EVALUATION OF FUEL USAGE FACTORS IN HIGHWAY CONSTRUCTION IN OREGON

Final Report

SPR 668

RESEARCH

Oregon Department of Transportation

EVALUATION OF FUEL USAGE FACTORS IN HIGHWAY CONSTRUCTION IN OREGON

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by

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16. Abstract:

Prices for different construction materials change frequently. In recent years, the price for these different materials has dramatically increased. This result leads contractors to inflate the bid price for a construction project in order to cover the potential increased cost. In an attempt to modify the inflation inserted into bid prices, the Oregon Department of Transportation allows for adjustments in the monthly payment to the contractor for various inputs. One major input that receives an adjustment is fuel. The contractor is eligible to receive adjustments in the monthly payments for fuel when the project is of a certain magnitude. After the project qualifies for the adjustment, when the price of fuel varies by more than twenty-five percent positive or negative from the previous month, the ODOT will make a fuel price adjustment to the monthly payment. The fuel price adjustment is a function of a fuel usage factor. The value for the fuel usage factor for different bid items is based on an over thirty five year old 1974 national survey titled, "Fuel Usage Factors for Highway Construction."

From that original survey the fuel usage factor for each bid item was recommended to be multiplied by the distance, weight, or volume built of the respective bid item, but not for structures. The fuel usage factor for structures was to be multiplied by the gallons of fuel used per $1,000 worth of work. The research presented in this report determines from a national survey whether other states, and their DOTs, use this same procedure to calculate a fuel price adjustment, and if so, whether the values for the fuel usage factors are the same. In addition, the report examines how the price of structural construction has changed over time to ascertain whether the current fuel usage factor for structures is still applicable. A new index is developed in a national model and one for the state of Oregon.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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EVALUATION OF FUEL USAGE FACTORS IN HIGHWAY CONSTRUCTION IN OREGON

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1.0 BACKGROUND AND SIGNIFICANCE OF WORK

Price volatility of construction materials and supplies such as asphalt, fuel, cement, and steel can create significant problems for construction contractors when preparing realistic and accurate bids. It can also be problematic for agencies sponsoring the projects. In many cases, the bidder or construction company cannot obtain firm price quotes from material suppliers for the duration of the project. This type of uncertainty can lead to price speculation and inflated bid prices by the contractor to protect against possible price increases.

Although price speculation and bid inflation are not new, escalation of global fuel prices in 2008 led to greater uncertainty in the bidding process. The effects of higher fuel prices are magnified when combined with the other component prices for concrete and asphalt, along with other demand factors currently affecting the construction industry.

Since 1974, the building and construction industry, as well as some state and federal departments of transportation, have handled this problem by allowing specific price adjustments for select commodities in highway contracting. For the contractors, these adjustments decrease the risk of fluctuating prices over the life of a contract. The application of fuel usage factors is generally accepted as a way to obtain bids that more closely reflect actual costs for any given project. More accurate estimates, however, can only be achieved if the fuel factors accurately reflect the fuel consumption.

Fuel usage factors were published in Highway Research Circular Number 158[1] by the Highway Research Board in July 1974. Later, in 1980, they were formally incorporated into the Federal Highway Administration (FHWA) publication *Technical Advisory T 5080.3*. These fuel factors, however, have not been revised in 35 years, despite obvious changes in the purchasing power of construction dollars, construction techniques, industry innovations, and the type of fuel used for the wide-ranging tasks in construction. Because fuel factors have not been brought up to date, the Oregon Department of Transportation (ODOT) has stated that "it is very unlikely that those fuel usage factors are accurate or effective in removing the risk of fuel price fluctuations to the grantor or construction firm.

Under established fuel factors, diesel and gasoline consumption per unit of work are specified for each nonstructural unit of work (excavation, aggregates, asphalt concrete, and portland cement concrete pavement). The process involves applying the quantities of completed work to the fuel factors in the table, summing the total used for each separate item, and applying the

[1] The authors conducted an exhaustive search to obtain this original FHWA study upon which so many states have based their fuel factors adjustments. It was determined that this study was originally housed at one of the regional FHWA facilities but when FHWA was re-organized in the mid-1990's, this report (and any data or documentation related to the study) was lost at that time. Without being able to review the 1974 study or the methods incorporated, the authors of this report have proceeded under the assumption that the study was conducted utilizing the best available information and methods at the time and sound analytical techniques.

price adjustments. Gasoline and diesel fuel usage factors exist for excavation (gallons per cubic yard), aggregate and asphalt production and hauling (gallons per ton), and portland cement concrete (PCC) production and hauling (gallons per cubic yard).

Of particular concern, fuel usage factors for structures and miscellaneous construction are expressed in gallons per $1,000 of construction based on 1980 estimates. ODOT's construction expenditures in recent years have increased from about $250 million per year to $400-500 million per year, mostly for bridge construction. What this amount of capital buys in physical construction compared to earlier years has decreased considerably, resulting in higher fuel allowance for a given physical structure. Dramatic fuel price increases in the summer of 2008, have also contributed to the overall difficulty and price sensitivity regarding vendor reimbursement. Consequently, inflation and construction cost indices are increasingly important areas of research.

ODOT has identified three analytically separable sources of error in the current method:

1. Inflation. The effect of inflation on construction costs over the last three decades is a primary concern for structures and miscellaneous construction. Fuel usage factors were calculated in gallons per $1000 in 1980 and have never been revisited.
2. Construction Practices and Fuel Efficiency. The relationship of fuel consumption to the production and transportation of specified quantities of aggregate asphalt and PCC have likely been affected by changes in construction practices, use of new and prefabricated materials, improved equipment, and improved fuel efficiency on new and old machines.
3. Fuel Preferences. There have been changes in fuel preference, particularly in the substitution of natural gas for diesel in asphalt plant operations.

The research here will focus primarily on the first source of potential error — the effects of inflation on construction costs. General information on the other two sources of error dealing with unit price fuel factors, however, will be generated to some degree. Continuing research efforts through the extension of this current project could address the other factors identified above.

The primary research document on the application of fuel usage factors is *The Development and Use of Fuel Price Adjustment Contract Provisions (FHWA 1980*). The AASHTO Subcommittee on Construction's August 2005 survey summarized contract price adjustment clauses used by states for asphalt cement, fuel, steel, and portland cement.

This report directly evaluates the impact of inflation on the applicability of current fuel usage factors in Oregon and the nation. The results provide information and recommendations that all states may consider and many may adopt, given that improvements in usage and application have been found.

1.1 OBJECTIVES OF THE STUDY

The overall objective of this study was to determine the impact of inflation, if any, on structural bid items. To meet this objective, the goals of this research project were to:

1. Compile the state's fuel adjustment methods for structures.
2. Analyze the effects of inflation in relevant areas of structural construction costs.
3. Analyze the current fuel factors for accuracy while updating them to reflect current conditions in various construction materials and processes.
4. Develop a revised fuel usage factor for structures as addressed in the current FHWA Technical Advisory T 5080.3 and the current process for ODOT.

1.2 BENEFITS

Given limited public budgets, reasonable construction costs are critical to providing the quality of services expected from ODOT. The correspondence between estimated fuel usage and actual fuel usage in construction bids, based on the 35 year-old fuel factors, may no longer be accurate. Examining the current structure of these factors in current dollars and the fuel used in construction will allow decisions to be made regarding the need for new fuel factors to mitigate risk, while getting the most construction for the dollar for ODOT. Risk and uncertainty, under extremely volatile construction cost market situations, may result in overpriced bids. A sound basis for associating fuel usage with higher construction is critically important for the responsible allocation of public funds. Additionally, less administrative oversight and effort are required with a more accurate and dynamic adjustment tool. Thus, the payoff potential is very high for Oregon and the nation through the FHWA's reconsideration of the Technical Advisory T 5080.3. The construction industry will also be better served through minimization of risk in bidding estimates, related to fuel in the construction processes.

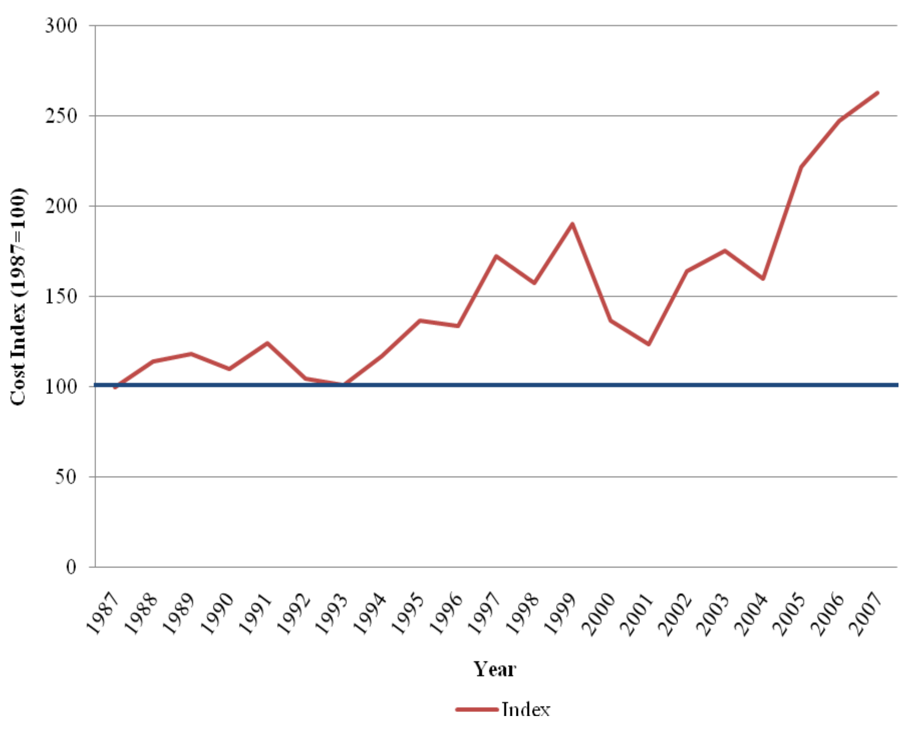
2.0 LITERATURE REVIEW

The research team began by investigating the price of materials for construction projects over the past several years, along with the components that make up the majority of construction bid costs. When prices for different construction materials increase, it becomes difficult for contractors to make an accurate bid.

Fluctuations in fuel prices also directly affect the Oregon Department of Transportation (ODOT). ODOT allows a fuel price adjustment for different projects if they meet certain criteria. Particular bid items in construction are designated with a specific fuel factor. As illustrated below in Table 2.1, the construction cost for structures has increased considerably over the last several years. From 1987 to 2007, highway construction costs for structures in Oregon have increased 163 percent.

Table 2.1: Oregon Highway Construction for Structures Cost Trend (Base Index: 1987 = 100)

Year	Index	Chart
1987	100.0	
1988	114.1	
1989	118.1	
1990	109.9	
1991	124.3	
1992	104.5	
1993	101.0	
1994	116.9	
1995	136.4	
1996	133.4	
1997	172.4	
1998	157.5	
1999	190.2	
2000	136.8	
2001	123.4	
2002	164.1	
2003	175.2	
2004	159.8	
2005	221.8	



Source: (*ODOT 2007a*)

ODOT's asphalt cement material price index and fuel price index (Tables 2.2 and 2.3, respectively) show that prices have increased by more than 70 percent, and 189 percent, respectively, from 2003 to 2007.

Table 2.2: ODOT Average Annual Asphalt Cement Material Price

Year	Pacific Northwest ($/ton)	Boise Idaho ($/ton)
2003	$175.00	$155.00
2004	$181.42	$171.50
2005	$192.25	$192.42
2006	$298.75	$340.25
2007	$327.92	$362.17

Source: (*ODOT 2007b*)

Table 2.3: ODOT Average Annual Fuel Price History

Year	Price ($/Gallon)
2003	$0.91
2004	$1.29
2005	$1.82
2006	$2.12
2007	$2.23

Source: *(ODOT 2007c)*

The price of reinforcing steel, structural steel, and structural concrete has increased by more than 32 percent, 26 percent, and 17 percent, respectively, from 2001 to the first quarter of 2006. Table 2.4 shows FHWA reported prices of reinforcing steel, structural steel, and structural concrete from 1972 to 2006[2] .

[2] FHWA discontinued these reports after the first quarter of 2006.

Table 2.4: FHWA Historic Prices for Reinforcing Steel, Structural Steel, and Structural Concrete

Year	Reinforcing Steel Avg. Contract Price ($/lb.)	Structural Steel Avg. Contract Price ($/lb.)	Structural Concrete Avg. Contract Price ($/cu. yd.)
1972	0.181	0.342	100.17
1973	0.207	0.372	111.81
1974	0.339	0.551	136.80
1975	0.297	0.554	138.76
1976	0.258	0.484	139.59
1977	0.272	0.520	143.51
1978	0.316	0.603	172.41
1979	0.421	0.759	211.33
1980	0.483	0.941	226.68
1981	0.438	0.790	231.64
1982	0.407	0.762	219.63
1983	0.398	0.708	213.85
1984	0.409	0.709	218.02
1985	0.444	0.796	243.60
1986	0.442	0.850	236.37
1987	0.441	0.885	240.81
1988	0.494	0.924	274.12
1989	0.556	1.018	283.40
1990	0.529	1.010	286.18
1991	0.505	1.030	264.98
1992	0.520	0.916	259.61
1993	0.467	0.861	261.89
1994	0.515	0.847	271.94
1995	0.542	0.922	302.66
1996	0.581	1.068	293.85
1997	0.567	1.186	320.90
1998	0.544	1.111	337.25
1999	0.554	1.224	342.24
2000	0.549	1.351	363.66
2001	0.601	1.201	339.44
2002	0.610	1.436	374.96
2003	0.718	1.219	406.02
2004	0.815	1.521	331.49
2005	0.941	1.571	394.88
2006	0.795 (Q1)	1.520 (Q1)	397.21 (Q1)

Note: FHWA no longer keeps this information after the 1st Quarter (Q1) of 2006.
Source: *(FHWA 2007)*

The index for highway construction costs has increased by more than 60 percent within the last five years. The complete list of bid items, and respective fuel factors and minimum qualifiers are shown in Table 2.5

Table 2.5: Oregon Fuel Escalation Project Determination

BID ITEM	UNIT	FUEL FACTOR ($)	MIN QUALIFIER ($)
General Excavation	Yd3	0.29	5,000
Embankment in Place	Yd3	0.29	5,000
Subgrade Stabilization (12 in. depth)	Yd2	0.33	5,000
Trench Excavation	Yd3	0.29	5,000
Stone Embankment	Yd3	0.29	5,000
Other Excavation	Yd3	0.29	5,000
Cold Plane Removal	Yd3	0.72	5,000
Cold Plane Removal	Yd2	0.04	5,000
Conc. Pvmt. Diamond Grinding	Yd2	0.04	5,000
Base Aggr., Shoulder Aggr. & Sub-Base Aggr. (Combined)	Ton	0.69	5,000
Shoulder Aggregate (Overlays)	Ton	0.69	5,000
Cement Treated Base	Ton	1.00	5,000
Bituminous Base	Ton	2.93	5,000
AC Mixture	Ton	2.93	5,000
Aggregate in Chip Seal	Ton	0.69	5,000
Emulsified AC Mixture	Ton	1.00	5,000
Concrete Pavement	Yd2	1.00	5,000
Other PCC:	Yd2	1.00	5,000
Structures (Gallons/$1000)	Pre-cast	10.00	10,000
Structures (Gallons/$1000)	Cast-in-place	19.00	COMBINED
Total for Project			25,100

Source: (*ODOT "unpublished data")*

For a bid item to be eligible for a fuel price adjustment, it must first meet a minimum qualifier threshold, which is calculated by multiplying the total quantity of work for each item over the whole project by the respective factor. The sum of eligible bid items has to be greater than 25,100 gallons for the entire project to qualify for a fuel price adjustment. An adjustment will be made through monthly payments for eligible bid items that were used during construction if the price of fuel[3] increases or decreases by more than 25 percent. In other words, there will be an increase in payment when fuel prices increase by more than 25 percent and a deduction when fuel prices decrease by more than 25 percent. Section 2.2 presents a review of how other states address fuel price fluctuations and alternative methods for fuel price adjustments.

[3] Fuel price is based from the Oil Price Information Service (OPIS).

According to the Federal Acquisition Regulation, the U.S. government will not make payment adjustments to a private contractor if the price of construction materials increases during building repair or construction, unless it is written in the contract before the contract is accepted. Furthermore, the responsibility lies with the contractor to write it in the contract, otherwise no additional payments will be made. After viewing various department of transportation (DOT) web sites, most states have some type of fuel price adjustment, and in several states make it optional for the contractor.

In addition to reviewing the literature, the research team examined fuel price adjustment approaches for 10 western states.[4] The results indicate there is high variability between the approaches of different states to the adjustment process. Two of the 10 states do not allow for any fuel price adjustment. Some states' fuel price adjustment requirements are more restrictive than others. For example, in some states any project is eligible for a fuel price adjustment, while in other states project size determines adjustment eligibility. A detailed explanation for each of these 10 states in the western United States and Florida is presented. First, the states that use a fuel price adjustment are identified. Subsequently, specific requirements for fuel price adjustment eligibility are described. Finally, for projects entitled to a fuel price adjustment, the specific bid items included in the fuel price adjustment are listed for each state.

2.1 SUPPORTING STUDIES AS GUIDES TO ODOT'S FUTURE STRUCTURE OF FUEL FACTOR ADJUSTMENTS

In 2006, the American Association of State Highway and Transportation Officials (AASHTO) and Federal Highway Administration (FHWA) jointly prepared a survey to determine the effects of recent price increases and the decline in competition for bids (*FHWA 2006a*). Forty-four state DOTs responded to the survey. Survey results showed that over a one year period eight states[5] implemented or made changes to their fuel price adjustment process. Thirty-one states did not make changes, and California and Maryland reported that they do not have a fuel price adjustment. North Dakota stated they were developing a fuel price adjustment clause. Twenty-two states used a price adjustment clause for certain materials to encourage competition and to compensate for significant cost increases. Arizona and Kentucky reported that using price adjustment clauses has effectively promoted competition and controlled costs.

The Contract Administration Section of the AASHTO Subcommittee on Construction also surveys all states regarding the use of price adjustment clauses. The adjustment clauses for fuel, asphalt cement, steel, and portland cement are analyzed and updated on a regular basis; the most recent survey was administered in the fall of 2008 (*AASHTO Subcommittee on Construction, Contract Administration Section 2008*). For the fuel price adjustment, the survey reports whether the adjustment exists, the fuel index used, the trigger value, whether the adjustment is optional, the web reference, and additional comments. Contact information is provided for each state.

[4] Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Wyoming
[5] Colorado, Delaware, Idaho, Kansas, Ohio, South Carolina, Virginia, and Washington

In 2004, the Monmouth County Department of Human Services in New Jersey contracted with the Alan M. Voorhees Transportation Center at Rutgers University to identify fuel price indexing/adjustment techniques in the public transportation industry (*2004*). The purpose of the study was to learn what fuel price adjustments agencies use and outsource to the private sector. The report listed the following four most common fuel price adjustments and the benefits and drawbacks of each method:

1. **Contract Pricing.** The price for fuel cost reimbursement, based on fuel price fluctuations during the contracting process, is set before the project is started. If prices fluctuate below the contract price then the agency pays more than the market price. Conversely, if prices fluctuate above the set price, providers must absorb the higher price, which could limit the number of firms making a bid on the contract.

2. **Fixed Price with Adjustment.** If the price of fuel rises by a certain percentage, then the provider receives an additional payment for the increase in fuel price. Since the agency will make additional payments for changes in fuel prices, some of the risk in construction costs is transferred from the provider to the agency. ODOT currently uses this method.

3. **Direct Refueling Using Agency-Operated Fueling Facilities.** The agency owns its own fleet and refuels them at county owned and operated refueling facilities. The agency has control over the fuel price, but shifts the risk from the provider to the agency.

4. **Floating Price.** Fuel is treated as a pass-through cost. The provider buys the fuel and the agency reimburses for specific cases. The price risk for the provider is eliminated, but leaves the agency susceptible to dramatic price fluctuations.

The Alan M. Voorhees Transportation Center et al. made the following observations from the survey (*2004*):

- Fuel price changes affect all parties.
- Placing the burden of risk on providers will lead to inflated costs and possibly lower quality service.
- The fixed price with adjustment method appeared to be favored by the agency and the provider.
- Administrative complexity likely burdens both the agency and the provider.

Carroll et al. (*2006*) performed an extensive literature review and described the methods used for calculating the fuel adjustment by southeastern states including Alabama, Delaware, Florida, Kentucky, Maryland, North Carolina, South Carolina, West Virginia, and West Virginia. They conclude that fuel adjustment policies lead to inefficiency in a firm's choice of technology.

The FHWA report entitled *Technical Advisory T 5080.3* (*FHWA 1980*) outlines the procedures for development and use of price adjustment contract provisions. According to the FHWA, price adjustments should apply to both upward and downward movements of prices. When an adjustment is implemented into a contract, it should be based on an index from suppliers serving the area. The base index for any item is the price of that item at the beginning of the month in which bids are received. The current index is established on the first business day of each month. When there is a significant difference between the base index and the current index (which is suggested to be between 3 and 10 percent) then an adjustment should be made to the contractor. FHWA suggests calculating this index each month. Additional considerations for fuel adjustments are also noted in the report. For instance, the difference between the base index price and current index price should be multiplied by the appropriate value since fuel is usually considered to be incidental to the project. For non-structural items the value is the quantities of work multiplied by the respective fuel usage factor. For structural items, the value is the fuel consumed per $1,000 of work is multiplied by the respective fuel usage factor. An appendix within *Technical Advisory T 5080.3* (*FHWA 1980*) includes some suggested fuel usage factors. One alternative suggested in the research circular is that the fuel usage factor be calculated as a percent rather than a value. Once each bid item has been multiplied by the respective fuel usage factor, the sum of the values represents the total price adjustment.

The *Technical Advisory T 5080.3* (*FHWA 1980*) publication drew on research findings from a 1974 Highway Research Board study of fuel usage factors. The findings from that study have been used by over 35 states, including Oregon. As previously mentioned, the original 1974 publication could not be found. Although the report could not be reviewed to validate methodology and approach, it is assumed, given the broad reliance on the study's findings as well as feedback from the industry, that the results were derived from sound analytical techniques. Thus, in researching updates to Oregon's fuel factors analysis focused on 1974 base information.

In addition to research presented in this report, several current efforts are underway that may help guide Oregon's implementation of fuel factors. The National Highway Cooperative Research Program (NCHRP) has initiated a project titled "*Fuel Usage Factors in Highway and Bridge Construction*" (NCHRP 10-81), which is expected to conclude in 2012. Also, a sub-committee to the AASHTO Committee on Design is producing a follow up co-operative research study.

2.2 FUEL ADJUSTMENT METHODS IN THE WESTERN STATES AND FLORIDA

Since there were a limited number of sources in the review literature, a handful of states were contacted to learn their method for calculating the fuel price adjustment and determine how much variability exists between the states. DOT offices were contacted by telephone in 10 western states, namely Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Washington, and Florida[6] to ask which method they use to calculate the fuel price adjustment. Responses varied considerably by state. At the time of this report, California and New Mexico did not have a fuel price adjustment. California has price adjustments for asphalt. New Mexico has been researching price adjustments for asphalt cement, but not for fuel. The

[6] The literature showed that Florida DOT was an active state in developing a fuel price adjustment.

approach for the fuel price adjustment for the remaining eight states also varies as do eligibility requirements. Sections 2.2.1 – 2.2.9 outline the fuel price adjustment method and eligibility requirements for each state.

2.2.1 Arizona

The fuel price adjustment is a special provision in Arizona *(ADOT "unpublished data")*. One of four conditions must be met for a contractor to qualify for the fuel price adjustment: 1) the total project exceeds $1,000,000; 2) earthwork exceeds 20,000 cubic yards; 3) aggregate quantity exceeds 1,000 cubic yards; or 4) asphaltic concrete quantities exceed 5,000 tons.

The state of Arizona makes fuel price adjustments when the price of fuel increases or decreases by more than 15 percent. The base index price of fuel is determined by OPIS for diesel fuel No. 2, Ultra Low Sulfur, and PAD 5 from the city of Phoenix Rack. The base index price for each month is calculated by averaging the selling price for diesel fuel from the previous four months using the last Wednesday of each month. The current index price is the base index price for the current month. The number of gallons of diesel fuel used per month will be considered to equal 1.5 percent of the dollar amount of work reported by the contractor for each month. The equation for calculating the monthly adjustment is shown in Equation 2-1.

$$S = 0.015(Q)*(CP - AC) \tag{2-1}$$

Where: S = Monetary amount of the adjustment (plus or minus) in dollars

Q = Dollar amount of work completed for the month

CP = Current index price in dollars per gallon

AC = Adjusted "initial cost" (1.15 or 0.85 times IC) in dollars per gallon

IC = "Initial cost" as determined above, dollars per gallon

Price adjustments will be shown on the monthly progress estimate.

2.2.2 Colorado

In Colorado, the contractor has the option to include the fuel price adjustment in the contract. If the contractor chooses to allow fuel price adjustments, the current specification of the adjustment is in a standard special provision titled *Fuel Cost Adjustment Notice (CDOT 2006)*

Colorado will make a fuel price adjustment when the current fuel index varies by more than 5 percent. The fuel index will be the rate posted by OPIS on the first working day of the month for Denver No. 2 Diesel. The rate will be the *OPIS Average* taken from the OPIS Standard Rack table for *Ultra-Low Sulfur w/Lubricity Gross Prices* (ULS Column) expressed in dollars per gallon and rounded to two decimal places. The adjustment formula is shown in Equations 2-2 and 2-3.

For EP greater than BP:

$$FA = (EP - 1.05 * BP) * (Q) * (FF) \quad \textbf{(2-2)}$$

For EP less than BP:

$$FA = (EP - 0.95 * BP) * (Q) * (FF) \quad \textbf{(2-3)}$$

Where: BP = Fuel price index for the month in which bids are opened

EP = Fuel price index for the month in which the partial estimate pay period ends

FA = Adjustment for fuel costs in dollars

FF = Fuel usage factor for the pay item (Pay items and respective fuel usage factors are shown in Table 2.6)

Q = Pay Quantity for the pay item on the monthly partial pay estimate.

Note: When the pay item is based on area, and the rate of fuel use varies with thickness, Q should be determined by multiplying the area by the thickness.

Table 2.6: Fuel Usage Factors for Colorado

Item	**Fuel Factor ($)**
202 - Removal of Asphalt Mat (Planing)	0.006 Gal/SY/Inch depth
203 - Excavation (muck, unclassified), Embarkment, Borrow	0.29 Gal/CY
203 - Excavation (rock)	0.39 Gal/CY
206 - Structure Excavation and Backfill [applies only to quantities paid for by separate bid item; no adjustment will be made for pay items that include structure excavation & backfill, such as RCP (CIP)]	0.29 Gal/CY
304 - Aggregate Base Course (if ABC is paid for by the CY) (if ABC is paid for by the ton, convert to CY by multiplying the quantity in tons by 0.557)	0.85 Gal/CY
307- Lime Treated Subgrade	0.12 Gal/SY
310 - Full Depth Reclamation	0.06 Gal/SY
403- Hot Mix Asphalt (HMA)	2.47 Gal/Ton
403- Stone Mastic Asphalt	2.47 Gal/Ton
405- Heating & Scarifying Treatment	0.44 Gal/SY
406 - Cold Bituminous Pavement Recycle	0.01 Gal/SY/Inch depth
412 - Portland Cement Concrete Pavement	0.03 Gal/SY/Inch thickness

Source: (*CDOT 2006*)

The fuel cost adjustment is the sum of the individual adjustment for each of the pay items. Increased payments for fuel price adjustments are paid in the account item "Fuel Cost Adjustment." Decreased payments are deducted from monies owed to the contractor.

