

EFFECT OF PRICE ESCALATION CLAUSE IN HIGHWAY CONSTRUCTION PROJECT

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Abstract - In highway Construction industry to save contractors form price fluctuations of material, Fuel, Labour etc. the price escalation clause is added but in different type project and Different type of Government entities are using differential formulae. Contractor/Concessionaire at the time of bidding the project and at the time of the project execution i.e from appointed dated its takes about 3-4 years; the project duration above 1 year is taken in to account of price escalation. The price escalation cost will calculate differently with different formulae due to same there is variation of amount. In this paper we will identify the differential cost of price escalation by using one project with different government formulae and we will conclude which type of formulae is adequate. Also, this paper gives us how these prices are calculated, for same which data is to be required. Using different entity price escalation clause, the most efficient and accurate method of price escalation will conclude in this dissertation.

Keywords: Price Escalation, Price Index, Clause, WPI, CPI, Preceding Quarter, CPWD, HAM, etc.

1. INTRODUCTION

1.1 AIM

In the construction industry, the contractor Highway works in an surroundings of chance and uncertainty resulting from the financial elements including fluctuations inside the expenses of materials, labour and equipment. Contractors and providers operating in nowadays volatile materials market discover that estimating, bidding and financing the development tasks are demanding situations. Many faces tremendous losses or erosion of expected earnings due to the fact lots of them are locked into fixed price creation contracts wherein contractors undergo the risk of material rate and provider value will increase. without the price escalation clause that permits for an adjustment to the agreement rate, if there may be a surprising rise inside the marketplace costs of key production substances, a contractor will have no respite from such will increase. it's miles vital to have an escalation clause within the contract to shield towards an unexpected spurt in the value of materials. To reduce this degree of hazard, it's miles vital for the contractor to consist of huge

contingencies in preliminary estimates of the agreement while he tenders the settlement. If the contingencies are puffed up, the probability of the agreement being provided to any other contractor is accelerated.

History

In India, Central Public Works department (CPWD) deals with public works of important authorities works. CPWD is above a hundred and fifty years old and contract sorts of the CPWD form the basis of many other agreement paperwork accompanied by other Central and state authorities Departments. For the primary time in Mar-1963, a sub-clause 10C becomes added in CPWD agreement paperwork (Gupta, 1992). inside the modern CPWD contract settlement, the ones summarized below.

Year/ Index	2013	2014	2015	2016	2017	2018	2019	2020	2021
All Commodi ties	111.1	114.8	110.3	110.3	114.1	118.9	121.2	121.8	135
Cement	103.9	108.7	108.6	107.5	109.9	111.8	118.9	120.2	123.8
Steel	98.8	101.7	90.2	84.2	91.3	109	106.5	107.2	131.9

Table# -1- Historical Index Data

1.1 Price Escalation

Escalation is the change in value or rate of specific items, products, materials & services in a given economy over duration or a period. Inflationary developments in economic system get contemplated through escalation in costs of units. It is the increase in price of any construction factors of the original contract or base price of a project because of passage of time.

Escalation impacts the finances and causes intense monetary overrun by the contractor. It also adds to contingency within the contractor's bid and is the major contributor to the overall cost uncertainty of escalation inside the smooth charges from the company. Creation work is accomplished in keeping with the pre showed agreement settlement. to manage up with the unexpected rate escalation, regulated provision is essential in construction contract document.

An escalation clause is a clause in a contract that ensures a exchange within the contract price as soon as a specific aspect past the manipulate of both party outcomes in an growth or lower within the Contractor’s expenses. it is also called “rise and Fall” which suggests that if the rate of positive prices falls then the agreement price could be adjusted within the customers prefer. What is going up may also cross down in any case. pretty often escalation clauses are little understood by using customers unexpected with the specifics of the dredging enterprise. regularly the question arises, “Why do tenderer qualify their gives particularly with admire to fuel escalation?”, that is a main element of unit price – typically 20 to 30%. anticipating Contractors to absorb the escalation threat of this of their fees is not exactly the ideal begin for a professional contractual courting among customer and Contractor. furthermore, it is able to properly backfire for the customer with all Tenderers having no other alternative than to place a hefty threat premium into their costs to cowl for sharp increases of factor expenses. based on studies and experience, the advice is made that any dredging agreement of length of greater than 3 to 6 months ought to have an escalation clause covered. on this manner, speculation is eliminated from the obligations of the Contractor and those outcomes in a higher attention on the projected works themselves.

1.2 Price Fluctuations

The volume and the information of the escalation clause and method can and do range in line with the scenario handy. Some examples are given following below such as. Fuel, Steel, Wages. Etc.

1.2.1 Fuel

The escalation clauses in dredging contracts goes returned to the early Nineteen Seventies while the oil crisis imposed a massive spike in oil costs. From September 1973 to March 1974 the oil fee elevated 260% in actual phrases paralyzing the arena economy. similarly spikes occurred in 1979 with the fall of the Shah in Iran and extra currently from 2001 onwards the oil rate has been driven up with the upward thrust of demand from the Developed and developing nations like China, India and Brazil competing with the non-stop call for oil inside the US economy. picture 1 indicates the world crude oil prices from 1970 to 2022.



Image # 01: World crude oil prices from 1970 to 2022

1.2.2 Steel

From 2004 onwards steel costs greater than doubled because of China’s never-ending call for iron ore, with simplest a quick respite because of the global economic disaster. Now the demand for raw Products has resumed and steel prices have hit High stages. Image -2 shows the average month-to-month cost of Iron Ore in Metric Ton Unit from 2002 thru 2021. steel is a not an obvious – but however crucial – element in dredging costs as the dredging contractors use metal in new-construct vessels and for Current repairs to their current fleets.

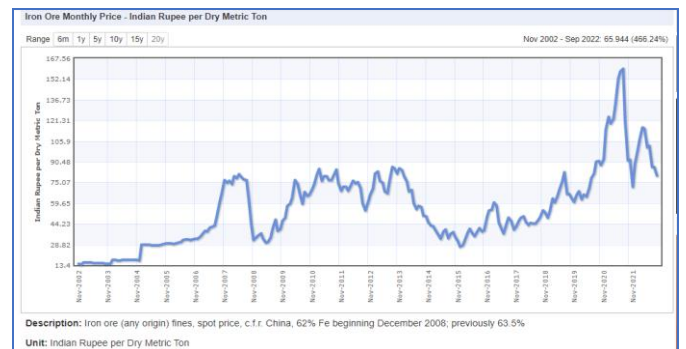


Image # 02: Iron ore Historical Prices 2002-2021

1.2.3 Wages (Labour Index)

The wages of all employees employed by the employer are paid weekly within three days following the last payment period, otherwise not later than the seventh day after the end of the payment period. In the event that the Employee’s employment contract is terminated by or on behalf of the Employer, the Employee’s wage is paid until the last day of the day following the termination of the employment contract. Payments must be posted online at the office on the working day, unless the job is completed before the due date, the final price must be posted on the paint site within eight hours of the last working day and at any stage of normal business hours. The compilation and data collection of the factory worker’s cost index started from the poor financial

conditions of the workers as a result of rising costs after World War I. Due to the increase in cost and cost of living, some state governments have started their own research on household budget and consumer indexation for Indian businessmen.

However, none of them were the best. The collection and control of the CPI for commercial workers is taken over by the central government, in line with recommendations made with the assistance of the Ministry of Labour. However, under the direction of the Industrial Welfare Board, in 1958-59, the Ministry of Labor conducted a survey of household behavior in 50 major industrial centers in India and compiled the Consumer Price Index for Industrial Workers on the basis of 1960 (1960) = 100. In 1941, the compilation of the Uniform and Scientific Strain Index began the most successful work. Since then, the collection and maintenance of the consumer price index for workers in the industry has been maintained by the Labor Bureau.

This series (1982 = 100) is a modification of the old series (1960 = 100), only when the numerical index was published in October 1988, the current series based on 2001 (two thousand one) = 100 was corrected and completed in 2006 relative to the previous version (1982 = 100).

1.4.4 Centre selection under new series (2016=100):

The services of the new database in 2016 were extensively reviewed and provided information on employment for specific jobs provided by states/union districts, including a list of state centres focused on workers, and aggregated employment data for all states/union territories in India for these jobs from various state governments. The actual operation of the seven existing buildings was used to train all the centres to be included in the new series. Employment of commercial workers in these seven sectors increased by 15 percent, as research from 1999 to 2000 showed that 78 centres were protected. Therefore, the actual location selection depends on the business importance of the location, which is affected by the operation of the intelligent operation.

The 88 centres contain about 60 percent of all jobs in seven industries. There are 65 original stations in the old series (2001=100) and the new series (2016=2016), 23 new stations in the new series and 13 simultaneously cancelled stations.

