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Effect of Fluid Density and Temperature on Discharge Coefficient of Ogee Spillways Using Physical Models

M. SREENIVASULU REDDY [1] DR Y. RAMALINGA REDDY[2]
Assistant Professor, School of Civil Engineering REVA University[1]
Dean and Director of School of Civil and Mechanical Engineering, REVA University[2]

Abstract:

Spillways are constructed to allow excess flood safely to downstream of a dam. In any dams spillways are used for passing of water flow that exceeds the designed capacity. Most of the dams fail due to insufficient spillway capacity or inappropriate design. Spillways are structures, used for measuring water pass of canals and many other applications. Hence lots of efforts have been made in increasing accuracy of flow measurement of such structures. The structure of the Spillway is a major problem in fixing the type of spillway and its design for construction of dam. Taking into account appropriate discharge coefficient and investigation of spillway for long term hydraulic performance plot are understood to be important. Spillways are of the most impo tant structure, upper limit of the curved is designed in a way that it will be closer to lower profile of water pass which is ventilated on a sharp crest and is in appropriate with water pass. Preventing ventilation under the water pass, there is a contact between spilled water and spillway head profile. This work presents suitable graphs for selection and supply based on type of fluid flowing on the spillways as the key elements to use this type of spillways in construction of dams. To do this, physical-hydraulic model and observed Power Industry performed measurement tests and hydraulic parameters were analyzed and discharge coefficient in different fields including surface roughness in Ogee spillway model were studied. Increase of density and temperature of water over spillway the discharge coefficient decreases. Also from experiments results it is found that for different discharges, with the increase in density decrees the performance and increase in temperature decreases the performance.

Keywords — **Ogee Spillways, density, relative density, Temperature**

I INTRODUCTION

The efficient and safe ability of Ogee spillway to pass water on the downstream is possible when it is designed and constructed properly, with the capability of measuring good flow, it has encouraged engineers to use it as a as a water discharge structure in numerous situations. The Ogee spillway's has an upper hand as compared to sharp crested weir due to its shape that makes the flow smooth and as a result near-atmospheric pressure is observed over the crest section for the head designed. If the head is lesser than the designed head, the discharge over the crest will be less because of the crest resistance. If the head is more, the discharge will be greater when compared to sharp crested weir that is aerated. From the understanding of the flow characteristics and the general shape of ogee weir we can conclude that any deviation from the standard design parameters like modification in the shape of the crest or any change in flow conditions on the upstream, or any alteration of local geometric properties in approach channel disturbs the property of the flow. As spillway is an important structure for the safety of dam. Hence physical models have to be used for the analysis of the effects.

II. PROFILE OF OGEE SPILLWAY

Extensive survey and from the field observation it can be concluded that most common type of spillway adopted on the field is ogee spillway. Spillway face, Crest and the toe are the three components of the ogee spillway. The lower nape of the flow over thin plate is replaced by weir solid boundary.