2.2.3 Idaho

The state of Idaho does not put any restrictions on who can receive a fuel price adjustment and it is optional for the contractor. If the contractor chooses fuel price adjustments, the specifications of the adjustment can be attained by vocal request (*IDOT "unpublished data"*).

Idaho's current fuel index (CFI) is established each month by using the price of ultra-low sulfur, clear, diesel #2 fuel, as reported in OPIS for the first Monday of the month. The base fuel index (BFI) will be the CFI for the month the contract was awarded. If the ratio of CFI/BFI is greater than 1.20, additional payments to the contractor will be computed. If the ratio is less than 0.80, a credit to the Idaho Transportation Department will be computed. If the ratio falls between 0.80 and 1.20 inclusive, no fuel adjustment will be made for that pay estimate. The fuel price adjustment credit and payment are shown in Equations 2-4 and 2-5. Fuel usage factors for Idaho are shown in Table 2.7.

Contractor Payment:

$$FA = ((CFI/BFI) - 1.20) * Q * BFI \tag{2-4}$$

Department Credit:

$$FA = ((CFI/BFI) - 0.80) * Q * BFI \tag{2-5}$$

Where: FA = Fuel Price Adjustment

CFI = Current Fuel Index

BFI = Base Fuel Index

Q = Total gallons of fuel used for the pay estimate

Note: The gallons of fuel used for the pay estimate are computed for each of the contract items (shown in Table 2.7) by applying the unit fuel usage factors to the quantity of work performed. The total gallons (Q) of fuel used for that pay estimate is summed for the applicable contract items.

Table 2.7: Fuel Usage Factors for Idaho

Item	Fuel Factor ($)
Excavation including topsoil	0.29 CY
Excavation - Rock (must be specifically identified as such in contract)	0.39 CY
Borrow	0.29 CY
Base	0.63 Ton
Surface treatments including sealcoats	0.02 SY; 1.47 Ton
Concrete pavements	0.03 SY per inch of depth
Concrete (all concrete paid by the CY or m^3	0.98 CY
Plantmix pavements	2.6 Ton
Piledriving	0.12 gal per ft
Rotomilling/Pulverizing/Mixing	0.02 SY per inch of depth
Pilot/Pace Car, pipe, guardrail	19.0/$1000
MSE Retaining Wall	19.0/$1000

Source: *(ITD 2008)*

A fuel price adjustment payment to the contractor is made as a dollar amount for each pay estimate. A fuel price adjustment credit to the Idaho Transportation Department is deducted as a dollar amount for each pay estimate from any sums due to the contractor. When the project is completed any difference between the estimated quantities and final quantities are determined. An average CFI, calculated from the CFI for all pay estimates that the fuel price adjustment was applied, is used in accordance with equations (2-4) and (2-5). A final fuel price adjustment is made on the final estimate.

2.2.4 Montana

Montana allows the fuel price adjustment to be optional as long as the accumulated diesel fuel, propane fuel, and gasoline fuel costs do not exceed 20 percent of the contract unit price. The details of fuel price adjustment may be attained by vocal request (*MDOT "unpublished data"*). If a contractor decides to have a fuel price adjustment added to the contract, up to ten contract items are eligible for the fuel price adjustment.

Montana only makes adjustments when the monthly average fuel price is $0.25 more or less than the base price. The monthly average fuel price is the average of the high and low prices on Wednesday of each week in the adjustment period taken from Platt's Oilgram Price Report (*Platts 2010)*, or other fuel price reports determined by the Montana Transportation Department for unleaded gasoline and low sulfur No. 2 diesel fuel. The base price for the contract is the average of the high and low price for five business days prior to the bid opening. Adjustments are made according to Equations 2-6 and 2-7.

$$Increase = \left(\frac{AP - BP - 0.25}{BP} \right) * FC * Q \qquad \textbf{(2-6)}$$

$$Decrease = -\left(\frac{BP - AP - 0.25}{BP}\right) * FC * Q \qquad \textbf{(2-7)}$$

Where: AP = Monthly average price

BP = Base price

FC = Fuel cost

Q = Quantity

Note: Quantity is the quantity of work for one of the ten contract items that the Contractor specified at the beginning of the project.

Adjustments are calculated for each item without regard to the grade or amount of fuel actually used. The total of the fuel price adjustments are added to, or subtracted from, the monthly progress estimate.

2.2.5 Nevada

In Nevada, the fuel price adjustment may be enacted when requested by the contractor or deemed necessary by the state's transportation department. If a contractor opts out at the beginning of the project, there is no provision for adding a fuel price adjustment at a later time. The specifications for the fuel price adjustment in Nevada may be acquired by vocal request *(NDOT "unpublished data")*.

Contract fuel costs for Nevada are adjusted upward or downward when the price of fuel varies by 25 percent on a bi-weekly basis. The adjustment is determined by the state's transportation department using the average diesel (No. 2 fuel oil) price postings for Reno and Las Vegas provided by OPIS. The bi-weekly price fuel adjustment is determined by the Equations 2-8 and 2-9.

Increase in fuel adjustment prices that exceed 25 percent of the "Contract Price" (CP) (2-8):

$$A = (AP/CP - 1.25) * BFC \qquad \textbf{(2-8)}$$

Decrease in fuel adjustment prices that exceed 25 percent of the CP (2-9):

$$A = (0.75 - AP/CP) * BFC \qquad \textbf{(2-9)}$$

Where: A = Bi-weekly fuel adjustment in dollars rounded to the nearest dollar

AP (Adjustment Price) = the average of the "Base Prices" recorded during the bi-weekly progress payment period.

CP (Contract Price) = the "Base Price" of fuel for the week of the bid opening averaged with the "Base Price" of fuel recorded for the previous three weeks, which is established for the week during which the bid opening is held.

BP (Base Price) = determined weekly using the prices posted on Monday of each week.

BFC (Bi-Weekly Fuel Cost) = the contract bi-weekly progress payment balance due multiplied by the "Fuel Factor Percentage."

FFP (Fuel Factor Percentage) = estimated fuel factor as a percentage of cost by type of construction as determined by the Department (found in Table 2.8).

Table 2.8: Fuel Usage Factors for Nevada

Item	Fuel Factor (in terms of %)
Major Structure	1.0
Earthwork	7.0
Drainage	3.0
Surfacing	6.0
PCCP	1.0

Source: NDOT "unpublished data"

Compensation payments are made as part of the progress payment. The maximum adjustment allowed under the terms of this specification occurs when the adjusted price exceeds the contract price by 75 percent. Nevada's transportation department reserves the right to cancel the contract whenever the adjustment exceeds 75 percent.

2.2.6 Utah

The state of Utah determines fuel price adjustment eligibility based on a list of specific items and costs. For instance, if an approved item's value is more than $100,000 over the entire project, then the contractor is eligible for a fuel price adjustment for the specific item. If the project requires constructing a bridge, the bridge needs to exceed $500,000 to be eligible. If a pipe culvert 36 inches or larger is used, then the combined items need to exceed $100,000. When the contract has met these requirements the specifications for the fuel price adjustment is located in the *2008 Individual Standard Specifications* (*UDOT 2008*). Details of the fuel price adjustment are under section "01282 Payment."

The Utah DOT determines the Estimated Price for Fuel (EPF) on the first Monday of each month using the spot price per barrel for West Texas Intermediate (WTI) crude oil posted in the commodities and futures section of the Wall Street Journal. This spot price is averaged with spot prices posted for the previous three Mondays to establish the EPF. The EPF remains in effect until the first Monday of the following month and is used for regular partial estimates closed before the first Monday of the following month. The fuel price adjustment is only in effect when the price of fuel increases or decreases by more than 15 percent. The method for calculating the fuel price adjustment (FPA) are shown in Equations 2-10 and 2-11. Utah's Fuel Usage Factors are shown in Table 2.9.

When the EPF is more than 15 percent above the BPF (2-10):

$$FPA = \frac{[(EPF - BPF) - 0.05 * BPF] * Q * FF}{42} \quad \textbf{(2-10)}$$

When the EPF is more than 15 percent below the BPF (2-11):

$$FPA = \frac{[(EPF - BPF) + 0.05 * BPF] * Q * FF}{42} \quad \textbf{(2-11)}$$

Where: FPA = Fuel Price Adjustment

EPF = Estimate Price of Fuel

BPF (Base Price Fuel) = the contract base fuel price, equal to the EPF in effect on the date of the contract bid opening.

Q = Quantity of acceptable work performed

FF (Fuel Factor) = combined diesel and gasoline usage factor established for purposes of calculating the FPA found in Table 2.9.

42 = Conversion of gallons of fuel per barrel of crude.

Table 2.9: Fuel Usage Factors for Utah

Item	**Quantity of Work (Q)**	**Fuel Factor (FF) ($)**
Roadway, Excavation, Borrow, Granular Borrow, Top Soil	Cubic Yard Ton	0.45 0.25
Underdrain Granular Backfill	Cubic Yard	1.16
Untreated Base Course	Ton Cubic Yard	0.84 1.63
Hot Mix Asphalt	Ton Cubic Yard	3.60 7.00
Open Graded Surface Course	Ton Cubic Yard	3.60 6.80
Stone Matrix Asphalt (SMA)	Ton Cubic Yard	3.60 6.80
Rotomilling, Profile Rotomilling, In-Place Cold Recycled Asphaltic Base, Recycled Surface	Sq Yd	0.03
Chip Seal Coat	Sq Yd	0.03
Portland Cement Concrete Pavement Lean Concrete Base Course	Sq Yd-In	0.214 0.048
Riprap	Cubic Yard	0.57
Bridges exceeding $500,000 Includes the following items: Structural Concrete, Piles, Reinforcing Steel, Prestressed Concrete Members, and Structural Steel 36 inch and larger pipe culvert - combined items exceeding $200,000	$	0.038

Source: (*UDOT 2008*)

The Utah DOT determines the feasibility of proceeding with the remainder of the project and notifies the contractor in writing if the project is to be terminated or if the EPF increases by more than 50 percent from the BPF for an eligible item of work.

2.2.7 Washington

Washington requires that the total project be more than 200 working days with a bid over $2 million for a contract to be eligible for a fuel price adjustment. If a project is eligible, the fuel price adjustment is a general special provision. The specifications are in Division 1 under Section 0903.FR1 (*WSDOT 2008*).

Washington makes fuel price adjustments, either a credit or a payment, for qualifying changes in the index price of on-highway diesel fuel when the price of fuel varies by 10 percent or more. The Base Fuel Cost (BFC) is the **weekly** *US On-Highway Diesel Fuel Price for West Coast No. 2 Diesel Retail Sales by All Sellers (cents per gallon)* published by the Energy Information Administration (Department of Energy), and is fixed for the duration of the contract. The Monthly Fuel Cost (MFC) is the **monthly** *US On-Highway Diesel Fuel Price for West Coast No. 2 Diesel Retail Sales by All Sellers (Cents per Gallon)*, published by the Energy Information Administration (Department of Energy). The BFC can then be multiplied by the appropriate Contract Duration Factor (Table 2.10) to determine the Estimated MFC.

Table 2.10: Washington Contract Duration Factor

Contract Duration	1 yr > 2 yr	2 yr > 3 yr	3 yr > 4 yr	4 yr > 5 yr
Contract Duration Factor	$1.25	$1.37	$1.49	$1.62

Source: *(WSDOT 2008)*

Equations 2-12 and 2-13 are used to calculate the fuel price adjustment as shown below.

If the Monthly Fuel Cost is greater than or equal to 110 percent of the Base Fuel Cost, then (2-12):

$$Adjustment = \frac{(EstimatedMonthlyFuelCost - (1.1xBaseFuelCost))xQ}{100} \quad \textbf{(2-12)}$$

If the Monthly Fuel Cost is less than or equal to 90 percent of the Base Fuel Cost, then (2-13):

$$Adjustment = \frac{(EstimatedMonthlyFuelCost - (0.90xBaseFuelCost))xQ}{100} \quad \textbf{(2-13)}$$

Where: Q = Σ ((Fuel Usage Factor for each Eligible Bid Item) x (Quantity paid in the current months progress estimate for each Eligible Bid Item) for all Eligible Bid Items listed in Table 2.11.

Table 2.11: Fuel Usage Factors for Washington

Item	Fuel Factor ($)
___ Excavation Incl. Haul, per cubic yard	0.2
___ Excavation Incl. Haul – Area ___ per cubic yard	0.2
___ Borrow Incl. Haul, per cubic yard	0.2
___ Borrow Incl. Haul, per ton	0.1
Structure Excavation Class ___ Incl. Haul, per cubic yard	0.2
Shoring or Extra Excavation Class A ___, lump sum	0.0
Crushed Surfacing ___, per ton	0.7
Crushed Surfacing ___, per cubic yard	1.0
Processing & Finishing, per mile	270
Agg. From Stockpile for BST, per cubic yard	0.6
Furnishing & Placing Crushed ___, per cubic yard	1.0
HMA Cl. ___ PG ___, per ton	2.9
HMA for ___, per ton	2.9
Commercial HMA, per ton	2.9
Cement Concrete Pavement, per cubic yard	1.0 gal/cy
Cement Concrete Pavement - Including Dowels, per cubic yard	1.0
Concrete Class ___, per cubic yard	1.0
Commercial Concrete, per cubic yard	1.0
Superstructure ___, lump sum	0.0
St. Reinf. Bar, per pound	0.02 gal/Lb
Epoxy-Coated St. Reinf. Bar, per pound	0.0

Source: *(WSDOT 2008)*

2.2.8 Wyoming

Wyoming does not put any restrictions on who can receive a fuel price adjustment and it is optional for the contractor. The specifications for the fuel price adjustment are located in Supplemental Specification SS-100J (*WYDOT 2008).*

Compensation adjustments are assessed for the cost of motor fuels and burner fuel whenever the Current Fuel Index (CFI) price is outside the range of 92.5 percent to 107.5 percent of the Base Fuel Index (BFI) price. The price index is the average wholesale price for No. 2 fuel oil (diesel), in Casper, Wyoming as listed in the OPIS publication. The BFI price for motor fuels will be the average wholesale price for the month prior to the bid opening. The CFI price for motor fuels to be used for each monthly progress payment is lagged one month for the month of the estimate. The monthly change in fuel cost percentage is shown in Equation 2-14.

$$Change = \left(\frac{CFI - BFI}{BFI} \right) \qquad \textbf{(2-14)}$$

Both CFI and BFI are defined above.

If *Change* from equation 2-14 is greater than 0.075, then Equation 2-15 will be used to determine the compensation adjustment.

$$FCA = \left(\frac{AffidavitCost}{OriginalContractCost} \right) * EstimateCost * (Change - 0.075) \quad \textbf{(2-15)}$$

If *Change* is less than -0.075, then Equation 2-16 will be used to determine the compensation adjustment.

$$FCA = \left(\frac{AffidavitCost}{OrigianalContractCost} \right) * EstimateCost * (Change + 0.075) \quad \textbf{(2-16)}$$

Where: Affidavit Cost = the Contractor's estimated cost that was presented in the bid.

Original Contract Cost = total original contract bid cost excluding Lane Rental.

Estimate Cost = total amount paid to the Contractor for work done during the month.

The fuel price adjustment is not assessed for fuel if the contractor has obtained a fixed fuel cost, or if the contractor elects not to participate.

2.2.9 Florida

The state of Florida requires that projects lasting over 100 working days be eligible for a fuel price adjustment. Contracts meeting this requirement follow the specifications for the fuel price adjustment set forth in the Standard Specifications for Road and Bridge Construction, under Section 9-2.1.1 (*Florida Department of Transportation 2007*). Price adjustments for Florida are made only when the current fuel price varies by more than five percent from the price prevailing in the month when bids were received. The price index will be determined by the state's transportation department[7] and are available the 15th of each month. When fuel prices have decreased between month of bid and month of progress the fuel price adjustment is shown in equations 2-17 and 2-18.

$ Adjustment = (ID)*(%Increase, This Estimate)*(TEF) **(2-17)**

Where: ID = Index difference = [CFP - 0.95*(BFP)] **(2-18)**

When fuel prices have increased between month of bid and month of progress the fuel price adjustment is shown in Equations 2-19 and 2-20.

$ Adjustment = (ID)*(%Increase, This Estimate)*(TEF) **(2-19)**

Where: ID = Index difference = [CFP - 1.05*(BFP)]. **(2-20)**

% Increase = the quantity of work performed for the month for each pay item.

[7] Currently the Florida transportation department contacts every vendor that supplies fuel to the contractor and uses the average price of fuel.

TEF = the fuel factor for each pay item, where the fuel factors are listed in Table 2.12.

Every pay item has two different fuel factors one for gasoline and the other for diesel fuel. The contractor is not given the option of accepting or rejecting these adjustments.

Table 2.12: Fuel Usage Factors for Florida

Pay Item Description	Unit	Gasoline Factor ($)	Diesel Factor ($)
Clearing & Grubbing	LS/AC	32.000000	45.640000
Regular Excavation	CY	0.002800	0.201500
Borrow Excavation	CY	0.003900	0.444100
Lateral Ditch Excavation	CY	0.000000	0.053300
Subsoil or Channel Excavation	CY	0.004300	0.278800
Embankment	CY	0.034100	0.517500
Type B Stabilization	SY	0.030600	0.119600
Soil Layer	SY	0.000000	0.006000
Base Optional (Group 01 to 08)	SY	0.056007	0.215614
Base Optional (Group 09 to 15)	SY	0.092254	0.435916
Base Superpave Type 12.5 (Asphalt Only)	SY	0.040150	0.973288
Base Superpave Type 12.5 (Asphalt Only)	SY	0.066000	1.599957
Turnout Construction	SY	0.026400	0.692500
Turnout Construction	TN	0.176000	4.622011
Mill Existing Asphalt Pavement	SY	0.027969	0.091162
Mill Existing Asphalt Pavement	SY	0.041225	0.133895
Superpave Asphalt Concrete	TN	0.176000	4.622011
Asphalt Concrete Friction Course (Rubber)	TN	0.176000	4.622011
Misc. Asphalt Pavement	TN	0.176000	4.622011
Cement Concrete Pavement, Plain	SY	0.125627	0.280758
Concrete Class I to IV	CY	0.255067	1.867733
Concrete Class V	CY	0.257150	1.855600
Precast Concrete Box Culvert	LF	0.263400	3.259300
Reinforcing Steel	LB	0.000000	0.001311
Drainage Inlets, Manholes or Junction Boxes	EA	1.317000	7.922600
Pipe Concrete Culvert	LF	0.169478	0.562604
Pipe Concrete Culvert	LF	0.169478	0.562604
Prestessed Beams	LF	0.035100	0.860400
Prestressed Slabs	LF	0.035100	0.867800
Prestressed Beams	LF	0.035100	0.860400
Piling (Prestessed Concrete)	LF	0.046800	0.200800
Drilled Shaft	LF	2.281000	5.530100
Test Pile	LF	0.046800	0.200800
Structural Steel, Rehabilitation	LB	0.000060	0.001650
Structural Steel, New Construction	LS/LB	0.000060	0.001650
Ladders & Platforms	LB	0.000060	0.001650
Structural Steel Repair	LB	0.000060	0.001650
Concrete Curb & Gutter, Traffic Separator, etc.	LF	0.000000	0.180531
Barrier Wall Concrete	LF	0.018400	0.159900
Conc. Sidewalk	SY	0.000000	0.280700
Concrete Ditch or Slope Pavement	SY	0.360000	0.169000
Performance Turf	SY	0.010000	0.000000

Source: (*FDOT "unpublished data")*

2.3 SUMMARY

The Alan M. Voorhees Transportation Center (*2004*) identified several issues related to alternative price adjustment methods. These studies show that in the utilities, petroleum coke, and coal markets, price adjustments have led to inefficiencies. Construction contractors and business that are allowed price adjustments may not have incentives to cut costs or invest in more fuel efficient technology and construction methods. In the case of the utilities market, when price adjustments are removed, consumer costs decreased. Adjustments are more effective when paid annually than monthly in the utilities market.

The FHWA Technical Advisory T5080.3 (*FHWA 1980*) shows how states should enact a fuel price adjustment in road construction. Currently, there is wide variation in fuel price adjustment calculation methods for highways and bridges in the 10 U.S. states outlined above. For example, the change in the fuel price for the adjustment to take effect is different in almost every state. Some states do not put any restrictions on who can receive a fuel price adjustment, and in a number of states the fuel price adjustment is optional to the contractor. This demonstrates that the states in the West use varying approaches, if any, for calculating the fuel price adjustment.

3.0 A NATIONAL SURVEY

Since states in the West use different approaches for calculating a fuel price adjustment, a formal national survey was developed to learn how fuel price adjustments are implemented throughout the United States, as well as Puerto Rico and Guam. The survey asked questions about when and why the fuel price adjustments were implemented, and if there were recent changes in the process or current problems. The national survey was administered by telephone interview to departments of transportation across the country. Once the appropriate respondents were reached they were asked specific questions about their state's fuel price adjustment. Some states referred to the fuel price adjustment as the fuel cost adjustment; to avoid confusion it is referred to in this chapter of the report as fuel adjustment.

The purpose of the national survey was to determine how many states use a fuel adjustment in their contracts, and the type of method used. Historical information was also gathered about the way the states developed their method, whether there were changes to the method overtime, and if any future changes were expected. They were also asked about any recent studies they might be aware of based on their experience. The results of the telephone survey provided more in depth information which supplemented the AASHTO Subcommittee on Construction, Contract Administration reports (see Section 2.0). Interestingly, some of the states responses were not consistent with the information posted by AASHTO. The questions and summary of the survey can be found in Appendix A. The results of the national survey are outlined in Sections 3.1 – 3.9 of this report.

3.1 THE IMPLEMENTATION PROCEDURE

Thirty-two states, including Oregon, use the procedure from the FHWA Technical Advisory T 5080.3 (Section 2.0) to calculate the fuel adjustment. Six states follow the method outlined in T 5080.3, but the fuel usage factors do not exist in the formula. Seven states, as well as Puerto Rico and Guam, have no fuel adjustment, but most have some other type of adjustment. Five states use different methods that are discussed later in this report. The list of states and the type of method used to calculate the fuel adjustment is shown in Table 3.1.

Table 3.1: States' methods for Fuel Adjustment

States	Use method proposed by T 5080.3	Use method proposed by T 5080.3 w/o fuel usage factors	Alternative method	No fuel adjustment
Alabama			X	
Alaska			X	
Arizona		X		
Arkansas				X
California				X
Colorado	X			
Connecticut		X		
Delaware	X			
Florida	X			
Georgia	X			
Hawaii				X
Idaho	X			
Illinois	X			
Indiana				X
Iowa	X			
Kansas	X			
Kentucky	X			
Louisiana	X			
Maine	X			
Maryland	X			
Massachusetts	X			
Michigan				X
Minnesota	X			
Mississippi	X			
Missouri	X			
Montana		X		
Nebraska	X			
Nevada			X	
New Hampshire	X			
New Jersey			X	
New Mexico				X
New York	X			
North Carolina	X			
North Dakota		X		
Ohio	X			
Oklahoma	X			
Oregon	X			
Pennsylvania	X			
Rhode Island			X	
South Carolina	X			
South Dakota		X		
Tennessee	X			
Texas				X
Utah	X			
Vermont	X			
Virginia	X			

States	Use method proposed by T 5030.3	Use method proposed by T 5080.3 w/o fuel usage factors	Alternative method	No fuel adjustment
Washington	X			
West Virginia	X			
Wisconsin	X			
Wyoming		X		
Guam				X
Puerto Rico				X

The fuel usage factors and the number of included bid items vary by state. Since the fuel usage factors suggested in the FHWA Technical Advisory T 5080.3 were compiled in 1974, many states consider them outdated and have established different approaches. Colorado, for example, has allowed the Colorado Contractor's Association (CCA) to create a fuel usage factor bid item list. Florida contacted several contractors and hired a firm to develop the current fuel usage factor values. Georgia used the Carroll et al (*2006*) study discussed in Section 2.0 of this report to calculate their values. Internal studies were performed in Illinois and the information was sent to Onan's System (a software company in Nashville, Tennessee) to calculate the current fuel usage factor values. In Idaho and Nevada, a committee was formed and based on committee recommendations new fuel usage factors were established. Delaware, North Dakota, and Oklahoma estimated new fuel usage factors by looking at other states' factors. Washington took this same approach and spoke with different agencies about the fuel efficiency of relevant vehicles.

Most states did not have a fuel usage factor specifically for structures. Instead states have introduced other bid items that are used in structures with a fuel usage factor in the specifications/provisions. Only 11 states, including Oregon, used a fuel usage factor for structures. Consistent with T 5080.3, the fuel usage factor values are multiplied by the dollar value of work divided by $1000. Georgia limits the number of structural items that are eligible for a fuel adjustment. An alternative approach specified in T 5080.3, which Nevada has adopted, is taking the dollar value of work multiplied by a percentage instead of a value. The fuel usage factor values are shown in Table 3.2 on the following page for the respective states.

Table 3.2: Values for Fuel Usage Factors

State	Fuel Usage Factor for Structures* ($)
Delaware	8
Georgia	8
Idaho	19
Illinois	8
Mississippi	11
Nevada	1%
New Hampshire	13
Oregon	10 (pre-cast)/19 (cast-in-place)
Pennsylvania	8
Utah	38

*The fuel usage factor for structures is one percent of the total cost of structural bid items spent per month.

As is evident from the table above, considerable variation exists among the states that use a fuel usage factor for structures. The Highway Research Circular Number 158 suggests the fuel usage factor for structures should be 10 when low fuel intensive diesel fuel vehicles are used and 19 when high fuel intensive diesel fuel vehicles are used. Since that time, most states have decreased that value believing fuel efficiency has decreased. Utah is the only state that has increased that value.

There are some states that use the approach in T 5080.3, but no fuel usage factors exist in the fuel adjustment calculation. In Connecticut, for example, the trigger method is when the price of fuel changes by more than 5 percent, then a fuel adjustment will be made. The state will pay the contractor the amount calculated in Equation 3-1.

$$[(Period\ Price/Base\ Price) - 1.05] * 0.015 * Q * (Base\ Price/100) \qquad \textbf{(3-1)}$$

When the price of fuel increases by 5 percent, then contractor will pay the state the amount calculated in Equation 3-2.

$$[(Period\ Price/Base\ Price) - 0.95] * 0.015 * Q * (Base\ Price/100) \qquad \textbf{(3-2)}$$

Here *Period Price*, *Base Price*, and *Q* refer to the average calculated fuel price representing the payment estimate period, the posted fuel price posted 28 days prior to the actual bid opening date, and dollar amount of work completed for an estimate period, respectively. North Dakota, South Dakota, and Wyoming use this same approach, but the trigger value varies by state.

