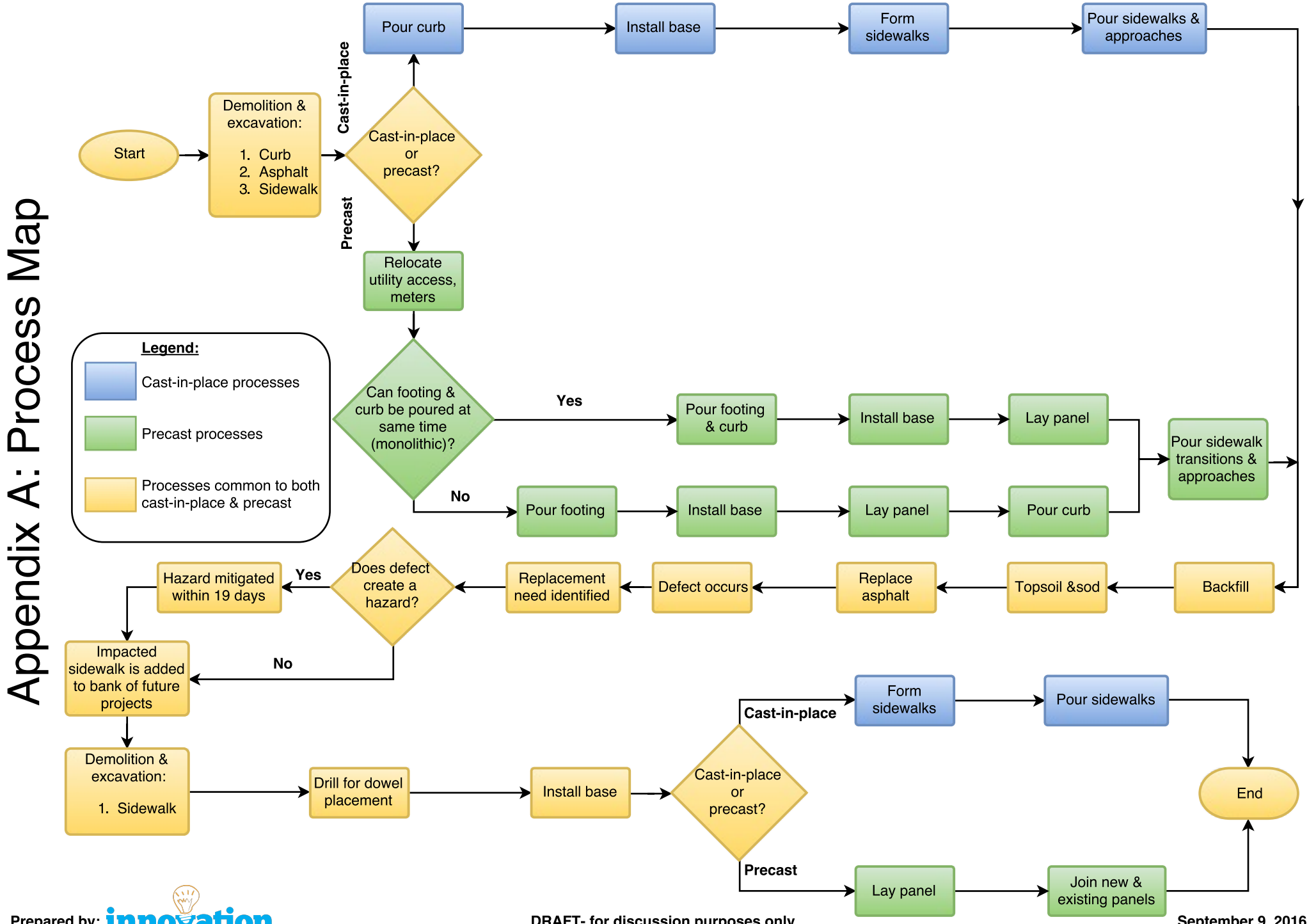
The City of San Antonio's experimentation with precast sidewalk construction is an innovative endeavor that is unique among cities. Additional observation, complete with comprehensive data analysis, is recommended to further assess the future use of this product.

