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An Optimal Design of the Inlet and Outlet Obstacles at USBR II Stilling Basin

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Abstract: Hydraulic jump is one of the rapidly varied flows that different elements can be employed to control it in stilling basins. The purpose of this study is optimal design of obstacles at USBR II stilling basin of Nazloochay dam model. For this purpose, the obstacles at the end chute with thicknesses and heights of 0.5, 1, 1.5 and 2 m and 2, 3 and 4 steps at the end USBR II stilling basin have been considered. Then for the most optimal state, the pressure, water surface profile, turbulent kinetic energy, and turbulent kinetic energy dissipation investigated for discharging 830 m^3/s by using K-ε and RNG turbulence model and VOF method. According to changes in water height, obstacles selected with heights of 1 and 1.5 equal of standard state at the end chute and 3 steps at the end stilling basin. The comparison of numerical and experimental values of water surface and pressure profiles showed that numerical model has good agreement with experimental results. Also, hydraulic jump on adverse steps at the end stilling basin increase energy dissipation and stability of hydraulic jump. In addition, numerical model can be used to model stilling basins and measuring non-measurable parameters in laboratory.

Keywords: Optimal USBR II Stilling Basin, Chute Blocks, Adverse Steps, Numerical Model.

1. INTRODUCTION

Stilling basins are usually built at the downstream of structures such as chutes and gates to control the energy dissipation of hydraulic jump (Vischer and Hager, 1998; Chanson, 2015; Chow, 1959, Hamedi et al. 2016, 2014, 2012, 2011). In the energy dissipater structures, baffle blocks and end sills are used to prevent the existing jump and placing it in stilling basin, even if the tail water depth is less than the conjugate depth of free hydraulic jump (Peterka, 1984). Forester and Skrinde (1950) were the first ones who done studies about hydraulic jump on the adverse-sloped surface.

For the first time in Nimrod dam in 1975, a stilling basin was used with end steps where the basin was located in downstream of an ogee spillway, and the flow was controlled through 7 slide gates. The performance of stilling basin has been satisfied in terms of energy dissipation and eroding downstream (Hager, 1992). (Harleman, 1955) was one of the first researchers who investigated the role of baffle blocks and its effects on flow characteristics at stilling basins. (Armenio et al., 2000) studied the pressure fluctuations using a negative step at the end of hydraulic jump. Ohtsu and Yasuda (1991) investigated the hydraulic jump on adverse steps with the effect of tail water depth, Froude number and the step heights on the type of hydraulic jump and divided the hydraulic jump to six categories. In this regard, (Mossa et al., 2003) studied various types of hydraulic jump on the adverse step with a wider range of effective parameters. They proposed 11 graphs according to Froude number and tail water depth, and they divided the jump to 5 groups. Abdelazim and Yaser (2010) studied the effect of stilling basin shapes on submerged hydraulic jump. The results showed that stilling basins with end steps create the shortest submerged hydraulic jump in stilling basin. Zhao and Misra (2004) simulated hydraulic jump in 2-Dimentioal state and presented the results by velocity and water level profiles, calculating the amount of kinetic energy (k) and energy loss (ε). (Tiwari, 2013) designed a stilling basin model with the effect of wall and the end still and concluded that by a suitable design of the walls size, not only the efficiency of the stilling basin model increases, but also basin lengths decreases 29% in comparison to USBR IV stilling basin. Bharat and Tiwari (2014) studied several models of the stilling basin at the pipe outlet with rectangular and circular sections. They used studies of previous researcher's. Youngkyu et al. (2015) and Hamedi & Fuentes (2016) experimentally studied hydraulic jump, energy dissipation, and characteristics of downstream flow for different types of spillways with sluice gate. Palermo and Pagliara (2015) compared two configurations of stilling basins and predicted the energy dissipation in downstream of the stilling basin for them. (Neveen, 2016) investigated the impact of channel slope on the characteristics of hydraulic jump and tested the attributes hydraulic jump in the vertical valves located in the downstream of a rectangular channel. (Gamal et al., 2016) explored the impact of different shapes of stilling basin with different heights of the end steps on characteristics of submerged hydraulic jump and energy dissipation in the downstream of a sluice gate. (Feimster, 2016) studied the impact of tail water on the designing several stilling basins in the USA.

