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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.

I. 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.

1.1 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 March 1963, a sub-clause 10C become 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

1.2 Price Escalation

Escalation is the change in value or rate of specific items or services in a given economy over a duration. Inflationary developments in economic system get contemplated through escalation in costs of units. it is the growth 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.

1.3 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.

1.3.1 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 paralysing 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

1.3.2 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.

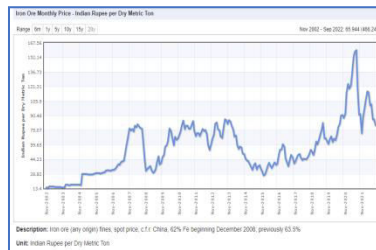


Image # 02: Iron ore Historical Prices 2002-2021

1.3.3 Wages (Labour Index)

The records of compilation & preservation of customer price Index Numbers for Factory employees owes its beginning to the deteriorating financial circumstance of the workers due to unusual rise in costs following the first world war. due to sharp rise in costs and the value of living, a few Provincial Governments commenced carrying out own family finances Enquiries and compilation of client charge Index Numbers for business people in the India. however, none of them became absolutely first-rate. In pursuance of the tips made with the aid of the Rau court of Enquiry, the job of compilation & upkeep of customer rate Index Numbers for business workers became taken over through the central govt. in 1941. but, the compilation of index numbers on uniform and scientific strains was started out most effective after the behavior of the own family living Surveys via the Labour Bureau throughout 1958-59 at 50 essential industrial centers, spread over period and breadth of the India, under the guidance of the Technical Advisory Committee on Price-of-Living Index Numbers and compilation of Consumer Price Index Numbers for Industrial Workers on made a base as 1960 (Nineteen Sixty) =100. Since then, the compilation and maintenance of Consumer Price Index Numbers for Industrial Workers are being done by the Labour Bureau on a continuous basis. The series (1982=100) had revised form the old (1960=100) series with the release of October, 1988 index numbers then only, the current series on base 2001(Two Thousand One) =100 has Revised and Finalized as the earlier (1982=100) series in 2006.

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

The coverage the centers for the new collection throughout 2016 has been very well reviewed on the premise of employment information supplied using the states/ Union territory for unique sectors included within the states list of Centre having attention of workers and total employment information in the states in India/ Union territory regarding those sectors were acquired from numerous state govt. Employment facts concerning seven present sectors has been used to exercise session the entire centers to be included in the new series. The employment of commercial workers in those seven sectors has registered a growth of 15% for the reason the remaining survey of 1999-2000 where in 78 centers have been protected. Consequently, the real choice of centers has been finished on the premise of industrial importance of the Centre as curtained via canter smart employment statistics. These 88 centers cover about 60% of overall employment in the seven sectors. There are 65 commonplace centres among old (2001= a Hundred) and new series (2016= Two Thousand Sixteen) and 23 new centres beneath new series at the same time as thirteen centres had been dropped.

1.4 Index Complication Methodology.

1.4.1 Basic framework:

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:

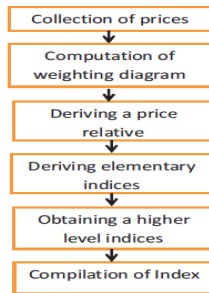


Image # 03: Stages Involved in Index Compilation.