Appendix

A. Process Map
B. Cast-in-place vs Precast Assessment (TCI)

Cast-in-Pace & Precast Sidewalk Construction

Appendix A: Process Map



Prepared by: innovation city of san antonio

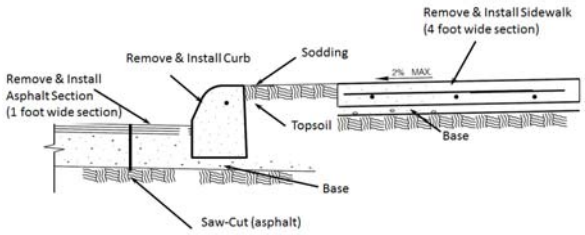
DRAFT- for discussion purposes only

September 9, 2016

Appendix B: Cast-in-place vs Precast Assessment (TCI)

Sidewalk Alternatives: Cast in place vs Precast

Traditional Concrete Sidewalk Installation



Construction pay items for cast in place sidewalk installation may include:

- Mobilization
- Preparation of Right-of-Way (removal and clearing of area)
- Traffic control barricading
- Removal and installation of curb, sidewalk and driveway
- Installation of topsoil/sod
- Contractor's insurance, and bonding/one year warranty bond

Construction cost per linear foot of 4' cast in place sidewalk is $66.28

- Assuming a 50' wide lot with removal/install of curb, 4' sidewalk, and one driveway approach, water valve, and mailbox

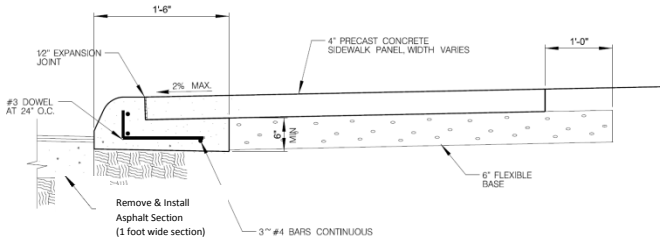
Construction related cost per linear foot is $9.34

- Inspection, construction contingency, material testing, TDLR

Design and Project Management cost per linear foot is $12.66

Total cost per linear foot of 4 ft. wide sidewalk is approximately $88.00; we use **$90** for Project Planning.

Precast Sidewalk Installation



Construction pay items for precast installation may include:

- Mobilization
- Preparation of Right-of-Way (removal and clearing of area)
- Traffic control barricading
- Removal and installation of curb, sidewalk and driveway
- Installation of topsoil/sod
- Contractor's insurance, and bonding/one year warranty bond

Construction cost per linear foot of 4' precast sidewalk is $98.00

- Installation of 4' sidewalk, curbs and driveways
- Cost based on only one project, La Manda (Vance Jackson to West Ave)

Construction related cost per linear foot is $9.34

- Inspection, construction contingency, material testing, TDLR

Design and Project Management cost per linear foot is $12.66

Total cost per linear foot of 4 ft. wide precast sidewalk is approximately **$120**

Sidewalk Alternatives: Cast in place vs Precast

Private vs Public Cost:

Public projects generally cost more for the following reasons:

- Prevailing wages required by Texas Local Government Code
- City ordinance for small, minority and women-owned businesses requirements limits pool of contractors
- Certified payrolls
- Environmental Regulations
- Working in Public Right-of-Way

Precast sidewalks Success Measures:

- Cost Benefit Analysis - A cost comparison must be made between the cast in place cost, and the precast option to include initial capital investment, and projected maintenance costs

- Construction Quality – Precast sidewalks are anticipated to reduce the number of offset sidewalk joints, concrete cracks, and sidewalk settling. Reducing these failures will minimize trip hazards, ADA violations, and overall safety. A test period must be determined.

- Time of Installation – The construction time for precast sidewalks is anticipated to reduce, minimizing the inconvenience to the adjacent property owner by expediting the construction process, and minimizing time requiring a construction inspector and field engineer