Five states use alternative methods for calculating the fuel adjustment. An alternative approach in T 5080.3 for using fuel usage factors as a value is to replace it with a percentage. Rather than multiplying the respective bid item by a fuel factor, the total amount spent on structures is multiplied by a fuel factor in terms of a percent. Nevada applies this method to its price adjustment wherein the amount of work performed is multiplied by a percent rather than a value. The details of this approach can be found in the review of literature (Section 2.0).

Alabama uses a fuel adjustment to cover the costs of fuel required for the production of hot mix asphalt (HMA). When the amount of HMA used in construction is greater than 2.0 gallons per ton in a month, and the price of fuel changes, the state makes an adjustment. The adjustment is made by determining the difference between the current index price and the base index price, and multiply by the number of gallons of fuel that are used in the production of HMA during the month.

At the time of the survey, the state of Alaska drafted, but had not finalized, a method for a fuel adjustment. The initial fuel adjustment approach is similar to the method used in T 5080.3 to calculate, but there is a change in how the quantity of fuel is ascertained. After a 10 percent change in the fuel price, the quantity of fuel is the amount of fuel used, multiplied by the respective fuel usage factor, and multiplied by a percent which is determined by a Diesel Fuel Price Adjustment Schedule. The Diesel Fuel Price Adjustment Schedule is shown in Table 3.3.

Table 3.3: The Diesel Fuel Price Adjustment Schedule for Alaska

Diesel Fuel Price Adjustment Schedule (in %)			
Price Adjustment Date	**Single Season**	**Two Season's**	**Three Season's**
June 15	12	6	4
July 15	24	12	8
August 15	24	12	8
September 15	24	12	8
October 15	16	8	5.33

Source: (*Alaska DOT "unpublished material"*)

Based on Table 3.3, the longer the contract period the lower the fuel adjustment the contractor receives.

The state of New Jersey uses a list of bid items and fuel usage factors. The quantity of work eligible is multiplied by the respective fuel usage factor, and the sum of the numbers gives the total quantity. When the total quantity is larger than 500 in one month, a price adjustment is performed. The price adjustment for Rhode Island is calculated by multiplying the total quantity by the difference between the base price and the current price. The price adjustment is only made when the amount of the adjustment is greater or less than $250 per month.

In some states, the fuel adjustment is optional to the contractor before the project begins. After the project has started, however, the contractor may not opt out. Alaska, Colorado, Illinois, Missouri, Montana, Nevada, North Dakota, South Dakota, Virginia, and Wyoming allow this option to contractors.

For states where a fuel adjustment does not exist, they employ other adjustments in the payment schedule. For instance, California, Hawaii, Indiana, and New Mexico have an asphalt adjustment. When the price of asphalt increases by a certain amount, the state will make an adjustment to the payment to cover the increased cost. Within the last two years, Puerto Rico has implemented price adjustments for hot plant bituminous mixes, hauling of materials, steel products, and copper and aluminum conductors.

3.2 RECENT CHANGES IN THE FUEL ADJUSTMENT

It is clear from the information collected by the national survey that states are searching for a fuel price adjustment procedure that will best serve their needs. One survey question asked if there had been any significant changes in the process over the years. Since the FHWA Technical Advisory T 5080.3 was published in 1974, many changes have taken place in the United States regarding the fuel price adjustment. Illinois, Maine, and Missouri report they had phased the fuel adjustment out during the 1980s, and have brought it back within recent years because of the dramatic price increase and fluctuations to fuel costs. Connecticut introduced the fuel adjustment in 2007 for projects that last multiple years, because bids were not being submitted for long-term projects. Subsequently, the number of bids has increased, which indicates that contractors believe the state is sharing more of the risk.

Within the last few years, 18 states have made minor changes to the way the fuel adjustment is calculated. These states are: Florida, Kentucky, Massachusetts, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, North Dakota, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, Washington, and Wyoming. Massachusetts, for example, previously made bi-monthly payments, but has now changed to monthly payments. Montana changed the trigger value from a percent to dollars. North Dakota allows the option for the fuel adjustment only at the beginning of the project. Pennsylvania changed the source of where they obtain the monthly index for the price of fuel. Tennessee eliminated the bid items that were not fuel intensive.

States have taken different measures to ensure that contractors do not disproportionately carry the burden of volatile fuel prices. To accommodate contractors, the methods for calculating the fuel adjustment have changed. A summary of the methods, recent changes, and alternative methods are shown in Table 3.4.

Table 3.4: States' Methods for Fuel Adjustments, Recent Changes, and Alternative Methods

States	Current Method for Fuel Price Adjustment	Recent Changes	If No Fuel Adjustment, Alternative Adjustment ?
Alabama	When Hot Mix Asphalt (HMA) is greater than 2.0 gallons per ton in a month and when the price of fuel makes any change the state will make an adjustment. The adjustment is made by determining the difference between the current index price and the base index price, and multiply by the number of gallons of fuel that are used in the production of HMA during the month.	-	-
Alaska	Method proposed by T 5080.3 where fuel usage factor is multiplied by diesel adjustment	-	-
Arizona	Method proposed by T 5080.3 w/o fuel usage factors	-	-
Arkansas	-	-	No
California	-	-	Asphalt Adjustment
Colorado	Method proposed by T 5080.3	-	-
Connecticut	Method proposed by T 5080.3 w/o fuel usage factors	-	-
Delaware	Method proposed by T 5080.3	-	-
Florida	Method proposed by T 5080.3	Added more bid items	-
Georgia	Method proposed by T 5080.3	-	-
Hawaii	-	-	No
Idaho	Method proposed by T 5080.3	-	-
Illinois	Method proposed by T 5080.3	-	-
Indiana	-	-	Asphalt Adjustment
Iowa	Method proposed by T 5080.3	-	-
Kansas	Method proposed by T 5080.3	-	-
Kentucky	Method proposed by T 5080.3	Changed trigger value from 10% to 5%	-
Louisiana	Method proposed by T 5080.3	-	-
Maine	Method proposed by T 5080.3	-	-
Maryland	Method proposed by T 5080.3	-	-
Massachusetts	Method proposed by T 5080.3	Changes payments from bi-monthly to monthly	-

States	Current Method for Fuel Price Adjustment	Recent Changes	If No Fuel Adjustment, Alternative Adjustment ?
Michigan	-	-	No
Minnesota	Method proposed by T 5080.3	Changed trigger value from 25% to 15%	-
Mississippi	Method proposed by T 5080.3	Added more bid items	-
Missouri	Method proposed by T 5080.3	Changed the fuel usage factor values	-
Montana	Method proposed by T 5080.3 w/o fuel usage factors	Changed trigger value from a percent to dollars	-
Nebraska	Method proposed by T 5080.3	Changed trigger value from 10% to 5%	-
Nevada	Method proposed by T 5080.3 where fuel usage factor is in terms of percent.	Changed the fuel usage factor values	-
New Hampshire	Method proposed by T 5080.3	Added more bid items	-
New Jersey	The quantity of work eligible is multiplied by the respective fuel usage factor and summing them up gives the total quantity. When the total quantity is larger than five hundred in one month a price adjustment will be performed.	-	-
New Mexico	-	-	No
New York	Method proposed by T 5080.3	-	-
North Carolina	Method proposed by T 5080.3	-	-
North Dakota	Method proposed by T 5080.3 w/o fuel usage factors	Contractor now allowed the option	-
Ohio	Method proposed by T 5080.3	-	-
Oklahoma	Method proposed by T 5080.3	-	-
Pennsylvania	Method proposed by T 5080.3	Source of monthly fuel price index changed	-
Rhode Island	Method proposed by T 5080.3	-	-

States	Current Method for Fuel Price Adjustment	Recent Changes	If No Fuel Adjustment, Alternative Adjustment ?
South Carolina	Multiply the total quantity by the difference between the base price and the current price. The price adjustment will only be made when the amount of the adjustment is greater or less than $250.00 per month.	Added more bid items	-
South Dakota	Method proposed by T 5080.3	-	-
Tennessee	Method proposed by T 5080.3 w/o fuel usage factors	Eliminated bid items not fuel intensive	-
Texas	Method proposed by T 5080.3	-	-
Utah	-	-	No
Vermont	Method proposed by T 5080.3	Added more bid items	-
Virginia	Method proposed by T 5080.3	Added more bid items	-
Washington	Method proposed by T 5080.3	Changed the fuel usage factor values	-
West Virginia	Method proposed by T 5080.3	-	-
Wisconsin	Method proposed by T 5080.3	-	-
Wyoming	Method proposed by T 5080.3	Changed trigger value from 15% to 7.5%	-
Guam	-	-	No
Puerto Rico	-	-	Hot Plant Bituminous Mixes, Hauling of Materials, Steel Products, Copper & Aluminum Conductors

Some variability exists between the states' methods and recent changes. There appears to be no correlation between the fuel adjustment approach used and the region where a state is located. Furthermore, recent changes do not appear to reflect current practices of other nearby states. Rather, adopted methods reflect the demand of local contractors and do not appear to be influenced by surrounding states.

3.3 SOURCE OF PRICE INDEX

A historic fuel index is created for each state that has a fuel price adjustment clause. The source for each fuel price index differs by state. The FHWA Technical Advisory T 5080.3 suggests the following sources for price indexing.

- U.S. Department of Labor monthly publication *Wholesale Prices and Price Indexes*
- Platt's Oilgram Price Service
- Engineering News – Record
- The Oil Daily
- The U.S. Oil Week

Many states use alternative sources other than the ones listed above. Table 3.5 shows the source states use for the fuel index.

Table 3.5: Sources for the Fuel Index

States	DOE, EIA	OPIS	Platt's	Other
Alabama			X	
Alaska	X			
Arizona		X		
Colorado		X		
Connecticut		X		
Delaware		X		
Florida				X
Georgia				X
Idaho		X		
Illinois				X
Iowa		X		
Kansas				X
Kentucky				X
Louisiana			X	
Maine	X			
Maryland	X			
Massachusetts	X			
Minnesota		X		
Mississippi			X	
Missouri			X	
Montana			X	
Nebraska			X	
Nevada		X		

States	DOE, EIA	OPIS	Platt's	Other
New Hampshire				X
New Jersey				X
New York				X
North Carolina				X
North Dakota				X
Ohio				X
Oklahoma	X			
Oregon		X		
Pennsylvania		X		
Rhode Island				X
South Carolina				X
South Dakota		X		
Tennessee				X
Utah				X
Vermont	X			
Virginia	X			
Washington	X			
West Virginia			X	
Wisconsin				X
Wyoming		X		

The survey found that states use for the fuel index is variable. In most cases, the fuel price index is calculated within the respective DOT.

3.4 TRIGGER VALUE

Once the price of fuel changes by more than the trigger value, there is a fuel adjustment. No definite trigger value is proposed in T 5080.3. Trigger values vary across the United States. The most common values are shown in Table 3.6.

Table 3.6: Most Common Trigger Values

States	Trigger Value	No Trigger	Other
Alabama		X	
Alaska	10%		
Arizona	15%		
Colorado	5%		
Connecticut	5%		
Delaware	5%		
Florida	5%		
Georgia	10%		
Idaho	20%		
Illinois	5%		
Iowa	$0.15		
Kansas		X	
Kentucky	5%		
Louisiana	5%		
Maine	5%		
Maryland	5%		
Massachusetts	5%		
Minnesota	15%		
Mississippi		X	
Missouri		X	
Montana	$0.25		
Nebraska	5%		
Nevada	25%		
New Hampshire	10%		
New Jersey			X
New York	$0.10		
North Carolina		X	
North Dakota	10%		
Ohio	10%		
Oklahoma	3%		
Oregon	25%		
Pennsylvania	5%		
Rhode Island			X
South Carolina	10%		
South Dakota	15%		
Tennessee	5%		
Utah	15%		
Vermont	5%		
Virginia		X	
Washington	10%		
West Virginia	5%		
Wisconsin	15%		
Wyoming	7.5%		

Some states, such as New York, Iowa, and Montana, apply a dollar value rather than a percent for the trigger value. In New York, when the price of fuel changes by $0.10 a fuel adjustment will be made. In New Jersey, the contractor has to use at least 500 gallons of fuel during the month the adjustment is made. Rhode Island will make a fuel adjustment when the cost exceeds $250.

3.5 CONTRACTOR'S CONCERNS

The trigger values imposed in the calculation occur when there is an increase or decrease in the price of fuel. The fuel price adjustment was incorporated so that the price risk fluctuations would be shared when the price of fuel changes. Many contractors across the country, however, do not feel the fuel adjustment covers the changing fuel costs. Although there are complaints about the burden of risk, there is no formal process in place to document or record these types of complaints.

In the state survey, a question to the respective departments of transportation asked if they received any complaints from contractors. Alabama, Florida, Nebraska, Nevada, and New Hampshire responded that when the fuel price drops over the contract periods, they do not receive complaints. Oregon reported that contractors complained when the fuel adjustment did not cover the increased cost of fuel. This same complaint was reported by 23 other states. Kentucky, Montana, Nebraska, New Jersey, South Carolina, and Utah reported that contractors believed more bid items needed to be included. Contractors in New Hampshire felt they had no obligation to pay the state when the price of fuel decreases. In Maine, the contractors working on paving projects wanted a fuel adjustment, while the contractors building structure projects did not. In response to complaints, Iowa asked contractors for alternative solutions. To date, contractors have not responded to this request. California and Texas do not currently have a fuel adjustment, although contractors are requesting one. Michigan does not have a fuel adjustment, but when contractors are asked about instituting an adjustment, the response has been negative.

3.6 STATES OPINION ABOUT PRICE ADJUSTMENT PAYMENT

In the survey, when the question was asked if the fuel adjustment was fair, most responded in the affirmative. The adjustment payment to the contractors is neither too little nor too much to cover the changing price in fuel. Another survey question asked if the state believed the risk was being shared appropriately. The responses from the different departments of transportation are shown in Table 3.7.

Table 3.7: States Responses about Fairness and Risk

States	Fuel Adjustment Fair?	Risk Shared Appropriately?
Alabama	Y	Y
Alaska	New Provision	
Arizona	Y	Y
Colorado	Y	Y
Connecticut	Y	Y
Delaware	Y	Y
Florida	Could Not Answer Question	
Georgia	Y	Y
Idaho	Y	Y
Illinois	Y	Y
Iowa	Y	Y
Kansas	Y	Y
Kentucky	N	N
Louisiana	Y	Y
Maine	Y	Y
Maryland	Y	Y
Massachusetts	Y	Y
Minnesota	Y	Y
Mississippi	Y	Y
Missouri	Y	Y
Montana	Y	Y
Nebraska	Y	Y
Nevada	Y	Y
New Hampshire	N	N
New Jersey	Y	Y
New York	Y	Y
North Carolina	Y	Y
North Dakota	Y	Y
Ohio	Y	Y
Oklahoma	Y	Y
Pennsylvania	N	Y
Rhode Island	Y	Y
South Carolina	N	Y
South Dakota	Y	Y
Tennessee	Y	Y
Utah	Y	Y
Vermont	Y	Y
Virginia	Y	Y
Washington	N	Y
West Virginia	Y	Y
Wisconsin	Y	Y
Wyoming	Y	Y

Kentucky, New Hampshire, Pennsylvania, and Washington reported that they may pay more to the contractor than the added cost to the fuel price increase. On the other hand, South Carolina suspects the state has not paid the contractor enough to cover the costs, and has added more bid items to remedy this. The state of Utah responded that their method is fair, but contractors do not agree.

In terms of risk, Utah also responded that the state believes the risk is being shared appropriately, while the contractors did not. Even though Utah believes the method is fair and the risk is being shared, they are considering changes to the method that will be described later in this report. Kentucky and New Hampshire responded that they are capturing more of the risk than the contractor.

Of the total construction budget, many states are paying a small percentage. Table 3.8 shows which states are paying and the percentage of their budget dedicated to fuel price adjustments.

Table 3.8: Fuel Adjustment Percent of the Annual Total Budget (2008)

States	0%, new provision	Less than 1%	More than 4%	Don't know	Don't use fuel adjustment
Alabama				X	
Alaska	X				
Arizona		X			
Arkansas					X
California					X
Colorado				X	
Connecticut		X			
Delaware				X	
Florida		X			
Georgia		X			
Hawaii					X
Idaho		X			
Illinois	X				
Indiana					X
Iowa		X			
Kentucky		X			
Louisiana		X			
Maine		X			
Maryland				X	
Massachusetts				X	
Michigan					X
Minnesota				X	
Mississippi		X			
Missouri		X			
Montana		X			
Nebraska			X		
Nevada		X			
New Hampshire		X			
New Jersey		X			
New Mexico					X
New York				X	
North Carolina				X	
North Dakota		X			
Ohio		X			
Oklahoma	X				
Oregon		X			
Pennsylvania		X			
Rhode Island				X	

States	0%, new provision	Less than 1%	More than 4%	Don't know	Don't use fuel adjustment
South Carolina		X			
South Dakota				X	
Tennessee			X		
Texas					X
Utah		X			
Vermont		X			
Virginia		X			
Washington				X	
West Virginia				X	
Wisconsin				X	
Wyoming			X		
Guam					X
Puerto Rico					X

The fuel price adjustment is 5.85 percent and 5 percent for Nebraska and Wyoming, respectively. Kansas did not provide a response to the percent of the total construction budget the state spent on fuel adjustments.

The Table 3.9 shows how much was paid out in fuel price adjustments during 2008.

Table 3.9: Total Amount Paid in Fuel Adjustments for 2008

States	$0, new provision	Less than $1 million	Between $1 & $10 million	More than $10 million	Don't know	Don't use fuel adjustment
Alabama					X	
Alaska	X					
Arkansas						X
California						X
Colorado			X			
Connecticut		X				
Delaware					X	
Florida				X		
Georgia			X			
Hawaii						X
Idaho		X				
Illinois	X					
Indiana						X
Iowa		X				
Kentucky				X		
Louisiana				X		
Maine					X	
Maryland					X	
Massachusetts					X	
Michigan						X
Minnesota					X	
Mississippi					X	
Missouri			X			
Montana			X			

States	$0, new provision	Less than $1 million	Between $1 & $10 million	More than $10 million	Don't know	Don't use fuel adjustment
Nebraska		X				
Nevada		X				
New Hampshire			X			
New Jersey			X			
New Mexico						X
New York					X	
North Carolina					X	
North Dakota			X			
Ohio		X				
Oklahoma	X					
Oregon			X			
Pennsylvania				X		
Rhode Island					X	
South Carolina			X			
South Dakota					X	
Tennessee					X	
Texas						X
Utah			X			
Vermont					X	
Virginia				X		
Washington			X			
West Virginia					X	
Wisconsin					X	
Wyoming				X		
Guam						X
Puerto Rico						X

Delaware and Minnesota stated that it would be difficult to calculate the total amount of fuel adjustments given their current system. Arizona wanted a public information request filed before releasing that information. Kansas was not willing to report how much was spent. As reported by most states, fuel adjustments differed from previous years and varied as construction budgets changed.

Six states gave additional information related to adjustments made in previous years. Missouri reported that in a typical year the fuel adjustment is around $500,000; however, from June to July of 2008, they paid between $3 and $3.5 million. New Hampshire reported that from 2002 to 2008 the range of fuel adjustments was between $46,336 and $2.4 million; the average was $1.2 million. Iowa, Nebraska, Pennsylvania, and South Carolina also provided the fuel adjustments over the last few years (Table 3.10).

Table 3.10: Historic Fuel Price Adjustments

States	2003	2004	2005	2006	2007	2008
Iowa	-	$319,832.35	$108,170.94	$712,152.13	$172,764.79	$579,702.79
Nebraska	-	-	-	$249,000	$303,000	$319,000
Pennsylvania	$819,000	$2,100,000	$9,500,000	$10,400,000	$7,500,000	$17,700,000*
S. Carolina	-$254,245	$3,568,939	$6,792,962	$6,827,521	$1,782,081	$4,809,340
*As of mid-Oct. 2008						

From this small sample, Nebraska and Pennsylvania paid more in 2008 than in earlier years. Iowa and South Carolina paid more in 2006 than 2008.

3.7 NEED FOR CHANGE?

One survey question asked if individual states suspected that changes to the fuel adjustment process may occur in the near future given that there had been dramatic changes in the price of fuel during the summer of 2008. Eight states[8] said any changes would depend on the market. Only four states—Montana, New Jersey, Pennsylvania, and West Virginia—stated there would be changes in the near future. In Montana, where the fuel adjustment process is optional to the contractor, the deadline when the contractor can decide to participate will change. New Jersey anticipates that changes will occur, but they are not sure what they will be. Currently in Pennsylvania, for a structure to qualify for a fuel price adjustment the project needs to last at least three months, but this will change to four months. West Virginia will introduce a supplementary specification to make it easier for the contractor to find the fuel index. South Carolina plans to hire Clemson University to develop optimal fuel usage factors.

Five states (Wyoming, California, Michigan, New Mexico, and New Hampshire) gave information on changes that most likely will occur. Wyoming believes they will lower the trigger value which is currently at 7.5 percent. The Associated General Contractors (AGC) met with California a few times requesting to implement a fuel adjustment procedure. The meetings between contractors and the state are frequent when fuel prices are high, but rare when gas prices fall. Michigan has proposed a fuel adjustment process to their contractors several times, but there is no demand. New Mexico plans to incorporate a fuel adjustment process at some point in the future, but not anytime soon. New Hampshire believes that more bid items will be added in the near future.

Utah is currently testing a new method to calculate the fuel adjustment with several of their projects. When the price of fuel increases by more than 15 percent the state will pay a fuel adjustment that will be calculated as shown in Equation 3-3.

$$Adjustment = \frac{(COP - 1.15 * BOP)(40/1000)(VWR)}{42} \qquad \textbf{(3-3)}$$

Where: *COP* is the current oil price,

BOP is the base oil price, and

[8] DE, GA, MN, MO, NE, UT, VA, WA

VWR equals the contract price less the cumulative amount invoiced by the Design-Builder, and less Change Orders that have been executed, which will be based upon approved invoice amounts.

When the price of fuel decreases by more than 15 percent the contractor will pay an adjustment that will be calculated as shown in Equation 3-4.

$$Adjustment = \frac{(COP - 0.85 * BOP)(40/1000)(VWR)}{42} \tag{3-4}$$

The trial method will not have any fuel usage factors for specific bid items.

3.8 SURVEY OVERVIEW

Most states' fuel adjustment approach is consistent with the general procedure documented in the FHWA Technical Advisory T5080.3. The source for the fuel index and the trigger values, however, show great variation between the states. Some states have modified their process and allowed different bid items for the fuel usage factors to be used, in addition to changing the value of the factors. Only 10 states use a fuel usage factor for structures. It appears that although states did not change their methods based on other states' procedures (Section 3.2), many states are influenced by how other states apply their fuel adjustments. Few states have performed studies to find an "updated" fuel usage factor value. In 2008, which was not a typical year, significantly more money was paid out by states to contractors, but was still less than 1 percent of the construction budget. In response, many states have made recent changes to their adjustment process for the contractors.

3.9 SURVEY SUMMARY

The survey covered all 50 states and two territories. It was conducted by telephone with the script listed in Appendix A. It started January 12, 2009 and concluded on February 26, 2009. The major findings are:

- Implementation across most states was consistent with the FHWA Technical Advisory T 5080.3.
- Many states have made changes to the fuel adjustment process.
- Source of the fuel price index varies among states.
- Trigger value for the fuel adjustment differs between states.
- A number of states have received complaints from contractors about the current fuel adjustment method.
- Most states believe the current fuel adjustment is fair and the risk is shared appropriately
- States have recently or will shortly implement changes to the fuel adjustment.

4.0 INFLATION INDICES

4.1 BACKGROUND

During the 1970s when the price of fuel increased dramatically, building contractors also increased their bids to absorb the added price risk and costs. FHWA implemented the fuel price adjustment in 1974 so the government would share some of this price risk when fuel prices increase. The method set forth by FHWA for calculating the fuel price adjustment has not changed over 30 years, although some states have changed their process. ODOT stated in September 2007 that “it is very unlikely that those fuel usage factors are accurate or effective in removing the risk of fuel price fluctuations to the grantor or construction firm,” *(ODOT “unpublished data”).* This chapter evaluates highway construction costs from 1991 to 2008 to determine whether the current fuel price adjustment method appropriately mitigates fuel price risk. Following this analysis, an improved fuel adjustment process is offered for the state of Oregon.

The results found that additional bid items are required when analyzing the total structural construction costs for the state of Oregon. Currently, a number of states track costs for a select number of bid items. FHWA also tracks the costs of these same bid items nationally. Indices assessing structural projects measure three bid items, namely structural concrete, reinforcing steel, and structural steel. No index exists, however, that measures additional costs for structures such as excavation, reinforcement, steel rail, or waterproofing membrane.

Given the unique physical and natural attributes that influence Oregon’s construction costs for different structural bid items, none of the current national indices seemed appropriate. The existing indices track too few bid items. A more appropriate index is one that follows the price of those components that make up a larger proportion of bid prices. Therefore, a new index was developed that captures a larger share of the total construction project for the state of Oregon. The additional bid items and their measurements over time are introduced. Two indices were created that measure costs at the national and Oregon state level. Through a comparison of the two indices, it can be determined whether Oregon’s structural costs are consistent with the rest of the nation. If the costs are not consistent, then the current national fuel usage factors are not appropriate for Oregon.

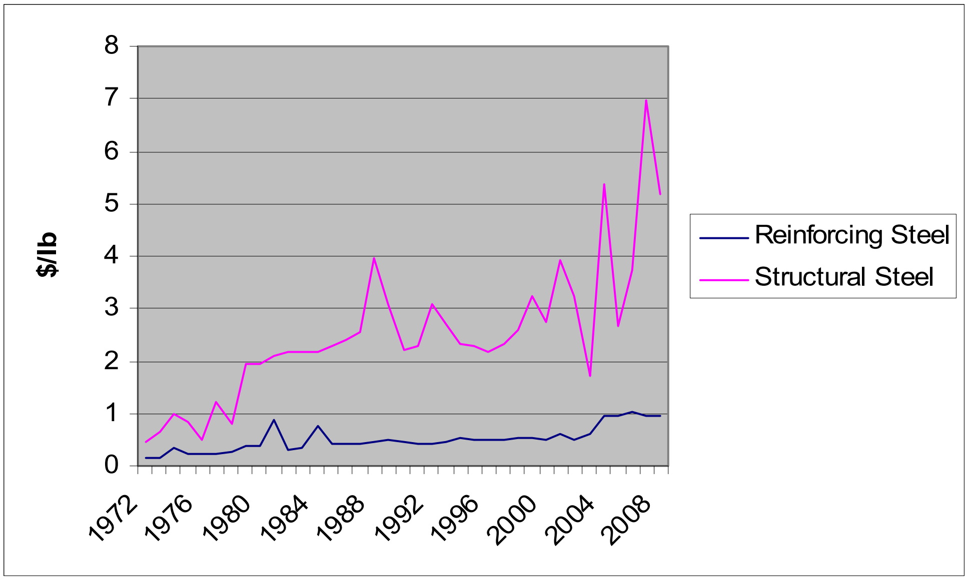
4.2 REVIEW OF CURRENT INDICES

Six states—California, Colorado, Oregon, South Dakota, Utah, and Washington—track the cost trends of the three bid items most frequently used in their construction projects. Each state includes bid items for excavation and surfacing. The major bid items analyzed for structures projects are structural concrete, reinforcing steel, and structural steel. In addition, Colorado, Oregon, and Utah have created a structural index from the composite of the three bid items. The indices from the respective states are represented in Tables 4.1 through 4.6, and bid and construction prices are shown in Figure 4.1 through 4.12.