1.3 Index Complication Methodology.

1.3.1 Basic framework:

The main factor in the creation of the product price index is weight and price. Weight is the percentage of actual spend on each product at the time of inception, and the starting price is the average annual interest price of the stock held on the exchange in 2016. Firm concept, holding and living costs are aggregated throughout the week and used as a basis for

capturing market price. The general steps involved in directory compilation are as follows: the primary components for constructing customer price index numbers are the weights and expenses. Weights are the proportion of real expenditure on every commodity for the duration of the base period and base prices are the once a year common of object degree charges throughout the 2016 in appreciate of objects retained within the index basket. The concept of fixity, the weights and base costs stays constant in the course of the life of the series and best modern period expenses are amassed on weekly, month-to-month and so on foundation to seize the charge motion at the marketplace stage. The extensive stages concerned within the index compilation are depicted as following below:

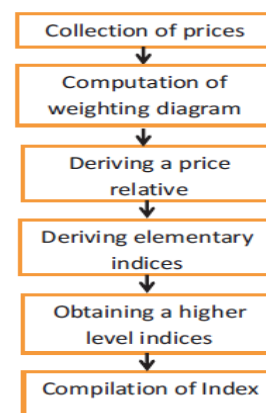
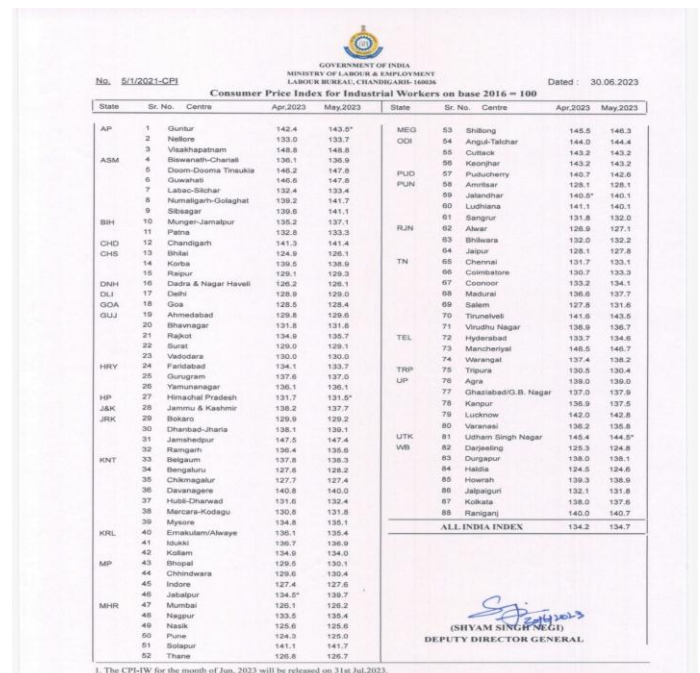


Image # 03: Steps Involved in Basic Index Compilation.



GOVERNMENT OF INDIA MINISTRY OF LABOUR & EMPLOYMENT LABOUR BUREAU, CHANDIGARH-160006									
No. 5/1/2021-CPI		Consumer Price Index for Industrial Workers on base 2016 = 100						Dated: 30.06.2023	
State	Sr. No.	Centre	Apr.2023	May.2023	State	Sr. No.	Centre	Apr.2023	May.2023
AP	1	Guntur	143.4	143.5*	MEG	53	Shillong	145.5	146.3
	2	Nellore	133.0	133.7	ODI	54	Angul-Talcher	144.0	144.4
	3	Vishakhapatnam	148.8	148.8	55	Cuttack	143.2	143.2	
ASM	4	Bowdoin-Chennai	136.1	135.5	56	Korchi	143.2	143.2	
	5	Doom-Dooma Tiruakia	146.2	147.8	57	Puducherry	145.7	145.8	
	6	Guwahati	146.0	147.8	58	Amritsar	128.1	128.1	
	7	Lahore-Bihar	132.4	133.4	59	Jalandhar	140.9*	140.1	
	8	Numaligarh-Golaghat	136.2	141.7	60	Ludhiana	141.1	140.1	
	9	Shillong	136.9	141.1	61	Sangur	131.8	132.0	
BBH	10	Munger-Jamshpur	135.2	137.1	62	Alwar	126.0	127.1	
	11	Patna	132.8	133.3	63	Bhilwark	132.0	132.2	
CHD	12	Chandigarh	141.3	141.4	64	Jaipur	128.1	127.8	
CHS	13	Bhilai	124.9	126.1	65	Chennai	131.7	132.1	
	14	Korba	139.5	138.9	66	Coimbatore	136.7	136.3	
	15	Raipur	126.1	125.2	67	Coonor	133.2	134.1	
DNH	16	Dadra & Nagar Haveli	126.2	126.1	68	Madurai	136.6	137.7	
DLI	17	Delhi	126.9	129.0	69	Salem	137.9	131.6	
ODI	18	Goa	126.5	128.4	70	Tirunelveli	141.5	143.5	
GUJ	19	Ahmedabad	129.8	129.6	71	Virudhu Nagar	136.9	136.7	
	20	Bhavnagar	131.8	131.8	72	Hydrabad	133.7	134.6	
	21	Rajkot	134.9	135.7	73	Manchester	146.5	146.7	
	22	Surat	129.0	129.1	74	Warangal	137.4	138.2	
	23	Vadodra	130.0	130.0	75	Tiruna	130.5	130.4	
HRY	24	Fardabad	134.1	133.7	76	Agri	139.0	139.0	
	25	Gurgaon	137.6	137.0	77	Ghaziabad/G.B. Nagar	137.0	137.9	
	26	Yamunanagar	136.1	136.1	78	Kanpur	136.9	137.8	
HP	27	Himachal Pradesh	131.7	131.8*	79	Lucknow	142.0	142.8	
J&K	28	Jammu & Kashmir	147.5	147.4	80	Varanasi	136.2	136.8	
JRK	29	Bilaspur	126.9	126.2	UTK	81	Litham Singh Nagar	145.4	144.8*
	30	Dhanbad-Jharia	136.1	136.1	WB	82	Darjeeling	135.3	129.8
	31	Jamshedpur	147.5	147.4	83	Durgapur	138.0	138.1	
	32	Ranchi	136.4	135.6	84	Haldia	124.5	124.6	
KNT	33	Belgaum	137.8	136.3	85	Howrah	139.5	139.9	
	34	Bengaluru	127.8	128.2	86	Jalgaon	132.1	131.8	
	35	Chennai	127.7	127.4	87	Kolkata	138.0	137.6	
	36	Davanagere	140.8	140.0	88	Rangpur	145.0	140.7	
	37	Hullid-Chawad	131.6	132.4					
	38	Mercara-Roddu	131.8	131.8					
	39	Mysore	134.8	135.1					
	40	Ertakulam/Alwaye	136.1	135.4					
KRL	41	Iskcon	136.7	136.9					
	42	Kollam	134.9	134.0					
	43	Bhopal	126.5	126.1					
MP	44	Chhindwara	126.6	126.4					
	45	Indore	127.4	127.6					
	46	Jabalpur	134.5*	133.7					
MHR	47	Mumbai	125.1	125.2					
	48	Nagpur	133.5	133.4					
	49	Nasik	125.6	125.6					
	50	Pune	124.3	125.0					
	51	Salapur	141.1	141.7					
	52	Thane	126.6	126.7					
ALL INDIA INDEX								134.2	134.7

Image # 04: Consumer Price Index Region wise adopted in India.

1.4 Objective of Project Dissertation

- 1.4.1 To study about price escalation & Collect data for same.
- 1.4.2 To examine the escalation clauses currently used in construction contracts followed through diverse Government Authorities / departments/ organizations in India
- 1.4.3 The adequacy of reimbursement paid to the contractor primarily based on presently used escalation clauses in government Authority containing various contracts.
- 1.4.4 A Case Study of NHAI HAM Project to find out; cost escalation impact on the outcome of construction projects to conclude the efficient way of calculation and Economical Price escalation Formulae.

2. LITERATURE REVIEW

A research paper published by **Mr. David Kinlan and Mr. Drik Roukema** mentioned a clause in the contract that requires price adjustment when there is an increase or decrease in prices. Restructuring provisions are increasingly common in facility contracts as a way to cover unexpected costs arising from changes in raw materials, fuel, and Labour during construction. Contractors must include oil, steel and wage costs when preparing tender estimates and assess the adequacy of the increase to cover the risk of price changes during contract execution. According to the analysis presented here, it is recommended that all screening contracts lasting more than three to six months include an increment clause, as this will remove the guesswork from the contractor's job, which will lead to better results for the job itself. The Changes in the total cost of dredging are mainly due to oil, metal and labour costs.

Ms. Surabhi Kharbanda and Mr. Ketan Jain learned in 2018 that upgrades could account for a significant portion of construction costs. Therefore, the volume of upgrades must be estimated for budgeting and competition. This article explores the use of time-based survey methods to predict construction progress. The time series construction cost index is used as a proxy for construction cost increase. The use of time series methods, their limits and their effects on inflation are determined and analyzed. The analysis strategy is best used in reliable situations to quickly estimate construction projects. This is because no assets can be predicted to increase due to unforeseen events, including war strikes or some key government action. Construction cost increases are at risk to the contractor or owner, or both, under the terms of the contract; any reasonable method to reduce the value.

Dr. N. B. Chaphalkar & Ms. Sayali S. Sandbhor examines the calculation model of today's products, analyses the building materials in the product basket, the changes in

the wholesale prices of these products and their effect on the success of the promotion. To give an overview of the Indian financial system, the institutions that contributed to it i.e. Inventories and products marketed in the financial market are regulated by various government-established indicators that affect the market, sale or production costs of products. The Indian market follows the Stock Market Index, which is compiled across the country and is a measure of changes in retail prices in the market. Development is one of the most important and controversial issues in the construction sector. Best Indian Business Rules allow the use of stock market capitalization to calculate capital gains for supplies. The volume of change in the wholesale price over a given period of time affects the calculation of the product.

Ministry of Labor, Ministry of Labor and Labor Function, reported the amount of goods and services from the public index. The index is also important to government as it is used to determine and fix the minimum wage for planned work, as well as to control and determine the Expensive Allowance (DA) paid to all Central/State government employees in the industry/construction sector. The measures implemented by the Office are based on international/international best practices and ILO guidelines. The publication of the CPI (Consumer Price Index)-IW is also based on Special Data on Demand Statistics (SDDS).