Sl. No.	State	Centre	Apr-2023	May-2023	Date	Sl. No.	State	Centre	Apr-2023	May-2023
1	AP	Banpur	142.4	143.7	14/05/23	53	West Bengal	Chhatrapati	148.5	148.5
2		Beluru	133.0	133.7	14/05/23	54		Angul Talbar	144.0	144.4
3		Bhadrachalam	148.8	148.3	14/05/23	55		Cuttack	143.2	143.2
4	ASSM	Biswanath-Chandni	136.1	136.8	14/05/23	56		Banspetta	142.2	142.2
5		Booni-Dooda Thakota	146.2	147.8	14/05/23	57	PUJ	Puducherry	142.7	142.8
6		Boudh	146.9	147.8	14/05/23	58	PUJ	Port Blair	126.1	126.1
7		Laban-Bidigar	132.4	133.4	14/05/23	59		Jaleswar	145.8*	146.1
8		Narasimha-Chingari	138.2	141.7	14/05/23	60		Ludhiana	141.1	142.0
9		Bilaspur	138.8	141.1	14/05/23	61		Bangur	131.8	132.0
10	BH	Malan-Jamalur	133.2	137.1	14/05/23	62	JUN	Alwar	128.9	127.1
11		Parla	132.8	132.8	14/05/23	63		Bhilwara	132.0	132.2
12	CHD	Chandigarh	141.3	141.4	14/05/23	64		Bikaner	128.1	127.8
13	CHG	Chennai	124.8	126.1	14/05/23	65	TN	Chennai	131.7	133.1
14		Kurva	138.8	138.8	14/05/23	66		Coimbatore	130.7	130.9
15		Nagpur	138.1	138.1	14/05/23	67		Coonoor	133.2	134.1
16	DHR	Dadra & Nagar Haveli	138.2	138.1	14/05/23	68		Madurai	128.6	127.7
17	DU	Dadra	138.8	138.8	14/05/23	69		Bikaner	127.2	127.4
18	GOA	Goa	128.5	128.4	14/05/23	70		Tirunelveli	141.8	142.8
19		Armoimbatad	129.8	129.8	14/05/23	71		Uttara Nagar	138.3	138.7
20	GUJ	Bhavnagar	131.8	131.8	14/05/23	72	TEL	Hyderabad	133.7	134.6
21		Rajkot	134.8	136.7	14/05/23	73		Warananasi	148.5	148.7
22		Surat	138.8	138.1	14/05/23	74		Warananasi	137.4	138.2
23		Vadodra	130.0	130.0	14/05/23	75	TRIP	Tripura	130.5	130.4
24	HRY	Fardabad	134.1	133.7	14/05/23	76	UP	Lucknow	142.2	142.8
25		Ganganagar	137.6	137.6	14/05/23	77		Shahjahanpur	137.0	137.8
26		Tarunagar	136.1	136.1	14/05/23	78		Kanpur	136.9	137.8
27	J&K	Jammu & Kashmir	138.2	137.7	14/05/23	79		Ludhiana	142.2	142.8
28		Diddar	138.8	138.2	14/05/23	80		Varanasi	138.2	138.8
29		Chandigarh-Darya	138.1	138.1	14/05/23	81	UP	Lakhimpur Kheri	144.4	144.8*
30		Jamshedpur	147.5	147.4	14/05/23	82	WB	Durgam	132.3	134.1
31		Rangpur	128.4	128.1	14/05/23	83		Durgam	138.0	138.1
32	KNT	Bengaluru	137.8	138.3	14/05/23	84		Madurai	124.5	124.8
33		Bengaluru	137.8	138.3	14/05/23	85		Huairath	138.3	138.8
34		Bengaluru	137.8	138.3	14/05/23	86		Jalgaon	132.1	131.8
35		Chennai	142.8	142.8	14/05/23	87		Bikaner	138.2	137.8
36		Madurai	131.8	132.4	14/05/23	88		Rangpur	140.0	142.7
37		Muzaffarpur	130.8	131.8	14/05/23	89		ALL INDIA INDEX	134.2	134.7
38		Nagpur	134.8	135.1	14/05/23					
39	KOL	Ernakulam/Kollam	136.1	136.4	14/05/23					
40		Kollam	136.7	136.8	14/05/23					
41		Kollam	136.8	136.4	14/05/23					
42		Kollam	136.8	136.4	14/05/23					
43	MP	Bhopal	139.8	140.1	14/05/23					
44		Chhindwara	138.8	138.4	14/05/23					
45		Indore	127.4	127.8	14/05/23					
46		Jabalpur	124.8*	125.7	14/05/23					
47	MHR	Mumbai	128.1	128.2	14/05/23					
48		Nagpur	133.0	133.4	14/05/23					
49		Pune	128.8	128.8	14/05/23					
50		Pune	124.5	125.0	14/05/23					
51		Bilaspur	141.1	141.7	14/05/23					
52		Thane	138.8	138.7	14/05/23					

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

1.5 Objective of Project Dissertation

1.5.1 To study about price escalation & Collect data for same.

1.5.2 To examine the escalation clauses currently used in construction contracts followed through diverse Government Authorities / departments/ organizations in India

1.5.3 The adequacy of reimbursement paid to the contractor primarily based on presently used escalation clauses in government Authority containing various contracts.