Table 4.1: California Department of Transportation Average Highway Contract Prices

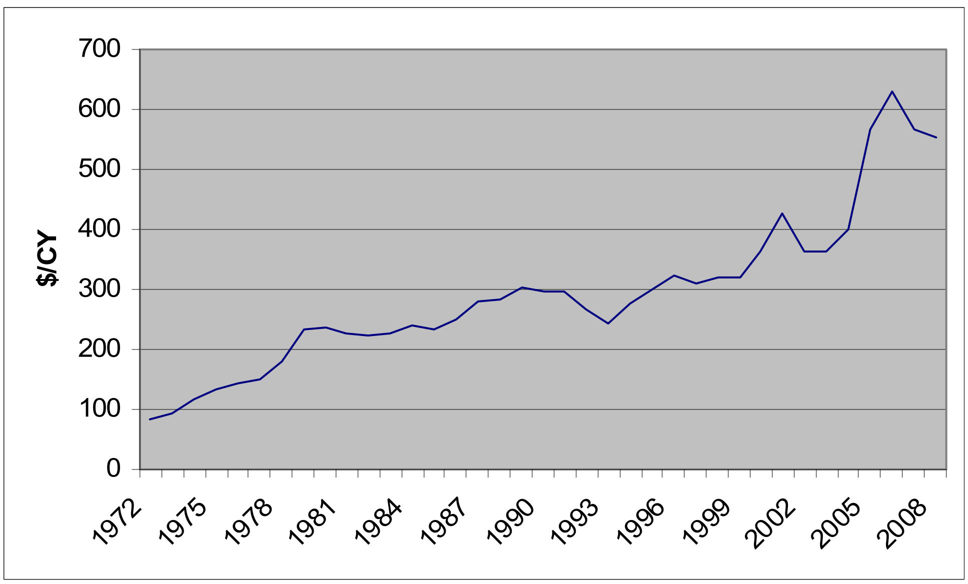
Year	Class "A" PCC Structure ($/CY)	Reinforcing Steel ($/lb)	Structural Steel ($/lb)
1972	82.08	0.16	0.45
1973	93.60	0.17	0.64
1974	115.19	0.33	0.99
1975	132.10	0.24	0.84
1976	143.05	0.22	0.50
1977	150.03	0.24	1.23
1978	180.77	0.28	0.81
1979	234.24	0.38	1.96
1980	235.45	0.38	1.94
1981	226.84	0.86	2.09
1982	224.72	0.32	2.16
1983	225.84	0.34	2.16
1984	238.48	0.75	2.16
1985	232.39	0.41	2.29
1986	249.74	0.41	2.39
1987	280.40	0.42	2.55
1988	284.55	0.44	3.96
1989	303.49	0.48	3.10
1990	295.24	0.47	2.21
1991	295.21	0.43	2.28
1992	265.31	0.42	3.07
1993	243.79	0.46	2.71
1994	277.92	0.55	2.33
1995	298.80	0.50	2.27
1996	321.88	0.51	2.17
1997	308.54	0.50	2.34
1998	319.95	0.55	2.60
1999	321.22	0.52	3.22
2000	363.59	0.51	2.75
2001	425.17	0.62	3.91
2002	363.50	0.51	3.25
2003	362.75	0.60	1.71
2004	399.64	0.95	5.39
2005	567.31	0.97	2.67
2006	630.16	1.04	3.73
2007	566.25	0.94	6.97
2008	553.62	0.94	5.18

Source: *(Luo 2010)*



Source: (*Luo 2010*)

Figure 4.1: California's Historic Reinforcing & Structural Steel Contract Prices



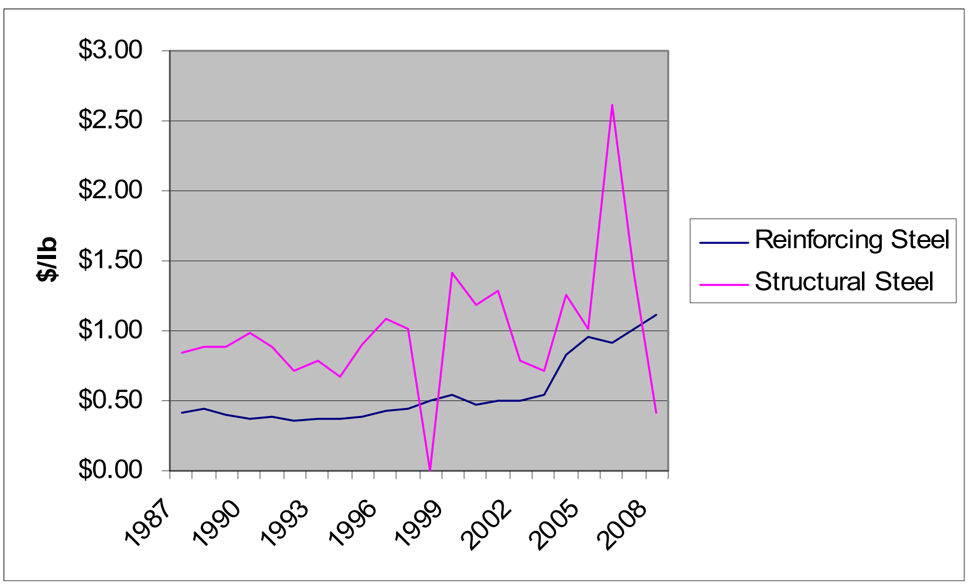
Source: (*Luo 2010*)

Figure 4.2: California's Historic Structural Concrete Contract Prices

Table 4.2: Colorado Highway Construction Cost Index

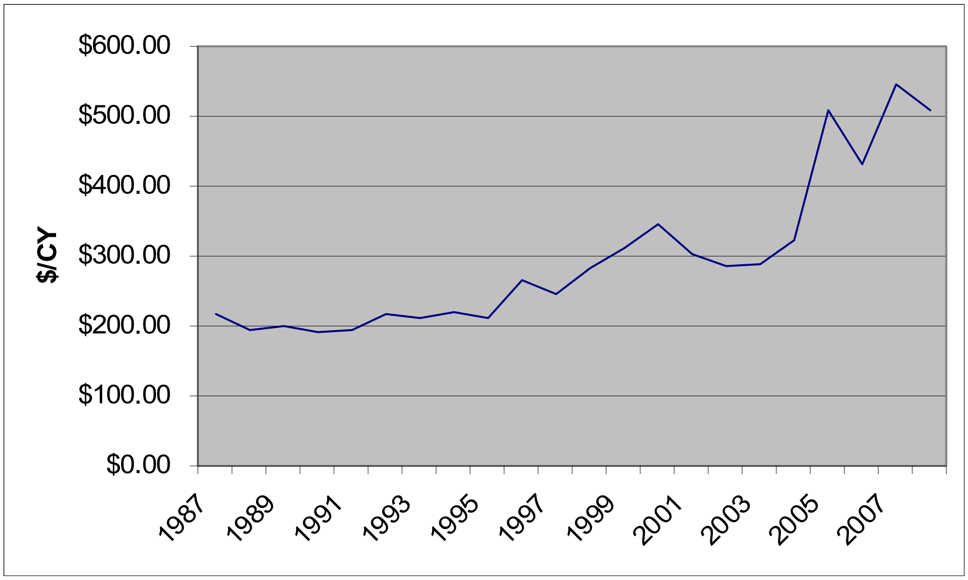
Year	Structural Concrete Bid Price ($/Cu. Yd.)	Reinforcing Steel Bid Price ($/lb.)	Structural Steel Bid Price ($/lb.)	Structural Index Base: 1987
1987	$217.32	$0.41	$0.85	100
1988	$195.02	$0.45	$0.89	96.7
1989	$199.41	$0.40	$0.88	95.3
1990	$190.86	$0.37	$0.99	94.1
1991	$195.43	$0.38	$0.89	93.5
1992	$216.87	$0.36	$0.71	94.0
1993	$212.43	$0.37	$0.79	95.3
1994	$219.94	$0.37	$0.67	94.4
1995	$211.29	$0.39	$0.90	98.3
1996	$265.98	$0.43	$1.09	120.2
1997	$246.29	$0.45	$1.01	113.8
1998	$283.01	$0.50	N/A	128.2
1999	$310.56	$0.54	$1.41	145.3
2000	$346.82	$0.47	$1.18	146.8
2001	$303.22	$0.50	$1.29	138.4
2002	$285.35	$0.50	$0.78	121.4
2003	$289.44	$0.55	$0.72	123.4
2004	$323.50	$0.83	$1.26	159.0
2005	$508.77	$0.96	$1.01	210.4
2006	$430.27	$0.92	$2.62	225.1
2007	$546.29	$1.01	$1.40	232.4
2008	$508.40	$1.11	$0.41	241.9

Source: (*Bieber 2009*)



Source: (*Bieber 2009*)

Figure 4.3: Colorado's Historic Reinforcing & Structural Steel Bid Prices



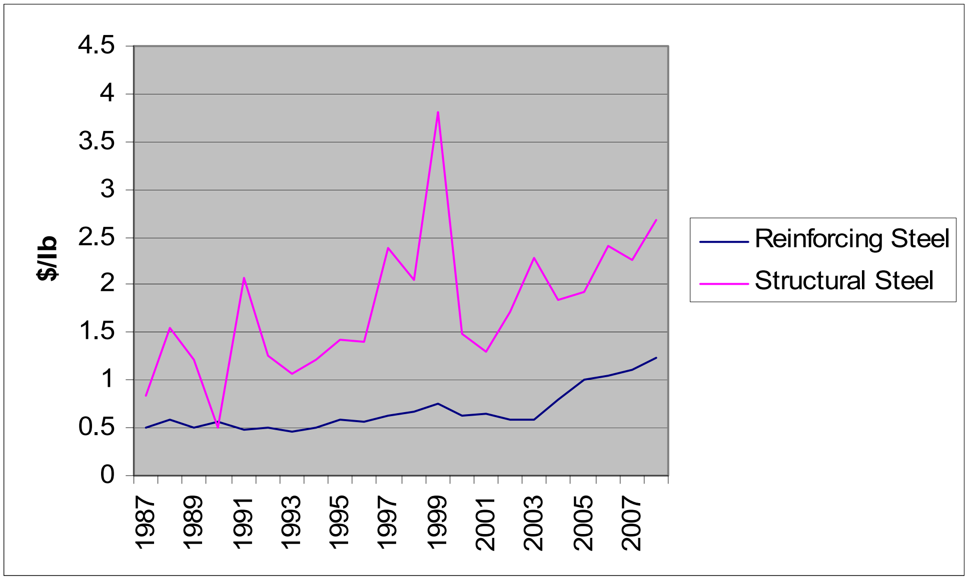
Source: (*Bieber 2009*)

Figure 4.4: Colorado's Historic Structural Concrete Contract Prices

Table 4.3: Oregon Highway Construction Cost Trends

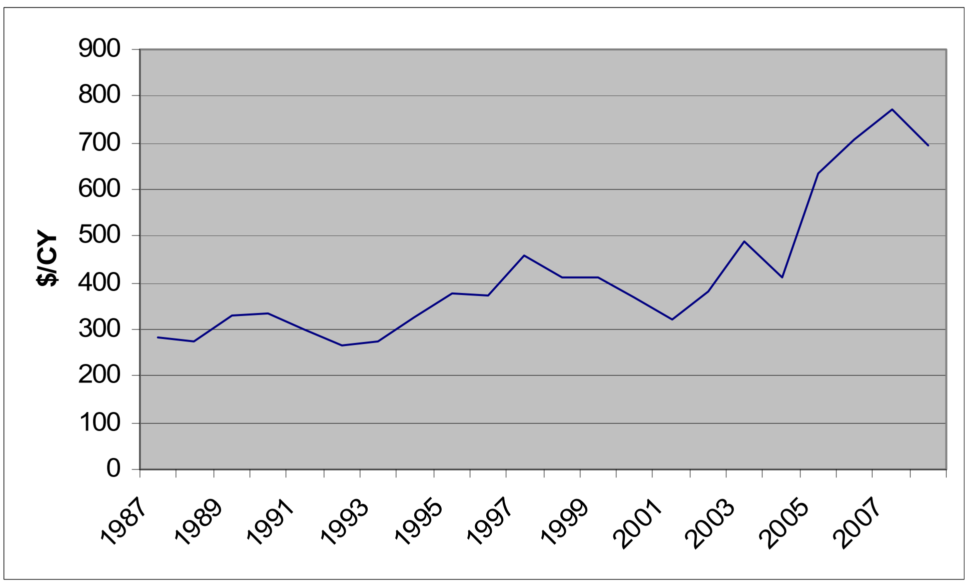
Year	Structural Concrete ($/Cu. Yd.)	Reinforcing Steel ($/lb.)	Structural Steel ($/lb.)	Structures Index Base: 1987
1987	280.91	0.50	0.84	100.0
1988	272.95	0.59	1.54	114.1
1989	329.59	0.51	1.22	118.1
1990	334.66	0.57	0.50	109.9
1991	298.64	0.49	2.08	124.3
1992	267.22	0.51	1.26	104.5
1993	275.37	0.46	1.07	101.0
1994	326.42	0.50	1.21	116.9
1995	379.06	0.59	1.43	136.4
1996	371.92	0.57	1.40	133.4
1997	459.52	0.63	2.39	172.4
1998	411.23	0.67	2.05	157.5
1999	411.87	0.75	3.81	190.2
2000	369.15	0.63	1.49	136.8
2001	319.42	0.65	1.30	123.4
2002	380.43	0.58	1.72	164.1
2003	489.04	0.58	2.28	175.2
2004	410.27	0.80	1.84	159.8
2005	635.51	1.01	1.92	221.8
2006	706.33	1.04	2.41	247.3
2007	772.21	1.11	2.26	263.0
2008	695.13	1.23	2.67	257.6

Source: *(ODOT 2007a)*



Source: (*ODOT 2007a)*

Figure 4.5: Oregon's Historic Reinforcing & Structural Steel Bid Prices



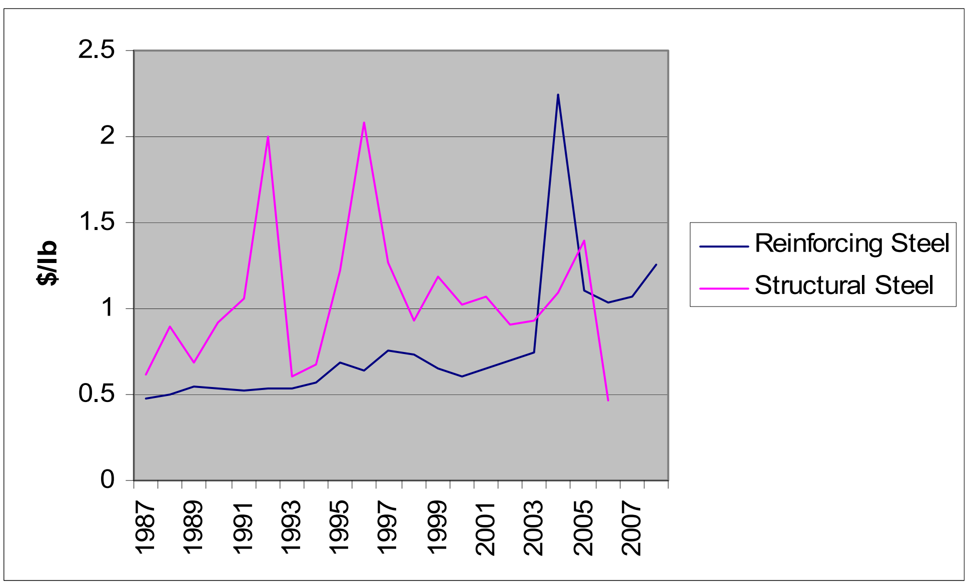
Source: (*ODOT 2007a)*

Figure 4.6: Oregon's Historic Structural Concrete Bid Prices

Table 4.4: South Dakota Department of Transportation Highway Construction Cost Index

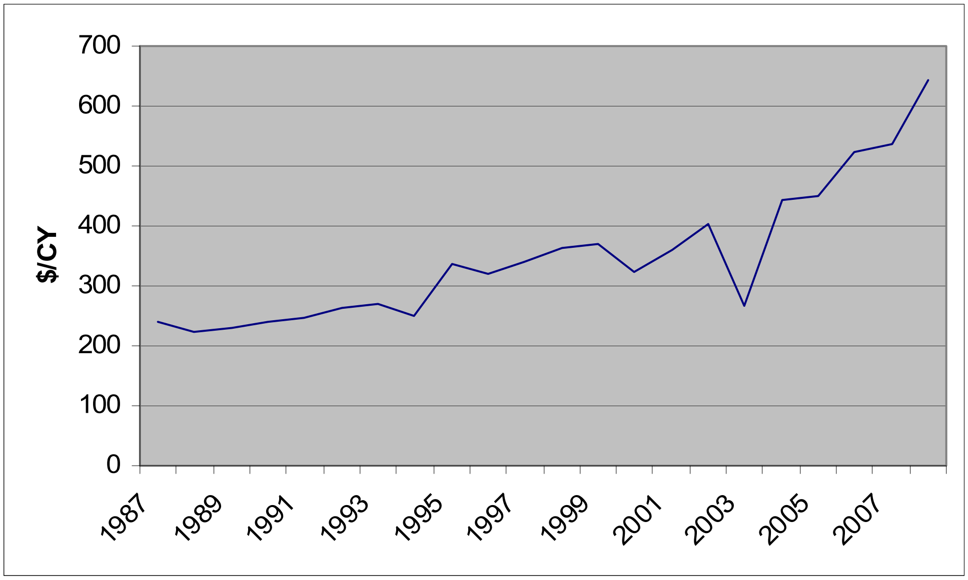
Year	Class "A" Concrete ($/Cu. Yd.)	Reinforcing Steel ($/lb.)	Structural Steel ($/lb.)
1987	239.27	0.48	0.62
1988	224.42	0.50	0.90
1989	228.66	0.55	0.69
1990	239.85	0.54	0.92
1991	247.72	0.52	1.06
1992	264.84	0.53	2.00
1993	270.83	0.54	0.61
1994	250.68	0.57	0.67
1995	337.08	0.69	1.22
1996	319.18	0.64	2.08
1997	340.10	0.76	1.27
1998	362.86	0.73	0.93
1999	369.00	0.65	1.19
2000	322.81	0.61	1.02
2001	361.05	0.65	1.07
2002	404.01	0.70	0.91
2003	265.91	0.74	0.93
2004	442.15	2.24	1.09
2005	449.22	1.10	1.40
2006	522.27	1.04	0.46
2007	535.45	1.07	N/A
2008	644.45	1.26	N/A

Source: (*SDDOT 2009*)



Source: (*SDDOT 2009*)

Figure 4.7: South Dakota's Historic Reinforcing & Structural Steel Bid Prices



Source: (*SDDOT 2009)*

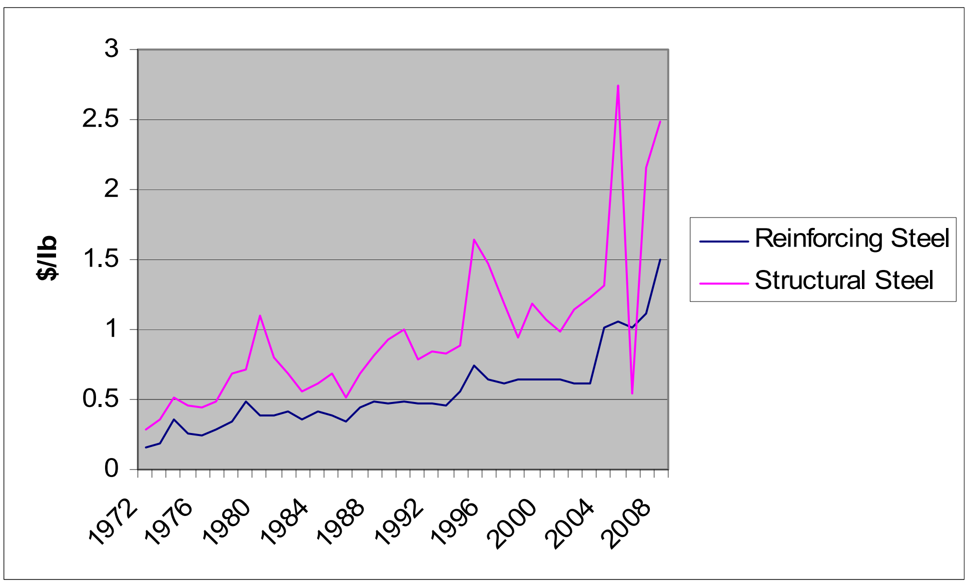
Figure 4.8: South Dakota's Historic Structural Concrete Bid Prices

Table 4.5: Price Trends for Utah Highway Construction

Year	Structural Concrete Bid Price ($/Cu. Yd.)	Reinforcing Steel Bid Price ($/lb.)	Structural Steel Bid Price ($/lb.)	Structural Index Base: 1987
1972	87.11	0.16	0.29	42.2
1973	98.89	0.19	0.36	50.1
1974	123.10	0.36	0.51	69.8
1975	115.99	0.26	0.46	62.2
1976	137.13	0.25	0.44	65.3
1977	153.09	0.28	0.48	72.3
1978	181.72	0.35	0.69	93.8
1979	187.54	0.48	0.72	100.8
1980	189.30	0.39	1.10	122.0
1981	190.48	0.39	0.80	103.7
1982	203.58	0.41	0.68	99.8
1983	181.05	0.36	0.56	85.9
1984	192.96	0.42	0.61	93.4
1985	199.27	0.39	0.69	98.9
1986	195.29	0.35	0.51	85.7
1987	197.59	0.44	0.69	100.0
1988	187.41	0.48	0.81	106.3
1989	184.28	0.47	0.93	112.8
1990	185.71	0.49	1.00	118.0
1991	214.88	0.47	0.78	110.3
1992	232.81	0.47	0.85	118.7
1993	250.34	0.46	0.83	120.9
1994	250.03	0.56	0.88	126.8
1995	192.86	0.74	1.65	167.2

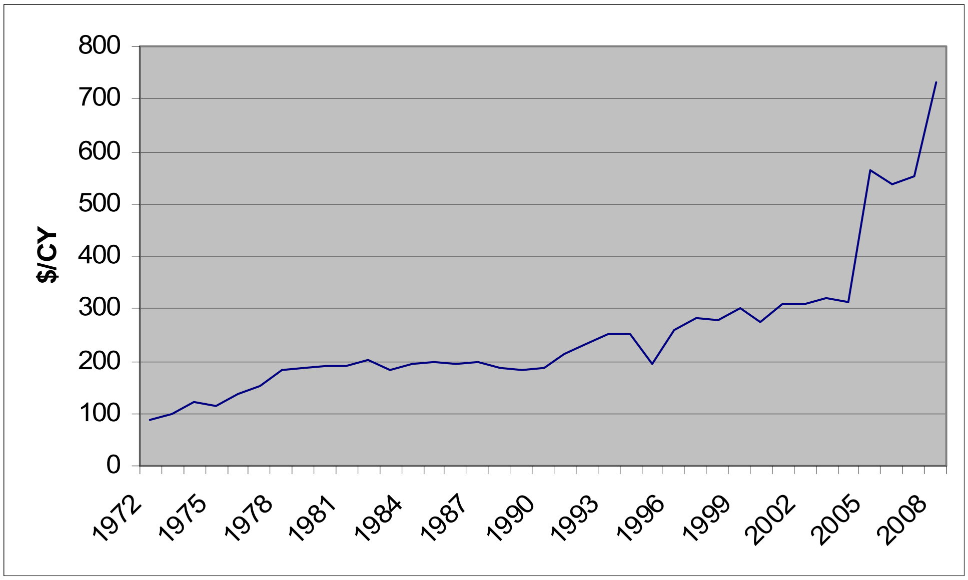
Year	Structural Concrete Bid Price ($/Cu. Yd.)	Reinforcing Steel Bid Price ($/lb.)	Structural Steel Bid Price ($/lb.)	Structural Index Base: 1987
1996	257.99	0.65	1.47	168.0
1997	280.28	0.62	1.18	154.1
1998	279.35	0.64	0.94	140.0
1999	300.84	0.65	1.19	160.4
2000	276.07	0.65	1.07	147.6
2001	308.30	0.65	0.99	149.6
2002	306.97	0.61	1.14	157.3
2003	320.71	0.62	1.23	166.7
2004	313.78	1.01	1.32	182.2
2005	563.88	1.06	2.74	327.4
2006	538.73	1.02	0.54	184.4
2007	554.19	1.11	2.16	290.7
2008	731.62	1.50	2.49	362.6

Source: *(UDOT 2009)*



Source: (*UDOT 2009)*

Figure 4.9: Utah's Historic Reinforcing & Structural Steel Bid Prices



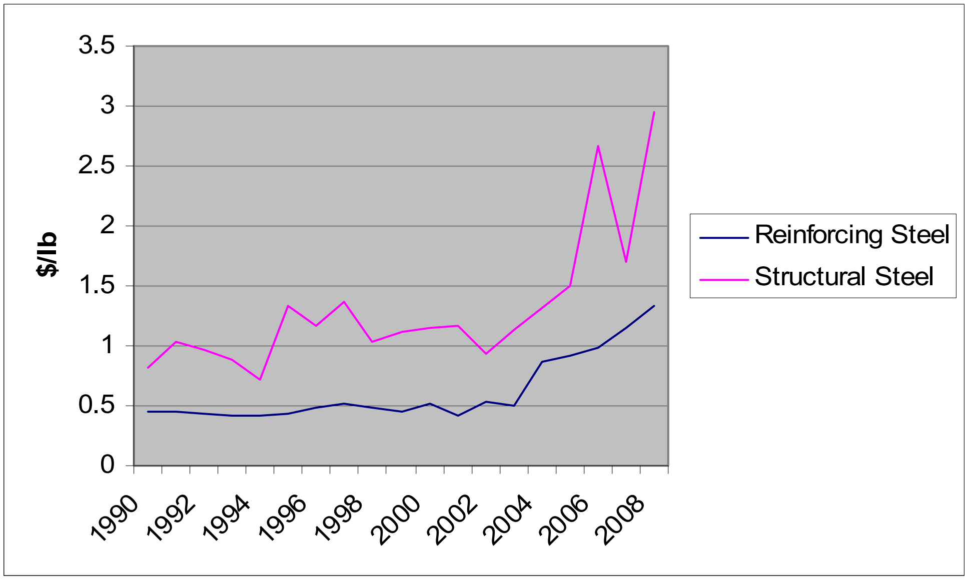
Source: (*UDOT 2009)*

Figure 4.10: Utah's Historic Structural Concrete Bid Prices

Table 4.6: Washington State Department of Transportation Unit Bid Prices

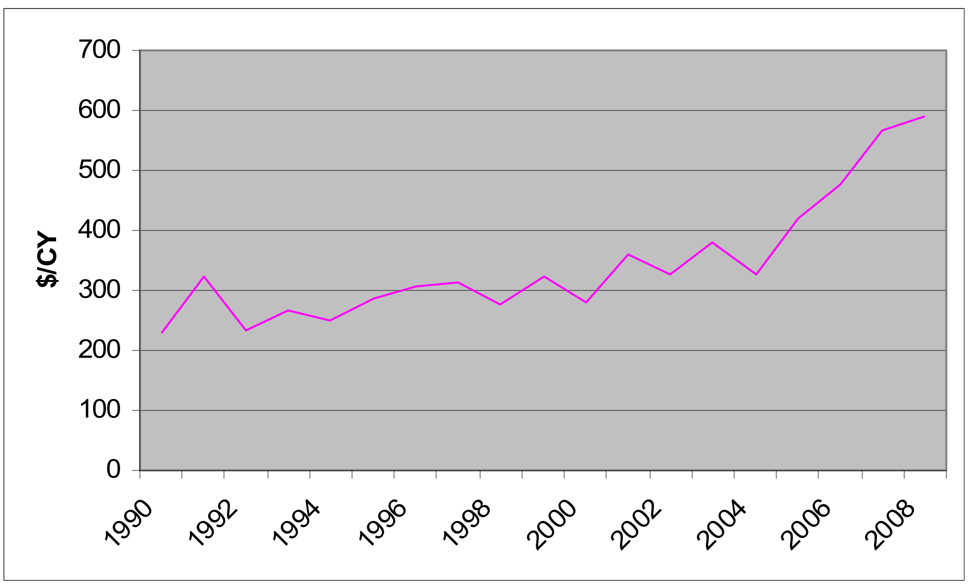
Year	Structural Concrete Bid Price ($/Cu. Yd.)	Reinforcing Steel Bid Price ($/lb.)	Structural Steel Bid Price ($/lb.)
1990	231.51	0.45	0.82
1991	322.81	0.45	1.04
1992	232.04	0.44	0.97
1993	265.49	0.42	0.88
1994	248.94	0.41	0.71
1995	285.02	0.44	1.34
1996	305.22	0.49	1.17
1997	313.29	0.51	1.37
1998	277.25	0.49	1.03
1999	323.92	0.45	1.12
2000	279.99	0.51	1.15
2001	359.38	0.41	1.17
2002	326.47	0.54	0.94
2003	380.84	0.50	1.13
2004	328.12	0.86	1.31
2005	419.25	0.91	1.50
2006	475.88	0.98	2.67
2007	567.75	1.15	1.70
2008	589.16	1.33	2.95

