PCA
America's Cement Manufacturers™

MARKET INTELLIGENCE

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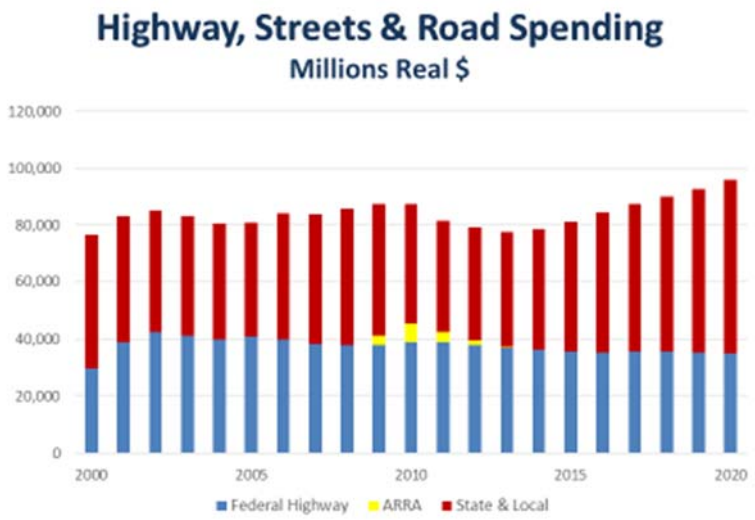
Paving Report 2016

Overview

The paving market is one of the largest arenas in which concrete competes. Concrete captures an average 14-15% market share of state DOT highway construction and maintenance, but only an estimated 6-8% of all paved roads in terms of lane miles. At such low levels, opportunity exists to expand concrete's share resulting in substantial industry revenue growth. The state highway segment alone, for example, holds an estimated potential of at least 18 million tons of cement annually. The purpose of this report is to evaluate the paving outlook in the context of the current economic environment. This evaluation includes a review of paving volume and market share performance as well as assessments regarding the impacts of relative price changes and non-price impacts on market share.

Paving Volume Assessment

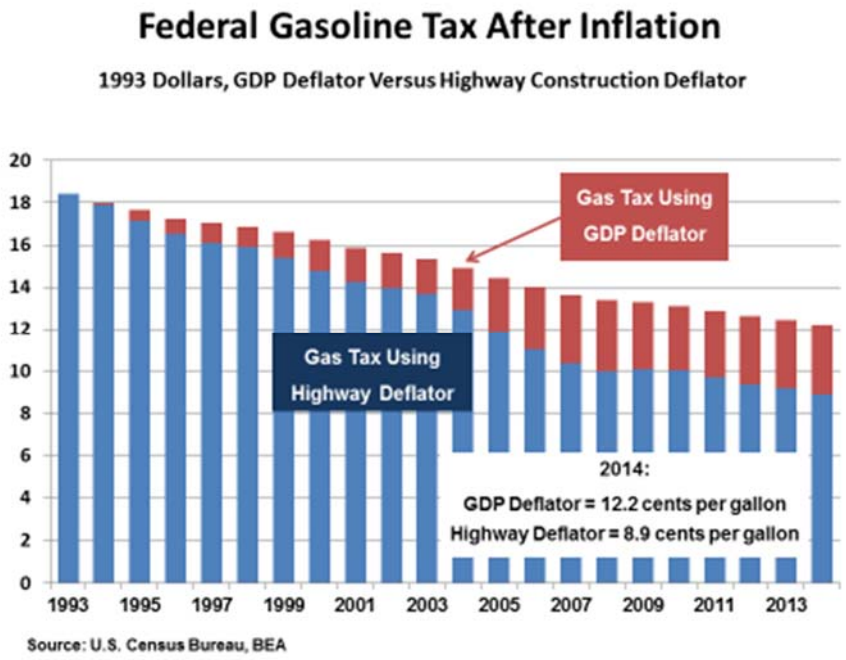
America's transportation network is in poor shape. The American Society of Civil Engineers (ASCE) rates the country's infrastructure every four years, grading different sections such as roads, transit, bridges, etc. as if they were school papers (A through F). According to their latest *Report Card for America's Infrastructure (2013),* America's roads and mass transit system earned D grades, with bridges and rail systems earning slightly better C+ grades. With all sections accounted for, American infrastructure received a D+. The ASCE estimates that the money needed to fix the problems would reach $3.6 trillion by 2020. The need equates to $170 billion each year for roads alone, according to the report.



Few question the need to accelerate investment in the nation's infrastructure. The issue is how can the necessary infrastructure improvements be financed at the federal, state and local levels? There is little doubt that the federal component of infrastructure funding is a critical component. It is a mistake, however, to dismiss the importance of state and local funding. State and local spending accounts for more than 50% of total roadway spending. Total highway, streets and local road spending, for example, increased in real dollars during 2015 despite declining real spending at the federal level.

Strong employment growth and the economic recovery has supported strong revenue growth at the state level. Rising home prices have supported gains in property taxes that underpin local revenue conditions. Improvement in state and local fiscal conditions has led to increases in highway, street and local spending. These conditions have been supplemented by other sources of funding. Last year, for example, six states increased the state gasoline tax. In addition, state sales taxes have been used to support infrastructure spending, and private-public partnerships have also been initiated as well as other creative funding solutions. These efforts are expected to continue in the near-term horizon.