1.5.4 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.

II. RELATED WORK

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 & Mr. Ketan Jain in 2018 Studied Escalation can account for a enormous part of construction prices. Therefore, forecasts of the amount of escalation are required for budgetary and bidding purposes. This paper examines methods for forecasting construction escalation the usage of statistical time series techniques.



Time series of creation price indices are used as a proxy of construction price escalation. The application of time series techniques, their boundaries, and their impact at the chance of cost escalation are confirmed and evaluated. The analytical strategies to be had are most effective beneficial in forecasting for quick construction projects in solid situations. This is due to the fact none of the techniques can forecast escalation as a result of unpredictable occurrences which includes outbreak of warfare or certain government action. Construction price escalation stays a risk to be borne by way of either the contractor or the proprietor, or both, relying at the terms of the contract; any logical method to decrease the chance is profitable.

Dr. N. B. Chaphalkar & Ms. Sayali S. Sandbhor studies research the modern-day structure of calculation of wholesale price index, identifies construction materials taken into consideration inside the commodity basket, variation in wholesale price indices of these materials and its impact on arriving at escalation amount. For outlining financial system of the India, units contributing to it viz. items and offerings traded inside the financial system are supervised indicated thru numerous indices drafted by means of involved government on the idea of retail, wholesale or manufacturer costs of the products. Indian economic system follows wholesale price indices compiled at nationwide stage that's a measure of wholesale price motion for the economic system. Escalation almost about construction industry is one of the most important dispute susceptible clauses. Preferred Indian construction contract conditions offer for calculation of escalation amount for materials the use of applicable wholesale price indices. Amount of exchange in wholesale price indices over a span of time impacts the amount of escalation calculated.

Government of India Ministry of Labour & Employment Labour Bureau published a report provides a comprehensive detail of key concepts, definitions and methodology used in revision of CPI (Consumer Price Index) – IW based on year from 2001 to 2016. CPI (Consumer Price Index) -IW is a vital economic indicator which measures the change in prices of goods and services consumed by index population. This index is also of high significance to the government for it is used for regulation and determination of Dearness Allowances (DA) being payable to all of Central/ State Government workers in industrial/Construction sectors besides fixation and revision of minimum wages in scheduled employments. Labour bureau complies the indices in keeping with global /international best practices & guidelines of international labour bureau. The dissemination of CPI (Consumer Price Index) -IW is also special data dissemination requirement standards (SDDS) Compliant.

Government of India having Ministry of Commerce & Industry Department for Promotion of Industry and Internal Trade Office of Economic Adviser the brand-new series of Wholesale price Index (WPI) with base 2011-12, Statistics for WPI (2011-12) has however been furnished from April 2012 to March 2017 for the cause of studies and evaluation most effective. Linking aspect given for conversion of WPI (2011-12) indices to WPI (2004-05) collection have to be used from April 2017 onwards. WPI captures the average value of wholesale costs of products and is frequently used as a GDP deflator. WPI (2011-12) reckons most effective fundamental costs and does now not consist of taxes, rebate/alternate discounts, transport and different prices.

Once a year price of inflation primarily based on all India Wholesale rate Index (WPI) number is 5.85% (Provisional) for the month of November, 2022 (over November, 2021) towards eight.39% recorded in October, 2022.

Decline in price of inflation in November, 2022 is broadly speaking contributed via fall in costs of food articles, primary metals, textiles, chemical compounds & chemical products and paper & paper products in comparison to the corresponding month of the preceding 12 months. The index numbers and inflation price for the final 3 (Three) months of all commodities and Whole sale price additives are given underneath:

All Commodities/Major Groups	Weight (%)	Index Numbers & Annual Rate of Inflation (Y-o-Y in %)*					
		Sep-22 (F)		Oct-22 (P)		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

III. METHODOLOGY

3.1 Collect data for Price Escalation Index and Clause.

Escalation is a phenomenon of economics pondered thru price of inflation computed from WPI information. Escalation is the alternate in cost or price of particular items or offerings in a given economic system over a duration. Inflationary developments in economic system get contemplated via escalation in prices of units. it's far the growth in the value of any construction factors of the original contract or base price of a project due to passage of time John Hollmann et. al.