The annual inflation rate based on All India Wholesale Price Index (WPI) data stood at 5.85% (temporary) in November 2022 (over November 2021), approaching the 8.39% recorded in October 2022. The last 3 (three) months index and inflation rates of all products and wholesale price contributions are as follows:

Index Numbers & Annual Rate of Inflation (Y-o-Y in %)*							
All Commodities/Major Groups	Weight (%)	Sep-22 (F)		Oct-22 (F)		Nov-22 (P)	
		Index	Inflation	Index	Inflation	Index	Inflation
All Commodities	100.0	151.9	10.55	152.5	8.39	152.1	5.85
I. Primary Articles	22.6	175.9	11.54	181.0	11.04	177.7	5.52
II. Fuel & Power	13.2	158.4	33.11	155.2	23.17	159.6	17.35
III. Manufactured Products	64.2	142.2	6.12	141.9	4.42	141.5	3.59
Food Index	24.4	175.1	8.02	177.5	6.48	174.3	2.17

Note: P: Provisional, F: Final. *Annual rate of WPI inflation calculated over the corresponding month of previous year

Table# -2 WPI Components

3. METHODOLOGY

3.1 Collect data for Price Escalation Index and Clause.

Inflation is the expected economic result from the inflation rate calculated from WPI data. Progress refers to the change in price or value of a product or commodity in a particular market over a period of time. Inflationary growth in an economic system is provided by an increase in house prices. John Hollmann and others argue that this is much more than just an increase in the value of the original contract or the

initial cost of building the project due to the passage of time. and others defines the increase as the change in the interest rate caused by the main financing. Renovation costs can be prohibitive and cause financial overload for contractors. It also provides an account of the situation in contractor competition, and "inflation" in price competition is important for price uncertainty. The construction process is based on a pre-approved contract. Regulatory clauses should be included in contracts or tenders to avoid exorbitant prices.

3.2 Construction contract and claims against price escalation clause.

Contracts and conditions play an important role in carrying out the work correctly and on time, preventing and resolving conflicts that arise. The Terms of Reference of the Contract define the rights, responsibilities, obligations and procedures that the interested parties must comply with. Setting up a construction bid is nothing more than sharing the risks involved with the various parties in the contract. Despite all the provisions in the tender contract, a bid was submitted at the construction site. Claims are usually made when one of the parties to a settlement is harmed and that party wants to get the money back from the other party. It can be defined as a valid additional payment request due to performance change. The possibility that the cost will increase during the completion of the project may result in additional funds being requested over the initial cost. Claims lead to conflict even if they are not resolved well.

3.3 Calculation of WPI (Wholesale price Index)

Each index has its own method of calculating and interpreting the content and is expressed as the change of the main value. The shopping cart is the subject of WPI as it is said to represent the entire market. After the cart is placed, changes to the items in the cart in a financial system are tracked and recorded. The offer for the same product comes from many sellers. Generally based on this information, further calculations are made as follows.

- 3.3.1 Allocation of weights
- 3.3.2 Calculation of price relative
- 3.3.3 Calculation of Index
- 3.3.4 Materials in commodity basket
- 3.3.5 Variation in WPI for major construction materials
- 3.3.6 Case study NHAI NH-6 Hybrid Annuity Project of 641.6 Cr. Project cost.

Price Escalation in Different Type of Project and Departments					
Item Compensated	Central Public Works Departments	Military Engineer Services	Public Works department Maharashtra	NHAI HAM Project	NHAI EPC Projects
Cement	$V_{Ct} = W * (C_t / 100)^{(C/C_0)}$	$V_{M} = ((K_1 * V_0) / 100) * V_1$ $E_{M} = ((V_{M1} - V_{M0}) / (C_1 - C_0)) * C_1$	$V_{P} = (C_1 / C_0) * C_0 * T * C_0$	Price Index Multiple: $((70% * WPI + 30% * CPI) / (70% * WPI_0 + 30% * CPI_0))$	$VRW = 0.85 RW * (PL_1 / (L_1 - L_0)) / (L_0 - PA_1(AI - AO) / AO + PF_1(FI - FO) / FO + PB_1(BI - BO) / BO + PM_1(MI - MO) / MO + PC_1(CI - CO) / CO + PS_1(SI - SO) / SO)$ $VBR = 0.85 BR * (PL_1 / (L_1 - L_0)) / (L_0 - PA_1(AI - AO) / AO + PF_1(FI - FO) / FO + PM_1(MI - MO) / MO + PC_1(CI - CO) / CO + PS_1(SI - SO) / SO)$
Steel	$V_{St} = W * (S_t / 100)^{(S/S_0)}$	$V_{M} = ((K_2 * V_0) / 100) * V_1$ $E_{M} = ((V_{M2} - V_{M0}) / (S_2 - S_0)) * S_2$	$V_{P} = (S_2 / S_0) * S_0 * T * S_0$	Project Cost (with Escalation)-Project Cost (Including GST)/Price Index Multiple	
Materials Plant and Machinery	$V_{P} = P * (P_t / 100)^{(P/P_0)}$	$V_{M} = ((K_3 * V_0) / 100) * V_1$ $E_{M} = ((V_{M3} - V_{M0}) / (W_3 - W_0)) * W_3$	$V_{P} = 0.85 * P_0 * 100 * R * (M_1 / M_0)$		
POL	$V_{P} = W * (Z_t / 100)^{(Z/Z_0)}$	Nil	$V_{P} = 0.85 * P_0 * 100 * R * (F_2 / F_0) * E_2$		
Labour	$V_{L} = W * (L_t / 100)^{(L/L_0)}$	$E_{L} = ((K_4 * 100 * V_0) / (L_4 - L_0)) * L_4$	$V_{L} = 0.85 * P_0 * 100 * R * (L_4 - L_0) / L_4$		
Bitumen	Nil	Nil	$V_{B} = (B_t / B_0) * B_0 * T$		

Table# -3 Escalation Formulae used in Construction Contracts; various tender types adopted by different govt. Entities/ department/ agencies in India

Description	Central Public Works Department			Military Engineer Services	Tamil Nadu Public Works Department	Airports Authority of India	Bharat Sanchar Nigam Limited
Compensation shall be payable for works whose stipulated period of completion is	6 months or less	0 to 18 months	> 18 months	> 6 months	> 12 months	> 6 months	> 12 months
Clause in the general conditions of contract	10C	10CA	10CC	Special conditions	Special conditions	10CC	10C
Components involved for escalation	Material and Labour	Material	Cement Steel Materials POL Labour	Material POL Labour	Cement, Steel, Material, POL Labour, Bitumen, Plant and Machinery Spares	Material POL Labour	Cement Steel Material POL Labour
Index used for materials	--	WPI	WPI	WPI	WPI	WPI	WPI
Index used for Labour	--	CPI	CPI	CPI	CPI	CPI	CPI

Table# -4 Escalation Clause using Conditions and Criteria using period.

3.3.1 Allocation of weights-

The release price refers to the transaction price obtained in the domestic market when the sales volume begins. Products are weighted according to their percentage of total production in the industry. The weight and impact of individual items. The history of WPI in India is representative of this phenomenon, and the series often goes through seven revisions to include good business practices. The meeting is to revise the series every ten years.

The revisions of the Indian WPI series to date are summarized in Table 1 below. Expressed as a percentage of the total price, their total reaches 100. These weights are used to calculate the index for all products. For new products, the weight of the existing product will be changed. Adjust the weight of the item to remove it from different groups.

Sr. No.	Base year	Year of Introduction	No. of Commodities	Groups of Commodities	No of Quotations
1	August, 1939	Jan, 1942	23	4	23
2	End of August, 1939	1947	78	4	215
3	1948-49	1952	112	5	555
4	1961-62 July	July, 1969	139	7	774
5	1970-71 Jan	Jan, 1977	360	3	1295
6	1981-82 July	July, 1989	447	3	2371
7	1993-94 April	April, 2000	435	3	1918
8	2004-05 Sept	Sept, 2010	676	3	5482
9	2011-12	May, 2017	697	3	8331
			1. PRIMARY ARTICLES-		
			2.FUEL & POWER- 13.15		
			3.MANUFACTURED PRODUCTS 64.23		
			ALL COMMODITIES= 100		

Table# -5. Revisions in WPI series in India

3.3.1.1. Primary Articles-

More details in the main article, including new vegetables and radishes, carrots, cucumbers, pickles, Mozambique, pomegranate, jackfruit, pear, and more. Materials such as copper concentrate, lead concentrate and garnet were added to the rock organization and copper ore, gypsum, kaolin, dolomite and magnesite were removed. Natural gas was announced as the new product of the main product.

3.3.1.2. Fuel and Power-

In the gas and power industry, non-coking coal can also be classified according to the total cost of electricity (GCV) to meet the needs of many households.

- Non-Coking Coal G1 to G6 [GCV > 5500 Kcal/kg.]
- Non-Coking Coal G7 to G14 [GCV 3100 Kcal/kg to 5500 Kcal/kg]
- Non-Coking Coal G15 to G17 [GCV < 3100 Kcal/kg.]

Coke product dropped. The Energy Index in the new series will be measured as a separate product suitable for agriculture, industry, home, business and rail use, recorded in 2004-05. In the new series, the monthly average electricity sales of 49 power plants covering water and electricity are used to record electricity meters. While Light

Diesel was removed due to its decreasing importance in the Mineral Oils subgroup, Petrol Koku was introduced to the market as a new product due to its significant growth. There are some adjustments to the weight of the fossil fuel tank. The number of offers has increased significantly to provide a wide range of services.

3.3.1.3. Manufactured Products

Numerous products containing synthetic material have been produced. As a result, the double-digit number of industries in the new series increased from 12 to 22 according to the 2008 National Industry Classification (NIC). Around 173 new products were launched, such as conveyor belts, rubber belts, metal cables, tissue paper, wood plywood, composites, while Khandsari, Papad, video CD player, etc. 135 products were removed from the market.