Robust increases in infrastructure investment, however, is unlikely to materialize unless the federal component to funding is increased significantly. Since 1956, the Highway Trust Fund (HTF) has provided financial aid to the states for transportation projects[1]. Gasoline taxes have historically supplied the HTF. Yet the federal tax rate has not been increased since 1993, and remains at 18.4 cents per gallon. At that time, the gasoline tax was set at a level to meet maintenance and expansion needs in 1993. Revenue



calculations included estimates for fleet miles per gallon, vehicle efficiency, and vehicle miles travelled. While this approach was apt in 1993, inflation rends the existing gas tax inadequate to meet current maintenance and expansion requirements posed by changing future demographics. At 1993 levels, 18.4 cents per gallon translates into 8.9 cents per gallon today. Inflation alone results in roughly a 50% shortfall in expected real dollar revenues. In addition, revenues from gas taxes have also taken a hit from

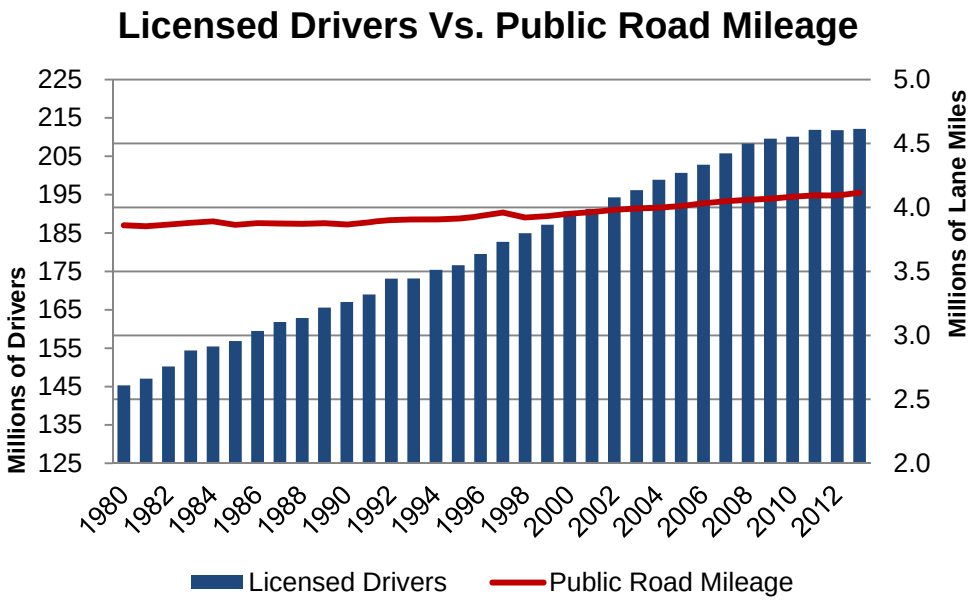
[1] Originally designed to supply funds exclusively for highway construction, the HTF now consists of three sections: Highway Account, Mass Transit Account and the Leaking Underground Storage Tank Trust Fund.

increased use of more fuel-efficient vehicles. The average fleet fuel efficiency of light vehicles on the road, for example, has increased from 11.5% since 1993 – reflecting a corresponding reduction in expected revenues.

An increase in the federal fuel tax is highly visible and as a result politically sensitive. According to many, there is significant resistance from Congress to solve the problems of highway funding by simply raising the federal fuel tax. Nevertheless, the gas tax rate is a critical factor in current highway trust funding. Without addressing this, other funding mechanisms must be put in place. The funding model for the highway trust fund, therefore, is ill suited for the robust increases required to improve the road system. In recent years, shortfalls in receipts has been supplemented by billions of dollars from the general fund. If unchanged, the Congressional Budget Office (CBO) expects the HTF will require an average of $19 to $23 billion annually from the general fund during the next five years.

It is in the context of resistance to increase the gas tax, that Congress recently passed the Fixing America's Surface Transportation Act (FAST), which will bring $207 billion to highways over the next five years. The new bill may alleviate some of the uncertainty surrounding states' transportation budgets, therefore allowing for the possibility of more large-scale DOT projects. This may provide greater opportunities for concrete to compete for these jobs and thus could lead to higher concrete shares. Due to long planning horizons, any share increases due to the added funding would not be expected until 2017 and beyond.

While FAST is an improvement over MAP-21, there are some troubling longer term assessments. FAST does not adequately solve the funding equation within the parameters of the HTF and requires $70 billion in support from the general budget as well as $50 billion in offsets from the Federal Reserve during the five year program. This leaves more than one third of FAST's funding coming from outside the HTF. The Congressional Budget Office estimates that without reform, the trust fund would exhaust its reserves by 2021, requiring an additional $100 billion just to keep it solvent through 2025.



Source: FHWA, PCA

Avoidance of tackling the federal funding model for highway infrastructure implies the possibility that only modest increases in real highway spending increases will materialize in the future. These modest investments are compared against forbidding demographics that are expected to unfold. Total vehicle miles traveled (VMT) in the U.S., for example, breached three trillion in 2014 and is expected to continue growing. According to Federal Highway Administration (FHWA) data, during the last 25 years, licensed drivers increased by 30%, the number of vehicles on the road increased by 65 million (or 35%), and total vehicle miles traveled increased by 45%. Public road mileage (lane miles), in contrast, increased only 7.7% over the same period.

Lack of investment in highways has led to increased traffic congestion, wasted fuel, pollution, wasted time, and higher logistical costs to the detriment of economic growth. According to the latest Urban Mobility Report (2015), the increased congestion has yielded the following consequences since 1982:

- The average commuter now faces 42 hours of traffic delays per year, up from 25 hours in 1989.
- The amount of additional fuel wasted during traffic congestion increased from 1 billion gallons in 1989 to 3.1 billion gallons in 2014.
- At a ratio of 20 pounds of CO_2 per gallon of fuel, roughly 30 million metric tons of CO_2 could be credited to highway congestion – or roughly 2% of all CO_2 emissions attached to motor fuel consumption, and this represents a 210% increase over 1989 levels.