(2007) defines escalation as modifications in rate ranges pushed by way of underlying economic situations. Escalation impacts the price range and causes excessive economic overrun by way of the contractor. It additionally provides to contingency inside the contractor’s bid and is a primary contributor to the general cost uncertainty of ‘escalation’ in h is tender rates from the organization. Construction work is done in keeping with the pre-confirmed contract agreement. to manage up with the unexpected price escalation, regulated provision is necessary in creation contract or tender.

3.2 Construction contract and claims against price escalation clause.

Contract phrases and conditions play a dominant function in right and well-timed execution of works, stopping and resolving disputes springing up thereto. conditions of contract manual the concerned parties concerning their rights, responsibilities, duties and techniques to be observed. Drafting a construction tender is nothing but allocation of risks concerned in a project a few of the parties to the contract. regardless of all the provisions inside the contract Tender Documents, claims are raised on a construction site. Claims typically rise up when one party to the agreement suffers a detriment for which that party desires to be compensated by way of the alternative party. it could be described as a valid request for extra reimbursement on account of a change within the scope of project. possibility of escalation over the duration of execution of project results in claim for escalation amount further to the base price. Claims while no longer nicely taken care of cause disputes.

3.3 Calculation of WPI (Wholesale price Index)

Every index has its very own calculation methodology and definition of terms and is expressed in terms of an exchange from a primary price. The commodity basket forms the idea of computation of WPI as it's far said to symbolize the overall marketplace. As soon as the basket is constant, transactions of the items within the basket in a given financial system are surveyed and recorded. Price quotations for the identical items are accrued from numerous providers. Primarily based on this data in addition calculations are accomplished 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	$V_e = W \times (X/100)^n \times (C_1/C_0)$	$V_e = (K_e \times V_0/1000) + V_0$ $B_e = (V_{0e} - V_{0e0}) \times (C_1 - C_0)/C_0$	$V_e = (C_1/C_0) \times T/C_0$	Price Index Multiple = $(100 \times WPI + 300 \times CPI) / (100 \times WPI + 300 \times CPI)$	$VRW = 0.85 RW + PL \times (L - 10)/LO + PA \times (AI - AO)/AO$ $PF \times (F1 - FO)/FO + PB \times (B1 - B0)/B0 + PM \times (M1 - M0)/M0 + PC \times (C1 - CO)/CO + PS \times (S1 - S0)/S0$ $VBR = 0.85 BR + PL \times (L - 10)/LO + PA \times (AI - AO)/AO + PF \times (F1 - FO)/FO + PM \times (M1 - M0)/M0 + PC \times (C1 - CO)/CO + PS \times (S1 - S0)/S0$
Steel	$V_e = W \times (X/100)^n \times (S_1/S_0)$	$V_e = (K_e \times V_0/1000) + V_0$ $B_e = (V_{0e} - V_{0e0}) \times (S_1 - S_0)/S_0$	$V_e = (S_1/S_0) \times T/S_0$		
Materials Plant and Machinery	$V_e = W \times (X/100)^n \times (M_1/M_0)$	$V_e = (K_e \times V_0/1000) + V_0$ $B_e = (V_{0e} - V_{0e0}) \times (M_1 - M_0)/M_0$	$V_e = 0.85 P_1/100 P_0 \times (M_1 - M_0)/M_0$	Project Cost (with Escalation) = Project Cost (including GST) / Price Index Multiple	
POL	$V_e = W \times (Z/100)^n \times (P_1/P_0)$	Nil	Nil		
Labour	$V_e = W \times (Y/100)^n \times (L_1/L_0)$	$B_e = (K_e/1000) \times V_0 \times (L_1 - L_0)/L_0$	$V_e = 0.85 P_1/100 P_0 \times (L_1 - L_0)/L_0$		
Bitumen	Nil	Nil	$V_e = (R_e - R_0) \times T$		

Table# -3 Escalation Formulae used in Construction Contracting; 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-

Cost of output is the price of transactions accomplished in domestic marketplace at the beginning factor of bulk sale. Weights are assigned to the commodity on the basis of its percentage within the overall value of output within the economic system. The weights of individual commodities, scenario. history of WPI in India is representative of this phenomenon with typical seven revisions of the series of commodities to include the dynamic modifications in market. it's been a practice in view that then to revise the series after each decade.

