USE OF CONCRETE PAVERS AS A ROADWAY STANDARD FOR THE CITY OF RIPON

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SUMMARY

This paper provides the rationale for using interlocking concrete pavements as a city standard in the City of Ripon, California. Unfavorable experiences with asphalt subject to increasing amounts of truck traffic enabled the city engineering department to develop and implement a city standard for concrete paver streets. The City now requires concrete paver streets for new developments. This investment is expected to lower municipal maintenance costs compared to asphalt. The approach may offer a model for other municipalities.

1. INTRODUCTION

The City of Ripon is located in northern California approximately 130 km east of San Francisco. The city was originally known as Murphy's Ferry in 1850, one of several crossings along the Stanislaus River that enabled gold prospectors and settlers into the area. Around 1916, the rich farmland attracted settlers from The Netherlands. The small rural town supported surrounding farmers and grew slowly from expanding agriculture. Manufacturing grew in the 1950's to support the agriculture (almond production) and the paper industry. Today's city includes an area of about 1,100 ha. The year 2000 population grew from 10,000 to an estimated 14,000 in 2006. Recent growth is primarily from San Francisco Bay area migration of homes and jobs. Even with this growth, the city has a small town character, many parks and wide, tree-lined streets. Figure 1 shows the small-town character of this growing area.

Figure 1. West Main Street, Ripon, California

Like most California cities, Ripon adopted California Transportation Department (CALTRANS) design procedures and material and construction specifications for streets. To better understand why and how the City of Ripon adopted concrete pavers as their roadway standard, it is helpful to have a historical perspective on a series of events, which led to this adoption in June 2004.

2. OVERLOADED ASPHALT PAVEMENT

The story begins with a very premature asphalt concrete roadway failure in 1995. The City had just constructed a new roadway, adjacent to a proposed truck stop. From its opening, the truck stop generated more traffic than was ever anticipated in the design. This heavy traffic resulted in severe rutting of the asphalt and within a few months the roadway was destroyed. Not having seen this type of extreme damage to asphalt, it was assumed that the mix design or placement was flawed. The roadway was repaved with a CALTRANS mix design calling for 19 mm coarse stone size, Type A asphalt concrete. The typical cross section was 127 mm thick asphalt, 203 mm crushed stone base (CALTRANS Class 2) over a compacted soil subgrade. This asphalt type is the most structurally stable mix in CALTRANS standards. Paying careful attention to placement, a more permanent solution was anticipated. However, within a year the road was showing signs of complete failure again.

3. A CONCRETE PAVER PROPOSAL

The roadway presented a unique situation with truck traffic well in excess of the capabilities of the asphalt subject to thousands of loaded trucks daily. A unique solution was needed. After considerable research, I learned that concrete pavers were being used under heavy loads and high volumes, such as rail yards and shipping ports. Papers from conferences such as this one provided evidence of performance as well as their use at the Port of Oakland, California. Concrete pavers offered that magical combination of flexible roadway design and rigid roadway design; just flexible enough to resist breaking and hard enough to withstand years of heavy loads without rutting or wearing out.

Even though concrete pavers seemed to be a good solution for this roadway, they became a tough sell due primarily to two factors: the high initial costs to construct and current engineering training which believed that asphalt was still the right solution. Since we could not let go of the asphalt roadway idea, we had to optimize it, leading us to our own in-house mix design. From research it became evident that asphalt failure in warm climates with heavy vehicles was typically due to poor aggregates and soft oils. The result of this information led us to a mix design using 50 mm coarse/crushed aggregate with AR-8000 oil. As of this writing, this roadway is still in place, yet showing some signs of failure (rutting). From the time it was constructed, was never visually pleasing because of its open-graded texture and appearance.