Source: (*WSDOT 2010*)



Source: (*WSDOT 2010)*

Figure 4.11: Washington's Historic Reinforcing & Structural Steel Bid Prices



Source: (*WSDOT 2010)*

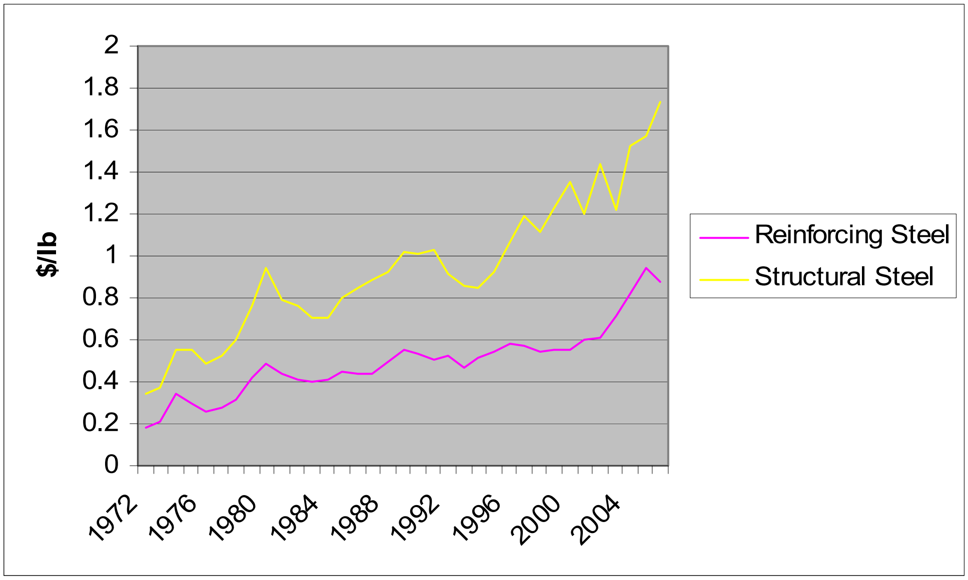
Figure 4.12: Washington's Historic Structural Concrete Bid Prices

FHWA also created a price index for federal-aid highway construction projects since 1972. This index tracks costs for common excavation, surfacing, and structures. The bid items for structures are the same as for the other six states. The composite structures index is calculated from these three items. The respective prices and indices are presented in Table 4.7 and contract prices are shown in Figure 4.13 and 4.14.

Table 4.7: Price Trends for Federal-Aid Highway Construction Structures (1987 Base)

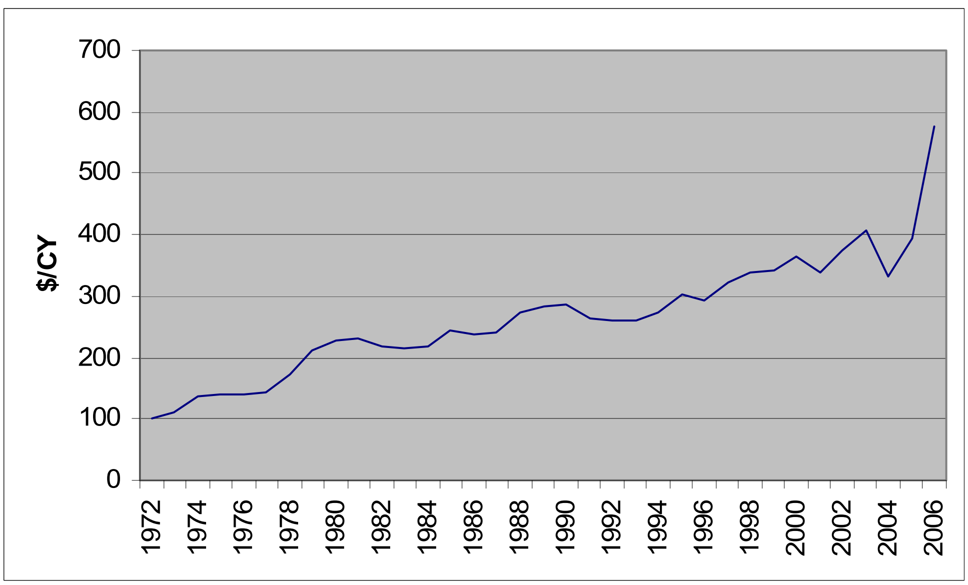
Year	Reinforcing Steel		Structural Steel		Structural Concrete		Structures Index Base: 1987
	Avg. Contract Price ($/lb.)	Index	Avg. Contract Price ($/lb.)	Index	Avg. Contract Price ($/cu. yd.)	Index	
1972	.181	41.1	.342	38.6	100.17	41.6	40.7
1973	.207	47.0	.372	42.0	111.81	46.4	45.4
1974	.339	76.9	.551	62.3	136.80	56.8	61.7
1975	.297	67.4	.554	62.6	138.76	57.6	60.6
1976	.258	58.5	.484	54.7	139.59	58.0	57.2
1977	.272	61.7	.520	58.8	143.51	59.6	59.7
1978	.316	71.7	.603	68.1	172.41	71.6	70.7
1979	.421	95.5	.759	85.8	211.33	87.8	88.6
1980	.483	109.6	.941	106.3	226.68	94.1	100.0
1981	.438	99.4	.790	89.3	231.64	96.2	94.9
1982	.407	92.4	.762	86.1	219.63	91.2	90.0
1983	.398	90.3	.708	80.0	213.85	88.8	86.7
1984	.409	92.8	.709	80.1	218.02	90.5	88.2
1985	.444	100.7	.796	89.9	243.60	101.2	98.1
1986	.442	100.3	.850	96.0	236.37	98.2	98.0
1987	.441	100.0	.885	100.0	240.81	100.0	100.0
1988	.494	112.1	.924	104.4	274.12	113.8	111.0
1989	.556	126.2	1.018	115.0	283.40	117.7	118.4
1990	.529	120.0	1.010	114.1	286.18	118.8	117.8
1991	.505	114.6	1.030	116.4	264.98	110.0	112.5
1992	.520	117.9	.916	103.5	259.61	107.8	108.4
1993	.467	106.0	.861	97.3	261.89	108.7	105.3
1994	.515	116.8	.847	95.7	271.94	112.9	109.0
1995	.542	122.9	.922	104.2	302.66	125.7	119.5
1996	.581	121.5	1.068	120.7	293.85	122.0	121.6
1997	.567	128.7	1.186	134.0	320.90	133.2	132.7
1998	.544	123.4	1.111	125.5	337.25	140.0	133.4
1999	.554	125.7	1.224	138.3	342.24	142.1	138.3
2000	.549	124.6	1.351	152.6	363.66	151.0	146.9
2001	.601	136.4	1.201	135.8	339.44	140.9	138.8
2002	.610	138.4	1.436	162.2	374.96	155.7	154.5
2003	.718	162.9	1.219	137.8	406.02	158.5	159.5
2004	.815	184.8	1.521	171.9	331.49	137.6	154.7
2005	.941	213.6	1.571	177.5	394.88	163.9	176.0
2006	.872	197.9	1.736	196.1	574.80	238.7	220.5

Source: (*FHWA. 2006b*)



Source: (*FHWA 2006b*)

Figure 4.13: FHWA's Historic Reinforcing & Structural Steel Contract Prices



Source: (*FHWA 2006b*)

Figure 4.14: FHWA's Historic Structural Concrete Contract Prices

The last year recorded for the FHWA index is 2006. After contacting FHWA, we learned the index is no longer calculated.

Figures A-1, A-2, and A-3 in the Appendix B compare the unit prices of structural concrete, reinforcing steel, and structural steel, respectively, for Colorado, Oregon, South Dakota, and Washington. Figures A-4, A-5, and A-6 compare the unit prices of structural concrete, reinforcing steel, and structural steel, respectively, for California, Utah, and the U.S..

In Figures A-1 and A-4, unit prices for structural concrete are similar between the seven different sources, although some variability exists. For reinforcing steel, the prices peak in 1981 and 1984 in California, and 2004 in South Dakota. The price of structural steel in Oregon does not demonstrate any relationship with the other states or the U.S. (see Figures A-3 and A-6). Since differences exist in the trends for structural steel, it suggests that Oregon should analyze price trends locally. The three bid items tracked by each of the six states and the U.S. may not be enough to identify the structural construction market. Section 4.3 identifies additional bid items that capture more of the total cost for structural construction.

4.3 FORMATION OF BID ITEM LIST

To identify additional bid items that capture the true cost of structural construction in Oregon, a request was made to ODOT for the 15 most frequently used bid items in the construction for structures. In addition to identifying the most frequently used, the 15 most expensive bid items in terms of individual annual total cost and frequency were also requested. Thorough examination of the most costly bid items in Oregon's construction contracts determined which bid items existed and weighed heavily on the total construction process, in addition to the frequency. ODOT sent to the research team the list of bid items that met the criteria from 1991 to 2008. Seven of the bid items appeared on both lists. Each bid item with the respective description, frequency, and total dollar amount is shown in Table 4.8.

Table 4.8: Most costly and frequently used structural bid items from 1991 to 2008

Bid Item	Item Description	Total Cost	Frequency
Bid Items Most Costly & Frequent			
0501-0100000A	Bridge Removal Work	$65,149,988.53	1133
0510-0100000A	Shoring, Cribbing, & Cofferdam	$28,623,904.62	854
0530-0100000A	Reinforcement	$64,311,482.65	1071
0530-0103000A	Coated Reinforcement	$19,728,636.58	493
0540-0301000A	General Structural Concrete, Class 3300	$55,657,472.30	549
0540-0302000A	General Structural Concrete, Class 4000	$60,670,164.41	287
0545-0100000J	Reinforced Concrete Bridge End Panels	$28,809,230.46	660
Remaining Bid Items Most Costly			
0510-0101000A	Structure Excavation	$7,181,939.36	750
0510-0101000K	Structure Excavation	$5,569,818.55	454
0510-0106000K	Granular Wall Backfill	$2,495,335.69	330
0510-0108000A	Granular Structure Backfill	$2,106,531.28	305
0510-0108000K	Granular Structure Backfill	$2,522,565.34	320
0520-0100000A	Furn Pile Driving Equipment	$10,581,439.89	617
0520-0303000E	Drive PP 12-3/4 X 0.375 Steel Piles	$3,712,563.76	240
0520-0330000E	Reinforced Pile Tips	$1,290,333.54	256
Remaining Bid Items Most Frequent			
0510-9Z90000A	Section 0510 Misc.	$57,993,661.36	42
0540-0303000A	General Structural Concrete, Class 5000	$65,176,949.70	124
0540-0307000A	General Structural Concrete, HPC4000	$32,960,586.64	117
0540-9Z90000A	Section 0540 Misc.	$45,770,094.00	195
0550-9Z90000A	Section 0550 Misc.	$25,736,401.00	27
0550-9Z90000F	Section 0550 Misc.	$20,157,360.41	43
0560-0100000A	Structural Steel	$77,386,643.40	176
0596-0104000J	Retaining Wall, MSE	$50,203,513.83	200

Source: (*ODOT "unpublished data"*)

The first four bid item numbers (e.g. 0501 or 0510) represent the section of work the item falls under.

The dollar values for the different bid items were summed to calculate the total amount spent on the most costly and frequently used structural bid items. The dollar value reported for the respective bid item was then divided by the most costly and frequent structural bid items. All bid items that were reported as being 4 percent[9] or higher were placed on a list shown here. Thus, the most frequent and highest in effect items were included.

- Bridge Removal Work
- Shoring, Cribbing, & Cofferdam
- Section 0510 Miscellaneous[10]
- Reinforcement
- General Structural Concrete, Class 3300
- General Structural Concrete, Class 4000
- General Structural Concrete, Class 5000
- General Structural Concrete, HPC4000
- Reinforced Concrete Bridge End Panels
- Structural Steel
- Retaining Wall, MSE

After reviewing the list, ODOT made adjustments to accurately reflect the bid items that are used specifically for structures. The authoritative final list of bid items (*final list*) is documented here.

- Structure Excavation
- Reinforcement
- Coated Reinforcement
- General Structural Concrete, Class 3300
- General Structural Concrete, Class 4000
- General Structural Concrete, Class 4500
- General Structural Concrete, Class 5000
- Structural Steel
- 2 Tube Steel Rail
- Warranted Waterproofing Membrane

[9] Upon visual inspection of the bid items listed, 4 percent appeared to be the best critical point.
[10]This bid item includes substructure and construction services on design-build projects, shoring and cribbing, controlled low strength structure backfill, etc.

The *final list* includes more bid items than FHWA and other states have analyzed in the past. The list also includes bid items that are the costliest and most frequently used in Oregon. The adjusted list more acutely reflects ODOT's experiences as it addresses costly bid items that will be phased out because of new construction techniques and the changes in frequency of bid items in the last several years. Therefore, the *final list* more accurately reflects the market for structural construction components in the state of Oregon.

4.4 THE NATIONAL PROTOTYPE

As noted earlier in this report, historically, fuel usage factor values used at the national level for structures have come from Highway Research Circular Number 158 *Fuel Usage Factors for Highway Construction*. The report was based on a 1974 survey of more than 400 highway contractors across the United States. For structural work, the fuel factors are given in terms of fuel consumed per $1,000 of work. Given that the results are based on a national survey, the final bid item list is analyzed for national prices. RS Means, a firm that gathers prices for various aspects of construction, supplied the national prices from one of their manuals printed annually titled *RS Means Heavy Construction Cost Data,* (henceforth referred to in this report as "*RS Means HCCD*"). Applying the bid item prices listed in *RS Means HCCD*, and how often they are used in Oregon, a national prototype index was developed that measures structural costs over time. The results of the national prototype determine whether $1,000 worth of work is the same in 2008 as it was in 1991.

The *final list* does not exactly match with items listed in *RS Means HCCD.* The Oregon bid items listed on the left hand column of Table 4.9 represent multiple material types. From 1991 to 2008 several different materials could have been used for each bid item, and the materials may have varied over time. *RS Means HCCD* also does not list every possible material item available to the contractor. The items that were most representative in *RS Means HCCD* were included. The *final list* with the respective item descriptions is presented in Table 4.9.

Table 4.9: Bid Item Descriptions from *RS Means*

Oregon Bid Items	*RS Means* Item Description
Structure Excavation	Avg. of Common earth, hydraulic backhoe for ¾, 1, 1-1/2, & 2 CY bucket, Sand & gravel ¾, 1, 1-1/2, & 2 CY bucket, & Clay till or blasted rock ¾, 1, 1-1/2, & 2 CY bucket.
Reinforcement	*Reinforcing, in place* (Bridge section)
Coated Reinforcement	*Epoxy coated* (Bridge section)
General Structural Concrete, Class 3300	Avg. of Cast-in-place concrete *3000 & 3500 psi*
General Structural Concrete, Class 4000	Cast-in-place concrete *4000 psi*
General Structural Concrete, Class 4500	Cast-in-place concrete *4500 psi*
General Structural Concrete, Class 5000	Cast-in-place concrete *5000 psi*
Structural Steel	*Structural steel, rolled beams*
2 Tube Steel Rail	*Approach railings, steel, galv. Pipe, 2 line*
Warranted Waterproofing Membrane	Sum of *Apply waterproof membrane* & *Apply waterproof sealer*

Source: (*ODOT "unpublished data"; RS Means HCCD)*

The costs listed in *RS Means HCCD* are material, labor, and equipment, except for waterproof membrane and waterproof sealer.

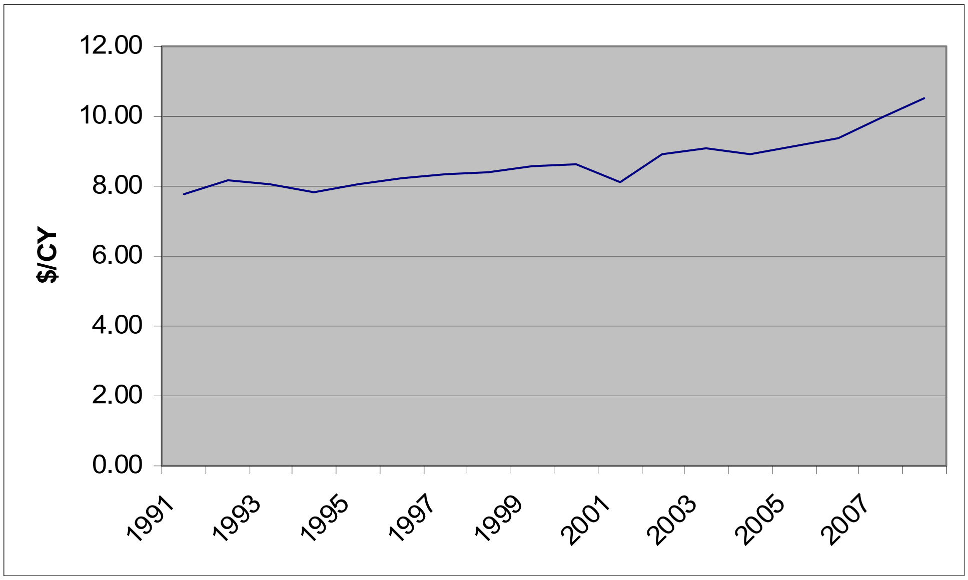
The items *apply waterproof membrane* and *apply waterproof sealer* only appear in the 1995 to 1999 editions of *RS Means HCCD*. For the years the bid item does appear in the respective manuals, the value listed is constant across years. ODOT reported that the bid items *apply waterproof membrane* and *apply waterproof sealer* did not exist in their database until 2002. Since the bid items do not appear in the manual in the same years as it appears in ODOT's database, the items were dropped from the list.

The remaining items appear in the 1991 to 2008 editions of the *RS Means HCCD.* Values for the bid items and available years are shown in Table 4.10, and prices are shown in Figure 4.15 through 4.18.

Table 4.10: National Bid Item Unit Prices

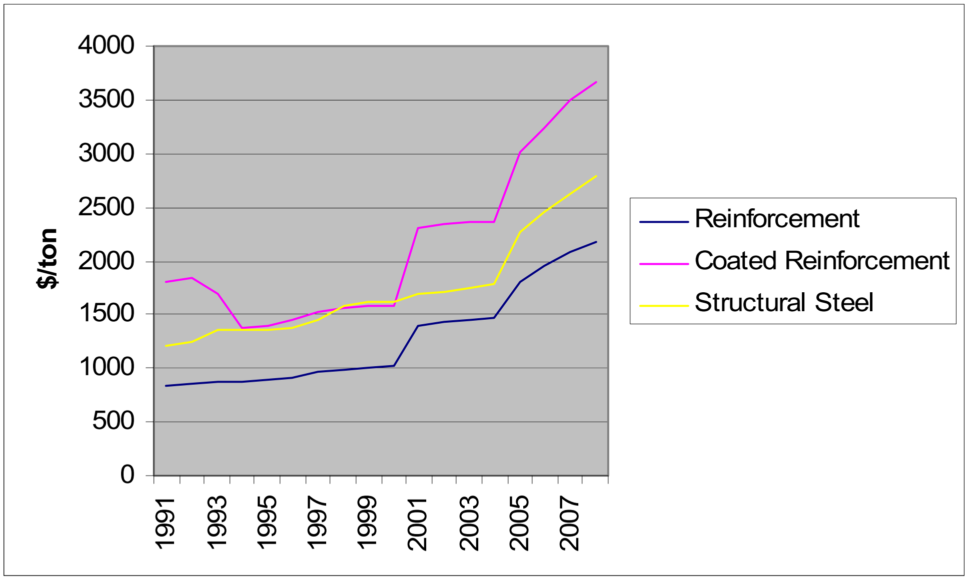
Year	Struct. Excav. ($/CY)	Reinf. ($/lb)	Coated Reinf. ($/lb)	Avg. Class 3000 & 3500 ($/CY)	Class 4000 ($/CY)	Class 4500 ($/CY)	Class 5000 ($/CY)	Struct. Steel ($/lb)	Steel Rail ($/LF)
1991	7.77	0.4225	0.9025	51.88	54.3	55.9	57.5	0.6075	62.70
1992	8.18	0.4325	0.9225	52.98	55.1	56.4	57.8	0.6250	63.02
1993	8.06	0.4380	0.8505	48.75	50.5	52.0	53.0	1350	65.25
1994	7.84	0.4410	0.6910	49.75	50.0	52.0	53.0	0.6765	65.44
1995	8.08	0.4445	0.6945	50.25	52.0	53.5	54.0	0.6790	65.65
1996	8.21	0.4580	0.7230	53.00	55.0	56.5	57.0	0.6855	66.86
1997	8.33	0.4850	0.7650	54.75	56.0	57.5	60.0	0.7280	71.12
1998	8.38	0.4950	0.7825	58.25	60.5	62.0	63.5	0.7915	72.88
1999	8.57	0.5000	0.7875	61.00	62.5	63.6	67.5	0.8065	74.69
2000	8.63	0.5075	0.7925	63.75	67.0	69.0	71.5	0.8120	75.50
2001	8.14	0.7000	1.1500	65.50	68.5	70.5	73.0	0.8460	75.96
2002	8.90	0.7200	1.1700	70.00	74.0	75.5	77.0	0.8590	76.45
2003	9.10	0.7275	1.1775	71.75	76.0	77.5	78.0	0.8780	76.79
2004	8.92	0.7350	1.1850	73.25	76.5	78.5	81.0	0.8975	77.21
2005	9.12	0.9025	1.5025	81.50	84.0	86.0	90.0	1.1350	102.50
2006	9.35	0.9725	1.6225	88.00	91.0	93.0	96.0	1.2240	110.48
2007	9.94	1.0450	1.7450	105.00	108.0	110.0	114.0	1.3155	119.11
2008	10.49	1.0925	1.8300	101.50	106.0	109.0	109.0	1.4000	124.65

Source: (*RS Means HCCD 2001-2008)*



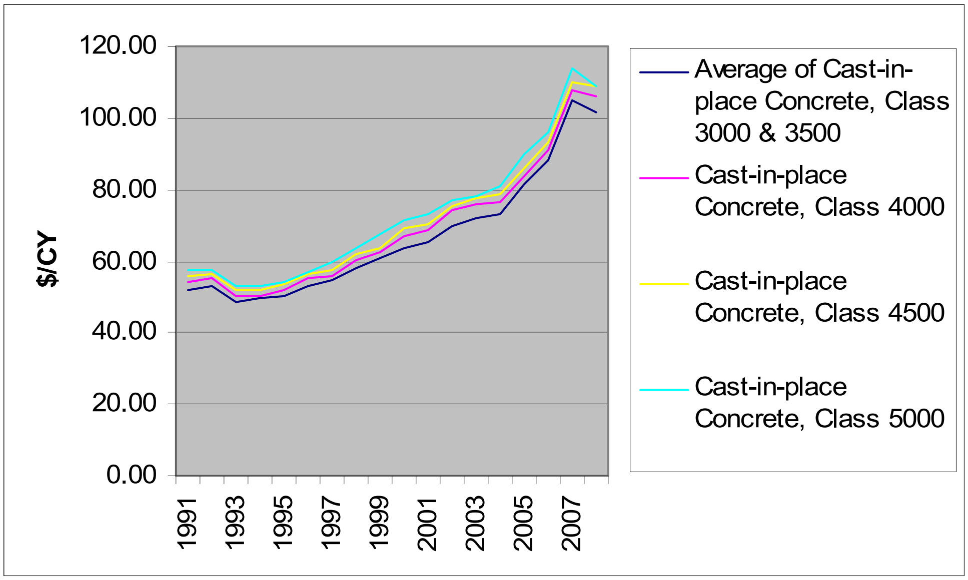
Source: (*RS Means HCCD)*

Figure 4.15: National Historic Structural Excavation Bid Item Unit Prices



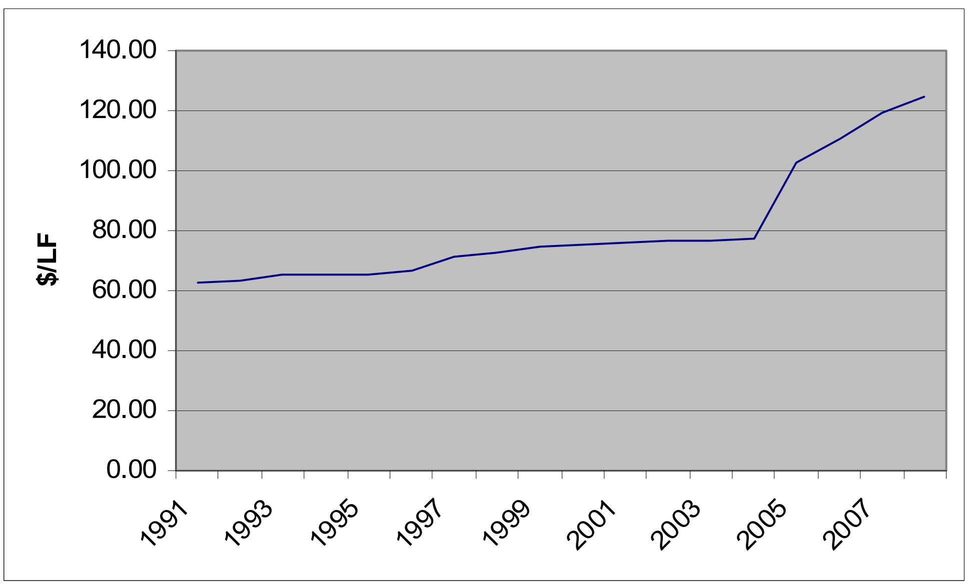
Source: (*RS Means HCCD)*

Figure 4.16: National Historic Reinforcement, Coated Reinforcement, & Structural Steel Bid Item Unit Prices



Source: (*RS Means HCCD)*

Figure 4.17: National Historic Structural Concrete Bid Item Unit Prices



Source: (*RS Means HCCD)*

Figure 4.18: National Historic Steel Rail Bid Item Unit Prices

For all bid items considered, the price in 2008 is higher than the 1991 price. In 2001, the structural excavation price dropped below the price listed in 1996 and also dropped in 2004. Reinforcement, coated reinforcement, and structural steel all experienced steady increases for most years. A significant increase in price for these bid items occurred in 2005. The price of reinforcement and coated reinforcement rose considerably in 2001. Concrete prices rose exponentially from 1991 to 2007 and then decreased in 2008. After 2005, the price of steel rails increased substantially. Therefore, the price for each bid item analyzed has inflated.