Congestion also reduces the efficient connection of suppliers to consumers. Vibrant logistical systems are critical to economic growth and some long-term economic growth may be unrealized without expansion of critical and already overstressed infrastructure such as ports, roads, railroads, and airports. More than 80% of all commercial freight, for example, is transported by truck. These added logistical costs, as well as quality of life issues related to congestion, translate into an annual economic cost of nearly $160 billion annually at prevailing gasoline prices, according to the Urban Mobility Report.

Going forward, the number of licensed drivers is expected to increase almost 44 million by 2040, 20% higher than 2015 levels. Vehicles on the road are expected to increase by 50 million and vehicle miles traveled to rise by one half billion miles. Without significant investment in highways, this will only exacerbate the congestion problem.

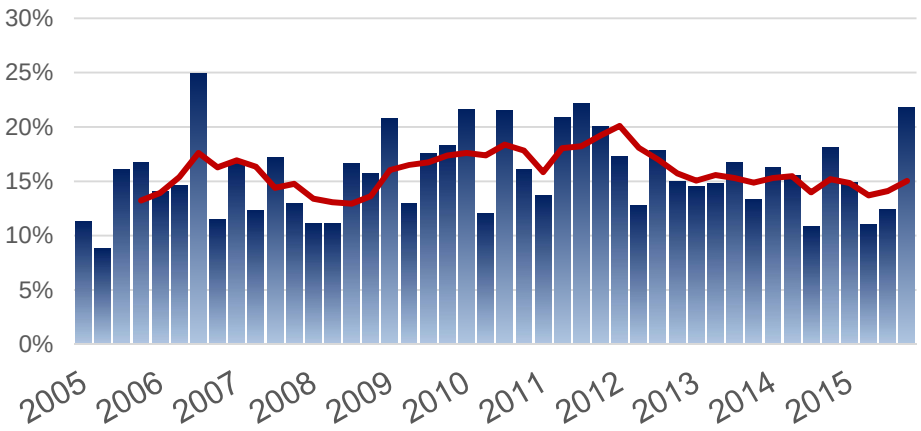
Keep in mind a very simple equation: The ASCE estimates $170 billion per year through 2020 is required to restore roadways to an acceptable level of performance. The economic cost of doing nothing is $160 billion annually and growing. The market balances and finds a way to extract its payment – either directly through higher taxes or indirectly through lost economic growth and jobs. Despite these consequences, PCA expects the funding model will remain broken and as a result only tenuous growth can be expected for infrastructure improvements, including paving activity.

Market Share Performance

Concrete's market share, based on Oman data[2], has shown a pattern of volatility but remains near its level 10 years ago. After a boost in market share during 2010-2012 attributed to the American Recovery and Reinvestment Act (ARRA), concrete's share has retreated to pre-ARRA levels. According to PCA's latest Oman estimate, concrete's paving share is 15.1%.

[2] Oman data is very specific and represents only a small portion of overall paving activity. Oman data represents concrete paving market share for a specific sub-set of paving activity, namely "state design- bid-build projects" (DBB). Design-bid-build projects are those let by state DOT's for private design, open to bid among competing contractors, and then built from the winning bid. It does not reflect DOT designed-build projects. Nor does it include much data on state, county or local roads.

Concrete Volume Share
2005 – 2015
(Oman Quarterly Data with 12MMA)

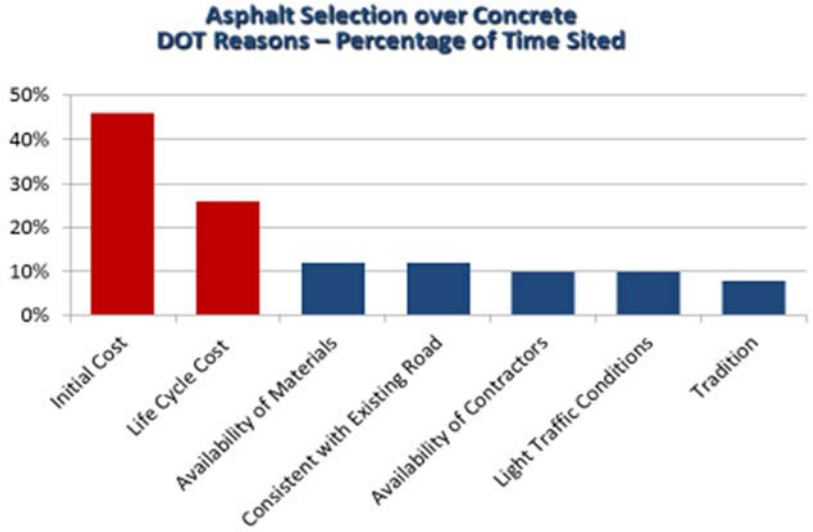


Source: Oman Systems, PCA

Many factors determine market share and its movement. Not all of these factors can be influenced by national or regional promotion efforts. Market conditions and pavement procurement practices are large determinants. Promotional activity, for example, cannot effect the level and size of paving activity or the relative price of concrete versus asphalt. Yet, these factors play important roles in determining paving share. In addition, the pavement procurement activities vary from state to state and influence the ease/difficulty of concrete's ability to penetrate various state markets.