3.3.2 Calculation of price relative-

The relative price is charged for the items in the WPI basket selected by the source identified for data collection. A proposal of at least five possible projects is required, although a smaller number is also recommended due to unavoidable circumstances. Relative price is the ratio of the daily price of the stock to the index price. A relative value is calculated for each calculation. The product offer allows the calculation of the relative price calculated by the formula below.

$$\text{Price relative} = (\text{Current price} / \text{Base price}) * 100$$

3.3.3 Calculation of Index

Average of price relatives for all quotations for a given commodity offers the WPI for that specific item. Technique of compilation of index follows Lasperyre's formula primarily based on weighted mathematics imply that is as follows:

$$I = (\sum(I_i X W_i)) / (\sum W_i)$$

Where,

I = Index number of wholesale prices of a subgroup/group/major group/ all commodities

I_i = Index for ith commodity in the subgroup/group/major group

W_i = Weight assigned to the item/subgroup/group/major group within the subgroup/group/major group/basket.

3.3.4 Materials in commodity basket

Include all products considered for use in the WPI calculation. It is essentially a product designed to demonstrate the effectiveness of a generic business. The items in the shopping cart are often updated over time to accommodate changes in customer behavior or behavior. While there were 676 items in total in 2004-05, there were 435 items in 1993-94. 259 items in the collection are not

uncommon. The 435 items in the 1993-94 collection, 176 were removed and a total of 417 new items from the 2004-05 collection were added to the basket. In the 2004-05 series the work is 3 main body ie. Primary products, POL and electrical, manufacturing products. Main substances are divided into three groups as food, non-food and food, and finished goods are divided into 12 groups as food, beverages, tobacco products, textiles, wood and wood products, paper and paper, leather and leather products, leather and leather products, rubber products and pharmaceutical products, nonmetal products and metal products, metal products and metal products.

3.3.5 Variation in WPI for major construction materials

Changes in wholesale prices during the year are the result of the economy. Changes in the market are affected by changes in wholesale prices. The construction industry has grown over the past few years. This is also reflected in the increase/change in wholesale prices of basic necessities. The table below shows the change in the Retail Price Index over the last eight fiscal years. Table 6 Monthly Changes in Market Value of Gray Cement and Rebar Products Between January-December 2021

Commodity	WPI of commodities for Month of January										
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	
OPC cement	100	103.9	108.7	108.6	107.5	109.9	111.8	118.9	120.2	123.8	
White cement	100	110.1	115.3	117.1	118.8	119.1	123.6	126.4	122	123.3	
Bricks	100	106	100.6	96.4	98	94.7	94	94.5	91.6	91.8	
Stone	100	107.4	112.8	116.2	116.7	113.7	112.3	113.4	111.1	113.5	
Steel	100	98.8	101.7	90.2	84.2	91.3	109	106.5	107.2	131.9	
Bitumen	100	109.3	112.4	84.4	64.7	70.4	85	82.5	73.4	106.2	

Table# -6. Yearly variation in WPI for major construction materials

3.3.6 Case study NHAH NH-6 Project.

The Case Study NHAH Project is Hybrid Annuity Mode of **641.6 Cr**. Bid Project cost **536.87 Cr** Estimated cost. In simplification of Price Escalation Calculation, we will consider Estimated project cost i.e., ₹ **5,36,87,28,668** Project in Brief as follows in Image.

Project in Brief	
Project Name	Balance work for 4 laning of Amravati-Chikhli section of NH-6 (Package-IV) from Km 315.000 (Near Nandura) to Km 360.000 (Near Chikhli) in the State of Maharashtra to be executed on Hybrid Annuity mode under Bharatmala Pariyojana.
Client	National Highway Authority of India, RO Nagpur under PIU Amravati. Maharashtra
Independent Engineer	M/s. L.N. Malviviya Infra Projects Pvt. Ltd.
Concessionaire	M/s. Nandura Chikhli Highways Private Ltd. (SPV Kalayn Toll Infrastructure Ltd.)
EPC Contractor	Kalayn Toll Infrastructure Ltd.
NH No.(New /Old)	NH-53/ NH6
Scheme/ Phase	NHDP-IV
Mode of the Execution (BOT Toll/ BOT Annuity/ EPC/ HAM/ Item Rate /Others)	Hybrid Annuity (HAM)
No. of Lanes / Configuration	Four Lanning
Length of Project(in Km)	45 km (Km 315+000 to Km 360+000)
Project Cost (in Cr)	Bid Project Cost :INR 641.60 Cr & Estimated Project Cost - 536.87 Cr.
No. of Bypasses (Name of Town, Length)	1 No Nandura Bypass –6 Km
No. of Toll plazas (Number and Location)	1No 356.542 (Near Chikhli).
Agreement Date	16.07.2020
Appointed Date	19.05.2021
Construction Period	730 days
Operation Period	15 yrs (from COD)

Table# -7 Project of Brief

Scope of Work			
Sr. No.	Description	Unit	Scope
1	Total Project Length	Km	45
2	Bypass Length	Km	6.7
3	Service Road/ Slip Road	Km	23.06
4	Toll Plaza	Nos.	1
5	Truck Lay bays	Nos.	1
6	Bus Bays/Passenger shelter	Nos.	20
7	Rail Over Bridge	Nos.	1
8	Vehicular Underpass	Nos.	3
9	Cattle/Pedestrian Underpass	Nos.	4
10	Major Bridge	Nos.	4
11	Minor Bridge	Nos.	18
12	Pipe Culvert	Nos.	25
13	Slab and Box Culvert	Nos.	10
14	RE Wall	Sq.M	56000
15	RCC Drain	Km	8.99
16	Boundary Wall	Km	60

Table# -8 Scope of Project

Case study NHAH NH-6 Project.

The Case Study NHAH Project is Hybrid Annuity Mode of **641.6 Cr**. Bid Project cost **536.87 Cr** Estimated cost. In simplification of Price Escalation Calculation we will consider Estimated project cost i.e., ₹ **5,36,87,28,668** Project in Brief as follows in Image.

CONSUMPTION STATEMENT

Sr. No.	Item in Brief.	Estimated Qty		Consumption Rate		Consumption		Item Qty	Remark
		Unit	QTY.	Unit	Consumption Rate	Unit	Item wise Consumption		
1	M-15	CuM	5098	Kg/Cum	308	MT	1570		
2	M-20	CuM	12374	Kg/Cum	341	MT	4220		
3	M-20	CuM	7132	Kg/Cum	377	MT	2689		0.07Cum/M
4	M-25	CuM	0	Kg/Cum	380	MT	0		
5	M-30	CuM	6046	Kg/Cum	393	MT	2376		
6	M-35	CuM	19557	Kg/Cum	402	MT	7862		
7	M-40	CuM	19304	Kg/Cum	418	MT	8069		
8	M-45	CuM	3043	Kg/Cum	449	MT	1366		
9	DLC	CuM	2446	Kg/Cum	165	MT	404		
10	PQQ	CuM	4168	Kg/Cum	450	MT	1876		
11	CTSB	CuM	211279	Kg/Cum	51	MT	10835		
12	CTB	CuM	75058	Kg/Cum	103	MT	7698	48964	Cement
13	Tack Coat	SqM	1017804	Kg/SqM	0	MT	305		VG-30
14	BC VG-30	CuM	5227	Kg/Cum	129	MT	676	1362	Bitumen
15	BC VG-40	CuM	34436	Kg/Cum	129	CuM	4451		VG-40
16	DBM VG-30	CuM	3603	Kg/Cum	106	CuM	381	11166	Bitumen
17	DBM VG-40	CuM	63504	Kg/Cum	106	CuM	6716		
18	Steel	MT	4298	MT	1	MT	4298	4298	Steel
19	Structural Steel	MT	950	MT	1	MT	950	950	Stru.Steel

Table# -9 Consumption Summary

As above details will be used for calculation of price escalation Cost. The Project Taken for case study is executing under HAM (Hybrid Annuity Mode) to calculate effect of price escalation clause in highway Construction industry we have to calculate price escalation cost of above project in using all types of departments adopted to calculate the price escalation to achieve conclusion. Also, this calculation also gives information about-

1. Index Adaptation to calculate price escalation.
2. Website on which index available.
3. For Calculation which quantity are to be taken.
4. Where, which and when index is to be calculated.
5. Constants and Star rate calculation using all types of Price escalation in different type departments.

4. RESULTS AND ANALYSIS

4.1 Price Escalation Cost using Central Public works (CPWD)Formulae.

As per central public works department Memorandum No.DGW/CON/237/ A Dated 31.12.2018 Amendment of Clause 10C, 10CA and 10CC of General Conditions of Contracts 2008 the formulae as follows.

4.1.1 Cement /Steel/Structural Steel Cost.

According to GCC 2008 Clause in CPWD 10 CA - Payment of changes in price of documents as Bids Received should extend the contract (equal) if, after submitting Bids, the price of documents listed in Schedule I/Chart B/Chart F is

increased/decreased by more than the price in effect at the last hour of the contract date. 2. However, performance within the extended reasonable period specified above will be limited to the current rate at the date of completion or the current rate for the anticipated period, whichever is shorter. The increase/decrease in the cost of cement, reinforcement and steel structure will be evaluated according to the price index announced by the CPWD Director (Works). For other items listed in Schedule "F",

This should be determined from the All-India Market Prices for Materials published by the Economic Advisor, Government of India, Ministry of Trade and Industry and Base Prices for Cement, Rebar and Structural Steel published by the Director General of CPWD (Works) for Delhi (including Noida, Director of Commerce) under the authority of the Director General of CPWD (Works). CPWD and other local rates for other documents issued by the Regional Marketing Officer specified in the Schedule 'F/G/B', including the extension in the evaluation period (if any), are valid on the date of receipt of the specified trailing offer. If the price index of a product has not been published by the Ministry of Trade and Industry, the closest product price index in the "F" Chart is taken as basis.