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

3.3.2 Calculation of price relative-

Prices Relative is accumulated for the ones items that are selected inside the WPI basket from decided on resources for data collection. Minimal five quotations consistent with item are suitable while lesser number because of unavoidable circumstances is likewise desirable. Price relative is the ratio of modern-day price and base price of the commodity. price relative is calculated for every citation. Price quotations for commodities permit calculation of price relative that's calculated as following formula.

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

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:

$$I = (\sum(iXWi)) / (\sum Wi)$$

Where,

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

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

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

3.3.4 Materials in commodity basket

Comprising of all commodities decided on for calculation of WPI. It is essentially a subset of products this is designed to imitate the overall performance of a universal market. The goods within the basket are frequently adjusted periodically to account for modifications in customer behaviour or habits. Series 2004-05 consists of total 676 items towards 435 items inside the preceding series 1993-ninety-four. 259 items are not unusual amongst those series.

3.3.5 Variation in WPI for major construction materials

Change in Whole sale price index through the years is the phenomenon of economic system. The change in economical conditions is affected through changes in Whole sale price index. Over the past few years construction industry has witnessed boom. This is additionally reflected via significant increase/variation in Whole sale price index for major construction materials. The following table highlights this variation in Whole sale price index for eight financial years. Table 6 indicate the monthly variation in Whole sale price index for commodities grey cement and rebars from January to December for the year 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. Malviya 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	53000
15	RCC Drain	Km	8.99
16	Boundary Wall	Km	60

Table# -8 Scope of Project

Sr. No.	Item in Brief	Unit	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.

IV. 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.

The cost of the contract/Tender accordingly be varied for all such materials and will be worked out as per the formula given below for major materials used in construction: -

Cement Price Variation Calculated such as,

$$Vc/Vs/Vsc = P * Q * \{((CI/SI/SCI)-(CIo/SIo/SCIo))/(CIo/SIo/SCIo)\}$$

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 as issued under the authority, CPWD or concerned Zonal Chief Engineer as indicated in Schedule 'G/B/ F' valid at the time of the last stipulated date of receipt of tender including extensions, if any, 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 2021-22 Star Rates

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

CIo/SIo/SCIo =Price index multiple form Ministry of Industry and Commerce., economic adviser Government of India, such as cement, steel reinforcement bars and structural steel as valid on the last stipulated date of receipt of tenders including extensions, if any, for other items, if any, provided in Schedule 'G/B/F', including extensions, if any.

CI/SI/SCI=Price index for cement, steel reinforcement bars and structural steel as published by Economic Advisor to Government of India, Ministry of Industry and Commerce as All India Wholesale Price Index for the material for period under consideration of payment or billed

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)

CIo=118.5 (13 Jan 2020)

So,

$$V_c = P * Q * \{ (CI - CI_o) / CI_o \}$$

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

$$V_c = 4700 * 48964 * (16.5 / 118.)$$

$$V_c = 4700 * 48964 * 0.1392$$

Vc = 3,20,34,207/- Cement Escalation Amount

4.1.1.2 Steel Cost.

$$V_s = P * Q * \{ (SI) - (SI_o) / (SI_o / SI_o) \}$$

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

Q= 4298MT as per Table No.9

SI= 144.5 (18 May 2023)