New Paving Realities: Changes in the Cost Competitiveness of Concrete

The relative cost of paving a road with asphalt versus concrete plays a key role in determining which material is used for roadway paving. Prior to 2006, in the context of low oil prices, asphalt was significantly cheaper than concrete on both initial bid and life cycle basis. Strong global demand for oil attributed to the emergence of a middle class in many transitional economies, pushed oil prices higher –

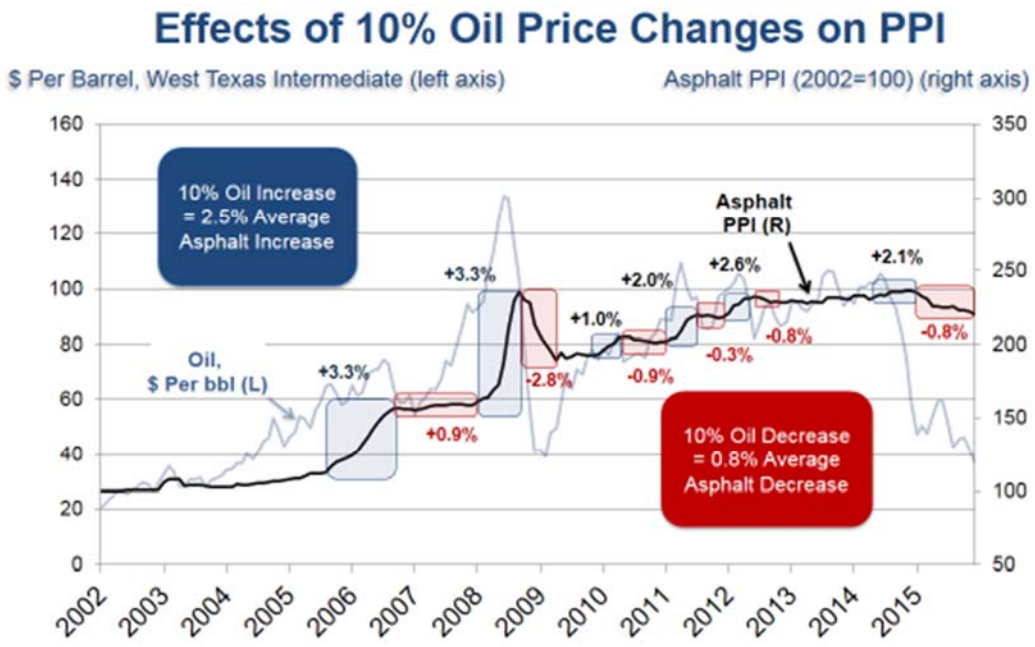


Source: Attitudes & Perceptions: Paving 2008

eventually reaching more than $100 per barrel. Since bitumen is an oil refining by-product and serves as a key factor input into the production of liquid asphalt, asphalt paving costs increased to such high levels that concrete became a cost effective alternative to asphalt for many paved roads with a depth of more than three inches.

Historically, changes in asphalt prices have been closely tied to changes in oil prices, lagged six to nine months. Asphalt PPI was previously believed to increase 4-7% for every 10% change in oil prices. In 2014, oil prices dropped off a cliff, from $105.79 in June of 2014 to $59.29 by the end of the year, and has fallen further to almost $30 a barrel (WTI spot prices) – reflecting roughly a 70% decline. Given the linkage between rising oil prices, rising asphalt prices and an enhanced competitive position for concrete pavers, it was initially feared that the recent decline in oil prices would restore asphalt's dominant competitive price position that existed prior to 2006. Assuming the previous correlations, the oil price decline would suggest a drop off in asphalt prices by as much as 30% to 50%. By the end of 2015, however, the asphalt PPI was down only 5.4% from the beginning of the oil price drop.

The plummeting oil prices over the last 18 months prompted a re-evaluation of the relationship between changes in oil prices and changes in asphalt prices. Recent research has shown there is more to the story regarding asphalt prices than just the factor costs associated with oil. Asphalt, for example, has moved proportionately with oil, but differently for increasing versus decreasing oil prices. ***On average*** from 2002, asphalt PPI increased by 2.5% for every 10% increase in crude prices, but fell by 0.8% for every 10% decrease in oil. Data from Oman Systems, which organizes DOT bid tabulations, shows similar trends.