Therefore, the contract/tender price for all these materials will be different and calculated according to the following formula for the main materials used in construction: -

Cement Price Variation Calculated such as,

$$Vc/Vs/Vsc = \frac{P*Q}{(C_{10}/S_{10}/SC_{10})} * \frac{((C_{11}/S_{11}/SC_{11}) - (C_{10}/S_{10}/SC_{10}))}{(C_{10}/S_{10}/SC_{10})}$$

Where-
 Vc/Vs/Vsc =Variation in material cost i.e. Increase or decrease in the amount in rupees to be paid or recovered.
 P=Base Price of material For documents issued by the Company, CPWD or the Regional Affairs Manager, as shown in the "G/B/F" Schedule, at the starting price valid at the date of the last receipt of the bids, including any extensions, Star Rates as per SSR 2019-20 i.e Last Receipt of Tender. i.e 13 Jan 2020.

Sr. No.	Material	Basic rate for 2019-20(Excluding GST)
a)	Cement /PPC	Rs. 4,700/- Per M. T.
b)	PSC	Rs. 4,840/- Per M. T.
c)	GGBS (IS-16714)	Rs. 3990/- Per M. T.
d)	TMT-FE-500 reinforcement	Rs. 41,200/- Per M. T.
e)	HCRM/ CRS reinforcement	Rs. 44,000/- Per M. T.
f)	Structural Steel	Rs. 44,100/- Per M. T.
g)	Bitumen VG-30 (Packed)	Rs. 32,500/- Per M. T.Ex. Refinery Mumbai
h)	Bitumen VG-10 (Packed)	Rs. 31,700/- Per M. T. Ex. Refinery Mumbai
i)	Bitumen VG-40 (Bulk)	Rs. 30,180/- Per M. T. Ex. Refinery Mumbai
j)	Bitumen VG-30 (Bulk)	Rs. 29,200/- Per M. T. Ex. Refinery Mumbai
k)	Bitumen VG-10 (Bulk)	Rs. 28,400/- Per M. T. Ex. Refinery Mumbai
l)	Bitumen VG-40 (Packed)	Rs. 33,580/- Per M. T. Ex. Refinery Mumbai
m)	Bitumen Emulsion	Rs. 23,490/- Per M. T. Ex. Refinery Mumbai
n)	CRMB - 55	Rs. 30,555/- Per M. T.
p)	CRMB - 60	Rs. 30,735/- Per M. T.

Table# -10 PWD SSR 2019-20 Star Rates

Q =Quantity of material buy at site for confide use in the works since previous bill.

CIo/SIo/SCIo = The price index is given by the Indian Ministry of Industry and Commerce, which is the Economic Advisor of the Government of India, such as Cement, Rebar and Structural Steel, valid on the last day of receiving bids for other items listed in the "G/B/F" Schedule with and with extensions if any.

CI/SI/SCI=Price index for Cement, Rebar and Structural Steel Price Indices published by the Economic Advisor to the Government of India Ministry of Industry and Trade as All India Commercial Price Indices for payment or payment period information

Using above all the Price escalation cost as follows.

4.1.1.1 Cement Cost.

$$Vc = P * Q * \{ (CI - CIo) / CIo \}$$

P= Rs.4700 As per Table no-10 Sr. (a)

Q= 48964 MT as per Table No.9

CI= 135 (18 May 2023) Quantity Billed as per Following Image.



Image # 05: WPI Cement May-2023.

CIo=118.5 (13 Jan 2020) receipt of tender as per Following Image

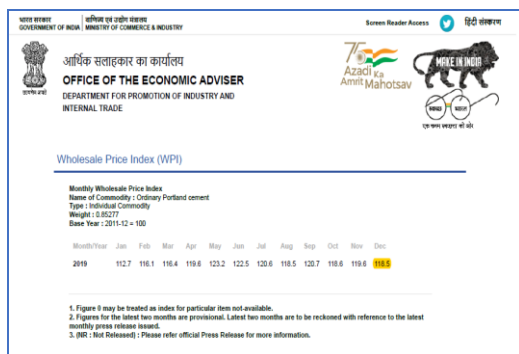


Image # 06: WPI Cement Dec-2019.

So,

$$Vc = P * Q * \{ (CI - CIo) / CIo \}$$

$$Vc = 4700 * 48964 * ((135 - 118.5) / 118.5)$$

$$Vc = 4700 * 48964 * (16.5 / 118.5)$$

$$Vc = 4700 * 48964 * 0.1392$$

$$Vc = 3,20,34,207/- \text{ Cement Escalation Amount}$$

4.1.1.2 Steel Cost.

$$Vs = P * Q * \{ (SI - SIo) / (SIo / SIo) \}$$

P= Rs. 41200 As per Table no-10 Sr. (d)

Q= 4298MT as per Table No.9

SI= 144.5 (18 May 2023) Quantity Billed as per Following Image.



Image # 07: WPI Steel May-2023.

SIo=102.4 (13 Jan 2020) receipt of tender as per Following Image

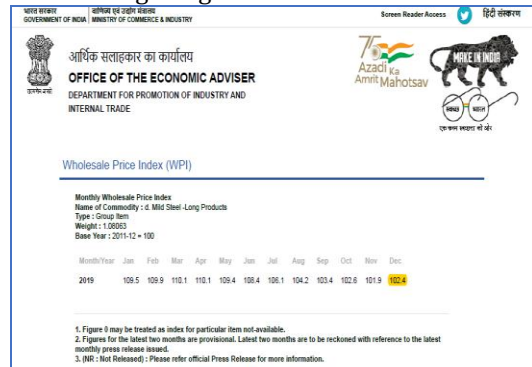


Image # 08: WPI Steel Dec-2019.

So

$$Vs = P * Q * \{ (SI - SIo) / (SIo / SIo) \}$$

$$Vs = 41200 * 4298 * ((144.5 - 102.4) / 102.4)$$

$$Vs = 41200 * 4298 * ((42.1) / 102.4)$$

$$Vs = 41200 * 4298 * 0.4111$$

$$Vs = 7,27,96,601/-$$

4.1.1.3 Structural Steel Cost.

$$Vsc = P * Q * \{ ((SCI) - (SCIo)) / (SCIo / SCIo) \}$$

P= Rs. 44100 As per Table no-10 Sr. (f)
 Q= 950MT as per Table No.9
 SCI= 154.7 (18 May 2023) Quantity Billed as per Following Image

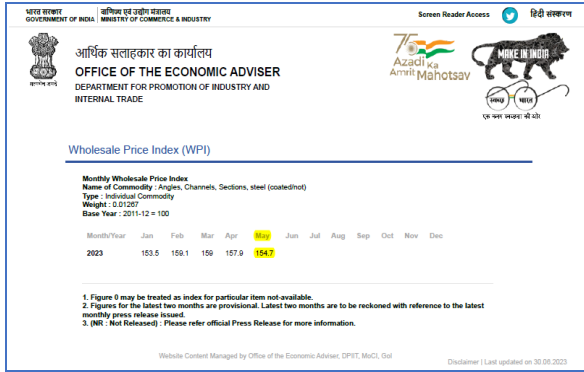


Image # 09: WPI Structural Steel May-2023.

SCIo=99.1 (13 Jan 2020) receipt of tender as per Following Image

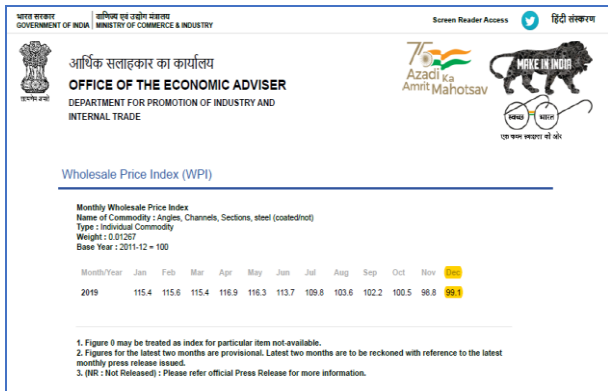


Image # 10: WPI Structural Steel Dec-2019.

So

$$V_{sc} = P * Q * \left\{ \frac{(SCI) - (SCIo)}{(SCIo / SCIo)} \right\}$$

$$V_s = 44100 * 950 * \left\{ \frac{(154.7 - 99.1)}{99.1} \right\}$$

$$V_s = 44100 * 950 * \left\{ \frac{(55.6)}{99.1} \right\}$$

$$V_s = 44100 * 950 * 0.5610$$

$$V_s = 2,35,03,095/-$$

4.1.2 Material (Expect Cement/Steel/ Structural Steel) Cost

Payment to rate/increase/decrease account when bidding for employment in the Central Department of Public Works (excluding information paid under section 10CA). If there is an increase in the prices of 10 CC Materials (no materials or goods delivered by the Department at a fixed price by the Department under the contract provisions in CPWD 4 10) and the contract will be specified below, the contract will therefore be different. less No such payment will be made for

works where the total time specified is equal to or less than the time specified in Schedule F. Such payments for material and labor costs will eventually be calculated according to the following rules: -

- i) The base period for working out such escalation shall be the last stipulated date of receipt of tenders/quote including extension, if any
- ii) The Price of work on which escalation will be payable shall is considered as below:
 - a) The total cost of the work has been done in the agreed quarter: (A)
 - b) Total operating cost increased compared to the previous quarter.: (B)
 - c) Total amount of work done since last quarter (A-B) : (C)
 - d) Total Estimated Value of Advance Payment (excluding information paid by clause 10) (CA)fresh paid in this quarter: (D)
 - e) Total value of security received for quarterly period (excluding items used by Chapter 10 CA): (E)
 - f) The total value of the adjustment is confirmed before payment is made for the quarter. (D-E) : (F)
 - g) Advance payment for this quarter: (G)
 - h) Advance payment recovered during quarter: (H)
 - i) Advance payments received this quarter (G-H): (I)
 - j) Pay for additional items at quarterly market rates: (J) Then, $M = C + F + I - J$
 $N = 0.85 M$
 - k) Deduct cost/Price of material supplied by the concerned department and recovered during the quarter in billing period: (K)
 - l) Reduce cost of service rendered at fixed costs and recovered for the duration of the quarter:(L)

Cost of work for which escalation is applicable:

$$W = N - (K + L)$$

- iii) Materials (excluding cement, HSYD/TMT rebar, steel structures or other materials in CPWD 10 CA clauses), labor, diesel, etc. Each work will be pre-ordered and placed in the Contract Schedule together with the tender documents in Schedule "E". The decision of the Responsible Agent to calculate this percentage is binding on the contractor.
- iv) Installment payments for other materials i.e. construction materials/works/materials (excluding cement, HSYD/TMT rebar, steel structures or other materials from CPWD 10 CA provisions) and diesel shall include the following standards:

v) Adjustment for civil construction material/Works/Components (except cement, Structural steel, reinforcement HSYD/TMT bars and other materials covered under clause 10CA) / electrical component of construction

'Materials',

$$V_M = W * (X_m/100) * \{(MI - M_{Io}) / M_{Io}\}$$

Where-

V_m = Variation in material cost i.e. Increase or decrease in the amount in rupees to be paid or recovered.