Numerical methods have been used by various researchers in recent decades (Hamedi et al. 2016, Ketabdar 2016, Ketabdar and Hamedi 2016, Nik and Vahidi 2015) Mathematical models (Kamyab 2017a, b) exactly express issues when modeling some the hydraulic phenomena (Blocken and Gualtieri, 2012; Murzyn and Chanson, 2009a). Moreover, modeling can caused save of time and expense in comparison to the experimental work. (Chen et al., 2010) 3-Dimensionally simulated flow in stilling basins using VOF RNG k-ε and Mixture RNG k-ε turbulence models. The result showed that the calculated the parameters of water depth, velocity profile and distribution pressure are in good agreement with the experimental data, and the Mixture turbulence model is better than the VOF turbulence model to calculate the air entrainment. (Morovati et al., 2016 and Hamedi and Ketabdar 2016 explored energy dissipation in pooled stepped by using numerical simulation. in this studies, velocity distribution, energy dissipation, turbulent kinetic energy have been investigated in stepped spillway. (Guven et al., 2006) used neural network to predict pressure fluctuations in a sloped stilling basin and presented a formula to calculate average pressure fluctuations on based on the features with the most impact on the hydraulic jump. (Mojtahedi et al., 2015) investigated energy dissipation in stepped spillways by using physical modeling and numerical simulation. They used to an image processing method to obtained water surface profile. (Babaali et al., 2015)simulated hydraulic jump in converged stilling basin by using flow-3D. (Valero et al., 2016) numerically studied the performance of USBR III stilling basin at the downstream of the smooth and stepped spillways. They employed unsteady RANS equations, VOF method and RNG- k-ε models to modelling free surface and turbulence. (Arnau et al., 2016) evaluated the performance of Flow-3D and OpenFOAM in the numerical modeling of hydraulic jump at a low Reynolds number.

In this study, the optimal performance of the USBR II stilling basin has been assessment with changing the structure of inlet and outlet obstacles at the stilling basin. Then, the flow was simulated by using Flow-3D software in stilling basin. Afterward, the thickness and height of the end blocks of chute changed, and the steps added to the end of USBR II stilling basin of Nazloochay dam model. Finally, the most optimal state of stilling basin selected.

2. MATERIALS AND METHODS

2.1 Experimental Model

Nazloochay reservoir dam is an earth dam with a clay core and 100 m height which has been constructed on Nazloochay river in northwestern Urmia-Iran. The hydraulic model of the flooding discharge system was built based on similarity of the dimensionless Froude number with a scale of 1:40. The material of bottom, the walls of the spillway and stilling basin model is Plexiglas. USBR II stilling basin has been designed for 1000 year old floods for discharging 500 m^3/s.

To measure the discharge over a rectangular weir and to regulate the water level, the sluice gates were placed in the end channel at the downstream. The rectangular weir and sluice gate is used at the end of channel in downstream to measurement the discharge and regulation of water level. The flooding discharge system of dam includes input channel, free-ogee spillway, chutes and the USBR II stilling basin. USBRII stilling basin, with dimensions of 42*30 m, has energy dissipater blocks at start and end of stilling basin. In Figure 1 the hydraulic model of Nazloochay dam is shown (Water Research Institute, 2000).

Figure 1. Hydraulic model of Nazloochay dam, Iran

2.2 Numerical Modeling

Although the flow pattern in stilling basins is very complex, the Navier-Stokes equations can presented a mathematically description about them. Nowadays, 3D numerical simulation of free surface flows has become a beneficial and commodious method (Wang and et al., 2009; Wu and Zheng, 2010).

In this study, Flow-3D software is used to simulate the flow in the stilling basin. This software solved governing equations by the finite volume method and is employed Fractional Area / Volume Obstacle Representation (FAVOR) and the Volume of Fluid (VOF) methods respectively to accuracy in modeling the rigid bodies and to simulate the fluid behavior. The Flow-3D software defines the equations of continuity; momentum and the free surface profile as following:

Continuity Equation

$$V_F \frac{\partial \rho}{\partial t} + \frac{\partial(\rho\rho u_x)}{\partial x} + R\frac{\partial(\rho\rho v_Y)}{\partial y} + \frac{\partial(\rho\rho w_z)}{\partial z} + \xi\frac{\rho u A_x}{x} = R_{DIF} + R_{SOR} \quad (1)$$

In Eq. (1) V_F is the fractional volume of the fluid, ρ is the fluid density, (u, v, w) are the velocity components, (A_x, A_y, A_z) are the fractional areas in (x, y, z) directions, R_{DIF} represents the diffusion caused by turbulence and R_{SOR} is a mass source term.