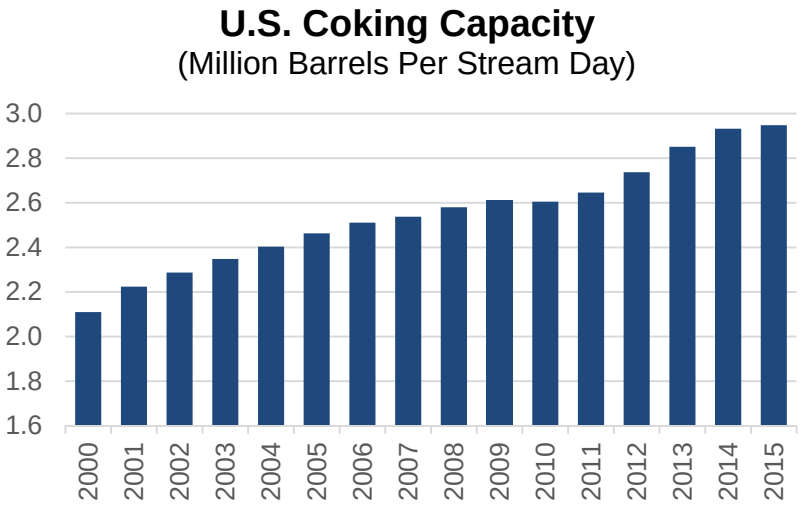


Source: BLS, EIA, PCA

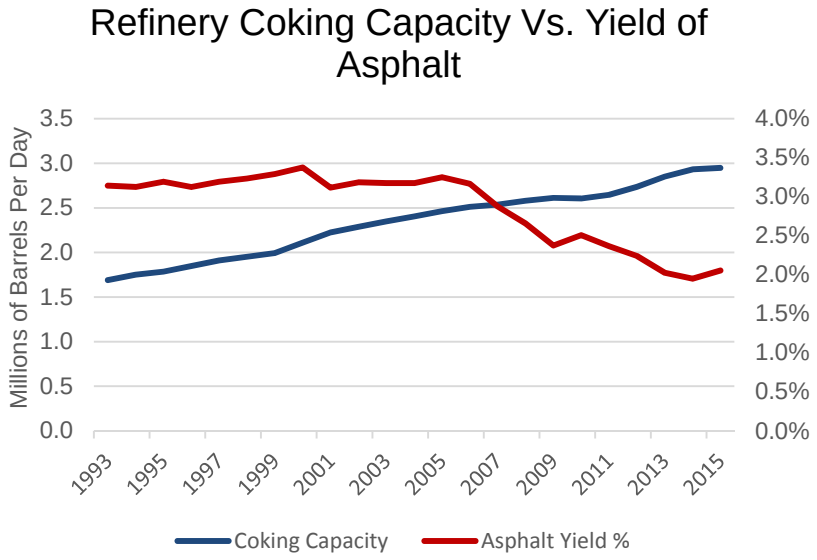
The relative insensitivity to the sharp oil price decline suggests that there are other factors in play in determining asphalt prices. On the supply side, there are a number of factors leading to asphalt's resistance to price declines. These include feedstock constraints such as the increased use of cokers and the rise in lighter, sweeter domestic crude availability. Another possibility features the lack of robust competitive conditions surrounding the paving industry. Consider the following assessments:

Cokers Impact on Asphalt Supply

Cokers are large equipment installed at refineries that can further refine crude oil into valuable products. They allow refineries to expand their range of inputs to also include heavier crudes, which are typically less expensive than lighter crudes. Much of the Canadian tar sands oil is heavier, as are many other imports such as Maya crude from Mexico.



Source: EIA



Source: EIA

Liquid asphalt, along with roofing tar and road oil, is derived from the heavy residual material produced during traditional oil refining, often called residuum. More residuum, and therefore more asphalt can be produced from heavier crudes. Because cokers further refine heavier crudes, they reduce the amount of residuum, thus constraining the feedstock supply for asphalt. Coking capacity for U.S. refineries has

increased by nearly 40% since 2000. Because oil prices have been depressed, and relative margins between crudes squeezed, the payoff for cokers has been reduced to the detriment of growth in cokers going forward. The amount of refinery yield of liquid asphalt has declined and is currently around 2%.

Increased Refining of Lighter, Sweeter Crude Oil

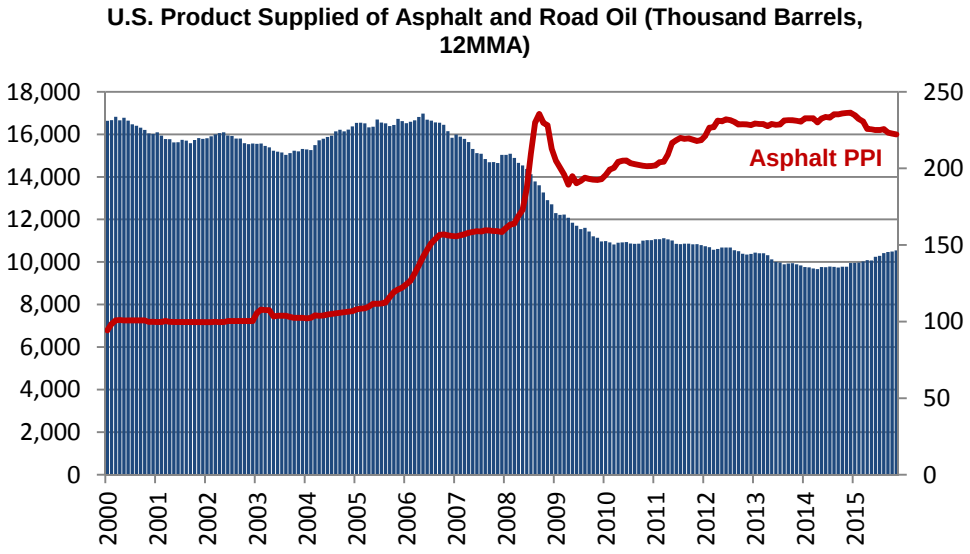
There are two ends of the crude oil spectrum: light and sweet to heavy and sour. The sweet or sour term refers to the sulfur content in the oil. Lower sulfur levels are more desirable as they require less work to refine into valuable gasoline, diesel, etc. The light or heavy designation comes from the crude's specific gravity, which relates to its density. Lighter crudes have been historically more desirable because more higher-valued petroleum products can be obtained through refining – leaving less residual oil used in the production of liquid asphalt.

According to the Energy Information Administration (EIA), domestic oil production has grown from 5.6 million barrels per day in 2011 to 8.7 million per day in 2014. Approximately 90% of the increase in production has been comprised of lighter crudes. The refining outputs from these U.S. crudes are similar to the Nigerian light crudes portrayed below. Less asphalt is produced from these types of crudes. Because of the large influx of domestic light oil, refineries are producing more higher-valued petroleum products. Since 2006, asphalt/road oil supplies have decreased over 33% on an average annual basis (EIA-U.S. Product Supplied of Asphalt & Road Oil).

The Asphalt Market Balance

The combination of increased use of cokers and lighter, sweeter crudes results in a reduction in asphalt supply to the market. This decrease in supply has occurred at a time when state and local fiscal conditions are rapidly improving due to strong sustained job creation and the tax revenues associated

Asphalt Market Balance



Source: BLS, EIA, PCA

with elevated employment. In the context of stronger fiscal conditions, state and local governments are increasing their paving activity – generating increased demand for asphalt products. Reduced supply in the context of increased demand conditions suggests significant market resistance to asphalt price declines.

Competitive Paving Conditions

Asphalt dominates certain types of paved roadways. In some cases, DOTs have narrowly defined competition to encompass only asphalt pavers. Because the paving cost dynamics have changed so radically during the past ten years, DOTs now enjoy the advantage of another cost competitive paving alternative – concrete roads. As a result, DOTs are no longer bound to be the risk insurer for asphalt paving contractors as implied by state escalator clauses and a host of other impediments to competition. Despite this transformational shift, many existing DOT policies aimed at maximizing taxpayer dollars remain in-place and perversely work to the detriment of taxpayer interests.