W = Cost of work done worked out as indicated in sub-para (ii) of Clause in CPWD 10CC.

i.e. $W = N - (K + L)$

X_m = Component of 'materials' (except cement, Structural steel, reinforcement HSYD/TMT bar sand other materials covered in CPWD clause 10CA) expressed as percent of the total value of work.

MI = All India Wholesale Price Index for civil component/electrical component* of construction material as worked out on the basis of All India Wholesale Price Index for individual Commodities/Group items for the period under consideration as published by Economic Advisor to Govt. of India, Ministry of Industry & Commerce and applying weightages to the individual Commodities/ Group Items. (In respect of the justified period extended under the provisions of clause 5 of the contract without any action under clause 2, the index prevailing at the time of stipulated date of completion or the prevailing index of the period under consideration, whichever is less shall be considered).

M_{Io} = All India Wholesale Price Index for civil component/electrical component of construction material as worked out on the basis of All India Wholesale Price Index for individual Commodities/Group items valid on the last stipulated date of receipt of tender, including extension, if any, as published by the Economic Advisor to Govt. of India, Ministry of Industry & Commerce and applying weightages to the individual Commodities/Group items.

Material Cost (Excluding Cement, Steel, Structural Steel)

$$V_M = W * (X_m/100) * \{(MI - M_{Io}) / M_{Io}\}$$

V_m = Variation in material cost i.e. increase or decrease in the amount in rupees to be paid or recovered.

W = Cost of work done worked out as indicated in sub-para (ii) of Clause 10CC.

i.e. $W = N - (K + L)$

$$N = 0.85 M$$

Where,

M= Total Cost executed during quarter Say its **Rs.5,36,87,28,668**

$$N = 0.85 M = 0.85 \times 5,36,87,28,668$$

$$W = N - (K - L) = X \ 5,36,87,28,668$$

X_m = Component of 'materials' (except cement, Structural steel, reinforcement bars and other materials covered under clause 10CA) expressed as percent of the total value of work.

$$X_m = 5368728668 - \{(Cement Qty \times Star Rate) + (Steel Qty \times Star rate) + (Stru. Steel Qty \times Star rate)\}$$

$$X_m = 5368728668 - \{(4700 \times 48964) + (41200 \times 4298)\} + \{(44100 \times 950)\}$$

$$X_m = 5368728668 - (230130800 + 177077600 + 41895000)$$

$$X_m = 5368728668 - 449103400$$

$$X_m = 4919625268$$

MI=Material Index all Commodities at Billing=**149.6**



Image # 11: WPI Material May-2023

M_{Io}=Material Index all Commodities at Tender Receipt=**123.**

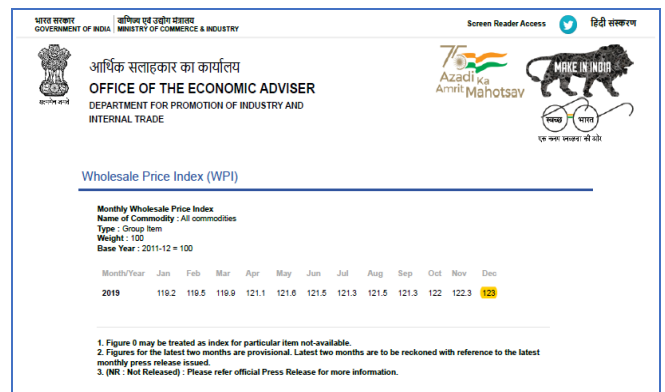


Image # 12: WPI Material Dec-2019

$$V_M = W * (X_m/100) * \{(MI - M_{Io}) / M_{Io}\}$$

$$V_M = 4919625268 * (149.6 - 123 / 123) \setminus$$

$$V_M = 4919625268 * 0.2162$$

$$V_M = 1,06,36,22,983 / -$$

Total Price Escalation Cost using central Public Works Department Formulae = **3,20,34,207 + 7,27,96,601 + 2,35,03,095 + 1,06,36,22,983 = 1,19,19,56,886 / -**

Total Price Escalation Cost using CPWD Formulae = **1,19,19,56,886 / -**

4.2 Price Escalation Cost using HAM Project Formulae-

The price of the bid will be adjusted from time to time in accordance with these provisions to reflect changes in the price evaluated after the date the evaluation was used prior to the bid date., the change in the value of the data showing the date before the tender date is adjusted according to the bid price and the date when the value is used before the specified date is accepted as the bid value at the start of the construction. The Company will calculate the change in the Price Index between the Previous Date Report and the Day Before Closing Date for each month after the specified date and will be expressed as a multiple of the Closing Date ("Price Index Multiplier"). All invoices sent by the Concessionaire to the Company for the construction period must be the product of the relevant portion of the tender price and the valid price on the invoice date.

In HAM Project the Price escalation is to be calculated on Milestone basis the milestone is 10%, 30%, 50%, 75%, and 90%. At each milestone the price escalation which is Positive or Negative side is decided on milestone payment and at the time of annuity this amount is revert back to Contractor by government on half annuity basis. To do simplicity of calculation the price escalation calculated for 90% i.e., after project completion is considered.

The increase in the form of is calculated as follows.

$$\text{Price Index Multiple} = \frac{\{(70\% * \text{WPI}) + (30\% \text{CPI})\}}{\{(70\% \text{WPI}_0) + (30\% \text{CPI}_0)\}}$$

$$\text{Project Cost (with Escalation)} = \text{Project Cost (Including GST)} * \text{Price Index Multiple.}$$

WPI-The Wholesale Price Index on the Reference Index Date preceding the Bid Say Jan-21 i.e Dec-2020. Index Taken i.e.**123.00**

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	119.2	119.5	119.9	121.1	121.6	121.5	121.3	121.5	121.3	122	122.3	123

Image # 13: WPI Material Dec-2019 for HAM.

CPI- The Labour Price Index on the Reference Index Date preceding the Bid Date i.e Bid Date Jan-20 i.e Dec-2019. Index Taken i.e.**405.00**

State	Centre Desc	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MHR	MUMBAI	300	302	305	307	308	309	312	313	321	322	322	322
	NAGPUR	383	387	386	386	389	393	403	403	403	405	407	405
	NASIK	353	357	357	358	360	360	362	364	369	375	377	380
	PUNE	330	329	331	336	341	344	351	353	353	355	358	357
	SHOLAPUR	320	324	324	327	332	331	335	341	341	347	350	347

Image # 14: CPI for Labour Dec-2019 for HAM.

WPI-The Wholesale Price Index Multiple applicable on the date of Invoice Jun-23 i.e May-2023. Index Taken i.e.**149.6**

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2023	150.7	150.9	151	150.9	149.6							

Image # 15: WPI for Material May-2023 for HAM.

CPI-The Labour Price Index Multiple applicable on the date of Invoice (Preceding Quarter) i.e Jun-23 i.e Mar-2023. Index Taken i.e.,**133.1 X 3.6 (Multiply Factor For 2016) = 479.16**

S.No	Base Year	State	Centre	Year	Month	Index
1	2016	MAHARASHTRA	Nagpur	2023	Feb	132.7
2	2016	MAHARASHTRA	Nagpur	2023	Mar	133.1
3	2016	MAHARASHTRA	Nagpur	2023	Apr	133.5
4	2016	MAHARASHTRA	Nagpur	2023	May	135.4

Image # 16: CPI for Labour Mar-2023 for HAM.

$$\text{Price Index Multiple} = \frac{\{(70\% * \text{WPI}) + (30\% \text{CPI})\}}{\{(70\% \text{WPI}_0) + (30\% \text{CPI}_0)\}}$$

$$\text{Price Index Multiple} = \frac{\{(70\% * 149.6) + (30\% * 479.16)\}}{\{(70\% * 123) + (30\% * 405.0)\}}$$

$$\text{Price Index Multiple} = 1.20 \text{ (Use Up to 2 Digit)}$$

$$\text{Project Cost (with Escalation)} = \text{Project Cost (Including GST)} * \text{Price Index Multiple.}$$

Project Cost (with Escalation) = 5,36,87,28,668* 1.2

Project Cost (with Escalation) = 6,44,24,74,402

Price Escalation Amount = Project Cost with escalation - Project Cost

Price Escalation Amount (HAM) = 6,44,24,74,402 - 5,36,87,28,668

Price Escalation Amount (HAM) = 107,37,45,734/-

4.3 Price Escalation Cost using PWD Maharashtra Formulae-

Government of Maharashtra Govt. Circular No. Sankirn-2017/C.R.121/Part II/Bldg.2 Dated 23-10-2017 Price Variation is to be calculated as.