Momentum Equation

$$\frac{\partial u}{\partial t} + \frac{1}{V_F}\{uA_x\frac{\partial u}{\partial x} + vA_yR\frac{\partial u}{\partial y} + wA_z\frac{\partial u}{\partial z}\} - \xi\frac{A_y uv}{xV_F} = -\frac{1}{\rho}R\frac{\partial P}{\partial x} + G_x + f_x - b_x - \frac{R_{SOR}}{\rho V_F}u$$

$$\frac{\partial v}{\partial t} + \frac{1}{V_F}\{uA_x\frac{\partial v}{\partial x} + vA_yR\frac{\partial v}{\partial y} + wA_z\frac{\partial v}{\partial z}\} + \xi\frac{A_y uv}{xV_F} = -\frac{1}{\rho}R\frac{\partial P}{\partial y} + G_y + f_y - b_y - \frac{R_{SOR}}{\rho V_F}v$$

$$\frac{\partial w}{\partial t} + \frac{1}{V_F}\{uA_x\frac{\partial w}{\partial x} + vA_yR\frac{\partial w}{\partial y} + wA_z\frac{\partial w}{\partial z}\} = -\frac{1}{\rho}\frac{\partial P}{\partial z} + G_z + f_z - b_z - \frac{R_{SOR}}{\rho V_F}w \quad (2)$$

In Momentum Eq. (2) (G_x, G_y, G_z) are the components of acceleration of the body fluids, (f_x, f_y, f_z) are the acceleration caused by viscosity and (b_x, b_y, b_z) are the flow drop in porous media.

Free Surface Profile

Free surface profile is estimated by the function of the volume of fluid (VOF), i.e., F (x, y, z). This function indicates the amount of fluid volume in the computational cell as Eq. (3):

$$\frac{\partial F}{\partial t} + \frac{1}{V_F}\{\frac{\partial}{\partial x}(FA_x u) + \frac{\partial}{\partial y}(FA_y v) + \frac{\partial}{\partial z}(FA_z w)\} = 0 \quad (3)$$

In Eq. (3), F is between [0, 1] that $F=1$ indicates exiting fluid, and $F=0$ presents no fluid. In addition, A is the average of flow area, and (u, v, w) are the average velocities in the directions of (x, y, z) respectively [Flow-3D Manual].

2.3 VERIFICATION OF NUMERICAL MODEL

In this study according to Figure 2, USBR II stilling basin has been modeled using Flow-3D software to verify the numerical model. To simulate a flow in USBR II stilling basin, the number of meshes are 300*60*48 in (X, Y, Z) directions as non-uniform structured meshes.

The water surface and velocity has been considered for the upstream boundary condition and tail water elevation for downstream boundary condition. Also in this study, air entrainment model has been used due to air entrainment into flow in hydraulic jump and effect on energy dissipation in stilling basin.