Given the new realities of paving, whereby concrete pavements are cost competitive, the definition of competition must be expanded beyond encouraging more bids among asphalt contractors and include competing materials, namely concrete.

Lacking a broader definition of roadway pavers, and with robust demand facing asphalt pavers, it is likely that asphalt pavers will likely hold their prices in the context of declining factors costs. The absence of a level playing field reduces competition from concrete pavers and insures higher asphalt paving costs.

PCA tested the theory that asphalt cost escalators lead to more competition and hence lower asphalt project bid prices[3]. A comparison of asphalt project bids were compared in "level playing field" states against states where DOT policy is heavily biased toward asphalt. Among biased states, concrete roads are generally excluded from the bid process due to the lack of alternative bidding, equivalent design, or competitively impaired in the bidding process due to the presence of asphalt cost escalator clauses with elevated employment.

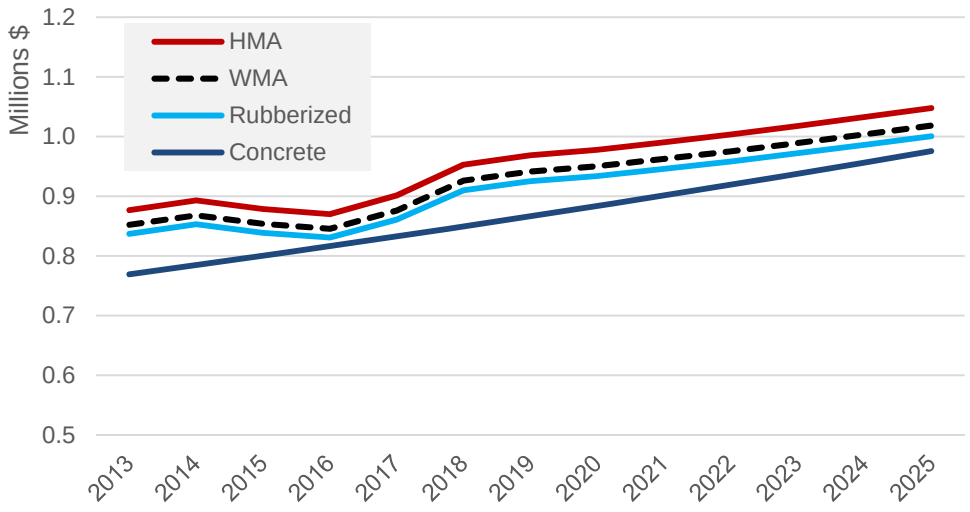
The results of this research suggest that asphalt project bids are far lower in "level playing field" states compared to states that utilize impediments to "free market" procurement practices. Asphalt prices in "level playing field states" were 12.6% lower than in states whose policies are heavily biased toward asphalt during 2006-2011. The results suggest that asphalt paving contractors use DOT policy, such as escalators, as a competitive shelter. Further, this suggests that DOTs view of competition is narrowly focused to include only asphalt pavers, and not more broadly defined to include concrete pavers. This leads to a destruction of competition.

Initial Bid and Life Cycle Cost Paving Assessments

Many factors determine market share and its movement. Based on previous research, cost effectiveness of asphalt versus concrete plays an important role in the material paving decision. To this end, PCA estimates the initial bid and life cycle bid for both asphalt and concrete paved roads that are designed for urban use. The factor costs surrounding oil are critical inputs into PCA's estimate for relative costs. Based on EIA oil price projections of $60 per barrel in 2020, asphalt prices increase at a rate of 2.5% for every 10% increase in oil price. Concrete prices, in contrast, are expected to rise at the expected rate of inflation.

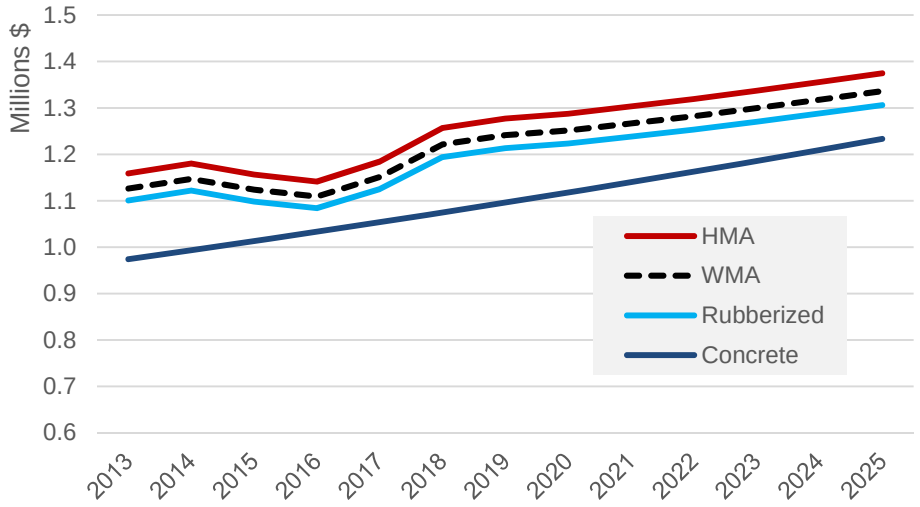
[3] The New Paving Realities: The Impact of Asphalt Escalator Clauses on State Finances, PCA February 2012.