It is obligatory to include this price correction clause for projects with a construction period of more than 1 year. According to MoRTH guidelines, there is no interest increase if the term is up to 1 year (12 months). For this reason, price adjustment provisions should be included in projects with a construction period of more than 1 year (12 months). It should also be clarified that works such as pit filling or 1-10km rehabilitation cannot continue beyond the completion of the year without the written approval of the relevant Project Manager. Price adjustment provisions included in the tender are also specified in Annex "A".

4.3.1 Price Adjustment

The contract price should be adjusted to increase or decrease the labor, material, oil and diesel (excluding asphalt, cement and steel) costs according to the following standards and the procedures and standards included in the contract. The amended provisions contained herein shall be as follows:

(a) The revised rate applies to work completed from the start date specified in the Contract Documents to the end of the initial completion period, or extended work as agreed by the Contractor, and failure of the work to be completed beyond the specified time due to the contractor. (b) The price adjustment shall be determined during each month from the formula given in the contract data.

(c) Following expressions and meanings are assigned to the work done during each month:

R = Total cost of work per month. If any, the Guaranteed Advance amount given in that month will be deducted from the Guaranteed Advance amount returned within the month, if any. The cost of the work done as a variation will not be included, and the cost will be adjusted separately according to the offer.

To the extent that full compensation for any rise or fall in costs to the contractor is not covered by the provisions of this or other clauses in the contract, the unit rates and prices

included in the contract shall be deemed to include amounts to cover the contingency of such other rise or fall in costs. The formula for adjustment of prices are: $R = \text{Value of work done}$

4.3.2 Adjustment for labour component

(i) Price adjustment for increase or decrease in the cost due to labour shall be paid in accordance with the following formula:

VL = $0.85 \times P1/100 \times R \times (LI - Lo) / Lo$

(ii) VL= increase or decrease in the labour Cost of work during the month under consideration due to changes in rates for local labour.

(iii) Lo= the consumer price index for industrial workers for the State on 28 days preceding the date of opening of Bids as published by Labour Bureau, Ministry of Labour, Government of India.

(iv) LI= The consumer price index for industrial workers for the State for the under consideration as published by Labour Bureau, Ministry of Labour, Government of India.

(v) PI= Percentage of labour component mentioned in tender document.

4.3.3 Adjustment of POL (fuel and lubricant) component

Price adjustment for increase or decrease in cost of POL (fuel and lubricant) shall be paid in accordance with the following formula:

Vf = $0.85 \times Pf/100 \times R \times (F1 - Fo) / Fo$

Vf = Increase or decrease in the Fuel influence of work during the month under consideration due to changes in rates for fuel and lubricants.

Fo = The official retail price of High-Speed Diesel (HSD) at the existing consumer pumps of lac at nearest center on the day 28 days prior to the date of opening of Bids.

F1 = The official retail price of HSD at the existing consumer pumps of IOC at nearest center for the 15th day of month of the under consideration.

Pf = Percentage of fuel and lubricants component of the work.

Note: For the application of this clause, the price of High-Speed Diesel oil has been chosen to represent fuel and lubricants group.

4.3.4 Adjustment of Other materials Component (Excluding bitumen, steel and cement)

Price adjustment for increase or decrease in cost of local materials other than cement, steel, bitumen and POL procured by the contractor shall be paid in accordance with the following formula:

$$V_m = 0.85 \times P_m / 100 \times R \times (M_I - M_0) / M_0$$

V_m = Increase or decrease in the Material cost during the month under consideration due to changes in rates for local materials other than cement, steel, bitumen and POL.
 M = The all-India wholesale price index (all commodities) on 28 days preceding the date of opening of Bids, as published by the Ministry of Industrial Development, Government of India, New Delhi.

M_I = The all-India wholesale price index (all commodities) for the month under consideration as published by Ministry of Industrial Development, Government of India, New Delhi.

P_m = Percentage of local material component (other than cement, steel, bitumen and POL of the work.

4.3.5 Adjustment of bitumen, steel and cement-

Cement Cost - $V_C = [C_0 \{CL_1 - CL_0\} * T] / CL_0$

Steel Cost - $V_S = [S_0 \{SL_1 - SL_0\} * T] / SL_0$

Structural Steel Cost - $V_S = [S_0 \{SL_1 - SL_0\} * T] / SL_0$

Bitumen Cost - $V_B = [BC_1 - BC_0] * T$

So, General Price Escalation using Constant P as Follows

Pl -25% (Labour)

Pm- 65% (Material)

Pf -15% (POL)

a) Cement Cost - $V_C = P * Q * \{(CI - C_0) / C_0\}$

$V_C = P =$ Rs.4700 As per Table no-10 Sr. (a)

$Q =$ 48964 MT as per Table No.9

CI = Avg Preceding Quarter of Invoice Raised
 $(136.8 + 136.4 + 135) / 3 = 136.07$. (18 May 2023) Quantity Billed as per Following Image.



Image # 17: WPI for Cement Bill Invoice Period.

CI = Avg Preceding Quarter of Tender Receipt
 $(118.6 + 119.6 + 118.5) / 3 = 118.9$ (13 Jan 2020)
receipt of tender as per Following Image.

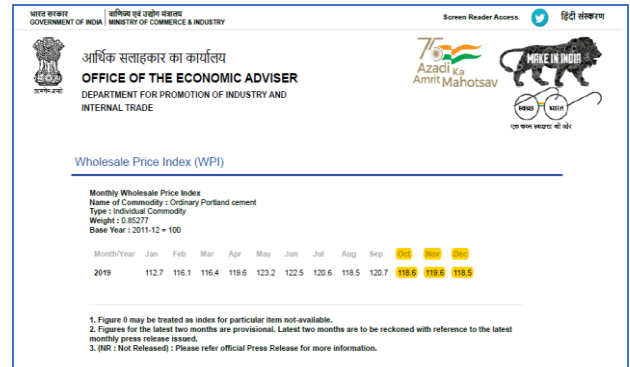


Image # 18: WPI for Cement at Tender Receipt.

Cement Cost - $V_C = P * Q * \{(CI - C_0) / C_0\}$

$V_C = 4700 * 48964 * \{(136.07 - 118.9) / 118.9\}$

$V_C = 4700 * 48964 * 0.1444$

$V_C = 3,32,30,888/-$

b) Steel Cost.

$V_S = P * Q * \{(SI - S_0) / (S_0 / S_0)\}$

$P =$ Rs. 41200 As per Table no- 10 Sr. (d)

$Q =$ 4298MT as per Table No.9

SI = Avg Preceding Quarter of Invoice Raised

$(147.6 + 145.7 + 144.5) / 3 = 145.93$ (18 May 2023)

Quantity Billed as per Following Image



Image # 19: WPI for WPI for Steel Bill Invoice Period.

SI = Avg Preceding Quarter of Tender Receipt
 $(102.6 + 101.9 + 102.4) / 3 = 102.3$



Image # 20: WPI for Steel at Tender Receipt.

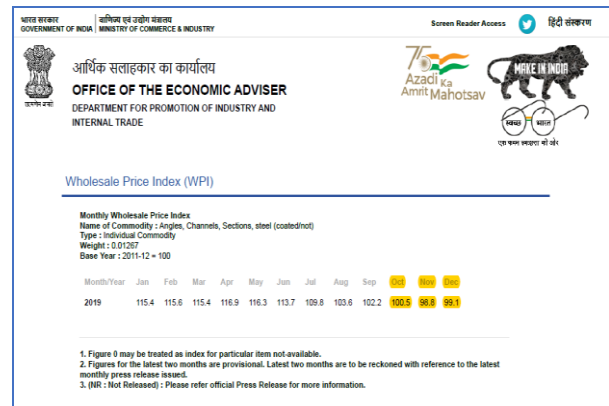


Image # 22: WPI for Structural Steel at Tender Receipt.

So

$$Vs = P * Q * \left\{ \frac{(SI) - (SIo)}{(SIo / SIo)} \right\}$$

$$Vs = 41200 * 4298 * \left(\frac{145.93 - 102.3}{102.3} \right)$$

$$Vs = 41200 * 4298 * \left(\frac{43.63}{102.3} \right)$$

$$Vs = 41200 * 4298 * 0.4265$$

$$Vs = 7,55,23,596/-$$

c) Structural Steel Cost.

$$Vsc = P * Q * \left\{ \frac{(SCI) - (SCIo)}{(SCIo / SCIo)} \right\}$$

P = Rs. 44100 As per Table no- 10 Sr. (f)

Q = 950 MT as per Table No.9

SCI = Avg Preceding Quarter of Invoice Raised, $(159 + 157.9 + 154.7) / 3 = 157.2$ (18 May 2023) Quantity Billed as per Following Image

So

$$Vsc = P * Q * \left\{ \frac{(SCI) - (SCIo)}{(SCIo / SCIo)} \right\}$$

$$Vsc = 44100 * 950 * \left(\frac{157.2 - 99.47}{99.47} \right)$$

$$Vsc = 44100 * 950 * \left(\frac{57.73}{99.47} \right)$$

$$Vsc = 44100 * 950 * 0.5804$$

$$Vsc = 2,43,15,858/-$$

d) Bitumen Cost.

$$VB = \{BCI - BC0\} * T$$

VB- Amount of price variation in Rupees to be allowed in the Bitumen component.

T= Quantity of Bitumen (Grade) in metric ton used in the permanent works and approved enabling works during the quarter under consideration.

BCI= Current average ex-refinery price per metric ton of Bitumen (Grade) under consideration including taxes (LBT, excise, sales tax) during the quarter under consideration for BPCL/HPCL/IOCL.

For

VG-30

$$(55893.44 + 55893.44 + 57783.33 + 59377.92 + 57724.27 + 59377.92 + 59377.92 + 59377.92 + 59377.92 + 59377.92) / 6 = 57,273.45$$

VG-

$$40(59566.91 + 59566.91 + 61740.28 + 63571.11 + 61941.08 + 61055.19) / 6 = 61,240.25$$

Quantity Billed as per Following Image.