SI_o=102.4 (13 Jan 2020) receipt

So

$$V_s = P * Q * \{ ((SI) - (SI_o)) / (SI_o / SI_o) \}$$

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

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

$$V_s = 41200 * 4298 * 0.4111$$

Vs=7,27,96,601/-

4.1.1.3 Structural Steel Cost.

$$V_{sc} = P * Q * \{ ((SCI) - (SCI_o)) / (SCI_o / SCI_o) \}$$

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 a

SCI_o=99.1 (13 Jan 2020) receipt of tender

So

$$V_{sc} = P * Q * \{ ((SCI) - (SCI_o)) / (SCI_o / SCI_o) \}$$

$$V_{sc} = 44100 * 950 * ((154.7 - 99.1) / 99.1)$$

$$V_{sc} = 44100 * 950 * ((55.6) / 99.1)$$

$$V_{sc} = 44100 * 950 * 0.5610$$

Vs=2,35,03,095/-

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

As per central public works dept. Clause 10 CC Payment due to upraise/decrease In Prices/Wages (Excluding materials covered under clause 10CA) after Receipt of tender for Works If the prices of materials (no longer being materials provided or offerings rendered at constant costs through the department according with clause in CPWD 10 & 34 thereof) and/or execution of the work increasing, the contractor will be compensated for such increase as consistent with provisions specific underneath and the amount of the contract shall consequently be various, concern to the situation that such reimbursement for escalation in prices and wages will be to be had best for the work carried out during the stipulated period of the contract which includes the justified period prolonged below the provisions of clause of the contract without any movement under clause, for the work performed throughout the justified period prolonged as above, the repayment as particular under might be constrained to costs/wages triumphing at the time of stipulated date of entirety or as triumphing for the period underneath attention, whichever is much less. No such reimbursement will be payable for a work for which the stipulated duration of entirety is identical to or much less than the time as laid out in schedule F. Such repayment for escalation within the prices of materials and labour, while due, will be worked out primarily based on the following provisions: -

- 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) Gross value of work done up to the quarter considered: (A)
 - b) Gross value of work done up to the last quarter considered: (B)
 - c) Gross value of work done since previous quarter considered(A-B) : (C)
 - d) Full assessed value of Secured Advance (excluding materials covered under clause 10 (CA)fresh paid in this quarter: (D)
 - e) Full assessed value of Secured Advance (excluding materials covered under clause 10 CA)recovered in this quarter: (E)
 - f) Full assessed value of Secured Advance for which escalation is payable in this quarter (D-E) :(F)
 - g) Advance payment made during quarter: (G)

h) Advance payment recovered during quarter: (H)

i) Advance payment for which escalation is payable in quarter (G-H): (I)

j) Extra items to be paid based on with respect to market rates during quarter: (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) Components for materials (except cement, reinforcement HSYD/TMT bars, structural steel or others materials covered under Clause in CPWD 10 CA), Labour, Diesel.etc. will be pre-determined for every work and incorporated in the conditions of contract attached to the tender papers included in Schedule 'E'. The decision of the Engineer-in-Charge in working out such percentage shall be binding on the contractors.

iv) The compensation for escalation for other materials i.e. construction material/Works/Components(excluding cement, reinforcement HSYD/TMT bars, structural steel or other materials covered under clause in CPWD 10 CA) and Diesel shall be worked as per the formula given below: -

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',

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

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 bars and 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).

MI_o = All India Wholesale Price Index for civil component/electrical component of construction material as worked out on the basis of All over India Wholesale Price Index for individual Commodities/Group items valid on the last stipulated date of receipt of tender documents, 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)

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

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.

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

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

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

$X_m =5368728668-449103400$

$X_m = 4919625268$

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

MIo=Material Index all Commodities at Tender Receipt=123.

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

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

$$V_M = 4919625268 * 0.2162$$

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

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 Bid Project Cost shall be revised from time to time in accordance with the provisions of this to reflect the variation in Price Index occurring after the Reference Index Date immediately preceding the Bid Date.

The Bid Project Cost adjusted for variation between the Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date immediately preceding the Appointed Date shall be deemed to be the Bid Project Cost at commencement of construction. At every month occurring after the Appointed Date, the Authority shall compute the variation in Price Index occurring between the Reference Index Date preceding the Bid Date and the Reference Index Date preceding the date of Invoice, and shall express the latter as a multiple of the former (the "Price Index Multiple"). All Invoices to be submitted by the Concessionaire to the Authority for and in respect of the Construction Period shall be the product of the relevant proportion of the Bid Project Cost and the Price Index Multiple applicable on the date of Invoice.

In form of Formulae price escalation is to be calculated as follows.

$$\text{Price Index Multiple} = \{(70\% * WPI) + (30\% CPI)\} / \{(70\% WPI_o) + (30\% CPI_o)\}$$

Project Cost (with Escalation) = Project Cost (Including GST) * Price Index Multiple.

WPIo-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**

CPIo- 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**

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 # : 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**



Wholesale Price Index (WPI)

Monthly Wholesale Price Index

Name of Commodity: All commodities

Type: Group Item

Base Year: 2011-12 = 100

Month/Year	2023	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2023	152.7	152.9	151	152.9	152.9	152.9	152.9	152.9	152.9	152.9	152.9	152.9	152.9

Image # : 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**

General Index | Official website of Labour Bureau, Ministry of Labour and Employment, Government of India

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 # : CPI for Labour Mar-2023 for HAM.