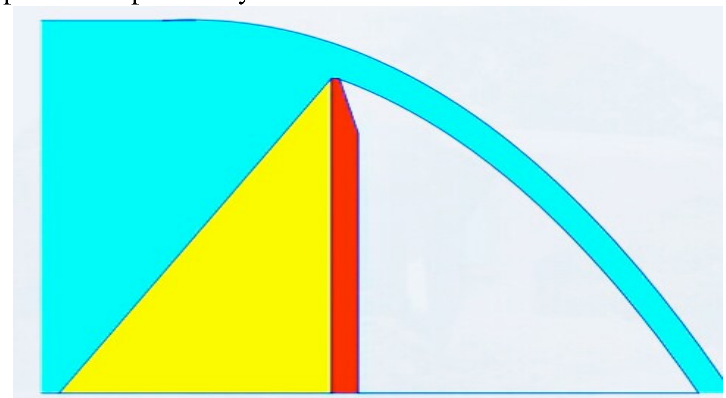


Fig 1.Flow over a thin weir

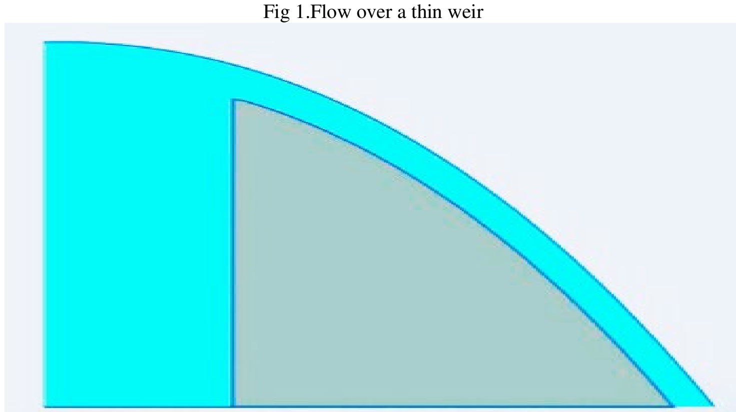


Fig 2.The fluid boundary bottom nappe has been replaced by solid boundary

III. OBJECTIVES

1. The ogee spillway has control weir that is ogee shaped or s-shaped
2. It is also a overflow type of spillway.
3. Reduces the impact of water at downstream.
4. To drop off the water at downstream from the foundation of the dam.
5. Reduces scouring etc.
6. Used for small concrete dams.
7. Provide recreational Impact at downstream.

IV.METHODOLOGY

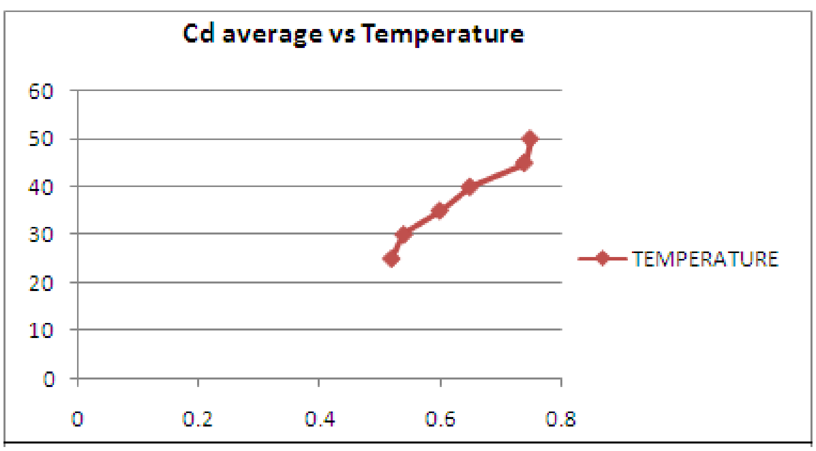
The apparatus consist of supply tank(with provision for maintaining constant head), collecting tank with sump tank, pump set, the glass tube to pass the water at required velocity, and the dye tank to supply colored liquid. The water drawn from the sump tank and fed to the supply tank through valve. The constant head can be maintained either by controlling the water flow or by overflow pipe adjustment. The water enters the channel through the bell mouth entry and pass through the channel the velocity in the channel is controlled by outlet valve at the downstream during the flow the dye is injected to the centre of the tube just after the entry and the flow observed and the result is tabulated. This paper concentrates on to reproduce ogee spillway overflow in controlled environment for higher heads than the design heads. To achieve this, high specific discharges are necessary. From the laboratory conditions the available capacity of discharge for a model with 15cm design head and

20 cm wide in order to minimize wall effects was possible.