Initial Bid Paving Costs
(WisPAVE: Two Lane Mile - Urban)



Source: EIA, BLS, PCA

Life Cycle Paving Costs
(WisPAVE: Two Lane Mile - Urban)

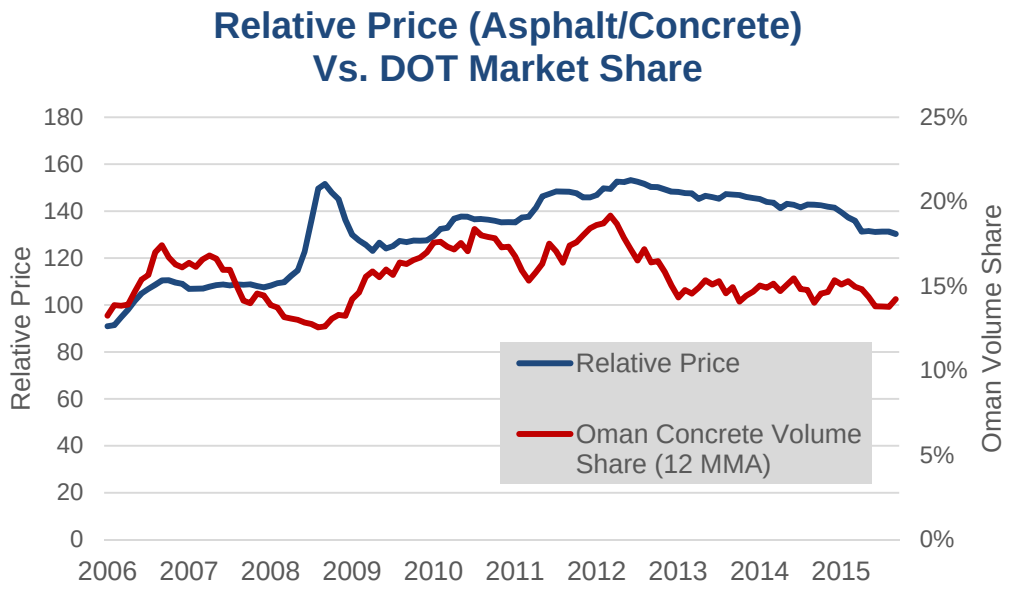


Source: EIA, BLS, PCA

Based on these inputs, and using Wisconsin DOT software (WISPAV), concrete pavement remains the least expensive choice for roadway pavement. Some have suggested that new asphalt mixes and processes may reduce asphalt paving costs. PCA has assessed the costs associated with these new technologies, namely warm mix asphalt and rubberized asphalt. The hot mix costs as well as these alternative mixes/processes were also run through WISPAV. Since 2008, concrete has been cost competitive on initial bids for an equivalent urban roadway – even with the proposed energy cost savings associated with warm-mix and rubberized asphalt. Because less maintenance is required and the life span is much longer than with an asphalt roadway, concrete exhibits a life cycle cost advantage for the same urban road.

Free Market Hindrances

PCA conducted econometric tests to determine the relationship between changes in relative prices and concrete's market share. In a true "free market," relative price changes between competitors would be expected to drive more significant market share movements. Free market dynamics suggest that the growing use of concrete paved roads could save potentially billions of dollars annually in road maintenance costs – enabling states to spend scarce dollars on higher priorities.



Source: BLS, Oman Systems, PCA

Unfortunately, these dynamics are hindered by many states' DOT procurement practices. These include the presence of asphalt price escalators, the lack of alternative bid processes, and the lack of equivalent structural designs, which biases the accuracy of life-cycle cost analyses (LCCA) and favors the placement of asphalt. These factors impede the free market price mechanisms from fully operating, slowing concrete's penetration of the paving market, and doing so costs states and taxpayers billions of dollars in unnecessary paving initiatives. Without removing these impediments, concrete's relative price advantage carries less meaning. These market hindrances exist within many state DOTs material procurement processes, and the presence of these factors can distort market guidance and lead to sub-optimal paving decisions. Consider the following market hindrances:

Asphalt Escalators

Asphalt cost escalator clauses are price adjustment provisions that allow for asphalt paving contractors to adjust their construction price based on a fluctuation in liquid asphalt cost. Asphalt escalator adjustments occur after the contractor has won the bid. In the context of rising oil and asphalt prices, taxpayers actually pay more to a contractor at the time of construction than the price quoted to win the project. This practice can result in DOTs choosing a more expensive paving option and thus result in significant cost overruns. Most state DOT paving material procurement policies allow for the use of asphalt escalators.

Escalators now serve only to potentially enhance asphalt's contract bid position versus concrete paved roads and mask unneeded cost overruns caused by asphalt's price volatility. Based on Oman systems data, PCA estimates that escalators have cost states roughly $70 million annually on state roads in cost overruns since 2008-2011. Based on a 2011 report prepared for the American Association of State Highway and Transportation Officials (AASHTO), this figure is a significant underestimation.[4]

MEPDG/Equivalent Design

The paving material performance characteristics of concrete and asphalt are vastly different. Existing road design processes often do not have the required resources to conduct equivalent design methods and, hence, performance comparisons are not frequently performed. Most existing design methods used by DOTs are based on the two-year AASHTO road test in the late 1950s and used only one asphalt and one concrete mixture. This dated information does not reflect the present realities of today's road requirements. Heavy truck traffic, for example, has increased up to 20 fold since the 1960s. At the same time, the expected design life of a road has doubled from 20 to 40 years. Both concrete and asphalt pavement designs have changed. Repair and maintenance cycles along with many other important design considerations are also not adequately accounted for in current design guides.

AASHTO has responded to the need for a better road design process by adopting a Mechanistic-Empirical Pavement Design Guide (MEPDG) and its companion software Pavement ME. The guide acknowledges the deficiencies of previous pavement design processes that have traditionally kept road building agencies from exploring equivalent paving alternatives in their current design practices. Pavement ME empowers a road designer to create equivalent designs for asphalt and concrete. The use of AASHTO's recommended Pavement ME approach toward road design could increase paving competition and result in reduced costs for state DOTs.