Price Index Multiple= $\{(70\%*WPI)+(30\%CPI)\}/\{(70\%WPI_0)+(30\%CPI_0)\}$

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

Price Index Multiple= 1.20 (Use Up to 2 Digit)

Project Cost (with Escalation) =Project Cost (Including GST) *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.

This Price Adjustment clause shall be included in works having **time limit of more than 1 year**. As per the MoRTH guidelines, price escalation is not payable where the time limit is up to 1 year (12 calendar months). Hence the Price Adjustment clause shall be included in works having **time limit of more than 1 year** (12 calendar months). It must also be clarified that works like pothole filling or one time renovation of 1-10 kms cannot be extended beyond one year without a written approval by the concerned Chief Engineer. The Price Adjustment clause to be included in the tender is attached

separately as Appendix "A".

Appendix "A"

4.3.1 Price Adjustment

Contract price shall be adjusted for increase/decrease in price of labour, materials, fuels and diesel excluding bitumen, cement and steel in respect within the following principles and procedures and as per formula given in the contract data. The price variation clause to be included shall be read as follows:

(a) The price adjustment shall apply for the work done from the start date given in the contract data up to end of the initial intended completion date or extensions granted by the Engineer and shall not apply to the work carried out beyond the stipulated time for reasons attributable 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 value of work done during the month. It would include the amount of secured advance granted, if any, during the month, less the amount of secured advance recovered, if any during the month. It will exclude value for works executed under variations for which price adjustment will be worked separately based on the terms mutually agreed.

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:

$$Vf = 0.85 \times Pf/100 \times R \times (F1 - F0)/F0$$

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 centre 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 centre 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 HSYD/TMT 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:

$$Vm = 0.85 \times Pm /100 \times R \times (MI - M0)/M0$$

Vm= 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.

MI= 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.

Pm= Percentage of local material component (other than cement, steel TMT/HYSYD, bitumen and POL of the work.

4.3.5 Adjustment of bitumen, steel TMT/ HYSYD and cement-

Cement Cost - VC=[C0{CL1-CL0}*T]/CL0

Steel Cost-VS=[S0{SL1-SL0}*T]/SL0

Structural Steel Cost-VS=[S0{SL1-SL0}*T]/SL0

Bitumen Cost-VB={BC1-BC0}*T

So, General Price Escalation using Constant P as Follows

PI -25% (Labour)

Pm- 65%(Material)

Pf -15% (POL)

a) Cement Cost - Vc = P*Q * {(CI-CIo)/CIo}

Vc= 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)

CIo=Avg Preceding Quarter of Tender Receipt (118.6+119.6+118.5)/3= **118.9** (13 Jan 2020) receipt of tender

Cement Cost - Vc = P*Q * {(CI-CIo)/CIo}

Vc= 4700*48964*{ (136.07-118.9)/118.9}

Vc= 4700*48964*0.1444

Vc= **3,32,30,888/-**

b) 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= Avg Preceding Quarter of Invoice Raised (147.6+145.7+144.5)/3=**145.93**(18 May 2023) Quantity Billed

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

So

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



$$V_s = 41200 * 4298 * ((145.93 - 102.3) / 102.3)$$

$$V_s = 41200 * 4298 * ((43.63) / 102.3)$$

$$V_s = 41200 * 4298 * 0.4265$$

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

c) Structural Steel Cost.

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

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

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

So

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

$$V_{sc} = 44100 * 950 * ((157.2 - 99.47) / 99.47)$$

$$V_{sc} = 44100 * 950 * ((57.73) / 99.47)$$

$$V_{sc} = 44100 * 950 * 0.5804$$

$$V_{sc} = 2,43,15,858/-$$

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

$$VG-30 (55893.44 + 55893.44 + 57783.33 + 59377.92 + 57724.27 + 56968.31) / 6 = 57,273.45$$
 (18 May 2023) &

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

Quantity Billed as per Following Image.