4. CONCRETE PAVER SOLUTION

A roadway discussion arose again within the City in late 2003. The City Council and staff received many complaints about poorly maintained roads specifically from potholes, uneven and rough road surfaces. The City Council asked me to respond to why our roads were in such poor condition. In March 2004, the City Council received specific pavement condition information. Ripon consisted of 80 km of roadway, 240 km of 3.6 m wide lane equivalents. Of these pavements, about 20% were in poor condition, about 20% in fair condition and the remaining streets were in good condition. Those pavements in good condition were declining rapidly due to lack of maintenance.

The maintenance dollars needed to properly care for this street system were calculated:
Annual striping, signage, crack patching and sweeping = $540,000/year

Chip seal/overlay every 10 years, total reconstruction at 30 year intervals = $3,700,000/year.
Estimated total annual cost = $4,240,000.

Existing revenue for maintenance equaled $710,000. Funding sources include Transportation Development Act, State Gas Tax, and a local sales tax. No additional funding was anticipated for the future. With total annual maintenance costs expected to be in excess of $4 million and annual revenue only around $700,000, the numbers were clearly daunting with an extremely discouraging forecast. This situation was worsened by the City building new roads without the resources to maintain them.

A partial solution to the problem would be to build better roads that require less maintenance. With this solution in mind, City Council was very receptive to the concrete paver idea for all new roadway construction. Another deciding factor was that in addition to the structural stability pavers provided, they offered a significant pleasing visual contribution. In June 2004, a City of Ripon standard for constructing concrete pavers on all new roadways was adopted. Initially, the development community protested the new standard due to the increased costs. Concrete pavers are approximately three times more expensive than asphalt. The City Council has repeatedly confirmed their desire to build a better road by denying any requested variance to the standard.

5. CONCRTE PAVER DESIGN STANDARD

The standard adopted is as follows:

- 80mm paver thickness, 200mm length, 100mm width
- Color: charcoal/beige
- Strength to comply with ASTM C 936, 80mm thickness avg. strength 6,800 psi, min. strength 6,100 psi
- Pattern: Herringbone
- Chamfer: 4-6mm
- CALTRANS design procedure for structural section: Gravel Equivalent (GE) = 0.0032 (Traffic Index) x [100-(R-value)], with the 80mm paver having a GE = 2.00

Subgrade requirements remained the same as the asphalt roadway standard: minimum 95% modified Proctor density on native soil over 95% modified Proctor density aggregate base. This portion of the roadway standard is being revised to require a minimum of 98% modified Proctor density on the aggregate base, for both paver streets and asphalt streets. See attached standard detail for structural design.

Additionally, the concrete paver standard may be modified as issues arise out of experience gained in constructing new roadways. Some of the issues/ideas under field experimentation are: soldier coarses at edges, transitions to asphalt or other roadway materials, cast iron utility structures in the roadway, and pavement markings (evaluating colored pavers versus paint or thermoplastic).

At writing, there are four residential subdivisions under construction using concrete paver roads. The total paver roadway area to be completed by the fall of 2006 is approximately 100,000 m^2. In addition, multiple commercial projects will be constructing portions of new roadways also with concrete pavers. Some of these roadways will be major arterials, if not expressways, having vehicle speeds of 55-70 kph and high traffic volumes. Figures 2 and 3 illustrate concrete paver roads under construction.

Figures 1 and 2. 2006 construction views of a residential subdivision entrance.

6. CONCLUSIONS

By requiring concrete pavers streets, developers are transferring the higher initial cost to homeowners and to commercial developments. This investment is expected to reduce maintenance costs compared to the lower initial costs of asphalt to the developer and higher maintenance costs to the City. Ripon's future in concrete pavers will include further design and specification standards development plus maintenance crews committed to maintaining these new roadways at a reduced cost. It seems historically fitting that a community settled by the Dutch are now using a pavement system that is widespread in The Netherlands.

7. REFERENCES

Caltrans Highway Design Manual, Caltrans Division of Design, Sacramento, California, http://www.dot.ca.gov/hq/oppd/hdm/hdmtoc.htm#hdm.