V.READINGS AND CALCULATIONS

Sl.no	Temperature	Volume(V)	Time(t)	Qact=V/t	Height(H)	Qth=2/3L√2gH3/2	Cd=Qact/Qth	cd avg
		In m3	In Sec	In m3/s	In cm	In m3/s		
1		0.0115	48.28	0.000238	1.05	0.000479	0.5	
2	25	0.0115	26.78	0.000429	1.5	0.000813	0.52	0.52
3		0.0115	18.94	0.000607	1.8	0.00107	0.56	
1		0.0115	36	0.000319	1.05	0.000479	0.66	
2	30	0.0115	21	0.000547	1.6	0.00094	0.58	0.54
3		0.0115	16.7	0.000688	2.5	0.001751	0.4	
1		0.0115	80	0.000127	0.75	0.0002887	0.5	
2	35	0.0115	34	0.0003382	1.05	0.00048	0.69	0.6
3		0.0115	20	0.000575	1.6	0.00094	0.615	
1		0.0115	21.6	0.000324	0.52	0.0053	0.6125	
2	40	0.0115	36	0.00032	0.59	0.0064	0.52	0.65
3		0.0115	20	0.000575	1.29	0.00065	0.82	
1		0.0115	40	0.00029	0.96	0.00042	0.68	
2	45	0.0115	23	0.0005	1.2	0.00059	0.85	0.74
3		0.0115	16.8	0.000684	1.7	0.000986	0.69	
1		0.0115	82	0.0001402	0.6	0.000206	0.68	
2	50	0.0115	31.6	0.000364	1.05	0.00048	0.76	0.75
3		0.0115	20	0.000575	1.36	0.000706	0.81	

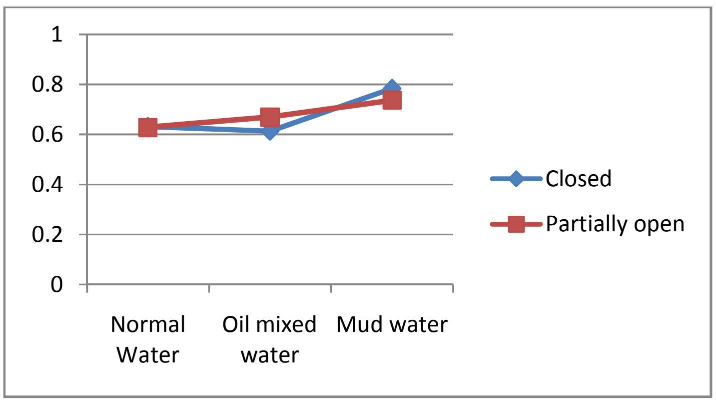
TABLE1: SHOWING DIFFERENT C_D VALUES FOR DIFFERENT TEMPERATURE



GRAPH1: BETWEEN C_D AVERAGES VS. TEMPERATURE

	By pass valve	% of water	Density Kg/m^3	H m	h m	Time seconds	Qact=V/T m^3/s	Qth= 2/3 L$(2g)^{1/2}h^{3/2}$ m^3/s	Cd= Qact/Qth m^3/s
Normal Water	Closed		1000	0.015	0.1	22.39	0.00051	0.000814	0.63
	Partially open		1000	0.012	0.1	31.45	0.00037	0.000582	0.63
Oil mixed water	Closed	10	962	0.001	0.1	22.17	0.00052	0.000846	0.62
	Partially open	10	962	0.012	0.1	29.51	0.00039	0.000582	0.67
Mud water	Closed	10	1070	0.012	0.1	22.62	0.00051	0.000649	0.78
	Partially open	10	1070	0.008	0.1	42.69	0.00027	0.000366	0.74