पदार्थ/PRODUCT	मूल्य BASIC	सी जी एस टी CGST दर RATE	सी जी एस टी सॉफ्ट AMOUNT	एस जी एस टी SGST दर RATE	एस जी एस टी सॉफ्ट AMOUNT	कुल TOTAL
दर प्रति लिट्रोमीटर (RATE PER KL)						
एस डी ओ LDO	40580.00	9.0%	3652.20	9.0%	3652.20	47884.00
कार्बन ऑक्साइड FO	26770.00	9.0%	2409.30	9.0%	2409.30	31588.00
एस डी ओ MTO	62800.00	9.0%	5652.00	9.0%	5652.00	74104.00
एस डी ओ MSP	64590.00	9.0%	5797.00	9.0%	5797.00	75874.00
हेक्सान HEXANE	45300.00	9.0%	4077.00	9.0%	4077.00	53454.00
एस डी ओ SKO	56740.00	9.0%	5106.60	9.0%	5106.60	66953.00
दर प्रति टन RATE PER MT						
कार्बन ऑक्साइड FO	27900.00	9.0%	2511.00	9.0%	2511.00	32922.00
हेक्सान HEXANE	43290.00	9.0%	3896.10	9.0%	3896.10	51082.00
एस एस एस एस LSHS	28750.00	9.0%	2587.50	9.0%	2587.50	33925.00
नाफ्थल NAPHTH	41000.00	9.0%	3690.00	9.0%	3690.00	48380.00
कार्बन BENZENE	45520.00	9.0%	4096.80	9.0%	4096.80	53614.00
एस डी ओ MTO	81760.00	9.0%	7358.40	9.0%	7358.40	96468.00
टोलुएन TOLUENE	55000.00	9.0%	4950.00	9.0%	4950.00	64900.00
बिटुमन पैक (दर प्रति टन) BITUMEN-PAK (RATE PER MT)						
सी 40 (VG40)	40080.00	9.0%	3607.20	9.0%	3607.20	47284.00
सी 30 (VG30)	37710.00	9.0%	3393.90	9.0%	3393.90	44496.00
सी 10 (VG10)	34910.00	9.0%	3141.90	9.0%	3141.90	43554.00
बिटुमन बाल (दर प्रति टन) BITUMEN-BULK (RATE PER MT)						
सी 40 (VG40)	34680.00	9.0%	3121.20	9.0%	3121.20	40922.00
सी 30 (VG30)	32310.00	9.0%	2907.90	9.0%	2907.90	38188.00
सी 10 (VG10)	32410.00	9.0%	2916.90	9.0%	2916.90	38244.00

Image #: Bitumen Prices at Tender Receipt.

BC0= 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,

$$\text{For VG-30 } (40321 + 41666 + 38188 + 38421 + 36438 + 35093) / 6 = 38354.5\&$$

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

VG-30 Cost

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

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

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

VG-40 Cost

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

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

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

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

$$\text{Total Bitumen Escalation Cost } VB = \underline{21,67,09,336.4}$$

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

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

$$Vm = 0.85 \times Pm / 100 \times R \times (MI - M0) / M0$$

$$Vf = 0.85 \times Pf / 100 \times R \times (F - F0) / F0$$

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.

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

$$R = 5368728668 - \{(4700 * 48964) + (41200 * 4298) + (44100 * 950) + (1362 * 29200)(V30) + (11166 * 30180)\}$$

$$R = 5368728668 - (230130800 + 177077600 + 41895000 + 39770400 + 336989880)$$

$$R = 5368728668 - 825863680$$

$$R = 4,54,28,64,988$$

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

$$L1 = (\text{Mar-23} + \text{Apr-23} + \text{May-23}) / 3$$

$$L1 = (133.1 + 133.5 + 135.4) / 3$$

$$L1 = 134.67 * 3.6 (\text{Multiplying Factor}) = 484.81$$

$$L0 = (\text{Oct-19} + \text{Nov-19} + \text{Dec-19}) / 3$$

$$L0 = (405 + 407 + 405) / 3$$

$$L0 = 405.67$$

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

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

$$VL = 0.85 * 15\% * 4,54,28,64,988 * 0.1951$$

$$VL = \underline{11,30,04,902/-}$$

$$Vm = 0.85 \times Pm / 100 \times R \times (MI - M0) / M0$$

$$M0 = (122 + 122.3 + 123) / 3 = 122.43$$

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

$$Vm = 0.85 \times Pm / 100 \times R \times (MI - M0) / M0$$



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

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

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

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

Where

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

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

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

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

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

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

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.

V. 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.

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