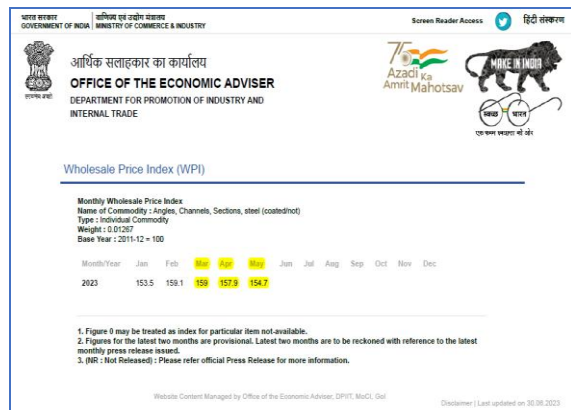


Image # 21: WPI for Structural Steel Bill Invoice Period.

SCIo = Avg Preceding Quarter of Tender Receipt, $(100.5 + 98.8 + 99.1) / 3 = 99.47$ (13 Jan 2020)

receipt of tender as per Following Image

Image # 23: Bitumen Prices at Tender Receipt.

BCo= Basic rate of Bitumen in rupees per metric tonne as considered for working out value of

P or average ex-refinery price for BPCL/HPCL/IOCL in rupees per metric tonne including taxes (LBT, excise, sales tax) of Bitumen under consideration for prevailing quarter preceding the month in which the last date prescribed for receipt of tender, falls, whichever is higher,

For VG-30 (40321+41666+38188+38421+36438+35093)/6 = **38354.5 &**

For VG-40 (42150+43684+40922+40132+37854+36297)/6 = **40173.17** (13 Jan 2020) receipt of tender as per Following Image

VG-30 Cost

VB={BCI-BCO}*T

VB(VG-30)=(61240.25-38354.5)*1362

VB(VG-30) = 2,57,67,609.9

VG-40 Cost

VB={BCI-BCO}*T

VB(VG-40)=(57273.45-40173.17)*11166

VB(VG-40) = 19,09,41,726.5

Total Bitumen Escalation Cost= VB(30)+ VB(40)= 2,57,67,609.9+19,09,41,726.5

Total Bitumen Escalation Cost VB=21,67,09,336.4

e) General Price (Excluding Cement, Steel, Structural Steel)

VL= 0.85 x P1/100 x R x (LI - Lo)/Lo

Vm = 0.85 x Pm /100 x R x (MI - M0)/M0

Vf = 0.85 x Pf/100 x R x (F - F0)/F0

General Price Escalation= VG= VL+Vf+Vm

R= Cost of work done during the Billing quarter under consideration of Work.

Minus-the cost of Cement, HYSD and mild Steel, Bitumen, calculated at the basic star rates as mentioned below.

Note: Above star rates are considered only for working out value of P as mention above and the Price Variation will be paid on the basis of formulas mentioned in the respective clauses as mentioned below.

Say,

P1 = Percentage of Labour Component as indicated above. 25%

Pm= Percentage of Material Component as indicated above. 60%

Pf= Percentage of Petrol, Oil and Lubricant Component. 15%

R = Cost of work

R= M-N

Where,

M= Total Cost executed during quarter Say its

Rs.5,36,87,28,668

N= Cost of All Components in Escalation multiplying with star rate mentioned in Table 10

R= 5,36,87,28,668

R = Component of 'materials' (except cement, Structural steel, reinforcement bars and other materials covered)expressed as percent of the total value of work.

R=5368728668- {(Cement Qty X Star Rate) + (Steel Qty X Star rate) + (Stru. Steel Qty X Star rate)-(Bitumen Qty*Star rate)}

R=5368728668-

{(4700*48964)+(41200*4298)}+(44100*950)+ (1362*29200)(V30)+(11166*30180)}

R=5368728668-

(230130800+177077600+41895000+39770400+336989880)

R =5368728668- 825863680

R=4,54,28,64,988

VL= 0.85 x P1/100 x R x (LI - Lo)/Lo

L1= (Mar-23+Apr-23+May-23)/3

L1=(133.1+133.5+135.4)/3

L1=134.67*3.6(Multiplying Factor) =484.81

Image # 24: CPI at Bill Invoice.

L0= (Oct-19+Nov-19+Dec-19)/3

L0=(405+407+405)/3

L0=405.67

Consumer Price Index Numbers for Industrial workers on Base 2001 = 100 for Year 2019														
State	Centre	Desc	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MHR	MUMBAI		300	302	305	307	308	309	312	313	321	322	322	322
	NAGPUR		383	387	386	386	389	393	403	403	403	405	407	405
	NASIK		353	357	357	358	360	360	362	364	369	375	377	380
	PUNE		330	329	331	336	341	344	351	353	353	355	358	357
	SHOLAPUR		320	324	324	327	332	331	335	341	341	347	350	347

Image # 25: CPI at Tender Receipt.

$$V_L = 0.85 \times P_L / 100 \times R \times ((L_I - L_o) / L_o)$$

$$V_L = 0.85 \times 15\% \times 4,54,28,64,988 \times ((484.81 - 405.67) / 405.67)$$

$$V_L = 0.85 \times 15\% \times 4,54,28,64,988 \times 0.1951$$

$$V_L = 11,30,04,902/-$$

$$V_m = 0.85 \times P_m / 100 \times R \times (M_I - M_0) / M_0$$

$$M_0 = (122 + 122.3 + 123) / 3 = 122.43$$

Image # 26: WPI at Bill Invoice.

$$M_I = (151 + 150.9 + 149.6) / 3 = 150.5$$

Image # 27: WPI at Tender Receipt

$$V_m = 0.85 \times P_m / 100 \times R \times (M_I - M_0) / M_0$$

$$V_m = 0.85 \times 60\% \times 4,54,28,64,988 \times ((150.5 - 122.43) / 122.43)$$

$$V_m = 0.85 \times 60\% \times 4,54,28,64,988 \times 0.2293$$

$$V_m = 53,12,56,260/-$$

$$V_F = 0.85 \times P_F / 100 \times R \times (F - F_0) / F_0$$

Where

$$F = (93.64 + 93.64 + 93.64 + 93.64 + 93.64 + 93.64) / 6 = 93.64$$

Image # 28: Diesel Rate at Bill Invoice.

$$F_0 = (72.08 + 70.34 + 70.22 + 70.2 + 70.29 + 72.55) / 6 = 70.95$$

Image # 29: Diesel Rate at Tender Receipt.

$$V_F = 0.85 \times P_F / 100 \times R \times (F - F_0) / F_0$$

$$V_F = 0.85 \times 15\% \times 4,54,28,64,988 \times ((93.64 - 70.95) / 70.95)$$

$$V_F = 0.85 \times 15\% \times 4,54,28,64,988 \times 0.3198$$

$$V_F = 18,52,33,048/-$$

Then,

$$\text{General Price Escalation} = V_G = V_L + V_f + V_m$$

$$V_G = 11,30,04,902 + 18,52,33,048 + 53,12,56,260$$

$$V_G = 82,94,94,210/-$$

Total Price Escalation Amount using PWD Maharashtra formulae is,

$$\text{Price Escalation} = V_C + V_S + V_{SC} + V_B + V_G$$

$$\text{Price Escalation (PWD-MH)} = 3,32,30,888 + 7,55,23,596 + 2,43,15,858 + 21,67,09,336 + 82,94,94,210.$$

$$\text{Price Escalation (PWD-MH)} = 1,17,92,73,888/-$$

In view of above all the price escalation from different type of Govt. firms & Projects is summarized below,

Price Escalation Cost in Different Type of Project and Departments			
Sr.No.	Central Public Works Departments	NHAI HAM Project	Public Works department Maharashtra
1	1,19,19,56,886	1,07,37,45,734	1,17,92,73,888

Table# -11 Price Escalation Cost Summary.

5. CONCLUSION

The dissertation gives detail study about Price Escalation. It offers us records about the escalation clauses presently used in construction contracts followed through numerous government departments/ agencies in India. The Dissertation gives the calculation of price escalation and collection of data and implementation of the data in formulae to calculate exact price variation cost. The Case Study which is included detail price and quantity calculation which all type formulae are to be used. After all this with reference to Table.11 Price Escalation Cost Summary different government entity calculate different cost due this it's impose financial loss to government firms and contractor also. As per Table.11 HAM project price escalation cost is economical with respect to other firms for Government sector but this impact on contractors and concessionaire. Also this method is much simpler that other PWD and CPWD formulae. The CPWD Cost is much higher and its loss making for government.

The PWD Maharashtra formulae are more suitable and detail calculation consisting in it. Also, the cost calculated in this type it is less that CPWD and Higher than HAM. HAM is Lum sum type of tender in which quantities are not to be considered but at the time of confirming schedule G the quantities have to be calculated. So, by using this paper it will suggest that the HAM project is also will be calculated by using PWD Maharashtra formulae. This dissertation gives the effect of price escalation clause in highway construction industry in which this helps contractors to save from price fluctuation also this increase financial burden on government entities. To do the same there will be uniform and only one formulae and calculation will be used to calculate adequate, efficient, accurate, uniform price escalation cost. After all, above the PWD Maharashtra Formulae is fulfil all the requirements.

Future Scope.

This Dissertation concludes that PWD Maharashtra formulae is more suitable while calculating Price Escalation Cost there are some Limitation should consider such as; Labor, Material and POL Impact Percentage are to be calculated on or Before Tendering on basis of total items and Estimated quantities. This Paper also gives detail calculation, Collection of Index, Calculation of Consummation statement etc. for outcome of price escalation cost of each government

entity and Type i.e. Hybrid Annuity Mode, Central Public works department and Public Works Department Maharashtra.

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