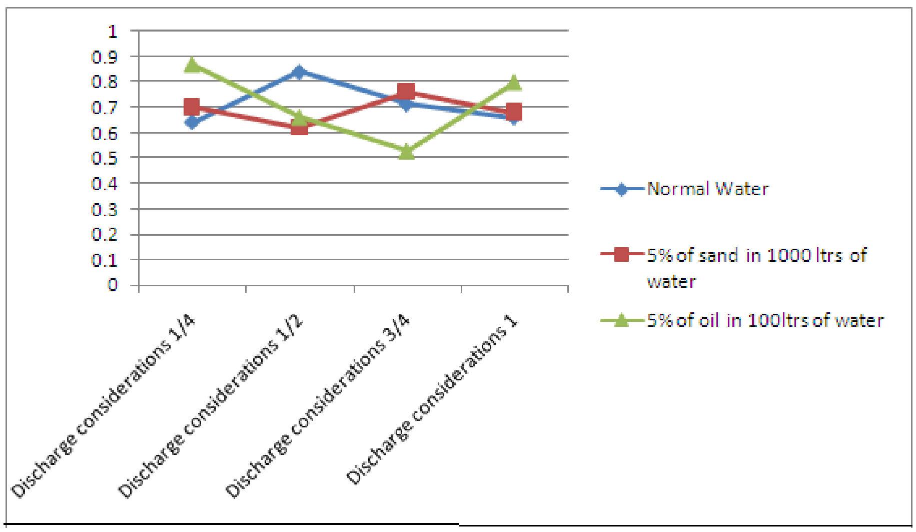
TABLE2: DENSITY OF FLUID FOR OGEE CRESTED WEIR



GRAPH 2: DISCHARGE FOR DIFFERENT TYPES OF WATER WITH RESPECT TO VALVE

	Discharge considerations	Volume	Time s	Qact=V/T m^3/s	V=Q/A m/s	H2 cm	H1 cm	H M	Qth= $Bh^{3/2}$ m^3/s	Cd=Qact/ Qth m^3/s
Normal Water	1/4	0.0115	168	$6.84x10^{-5}$	$5.94x10^{-4}$	0.7	0.1	4x10	$1.11x10^{-4}$	0.64
	1/2	0.0115	30	$3.83x10^{-4}$	$3.33x10^{-3}$	1.7	0.6	0.011	$5.42x10^{-4}$	0.7
	3/4	0.0115	19	$6.05x10^{-4}$	$5.26x10^{-2}$	2	0.7	0.31	$6.9x10^{-4}$	0.87
	1	0.0115	16	$7.18x10^{-4}$	$6.24x10^{-3}$	2.3	0.8	0.015	$8.94x10^{-4}$	0.84
5% of Sand in 1000ltrs of water	1/4	0.0115	39	$2.94x10^{-4}$	$2.55x10^{-4}$	1.6	0.5	0.010	$4.73x10^{-4}$	0.621
	1/2	0.0115	26	$4.42x10^{-3}$	$3.84x10^{-3}$	2	0.65	0.013	$6.67x10^{-4}$	0.662
	3/4	0.0115	21	$5.47x10^{-3}$	$4.75x10^{-3}$	2.2	0.7	0.014	$7.68x10^{-4}$	0.712
	1	0.0115	17	$6.76x10^{-3}$	$5.87x10^{-3}$	2.4	0.8	0.016	$8.90x10^{-4}$	0.759
5% of oil in 100ltrs of water	1/4	0.0115	45	$2.55x10^{-4}$	$2.21x10^{-4}$	1.6	0.5	0.010	$4.34x10^{-4}$	0.53
	1/2	0.0115	28	$4.10x10^{-4}$	$3.56x10^{-4}$	1.9	0.6	0.019	$6.14x10^{-4}$	0.66
	3/4	0.0115	23	$5.00x10^{-}$	$4.34x10^{-4}$	2.1	0.7	0.021	$7.28x10^{-4}$	0.68
	1	0.0115	16	$7.18x10^{-4}$	$6.24x10^{-4}$	2.3	0.9	0.023	$8.90x10^{-4}$	0.80

TABLE 3: COEFFICIENT OF DISCHARGE FOR DIFFERENT WATER PERCENTAGES



GRAPH3: BETWEEN COEFFICIENTS OF DISCHARGE FOR DIFFERENT WATER PERCENTAGE

VI. CONCLUSIONS

Experiments when conducted on two similar ogee spillways for heads greater than the design head. A large quantity of data was observed to be close to the spillway having few differences between them. For the spillway with greater head, the relative flow velocity was observed to be slightly higher. In the rest of the field, the data are in good understanding for both conditions from a head ratio of two. In this theory, the adjustment re-quires the identification of the potential head, because it operates on velocities that are same is potential. The relative pressures along the spillway crest, converted into velocities using Bernoulli's equation was used to convert the relative pressure at the spillway crest into velocities. Results confirm that amplitudes of relative pressure are overestimated for the larger spillway, while an averaging effect due to the size of the sensor is present for the smaller spillway.

It is observed that with the increase in the relative density of spilling water there is a decrease in the coefficient of discharge and temperature. From the experimental results it could be concluded that for different discharges, increase in density and temperature will decrease the performance.

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