Compiling the different bid items provided a national prototype. ODOT supplemented the annual total cost of each bid item on the *final list* for every project from 1972 to 2008 along with the total cost for each of those projects. Class 3300, 4000 and 4500 structural concrete have not been used for a number of years, and were therefore dropped from the national prototype. For future reference, these classes of structural concrete could be added to the national prototype and Oregon State Index. The initial process for developing the national prototype was to calculate the weighted average for each bid item on the *final list*. The first step for calculating the weighted averages was to determine the annual percentage cost. The annual percentage cost for each bid item on the *final list* was calculated by taking the annual total cost Oregon spent for each bid item and dividing it by the annual total cost for all six bid items. ODOT was able to acquire this information from 1972 to 2008. Table 4.11 lists the annual percentage costs for each bid item, and the average across all years.

Table 4.11: Annual Percentage Cost of Total Structural Construction for Selected Bid Items

Year	Structural Excavation	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	Steel Rail
1972	0.067227	0.372863	0.000000	0.425918	0.112379	0.021614
1973	0.053335	0.348363	0.000000	0.352316	0.223244	0.022742
1974	0.045375	0.566630	0.000000	0.088356	0.297112	0.002526
1975	0.097573	0.628157	0.025467	0.000000	0.201407	0.047396
1976	0.045161	0.268378	0.113939	0.492257	0.076422	0.003843
1977	0.044914	0.305510	0.090777	0.524442	0.004588	0.029768
1978	0.052475	0.329544	0.061292	0.225228	0.328856	0.002606
1979	0.061816	0.477502	0.097757	0.280276	0.059587	0.023062
1980	0.103541	0.370640	0.066258	0.364212	0.087024	0.008325
1981	0.082810	0.226179	0.047514	0.000000	0.621787	0.021710
1982	0.064226	0.289601	0.134757	0.208733	0.292899	0.009784
1983	0.063917	0.321177	0.071642	0.280957	0.247320	0.014987
1984	0.062650	0.300353	0.122859	0.256272	0.220673	0.037194
1985	0.047736	0.226659	0.185324	0.154206	0.331709	0.054365
1986	0.093030	0.358912	0.120794	0.314802	0.081970	0.030492
1987	0.061103	0.511169	0.160981	0.164251	0.092903	0.009593
1988	0.051667	0.067272	0.291902	0.408202	0.178393	0.002564
1989	0.055246	0.174462	0.113882	0.162264	0.481978	0.012167
1990	0.050331	0.260216	0.128456	0.242217	0.312390	0.006390
1991	0.071709	0.296968	0.198772	0.411152	0.015746	0.005655
1992	0.074763	0.286092	0.179964	0.356182	0.079123	0.023877
1993	0.124654	0.274685	0.123150	0.352835	0.106519	0.018157
1994	0.101185	0.221971	0.111654	0.479592	0.049293	0.036306
1995	0.075937	0.293148	0.144866	0.397493	0.027185	0.061371
1996	0.037204	0.187637	0.088581	0.354277	0.327662	0.004639
1997	0.138922	0.248638	0.073855	0.438262	0.072483	0.027840
1998	0.131847	0.342169	0.169078	0.123161	0.215056	0.018689
1999	0.071802	0.328895	0.154768	0.399430	0.030826	0.014279
2000	0.036848	0.181986	0.114200	0.257324	0.358322	0.051320
2001	0.088935	0.328771	0.109169	0.285044	0.169782	0.018299

Year	Structural Excavation	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	Steel Rail
2002	0.035987	0.262310	0.032949	0.231410	0.419531	0.017813
2003	0.030790	0.168377	0.055486	0.408684	0.328437	0.008227
2004	0.044671	0.420048	0.069951	0.245414	0.208860	0.011056
2005	0.019114	0.217825	0.056472	0.255343	0.449974	0.001271
2006	0.035393	0.489215	0.111185	0.021241	0.337825	0.005141
2007	0.044756	0.315945	0.110328	0.119394	0.407146	0.002432
2008	0.042319	0.274888	0.035771	0.023754	0.615072	0.008195
Average	0.055819	0.286577	0.099340	0.266078	0.277311	0.014876

From 1972 to 1974, coated reinforcement was zero, suggesting that this bid item did not appear in any of the projects during this time. This can be said about Class 5000 concrete in 1975 and 1981. The last row in Table 4.11 is the weighted average for each bid item. Of the six bid items on average reinforcement, structural steel and Class 5000 concrete are the most costly. The average across all years is used as the weighted average since some bid items occur infrequently over time.

All bid items, however, are not measured in the same units. To account for this difference the percentage change in the unit price is calculated each year where 1991 was the base year. The results are presented in Table 4.12.

Table 4.12: National Percentage Change in Price for Selected Bid Items

Year	Structural Excavatio n	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	Steel Rail
1991	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
1992	1.052982	1.023669	1.022161	1.004348	1.028807	1.005104
1993	1.037109	1.036686	0.942382	0.921739	1.111111	1.040670
1994	1.008580	1.043787	0.765651	0.921739	1.113580	1.043700
1995	1.040004	1.052071	0.769529	0.939130	1.117695	1.047049
1996	1.056199	1.084024	0.801108	0.991304	1.128395	1.066348
1997	1.072608	1.147929	0.847645	1.043478	1.198354	1.134290
1998	1.078614	1.171598	0.867036	1.104348	1.302881	1.162360
1999	1.102317	1.183432	0.872576	1.173913	1.327572	1.191228
2000	1.110575	1.201183	0.878116	1.243478	1.336626	1.204147
2001	1.047512	1.656805	1.274238	1.269565	1.392593	1.211483
2002	1.145538	1.704142	1.296399	1.339130	1.413992	1.219298
2003	1.171600	1.721893	1.304709	1.356522	1.445267	1.224721
2004	1.148434	1.739645	1.313019	1.408696	1.477366	1.231419
2005	1.174281	2.136095	1.664820	1.565217	1.868313	1.634769
2006	1.202917	2.301775	1.797784	1.669565	2.014815	1.762041
2007	1.279816	2.473373	1.933518	1.982609	2.165432	1.899681
2008	1.350386	2.585799	2.027701	1.895652	2.304527	1.988038

From 1991 to 2008, according to *RS Means HCCD,* the largest percentage change was the cost of reinforcement, which increased at the rate of 259 percent. Structural excavation had the smallest percentage change in cost, but still increased by 35 percent. Each of these values in

Table 4.12 was multiplied by the respective weighted average where the results are in Table 4.13.

Table 4.13: National Percentage Change in Price Multiplied by Respective Weighted Average

Year	Structural Excavation	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	Steel Rail
1991	0.055819	0.286577	0.099340	0.266078	0.277311	0.014876
1992	0.058777	0.293360	0.101541	0.267235	0.285299	0.014952
1993	0.057891	0.297090	0.093616	0.245255	0.308123	0.015481
1994	0.056298	0.299125	0.076059	0.245255	0.308808	0.015526
1995	0.058052	0.301499	0.076445	0.249882	0.309949	0.015576
1996	0.058956	0.310656	0.079582	0.263764	0.312916	0.015863
1997	0.059872	0.328970	0.084205	0.277647	0.332316	0.016873
1998	0.060207	0.335753	0.086131	0.293843	0.361303	0.017291
1999	0.061531	0.339144	0.086681	0.312353	0.368150	0.017720
2000	0.061991	0.344231	0.087232	0.330862	0.370661	0.017913
2001	0.058471	0.474802	0.126582	0.337803	0.386181	0.018022
2002	0.063943	0.488367	0.128784	0.356313	0.392115	0.018138
2003	0.065398	0.493454	0.129609	0.360941	0.400788	0.018219
2004	0.064105	0.498542	0.130435	0.374823	0.409689	0.018318
2005	0.065548	0.612155	0.165382	0.416470	0.518103	0.024318
2006	0.067146	0.659635	0.178591	0.444235	0.558730	0.026212
2007	0.071438	0.708811	0.192075	0.527529	0.600498	0.028259
2008	0.075378	0.741030	0.201431	0.504391	0.639070	0.029574

Summing the rows together from Table 4.13 gives the national prototype. The results are in Table 4.14.

Table 4.14: National Prototype

Year	Index
1991	1.000000
1992	1.021163
1993	1.017455
1994	1.001071
1995	1.011403
1996	1.041737
1997	1.099883
1998	1.154527
1999	1.185579
2000	1.212890
2001	1.401861
2002	1.447660
2003	1.468409
2004	1.495912
2005	1.801976
2006	1.934548
2007	2.128609
2008	2.190873

The national prototype represents the total cost for structures from 1991 to 2008. According to the table, the cost of structural projects has more than doubled during this time. Based on this approach with these specific bid items, $1000 work performed in 1991 is not the same as in 2008. Therefore, the fuel usage factor for structures should be reevaluated.

4.5 OREGON STATE INDEX

In addition to the national prototype, an index was created for the state of Oregon. ODOT compiled the unit price for each bid item in the *final list* from 1972 to 2008. The unit bid item price is the listed unit price from the lowest bid of the three final bid proposals. The unit price includes material, labor, and equipment costs that are consistent with *RS Means HCCD*. The unit costs for the respective bid items are in Table 4.15 and prices are shown in Figure 4.19 through 4.22.

Table 4.15: Oregon Bid Item Unit Prices

Year	Struct. Excav. ($/CY)	Reinf. ($/lb)	Coated Reinf. ($/lb)	Class 3300 ($/CY)	Class 4000 ($/CY)	Class 4500 ($/CY)	Class 5000 ($/CY)	Struct. Steel ($/lb)	2 Tube Steel Rail ($/LF)
1972	5.75	0.16	-	-	-	-	118.13	0.49	14.43
1973	4.57	0.21	-	106.42	116.24	-	132.56	0.34	14.16
1974	7.15	0.44	-	151.16	161.64	-	189.19	0.81	30.91
1975	11.53	0.29	0.63	143.03	144.33	-	-	0.76	30.55
1976	9.49	0.23	0.54	158.75	220.75	-	150.18	0.90	23.00
1977	4.38	0.24	0.40	110.06	173.70	145.25	154.33	1.13	32.60
1978	8.07	0.30	0.49	142.56	188.84	195.17	144.27	0.79	35.00
1979	9.07	0.44	0.78	271.00	175.00	249.00	366.00	0.77	37.00
1980	9.62	0.49	0.79	214.04	230.04	204.57	385.16	1.02	62.00
1981	18.49	0.44	0.59	249.96	190.05	210.68	-	1.24	40.87
1982	10.54	0.39	0.56	227.28	266.31	215.22	276.91	0.69	35.21
1983	7.54	0.36	0.51	196.93	235.39	241.79	205.64	0.70	35.69
1984	9.56	0.39	0.56	228.00	251.33	247.95	314.36	1.31	37.41
1985	9.46	0.37	0.55	220.80	215.06	186.85	192.16	0.90	35.60
1986	9.46	0.37	0.50	243.15	227.01	191.06	225.40	1.37	39.23
1987	9.23	0.49	0.52	283.94	259.42	-	306.44	0.98	32.54
1988	14.47	0.45	0.64	233.41	294.83	328.64	402.82	1.21	40.62
1989	14.61	0.45	0.61	325.78	338.95	304.35	287.47	1.18	38.24
1990	20.16	0.43	0.63	312.73	333.52	-	430.59	1.26	45.21
1991	15.87	0.43	0.61	309.56	322.51	-	298.29	2.08	47.07
1992	10.12	0.40	0.65	221.62	298.40	334.81	323.71	1.10	53.28
1993	11.16	0.41	0.60	301.71	229.98	309.03	292.23	1.01	58.03
1994	15.77	0.45	0.62	309.67	367.38	381.41	394.17	1.73	53.76
1995	8.97	0.54	0.75	361.46	496.75	382.32	378.30	1.50	45.44
1996	15.23	0.46	0.71	334.34	433.79	460.59	460.59	1.24	44.81
1997	28.11	0.57	0.61	398.48	-	-	657.64	2.47	70.14
1998	17.30	0.56	0.80	287.79	-	-	574.31	2.39	58.66
1999	19.98	0.55	0.76	295.09	-	-	438.06	1.04	128.82
2000	28.33	0.51	0.71	-	-	-	484.34	1.41	65.90
2001	18.60	0.61	0.89	-	-	-	326.29	1.30	65.35

Year	Struct. Excav. ($/CY)	Reinf. ($/lb)	Coated Reinf. ($/lb)	Class 3300 ($/CY)	Class 4000 ($/CY)	Class 4500 ($/CY)	Class 5000 ($/CY)	Struct. Steel ($/lb)	2 Tube Steel Rail ($/LF)
2002	19.46	0.57	0.67	-	-	-	447.30	1.72	52.33
2003	19.89	0.54	0.78	-	-	-	588.56	1.65	77.99
2004	15.00	0.75	1.05	1539.75	-	-	478.74	1.76	95.77
2005	20.11	0.93	1.20	466.67	-	-	1255.06	1.94	92.82
2006	32.22	0.94	1.07	1472.73	-	-	925.10	2.23	171.67
2007	26.68	1.04	1.36	-	1041.67	1005.97	1365.47	2.20	158.43
2008	27.88	1.22	1.36	1159.22	974.61	-	1374.23	3.07	163.22

Source: ODOT, "unpublished data"

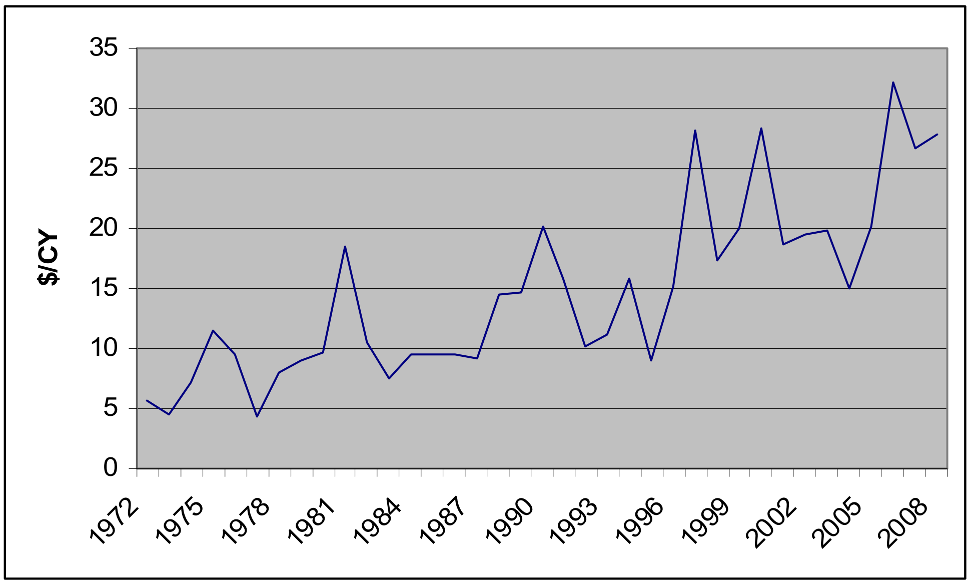


Figure 4.19: Oregon's Historic Structural Excavation Bid Item Unit Prices

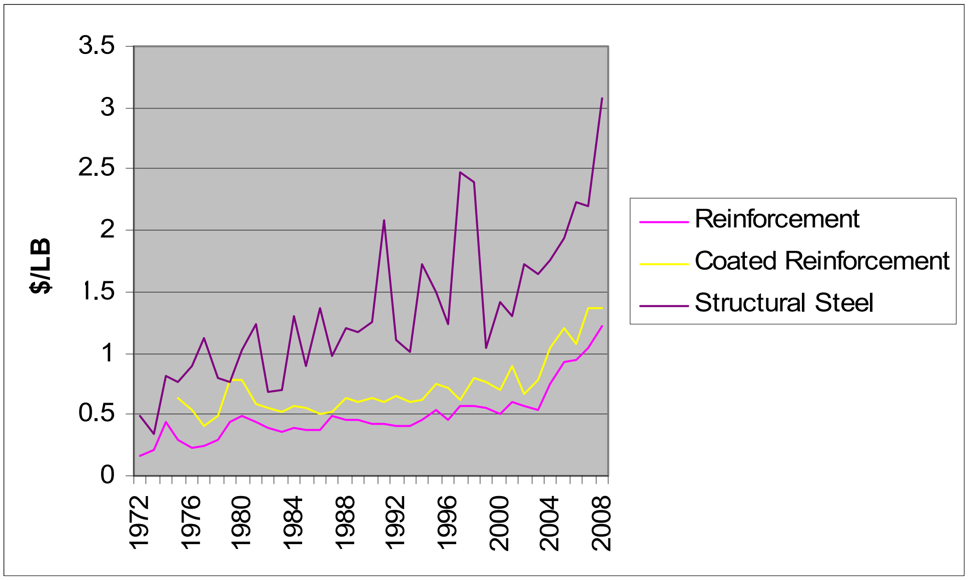


Figure 4.20: Oregon's Historic Reinforcement, Coated Reinforcement, & Structural Steel Bid Item Unit Prices

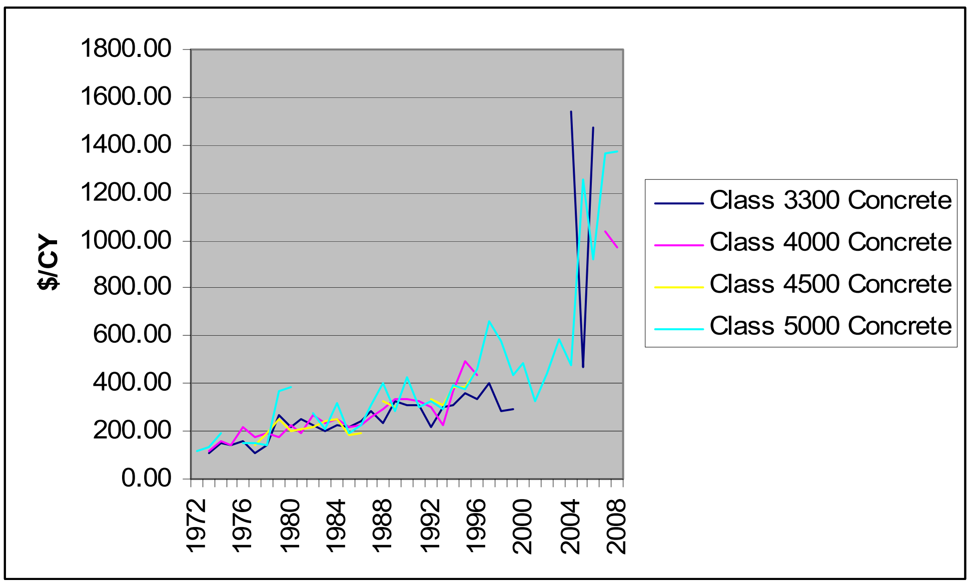


Figure 4.21: Oregon's Historic Structural Concrete Bid Item Unit Prices

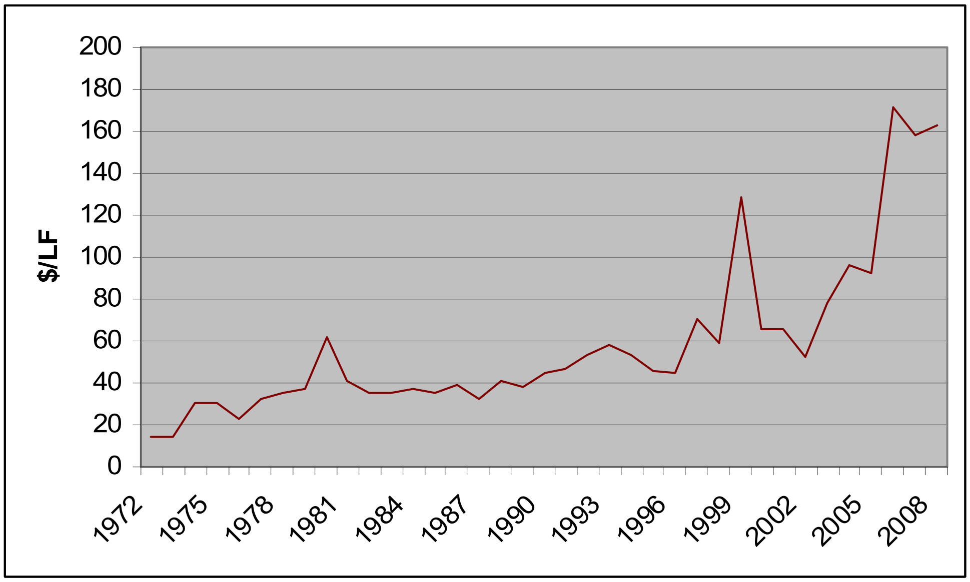


Figure 4.22: Oregon's Historic 2 Tube Steel Rail Bid Item Unit Prices

Overall, the unit prices for the different items have increased in Oregon. The structural excavation price increased significantly in 1981, 1990, 1997, 2000, and 2006, but then dropped the year after. Reinforcement and coated reinforcement showed steady increases for most years except for in 1974 and 1980. A significant price increase for structural steel occurred in 1997 and 1998. The price of concrete rose considerably in 1997, a larger increase existed in 2005 where the price increased by almost four times. Steel rail prices peaked in 1999 and rose again in 2006, which has not decreased since. For each of the structural bid items analyzed, the unit costs have inflated from 1972 to 2008.

Gathering the Oregon unit costs for each bid item yielded an Oregon State Index. Since Class 3500, 4000, and 4500 concrete were not used for a number of years from 1972 to 2008 they were dropped from the list. Dropping these three different concrete types from the list did not have any major impact since they account between 3 and 4 percent of the total structural construction costs. The method for calculating the Oregon State Index is consistent with the process for determining the national prototype. The percentage change in price from 1972 to 2008, using 1991 as the base year, was calculated for Oregon. The results are presented in Table 4.16.

Table 4.16: Oregon State Percentage Change in Price for Selected Bid Items

Year	Structural Excavation	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	2-Tube Steel Rail
1972	0.362319	0.372093	-	0.396011	0.233642	0.306565
1973	0.287965	0.490698	-	0.444392	0.162813	0.300829
1974	0.450536	1.023256	-	0.634245	0.389423	0.656682
1975	0.726528	0.672093	1.037530	-	0.363942	0.649033
1976	0.597984	0.525581	0.891803	0.503470	0.433654	0.488634
1977	0.275992	0.558140	0.655738	0.517382	0.543269	0.692586
1978	0.508507	0.700000	0.809836	0.483657	0.379808	0.743573
1979	0.571519	1.023256	1.278689	1.226994	0.370192	0.786063
1980	0.606175	1.134186	1.291475	1.291227	0.490721	1.317187
1981	1.165091	1.018605	0.960984	-	0.596154	0.868281
1982	0.664146	0.904651	0.916393	0.928325	0.331091	0.748035
1983	0.475110	0.844186	0.840984	0.689396	0.336538	0.758232
1984	0.602394	0.909302	0.921311	1.053874	0.628365	0.794826
1985	0.596093	0.860465	0.901639	0.644205	0.432692	0.756320
1986	0.596093	0.860465	0.819672	0.755640	0.658654	0.833440
1987	0.581601	1.139535	0.852459	1.027322	0.471154	0.691311
1988	0.911783	1.046512	1.049180	1.350431	0.581731	0.862970
1989	0.920605	1.046512	1.000000	0.963727	0.567308	0.812407
1990	1.270321	1.000000	1.032787	1.443528	0.605769	0.960484
1991	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
1992	0.637681	0.930233	1.065574	1.085219	0.528846	1.131931
1993	0.703214	0.953488	0.983607	0.979684	0.485577	1.232845
1994	0.993699	1.046512	1.016393	1.321432	0.831731	1.142129
1995	0.565217	1.255814	1.229508	1.268229	0.721154	0.965371
1996	0.959672	1.069767	1.163934	1.544101	0.596154	0.952086
1997	1.771267	1.324651	1.004590	2.204710	1.189788	1.490172
1998	1.090107	1.312226	1.314197	1.925324	1.148638	1.246322
1999	1.258979	1.272093	1.244262	1.468558	0.502114	2.736832
2000	1.785129	1.189535	1.157131	1.623724	0.678524	1.400015
2001	1.172023	1.418605	1.455989	1.093853	0.624404	1.388414
2002	1.226213	1.325581	1.098361	1.499547	0.828531	1.111778
2003	1.253201	1.265065	1.282118	1.973122	0.792365	1.656836
2004	0.944928	1.754936	1.716885	1.604933	0.847500	2.034543
2005	1.267410	2.164647	1.971230	4.207516	0.934158	1.971866
2006	2.030372	2.193032	1.757128	3.101348	1.073220	3.647217
2007	1.681386	2.429137	2.234377	4.577659	1.059142	3.365774
2008	1.756587	2.837940	2.231803	4.607037	1.477988	3.467511

Table 4.16 demonstrates that the price of the different construction bid items increased at a greater rate than was reported in *RS Means HCCD*. The bid item with the greatest percentage price increase was Class 5000 Concrete, which increased by almost 915 percent. The bid item with the smallest percentage change in price was structural excavation which increased 35 percent, the same result as found using the *RS Means HCCD*.

The weighted averages computed in the last row of Table 4.11 are applied to each row of Table 4.16. Results of this calculation are in Table 4.17.