Alternate Design/Alternate Bid

Frequently, DOTs strictly specify the paving material to be used in a road's construction, excluding a concrete paving solution from being considered in the bidding process. Such practices work against free market competition and exclude states from the potentially lower costs associated with concrete alternatives. Under increasing fiscal pressure, some state DOTs are beginning to recognize the costs associated with these procurement practices and have begun adopting new procurement protocols called Alternate Design/Alternate Bid (AD/AB).

AD/AB gives the contractor a choice to bid on either a concrete or asphalt option, thereby increasing the number of bidders on each job. AD/AB allows the bidding contractors to select the pavement type to be constructed, rather than a DOT. This not only eliminates any bias in the selection process, but also increases competition between paving industries. The end result is greater choice, lower costs, and enhanced innovation. According to a recent survey of five states, 178 AD/AB projects were adopted resulting in documented savings of $435 million.

[4] "Price Indexing in Transportation Construction Contracts" - http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(274)_FR.pdf

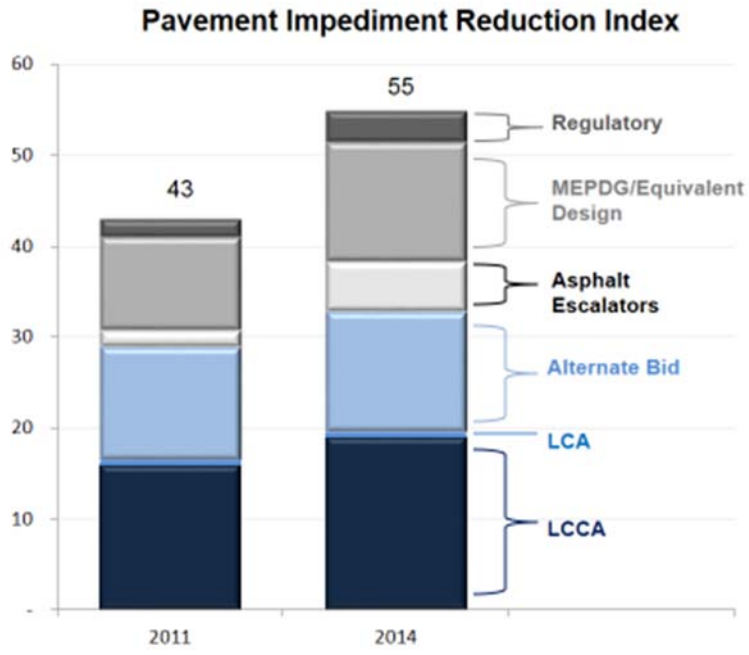
Life Cycle Cost Analysis (LCCA)

According to the Federal Highway Administration, “LCCA’s value as a decision-support tool is contingent upon its proper use”. Typically, one of the things that is wrong with LCCA estimates performed by state DOTs is that they don’t account for differential inflation or real price change. By using an economic technique known as “escalation,” estimates for future rehabilitation activity costs can be adjusted to account for the relative price changes in the cost analysis before costs are converted into present dollars and summed for each alternative. The analyst can then determine which alternative is the most cost effective. Such efforts typically work to improve the relative cost associated with concrete paved projects.

Removing the Hindrances

Economic analysis based on comparing relative costs, policy based on maximizing social welfare, and asset portfolio theory based on diversification of risk all suggest a greater role in concrete paved roads in the future. The free market mechanism, at least recently, would also seemingly opt for a greater role for concrete paved roads. The free market mechanism, however, cannot exert its will in the context of procurement policies that are skewed toward the adoption of asphalt paved roads. Policies initially designed to enhance competition among concrete pavers appear to be outdated in the context of a competitive environment that extends beyond asphalt pavers and now includes concrete pavers.

Primarily at the state level, efforts have been made to reduce or remove these market hindrances, let the free market decide, and hopefully lead to an increase in concrete paving activity. The political process of changing traditional policy is difficult, slow, and hampered by strong resistance from the asphalt pavers. Despite these challenges, successes have been achieved at the regional level.



Source: PCA

To this end, the Market Intelligence Group developed a paving measurement metric that will track progress made in removing the many free-market impediments facing concrete. Removal of these paving impediments is an important aspect to consider as paving advocacy is a long process that will not always demonstrate immediate market share gains. The metric consists of six impediment categories: LCCA, LCA, Alternate Bid, Asphalt Escalators, MEPDG/Equivalent Design, and Regulatory.

The result was an index value between 0 and 100, with 100 implying the complete removal of all market impediments. In 2011, this value was at 43. In 2014, the index was 55, showing an increase of nearly 28% over three years. Data for 2015 is expected to show further gains. With the separation of the regions from PCA, it is important that efforts in these areas continue and do not falter.

The Outlook for Market Share Gains

Paving activity is expected to grow at modest rates of roughly 3% to 4% annually through 2020. With the new five year highway bill in-place, DOTs may engage in a greater amount of large multi-year contracts. These projects are often more concrete friendly.

Many factors determine market share and its movement. Based on previous research, cost effectiveness of asphalt versus concrete plays an important role in the material paving decision. The knee jerk reaction to declining oil prices would be to conclude an improvement in asphalt cost relative to concrete and project share erosion for concrete pavers. While some erosion in concrete's competitive cost position is expected, the erosion is expected to be minor. Concrete paving is expected to have a similar competitive stature as it now enjoys.

The removal of market impediments may be a critical determinant in the movement in concrete's share of the paving market. This implies that political successes, which have materialized in recent years, must continue to be won at statehouses in the context of the forbidding strength of local asphalt lobbyists.