Table 4.17: Oregon State Percentage Change in Price Multiplied by Respective Weighted Average

Year	Structural Excavation	Reinforcement	Coated Reinforcement	Class 5000 Concrete	Structural Steel	2 Tube Steel Rail
1972	0.020224	0.106633	-	0.105370	0.064792	0.004560
1973	0.016074	0.140623	-	0.118243	0.045150	0.004475
1974	0.025149	0.293241	-	0.168759	0.107991	0.009769
1975	0.040554	0.192606	0.103068	-	0.100925	0.009655
1976	0.033379	0.150619	0.088591	0.133962	0.120257	0.007269
1977	0.015406	0.159950	0.065141	0.137664	0.150654	0.010303
1978	0.028384	0.200604	0.080449	0.128690	0.105325	0.011061
1979	0.031902	0.293241	0.127024	0.326476	0.102658	0.011693
1980	0.033836	0.325031	0.128295	0.343567	0.136082	0.019594
1981	0.065035	0.291908	0.095464	-	0.165320	0.012916
1982	0.037072	0.259252	0.091034	0.247007	0.091815	0.011128
1983	0.026520	0.241924	0.083543	0.183433	0.093326	0.011279
1984	0.033625	0.260585	0.091523	0.280413	0.174252	0.011824
1985	0.033273	0.246589	0.089568	0.171409	0.119990	0.011251
1986	0.033273	0.246589	0.081426	0.201059	0.182652	0.012398
1987	0.032465	0.326564	0.084683	0.273348	0.130656	0.010284
1988	0.050895	0.299906	0.104225	0.359320	0.161320	0.012837
1989	0.051387	0.299906	0.099340	0.256427	0.157321	0.012085
1990	0.070908	0.286577	0.102597	0.384091	0.167986	0.014288
1991	0.055819	0.286577	0.099340	0.266078	0.277311	0.014876
1992	0.035595	0.266583	0.105854	0.288753	0.146655	0.016838
1993	0.039253	0.273248	0.097711	0.260672	0.134656	0.018339
1994	0.055468	0.299906	0.100968	0.351604	0.230648	0.016990
1995	0.031550	0.359887	0.122139	0.337448	0.199984	0.014361
1996	0.053568	0.306570	0.115625	0.410852	0.165320	0.014163
1997	0.098871	0.379614	0.099796	0.586625	0.329941	0.022167
1998	0.060849	0.376053	0.130552	0.512287	0.318530	0.018540
1999	0.070275	0.364552	0.123604	0.390751	0.139242	0.040712
2000	0.099645	0.340893	0.114949	0.432037	0.188162	0.020826
2001	0.065421	0.406539	0.144637	0.291050	0.173154	0.020654
2002	0.068446	0.379881	0.109111	0.398997	0.229761	0.016539
2003	0.069953	0.362538	0.127365	0.525005	0.219731	0.024647
2004	0.052745	0.502924	0.170555	0.427038	0.235021	0.030265
2005	0.070746	0.620337	0.195821	1.119528	0.259052	0.029333
2006	0.113334	0.628472	0.174552	0.825201	0.297616	0.054255
2007	0.093854	0.696134	0.221962	1.218015	0.293712	0.050068
2008	0.098051	0.813287	0.221706	1.225831	0.409862	0.051582

Summing up each row yields the Oregon State Index, which is presented in Table 4.18.

Table 4.18: Oregon State Index

Year	Index
1972	0.301579
1973	0.324564
1974	0.604908
1975	0.446808
1976	0.534078
1977	0.539117
1978	0.554513
1979	0.892995
1980	0.986406
1981	0.630643
1982	0.737308
1983	0.640025
1984	0.852221
1985	0.672081
1986	0.757398
1987	0.857999
1988	0.988503
1989	0.876465
1990	1.026447
1991	1.000000
1992	0.860277
1993	0.823879
1994	1.055583
1995	1.065368
1996	1.066098
1997	1.517014
1998	1.416810
1999	1.129137
2000	1.196512
2001	1.101455
2002	1.202733
2003	1.329239
2004	1.418547
2005	2.294817
2006	2.093429
2007	2.573744
2008	2.820320

The Oregon State Index has tracked a significant percent of the cost for structures from 1972 to 2008. According to the table, the cost of structural projects in Oregon has increased by more than eight and a half times from 1972 to 2008. This further supports for these specific bid items, $1000 of work performed in 1972 is not the same as in 2008 when accounting for inflation of bid item prices.

4.6 ANALYSIS

Since the Oregon's bid items do not correspond exactly to those listed in *RS Means HCCD*, the percentage change in price is evaluated. The results indicate that the percentage change in price is more varied for the Oregon bid items. Figures 4.23 through 4.28 show price trends for six different items that were applied to the national prototype and the Oregon State Index using 1991 as the base year.

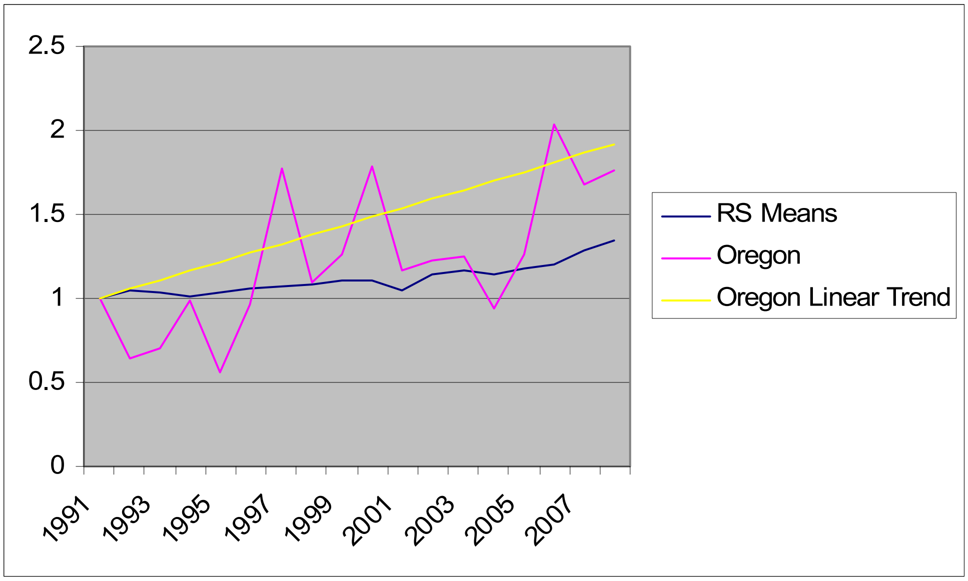


Figure 4.23: Price Percentage Change Trend for Structural Excavation

Figure 4.23 shows the percentage change in price for structural excavation in Oregon is highly varied. A linear trend for Oregon was also calculated that demonstrates the price of structural excavation in Oregon has been increasing over time at a greater rate than *RS Means HCCD.* From 1991 to 1998 the percentage change in price is lower in Oregon. For the remaining years, it is higher than the *RS Means RS Means HCCD* except in 2004.

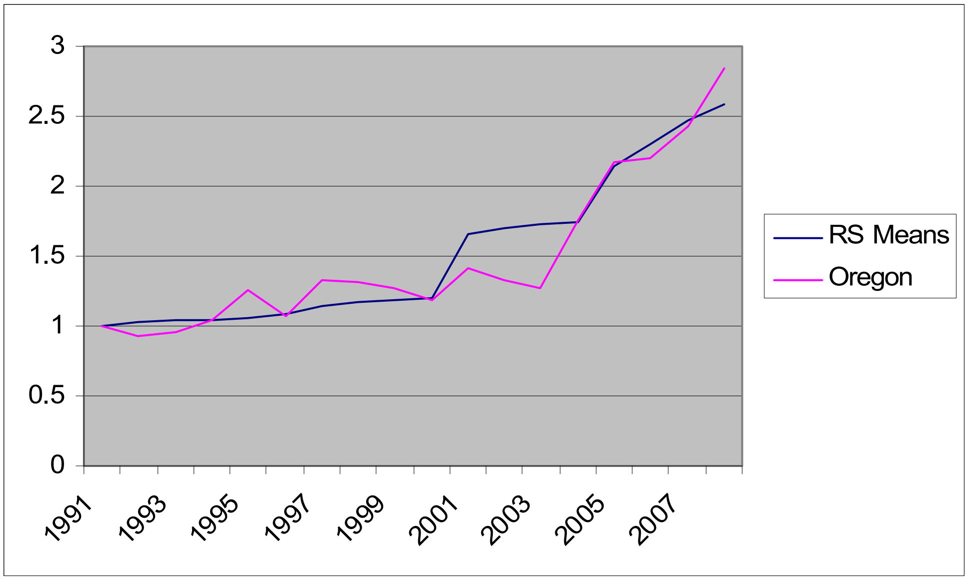


Figure 4.24: Price Percentage Change Trend for Reinforcement

Figure 4.24 demonstrates that for steel reinforcement the percentage change in price for Oregon and *RS Means HCCD* follow the same trend but except from 2001 to 2003 where Oregon is lower.

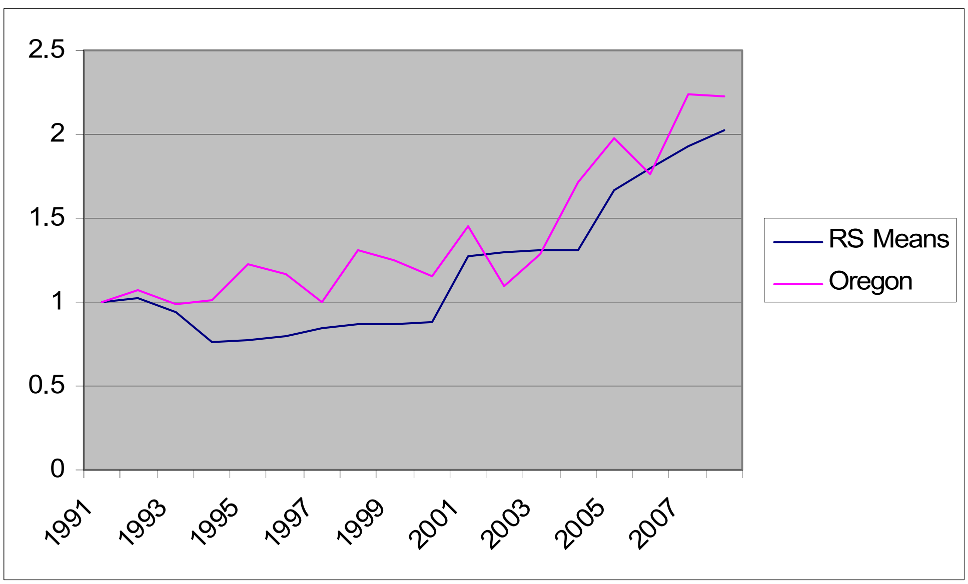


Figure 4.25: Price Percentage Change Trend for Coated Reinforcement

The *RS Means HCCD* percentage change in price is lower every year for coated steel reinforcement, except for 2002 and 2003, as shown in Figure 4.25.

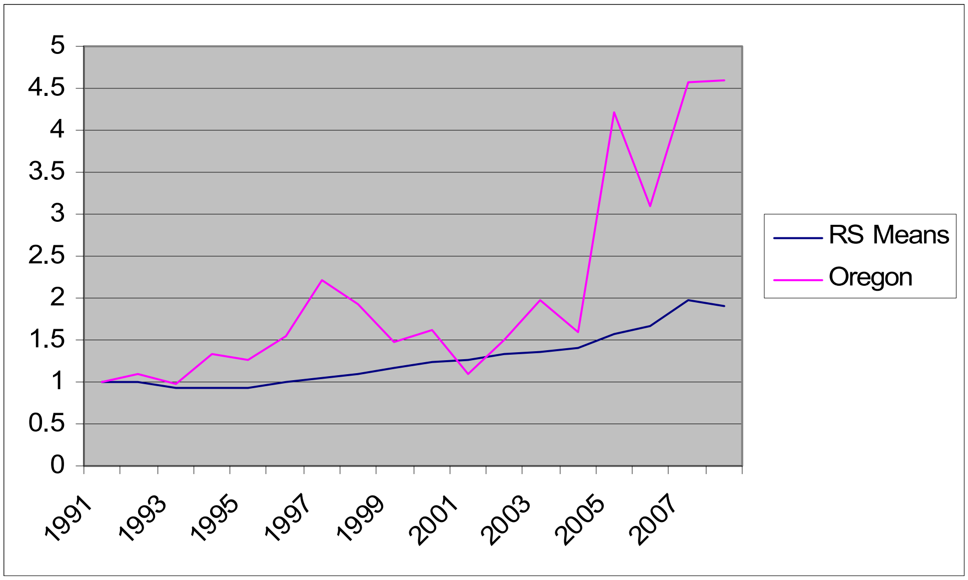


Figure 4.26: Price Percentage Change Trend for Class 5000 Concrete

In Figure 4.26, each year the percentage change in price for structural concrete Class 5000 is higher for Oregon, except in 2001 where it dropped below *RS Means HCCD*.

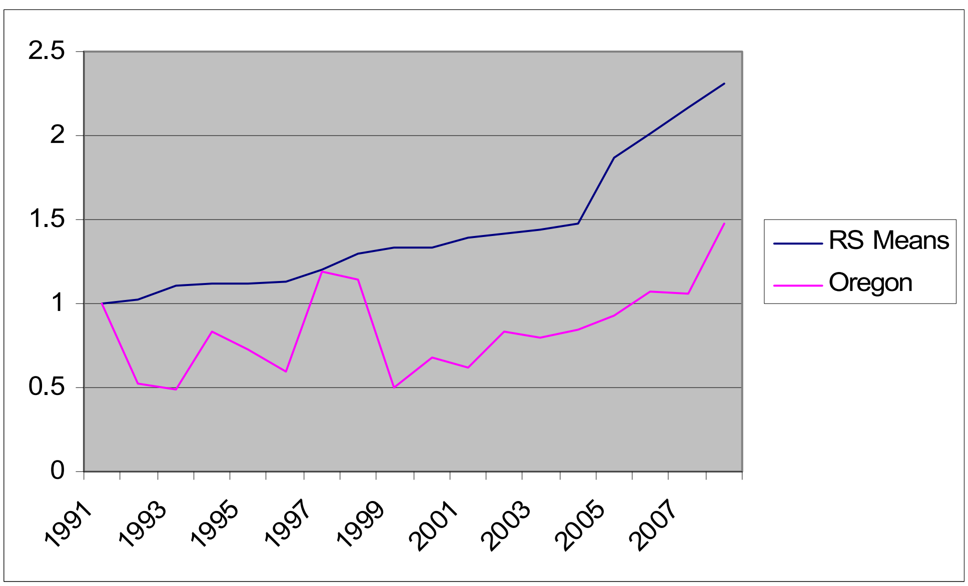


Figure 4.27: Price Percentage Change Trend for Structural Steel

After 2000, *RS Means HCCD* and Oregon's values for structural steel increase close to the same rate (see Figure 4.27). The percentage change in price is lower every year in the study for Oregon.

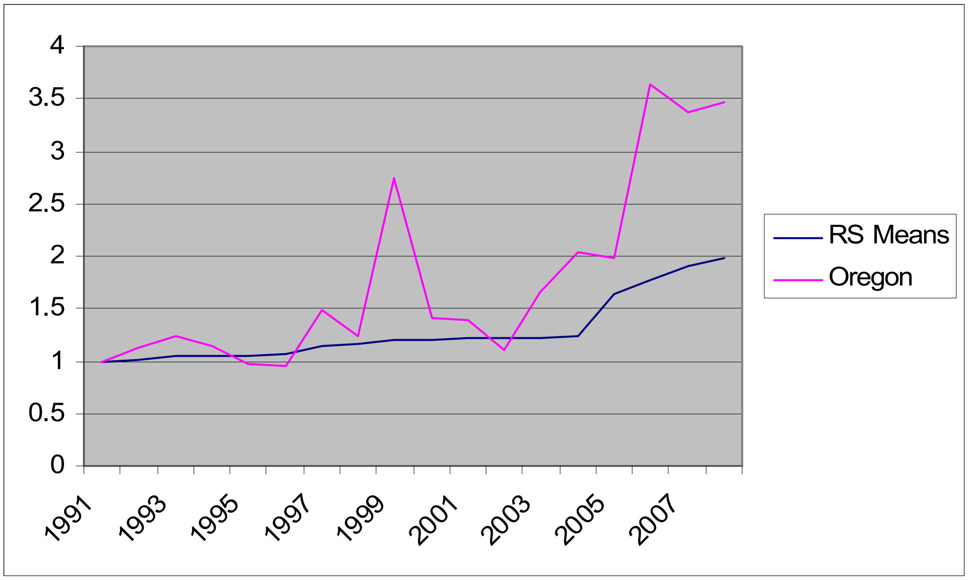


Figure 4.28: Price Percentage Change Trend for Steel Rail

Figure 4.28 shows that in 1999 the percentage change in bridge rails jumped in Oregon, but remained fairly constant for *RS Means HCCD*. After 2003, the percentage change in price for bridge rails in Oregon was much higher than listed in *RS Means HCCD*.

In general, for most bid items analyzed in this study, the percentage change in price was higher for Oregon, and showed more volatility. The unstable prices in Oregon, however, may be due to analyzing a specific bid item. The types of construction projects change from year to year and bid item prices are influenced by the amount each bid item is used. Therefore, the results here suggest that the state of Oregon should analyze local prices.

4.7 RELATIONSHIP OF THE TWO INDICES

The purpose for compiling two different indices is to determine the relationship between the two, and also identify construction costs over time. Neither index, however, measures the true cost of structural highway construction projects. For the six bid items analyzed, the indices are capturing, on average, about 20 percent of the total cost.

Figure 4.29 displays the trend between the national prototype and the Oregon State Index.

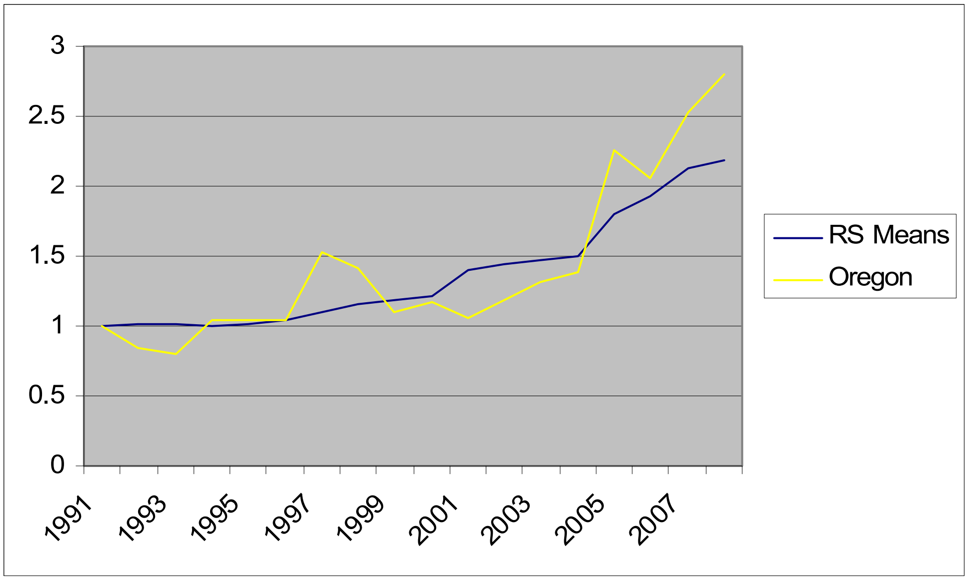


Figure 4.29: Price Percentage Change Trend for the National Prototype and Oregon State Index

Design standards and market forces in Oregon have changed during the time period shown in Figure 4.29, leading to fluctuating prices. The Oregon State Index exhibits more fluctuations between years, and is higher from 2005 to 2008. Oscillations in the Oregon State Index occur because of changes in the demand for the different bid items under investigation. Smaller changes in the *RS Means HCCD* prices could be due to the fact that the prices listed are averages from several different locations. This suggests that bid item prices in the state of Oregon are harder to predict than listed in *RS Means HCCD.*

The greatest variability between the two indices is found within the last four years of the study. Oregon bid items prices inflate more than the prices listed in *RS Means HCCD.* Transforming both indices into a linear trend yielded 0.019 and 0.013 for the Oregon State Index and national prototype, respectively. The standard error for the Oregon State Index and national prototype was 0.0013 and 0.0035, respectively. This implies that the linear trend for Oregon is almost one and one half of the national prototype. The trends also suggest that, on average, construction costs increase between 1 and 2 percent each year. The linear trend for each bid item from the respective source is shown in Table 4.19 where the standard error is in parenthesis.

Table 4.19: Linear Trend for Each Bid Item

	RS Means	Oregon
Structural Excavation	0.015893 (0.001903)	0.053973 (0.014679)
Reinforcement	0.095019 (0.00925)	0.091066 (0.012694)
Coated Reinforcement	0.066089 (0.010367)	0.067134 0.010074)
Structural Concrete	0.057303 (0.005662)	0.178744 (0.035489)
Structural Steel	0.068202 (0.007321)	0.024927 (0.011032)
Steel Rail	0.05103 (0.007284)	0.131809 (0.027021)

Of the linear trends from *RS Means HCCD* the steepest is reinforcement. From Oregon, the two greatest linear trends (structural concrete and steel rail) are around three times more than the linear trend in *RS Means HCCD.* The remaining bid item trends from Oregon are also approximately three times greater than *RS Means HCCD*, except for reinforcement and coated reinforcement, which are similar. Bid item weights cause the Oregon State Index and the national prototype trends to be more analogous than the individual bid item trends.

4.8 FORMATION OF TWO ADDITIONAL INDICES

The national prototype measures from 1991 to 2008, while the Oregon State Index begins in 1972. Table 4.7, supplemented by FHWA, reports unit costs on a national level for three bid items ranging from 1972 to 2006. A FHWA index was created based on these three bid items and compared to an adjusted Oregon State Index that is comprised of the same three bid items. The purpose of comparing these two indices is to ascertain the relationship between national and Oregon structural costs over the 37 year time period.

The computation for the FHWA index and the adjusted Oregon State Index is the same as the national prototype and the Oregon State Index. The annual percentage cost for each of the three bid items on the *final list* was calculated by taking the annual total cost spent in Oregon for each bid item and dividing it by the annual total cost for the three items in the unit costs from Table 4.7 where 1991 is the base year. Table 4.20 lists the annual percentage costs for each bid item, and the average across all years.

Table 4.20: Annual Percentage Cost of Oregon's Total Structural Construction for Selected Bid Items

Year	Reinforcement	Class 5000 Concrete	Structural Steel
1972	0.409218	0.467446	0.123336
1973	0.377048	0.381326	0.241627
1974	0.595138	0.092802	0.312061
1975	0.757213	0.000000	0.242787
1976	0.320621	0.588081	0.091299
1977	0.366082	0.628420	0.005497
1978	0.372944	0.254891	0.372165
1979	0.584197	0.342902	0.072902
1980	0.450968	0.443147	0.105884
1981	0.266731	0.000000	0.733269
1982	0.366012	0.263807	0.370180
1983	0.378098	0.330751	0.291152
1984	0.386407	0.329696	0.283897
1985	0.318085	0.216407	0.465508
1986	0.474950	0.416579	0.108471
1987	0.665305	0.213779	0.120916
1988	0.102883	0.624289	0.272827
1989	0.213096	0.198196	0.588708
1990	0.319353	0.297263	0.383384
1991	0.410253	0.567995	0.021752
1992	0.396581	0.493739	0.109680
1993	0.374210	0.480676	0.145114
1994	0.295624	0.638727	0.065649
1995	0.408383	0.553745	0.037872
1996	0.215779	0.407414	0.376807
1997	0.327421	0.577129	0.095449
1998	0.502904	0.181017	0.316079
1999	0.433240	0.526154	0.040606
2000	0.228158	0.322610	0.449232
2001	0.419566	0.363764	0.216670
2002	0.287227	0.253391	0.459382
2003	0.185949	0.451336	0.362715
2004	0.480427	0.280690	0.238883
2005	0.235960	0.276602	0.487437
2006	0.576714	0.025040	0.398247
Average	0.346607	0.351347	0.302047

The last row in Table 4.20 is the weighted average for each of the three bid items analyzed. The percentage change unit price for FHWA's and Oregon's three bid items is calculated each year for the unit prices using 1991 as the base year. The results of the percentage change for the three bid items from FHWA and Oregon are presented in Tables 4.21 and 4.22, respectively.

Table 4.21: FHWA Percentage Change in Price for Selected Bid Items

Year	Reinforcing Steel	Structural Concrete	Structural Steel
1972	0.358416	0.378029	0.332039
1973	0.409901	0.421956	0.361165
1974	0.671287	0.516265	0.534951
1975	0.588119	0.523662	0.537864
1976	0.510891	0.526794	0.469903
1977	0.538614	0.541588	0.504854
1978	0.625743	0.650653	0.585437
1979	0.833663	0.797532	0.736893
1980	0.956436	0.855461	0.913592
1981	0.867327	0.874179	0.766990
1982	0.805941	0.828855	0.739806
1983	0.788119	0.807042	0.687379
1984	0.809901	0.822779	0.688350
1985	0.879208	0.919315	0.772816
1986	0.875248	0.892030	0.825243
1987	0.873267	0.908786	0.859223
1988	0.978218	1.034493	0.897087
1989	1.100990	1.069515	0.988350
1990	1.047525	1.080006	0.980583
1991	1.000000	1.000000	1.000000
1992	1.029703	0.979734	0.889320
1993	0.924752	0.988339	0.835922
1994	1.019802	1.026266	0.822330
1995	1.073267	1.142199	0.895146
1996	1.150495	1.108952	1.036893
1997	1.122772	1.211035	1.151456
1998	1.077228	1.272738	1.078641
1999	1.097030	1.291569	1.188350
2000	1.087129	1.372405	1.311650
2001	1.190099	1.281002	1.166019
2002	1.207921	1.415050	1.394175
2003	1.421782	1.532267	1.183495
2004	1.613861	1.251000	1.476699
2005	1.863366	1.490226	1.525243
2006	1.726733	2.169220	1.685437

Table 4.22: Oregon Percentage Change in Price for Selected Bid Items

Year	Reinforcement	Class 5000 Concrete	Structural Steel
1972	0.372093	0.396011	0.233642
1973	0.490698	0.444392	0.162813
1974	1.023256	0.634245	0.389423
1975	0.672093	-	0.363942
1976	0.525581	0.503470	0.433654
1977	0.558140	0.517382	0.543269
1978	0.700000	0.483657	0.379808
1979	1.023256	1.226994	0.370192
1980	1.134186	1.291227	0.490721
1981	1.018605	-	0.596154
1982	0.904651	0.928325	0.331091
1983	0.844186	0.689396	0.336538
1984	0.909302	1.053874	0.628365
1985	0.860465	0.644205	0.432692
1986	0.860465	0.755640	0.658654
1987	1.139535	1.027322	0.471154
1988	1.046512	1.350431	0.581731
1989	1.046512	0.963727	0.567308
1990	1.000000	1.443528	0.605769
1991	1.000000	1.000000	1.000000
1992	0.930233	1.085219	0.528846
1993	0.953488	0.979684	0.485577
1994	1.046512	1.321432	0.831731
1995	1.255814	1.268229	0.721154
1996	1.069767	1.544101	0.596154
1997	1.324651	2.204710	1.189788
1998	1.312226	1.925324	1.148638
1999	1.272093	1.468558	0.502114
2000	1.189535	1.623724	0.678524
2001	1.418605	1.093853	0.624404
2002	1.325581	1.499547	0.828531
2003	1.265065	1.973122	0.792365
2004	1.754936	1.604933	0.847500
2005	2.164647	4.207516	0.934158
2006	2.193032	3.101348	1.073220

The average weights found in the last row of Table 4.20 are multiplied by each row in Table 4.21 and 4.22. The weight reinforcement is multiplied by the FHWA bid item Reinforcing Steel. Class 5000 Concrete weight is multiplied by the FHWA bid item Structural Concrete. Structural Steel appears in both tables. The results of this computation are in Tables 4.23 and 4.24, respectively.

Table 4.23: FHWA Percentage Change in Price Multiplied by Respective Weighted Average

Year	Reinforcing Steel	Structural Concrete	Structural Steel
1972	0.124229	0.132819	0.100291
1973	0.142074	0.148253	0.109089
1974	0.232673	0.181388	0.161580
1975	0.203846	0.183987	0.162460
1976	0.177078	0.185088	0.141933
1977	0.186687	0.190285	0.152490
1978	0.216887	0.228605	0.176829
1979	0.288953	0.280210	0.222576
1980	0.331507	0.300563	0.275947
1981	0.300621	0.307140	0.231667
1982	0.279344	0.291215	0.223456
1983	0.273167	0.283552	0.207620
1984	0.280717	0.289081	0.207914
1985	0.304739	0.322998	0.233426
1986	0.303367	0.313412	0.249262
1987	0.302680	0.319299	0.259526
1988	0.339057	0.363466	0.270962
1989	0.381610	0.375770	0.298528
1990	0.363079	0.379457	0.296182
1991	0.346607	0.351347	0.302047
1992	0.356902	0.344226	0.268616
1993	0.320525	0.347250	0.252488
1994	0.353470	0.360575	0.248382
1995	0.372002	0.401308	0.270376
1996	0.398769	0.389627	0.313190
1997	0.389160	0.425493	0.347794
1998	0.373374	0.447172	0.325800
1999	0.380238	0.453789	0.358937
2000	0.376806	0.482190	0.396180
2001	0.412496	0.450076	0.352192
2002	0.418673	0.497173	0.421106
2003	0.492799	0.538357	0.357471
2004	0.559375	0.439535	0.446032
2005	0.645855	0.523586	0.460694
2006	0.598497	0.762148	0.509081

Table 4.24: Oregon Percentage Change in Price Multiplied by Respective Weighted Average

Year	Reinforcement	Class 5000 Concrete	Structural Steel
1972	0.128970	0.139137	0.070571
1973	0.170079	0.156136	0.049177
1974	0.354667	0.222840	0.117624
1975	0.232952	-	0.109928
1976	0.182170	0.176892	0.130984
1977	0.193455	0.181781	0.164093
1978	0.242625	0.169931	0.114720
1979	0.354667	0.431100	0.111815
1980	0.393116	0.453668	0.148221
1981	0.353055	-	0.180066
1982	0.313558	0.326164	0.100005
1983	0.292600	0.242217	0.101650
1984	0.315170	0.370275	0.189796
1985	0.298243	0.226339	0.130693
1986	0.298243	0.265492	0.198944
1987	0.394970	0.360946	0.142310
1988	0.362728	0.474469	0.175710
1989	0.362728	0.338602	0.171353
1990	0.346607	0.507179	0.182971
1991	0.346607	0.351347	0.302047
1992	0.322425	0.381288	0.159736
1993	0.330485	0.344209	0.146667
1994	0.362728	0.464281	0.251222
1995	0.435273	0.445588	0.217822
1996	0.370788	0.542515	0.180066
1997	0.459133	0.774618	0.359372
1998	0.454826	0.676456	0.346942
1999	0.440916	0.515973	0.151662
2000	0.412301	0.570490	0.204946
2001	0.491698	0.384322	0.188599
2002	0.459455	0.526861	0.250255
2003	0.438480	0.693250	0.239331
2004	0.608273	0.563888	0.255985
2005	0.750281	1.478297	0.282159
2006	0.760119	1.089649	0.324163

Summing each row in Table 4.23 yields the FHWA Index, which is presented in Table 4.25.

Table 4.25: FHWA Index

Year	Index
1972	0.357340
1973	0.399416
1974	0.575641
1975	0.550293
1976	0.504098
1977	0.529462
1978	0.622321
1979	0.791740
1980	0.908018
1981	0.839428
1982	0.794016
1983	0.764339
1984	0.777711
1985	0.861164
1986	0.866040
1987	0.881505
1988	0.973485
1989	1.055909
1990	1.038717
1991	1.000000
1992	0.969745
1993	0.920262
1994	0.962427
1995	1.043685
1996	1.101586
1997	1.162447
1998	1.146346
1999	1.192963
2000	1.255176
2001	1.214764
2002	1.336952
2003	1.388627
2004	1.444942
2005	1.630135
2006	1.869726

Summing each row in Table 4.24 yields the adjusted Oregon State Index, which is presented in Table 4.26.

Table 4.26: Adjusted Oregon State Index

Year	Index
1972	0.338678
1973	0.375392
1974	0.695131
1975	0.342879
1976	0.490046
1977	0.539328
1978	0.527276
1979	0.897583
1980	0.995005
1981	0.533121
1982	0.739727
1983	0.636468
1984	0.875241
1985	0.655276
1986	0.762679
1987	0.898227
1988	1.012907
1989	0.872683
1990	1.036756
1991	1.000000
1992	0.863449
1993	0.821361
1994	1.078230
1995	1.098684
1996	1.093370
1997	1.593122
1998	1.478225
1999	1.108551
2000	1.187737
2001	1.064618
2002	1.236571
2003	1.371061
2004	1.428145
2005	2.510737
2006	2.173931

The relationship between the FHWA Index and the Adjusted Oregon State Index are shown in Figure 4.30.

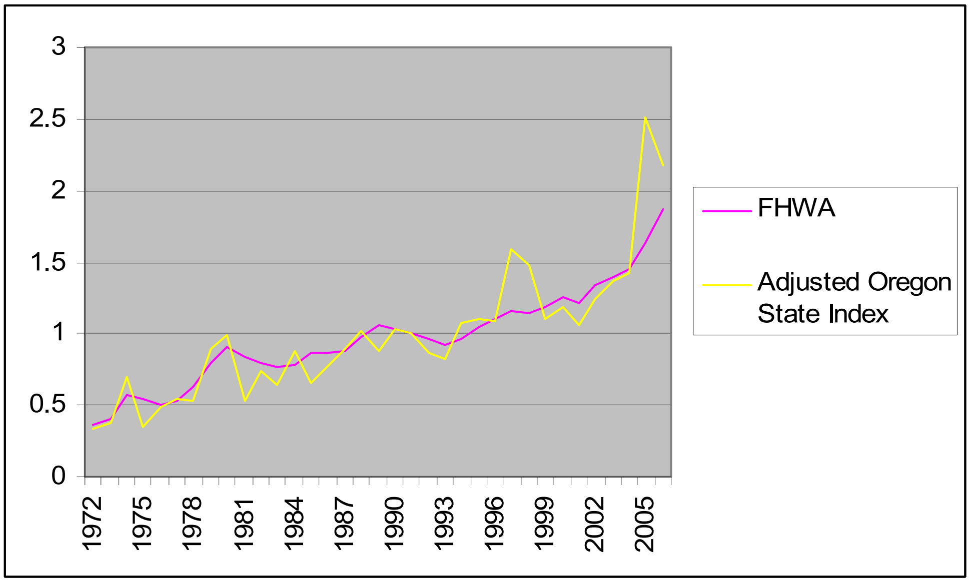


Figure 4.30: Price Percentage Change Trend for the FHWA Index and Adjusted Oregon State Index

Figure 4.30 demonstrates the relationship between the FHWA Index and the adjusted Oregon State Index from 1972 to 2006. For the three bid items being analyzed, the relation between the two indices is similar. From 1981 to 1994, the adjusted Oregon State Index is a little lower in magnitude, except in 1984. In the late 1990s, the opposite holds true where the adjusted Oregon State Index is larger. Similarly, during last recorded years, the adjusted Oregon State Index was much higher. The purpose of these two indices is to extend structural costs back to 1972. The indices provide further support that $1000 worth of work is not the same from 1972 to 2006.

4.9 SUMMARY OF INDICES

The national prototype, Oregon State Index, and the FHWA Index demonstrate that the price for structural construction has increased. The indices also show the magnitude of the price increase. The national prototype and the Oregon State Index examine this change for six different bid items, from 1991 to 2008. The FHWA Index and the adjusted Oregon State Index, however, measure this change from 1972 to 2006, but for only three bid items. The indices demonstrate that the price of structural construction changes each year, which implies that $1,000 worth of work is not the same between years. Therefore, alternatives to the current method are necessary.

Highway Research Circular Number 158: *Fuel Usage Factors for Highway Construction*, from which the values for the fuel usage factors originated, suggests that fuel usage factors for structures are given in terms of fuel consumed per $1,000 of work. The publication may not have anticipated the effects of inflation when proposing the specific fuel usage factors. Based on the survey of states, 10 have structural bid items listed where the respective fuel usage factor is multiplied by the monthly fuel used instead of fuel consumed per $1,000 of work. If implemented in Oregon, this alternative method would exclude the changes in structural construction costs that occur.

The national prototype constructed in this study demonstrates how structural construction costs have changed from 1991 to 2008. Volatility of prices between years and sources indicate that the state of Oregon should apply local prices when analyzing construction costs. Hence, an Oregon State Index was created to demonstrate how structural construction costs have behaved from 1991 to 2008. Volatility in construction prices suggest that this index may need to be calculated annually. An automated process could be developed to measure annual changes. The current results exemplified that structural costs have inflated by more than double. Assuming fuel efficiency of construction vehicles has not changed, a $1,000 of work in 1991 is less than $500 of work in 2008. Since the fuel usage factor for structures is fuel consumed per $1000 of work, the fuel price adjustment from structures is twice as much in 2008 than in 1991. This result suggests that the fuel usage factor for structures should be revaluated from the current standard of 19 and 10 diesel gallons per $1000 of work.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Most state departments of transportation allow specific fuel price adjustments in highway contracting. The fuel price adjustments are calculated using the monthly consumption of fuel for selected commodities multiplied by a fuel factor when the price of fuel changes by a certain amount. *Fuel Usage Factors for Highway Construction,* published in 1974, details the values for the fuel usage factors. Because of economic forces in the highway construction market, price adjustments occur that do not happen in other government contracts. In other markets, price adjustments are almost nonexistent.

The variability in the approach for calculating fuel adjustments in the western U.S. and Florida led to a national survey. All fifty states, Puerto Rico, and Guam responded to a series of questions about whether fuel adjustments were instituted in their state, how it was calculated, how long it had been around, and if there were problems with the current method. Since 1980, when *Development and Use of Price Adjustment Contract Provisions* was published and outlined how the fuel price adjustment should be calculated, most states have made changes to the method, and some have changed the fuel usage factor values. In some states the adjustment was dissolved in the late 1980s or early 1990s and then reintroduced when fuel prices increased in 2008. Most states that have a fuel price adjustment receive complaints from contractors when the price of fuel decreases, or as happened in 2008, when the price of fuel increases dramatically. Still, most states believe the risk is shared appropriately. For the states that track how much is paid in fuel price adjustments, the average annual fuel price adjustment in 2008 was around $8 million, which is less than 1 percent of the total annual budget.

After conducting the national survey, construction costs overtime were examined. The number of bid items analyzed was narrowed down to the six most costly and frequently used. All bid items, individually and collectively, showed an upward trend nationally and for Oregon at the state level. The fuel usage factor for structures is given in terms of fuel consumed per $1000 of work. Results of the national prototype and the Oregon State Index suggest that $1000 worth of work is not consistent from 1991 to 2008.

The upward trend for both indices revealed that the current fuel usage factor for structures is not appropriately current. Examining the prices for individual bid items shows that when the fuel usage factor is measured by fuel consumed per $1000 of work, the fuel usage factor should fluctuate reflecting construction cost variability.

The above findings lead to the following two specific recommendations for implementation; 1) the fuel factors for structures, the focus of this study, should be changed from 19 for cast-in-place and 10 for pre-cast to 9 for cast-in-place and 5 for pre-cast, to reflect the impact of inflation on construction costs; and 2) after 35 years of not incorporating the impact of construction cost increases on the fuel factors, and with this study as a new base, the fuel factors (gallons per $1,000 of construction value) should be reviewed and recalculated every three years, so as to keep the factors current and equitable.

The increasing structural construction costs may lead to a decrease in the number of bids. An incentive for changing this pattern, however, would be to hold fuel usage factors at 1980 levels where the average annual fuel price adjustment is less than 1 percent of the total annual budget.

Future research could determine if budget losses from fuel price adjustments would be offset by contractors making lower bids. Additionally, information gathered from the survey for this study found variation across states in values triggering adjustments. While an assessment of trigger values was not a focus of the project, it was noted that Oregon was at the higher end of the continuum. Further investigation of trigger values could be a potential avenue for future research and policy consideration by ODOT.

Structural construction costs are not the only aspect of the construction process that is changing. The type and amount of bid items used varies from year to year. One bid item heavily used in the construction process may be replaced by another in subsequent years. It would also be interesting to study the short and long term program budget impacts as a result of utilizing different fuel factors/trigger values and how price risk is shifted between the state and contractors during economic expansion or recession. This research has not addressed this issue, but future research may be able to track program cost (payments) over time and make comparisons between periods of volatile price changes and program cost under different fuel factor/trigger regimes.

Regardless, it is important that every few years ODOT reevaluate the adjustment process and whether the current six bid items carry the same weight in the construction process. The conclusions of this report suggest that prices change continually and that the variables examined need to be monitored routinely.

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APPENDIX A:
TELEPHONE STATE SURVEY

TELEPHONE SCRIPT FOR NATIONAL SURVEY

1. Name of respondent

2. Position of respondent

3. Phone number of respondent

4. We are investigating at the national level the current use of fuel factors so as to determine the structure and magnitude of the factors, and identify any issues felt by the DOTs regarding these factors. We appreciate your help with this survey.

5. If you are not the appropriate person within the DOT to answer these questions, could you please direct me to the person knowledgeable of these issues?

6. Please describe the current process e.g. minimum qualifications, factor levels, application timing, etc. your state uses in dealing with the issue of increasing fuel costs during the construction period? Let's discuss this.

7. Does your state utilize a process that is described in detail in a publication/manual? Where can I get the specific detail, Web site? Publication? Etc.

8. Is the price adjustment and fuel factors related to any index or is it a fixed factor, e.g. 19 gallons /$1,000 of construction for structures?

9. In your knowledge, how was the process decided upon for your state and how long has it been at this stage/level? By this we mean the percentage before a project qualifies, the level of the fuel factor, especially for structures, how and when payments are made, etc. etc.

10. Have there been any significant changes in the process or level of fuel factors over the years?

11. Are any changes being discussed at the current time? By whom and for what known reason?

12. What alternatives to your current system are being considered?

13. Do you expect any changes in the near future?

14. If so, can you estimate what they might look like and what would be the dominant reason that the changes would be instituted?

15. Are you familiar with any studies that have been done on fuel factors in your state, region or anywhere? Could you help us find them?

16. Do you receive complaints or concerns with the current methods used for the price adjustment?

17. Do they come from contractors? Are the concerns with the minimum qualifications, the fuel factor magnitude, the number of bid items that are in the fuel factor? Do the contractors offer alternatives?
18. Does the State or you as the official feel the current methods pay out either too much or too little to the contractor?

19. Does the State or you feel the risk isn't being shared appropriately?

20. What aspect of the process would the State be interested in changing?

21. If there were problems and concerns before the price of fuel went up so dramatically, what were the source and the type of concerns? Was it DOT, legislators, contractors, etc.?

22. Did this lead to any proposed changes?

23. Could give us a rough estimate of how many of your projects might qualify for a price adjustment, such as fuel factors?

24. What rough percentage of the total construction budget would have price adjustments such as fuel factors?

25. In fact, would you be able to give us a magnitude of $ paid out in fuel factors in a typical or recent year? eg. 1.5 million dollars in a yearly budget?

Table A.1: Summary of Telephone Survey

Description	Number of States
Number of Respondents	50 + Puerto Rico &Guam
Number of Specifications Engineers	7
Number of Assistant Construction Engineers	4
States Use Fuel Adjustment	42
Fuel Adjustment in Standard Specifications Manual	10
Fuel Adjustment is a Special Provision	24
Did not answer Questions 24 & 25	6

Source: Results from telephone survey

APPENDIX B:
HISTORIC UNIT PRICES

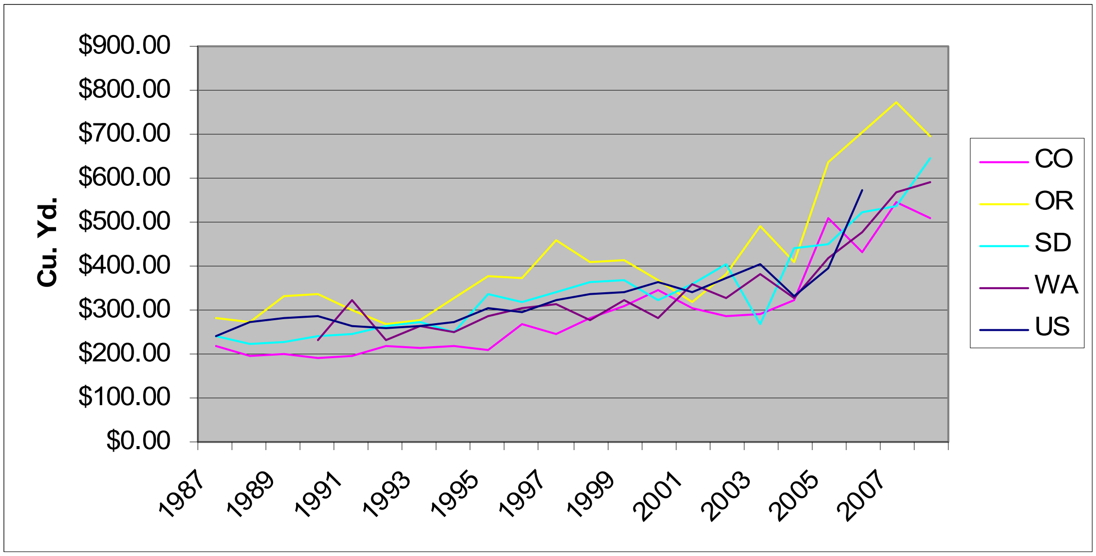

Figure B.1
Historic Unit Price of Structural Concrete
1987-2008
Colorado, Oregon, South Dakota, Washington, & the US

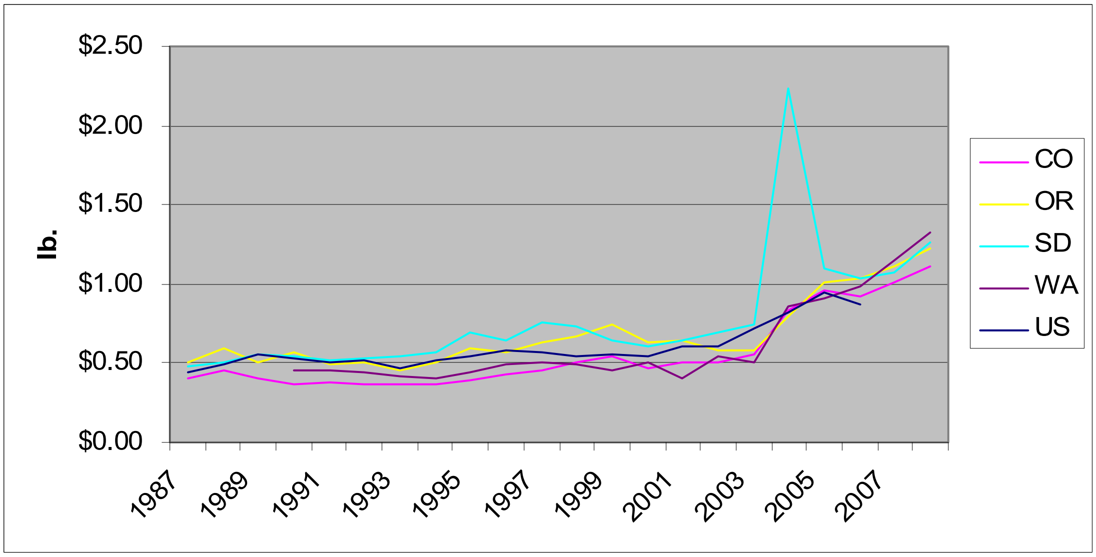

Figure B.2
Historic Unit Price of Reinforcing Steel
1987-2008
Colorado, Oregon, South Dakota, Washington, & the US

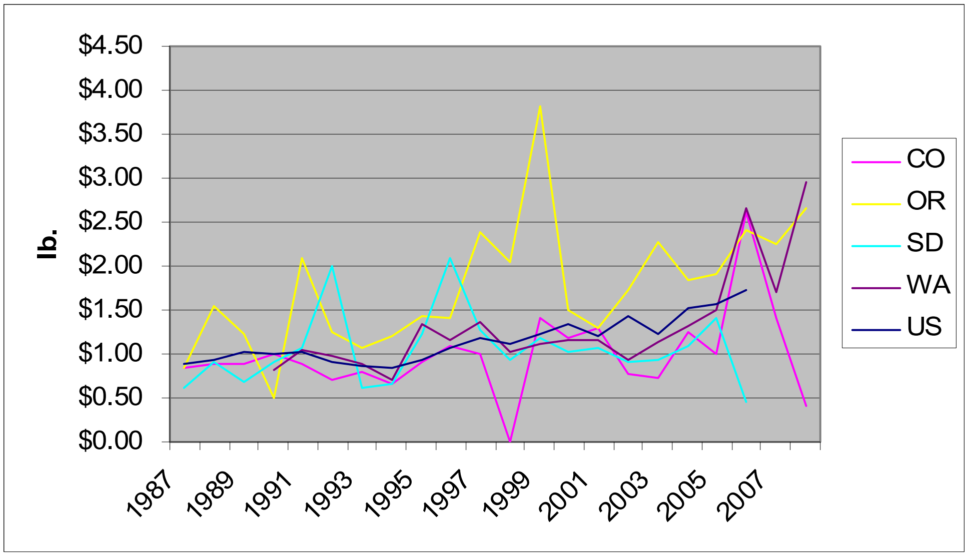

Figure B.3
Historic Unit Price of Structural Steel
1987-2008
Colorado, Oregon, South Dakota, Washington, & the US

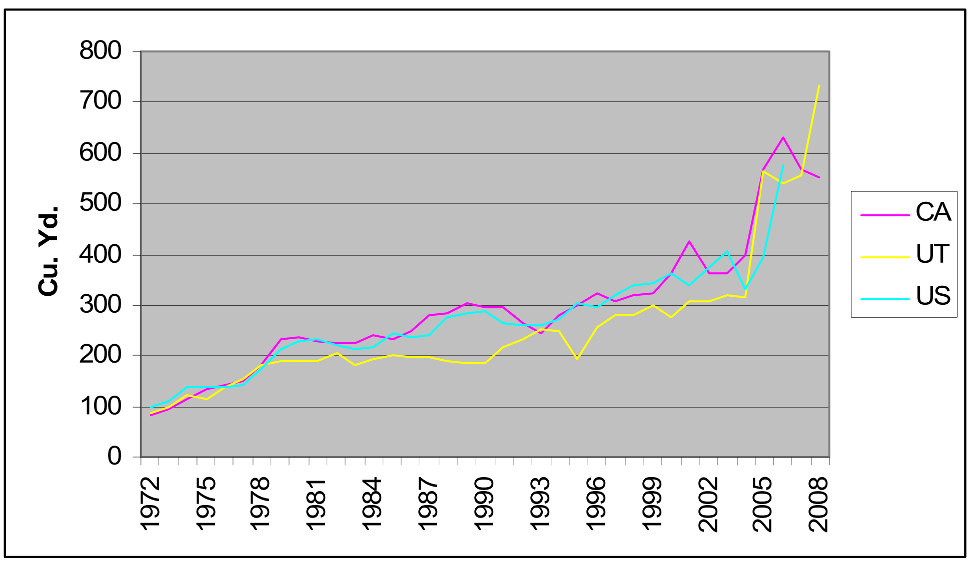

Figure B.4
Historic Unit Price of Structural Concrete
1972-2008
California, Utah, & the US

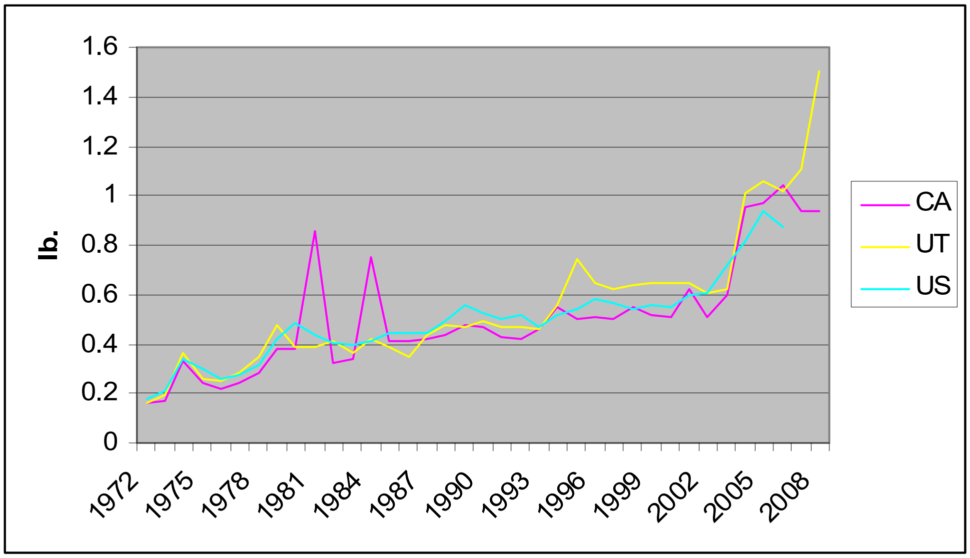

Figure B.5
Historic Unit Price of Reinforcing Steel
1972-2008
California, Utah, & the US

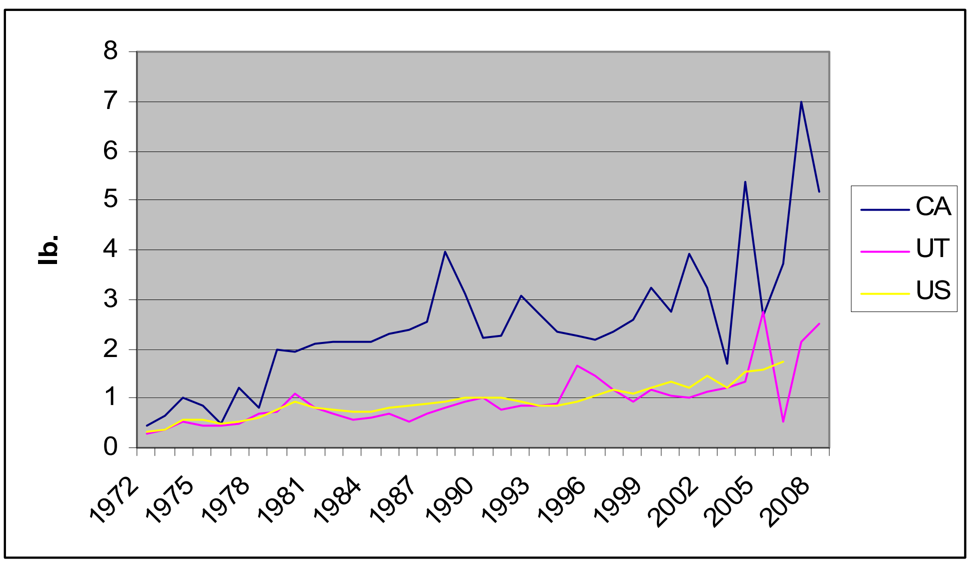

Figure B.6
Historic Unit Price of Structural Steel
1972-2008
California, Utah, and the US