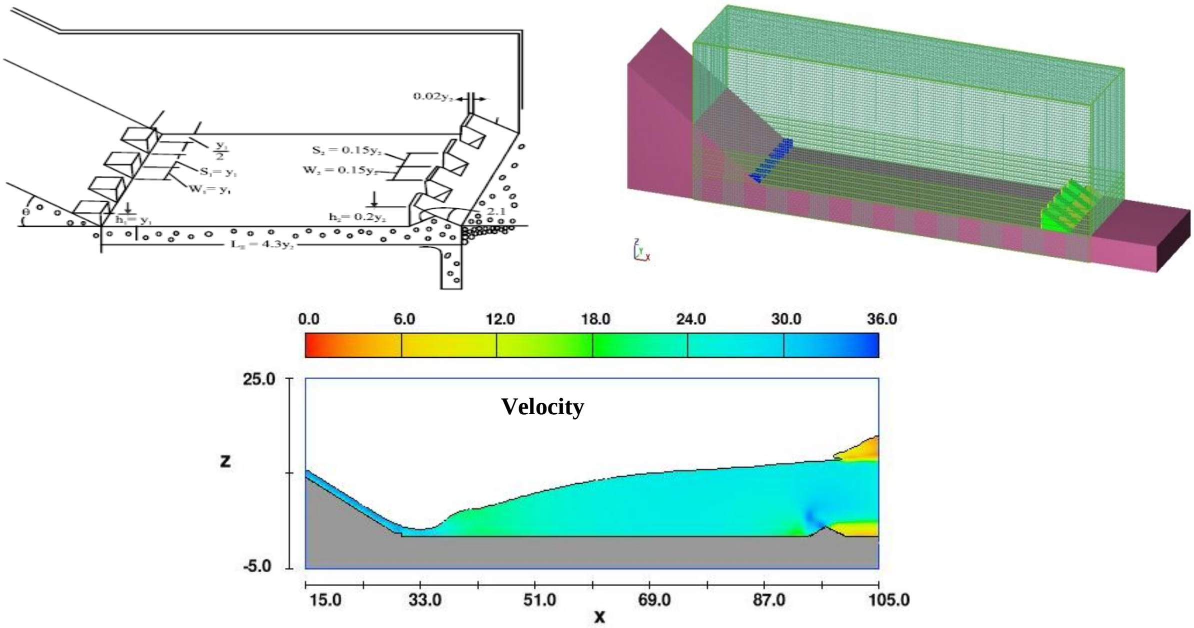


Figure 2. Numerical Simulation of USBR II stilling basin

In Table 1 the characteristics of the numerical and experimental model of USBR II stilling basin have been presented.

Table 1. Characteristics of models in USBR II stilling basin

Models	Experimental Model	Numerical Model
Basin length (m)	70.20	
Basin weight (m)	20	
Mesh Number		300*60*48
Initial depth (m)	1.33	1.32
Conjugate depth (m)	16.38	15.92
Initial velocity (m/s)	32.46	32.36
q (m^2/s)	43.2	43.2

Comparison of numerical and experimental values of water height in USBR II stilling basin in Figure 3 illustrate that the water height in numerical model has not difference with experimental model in the start of stilling basin, but 0.46 m difference has at the outlet of stilling basin (about less than 3%). Therefore, result demonstrates a very high accuracy of the numerical modeling.

3. RESULTS AND DISCUSSION

In the hydraulic model of Nazloochay dam, hydraulic jump is created for discharges more than the design discharge at the outlet of the stilling basin, and flow affected on tail water waterway and river. In order to reach to a better performance and placing the hydraulic jump into the stilling basin for discharges higher than the design discharge, a strategy is making changes in the structures of the energy-dissipater blocks at the end of chute and putting dentate at the outlet of stilling basin. These changes are implemented as follows:

3.1 Changes in Structures of stilling basin

3.1.1 *Chute Blocks*

In the primary design of USBR II stilling basin, the thickness and height of energy dissipater blocks were considered to be 0.5 m at the end chute. In this study, the chute blocks were investigated with the thicknesses and heights of 0.5, 1, 1.5 and 2 meters. In Figure 4, energy dissipater blocks are shown at the end chute in the USBR II stilling basin of Nazloochay dam model.

3.1.2 *End Structures of Stilling Basin*

In USBR II stilling basin, energy dissipater blocks are dentate designed at the end stilling basin. High rate of discharge lead to the erosion of dentate at the end of stilling basin and scour at the downstream waterways. Thus, by eliminating the dentate and creating adverse-sloped surface (3:1; H:V) at the end of the stilling basin, the stilling basin acts like a ski jump bucket at high velocities (Figure 5), although a stable hydraulic jump is created into the stilling basin.

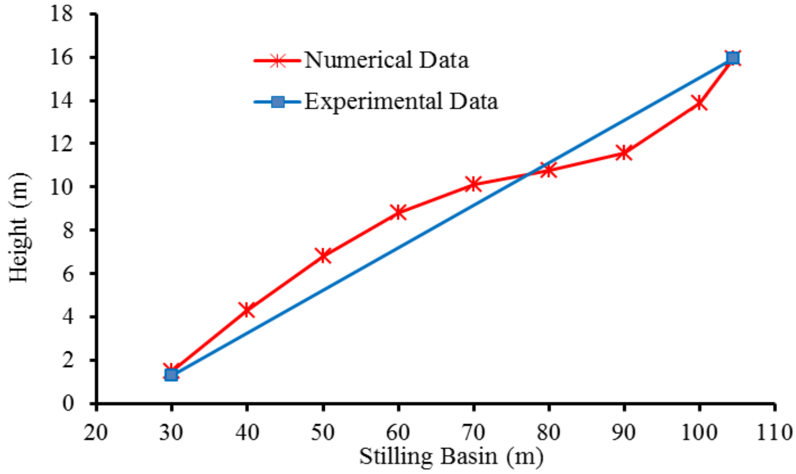


Figure 3. Water height at the length of stilling basin

Figure 4. Chute Blocks at USBR II stilling basin

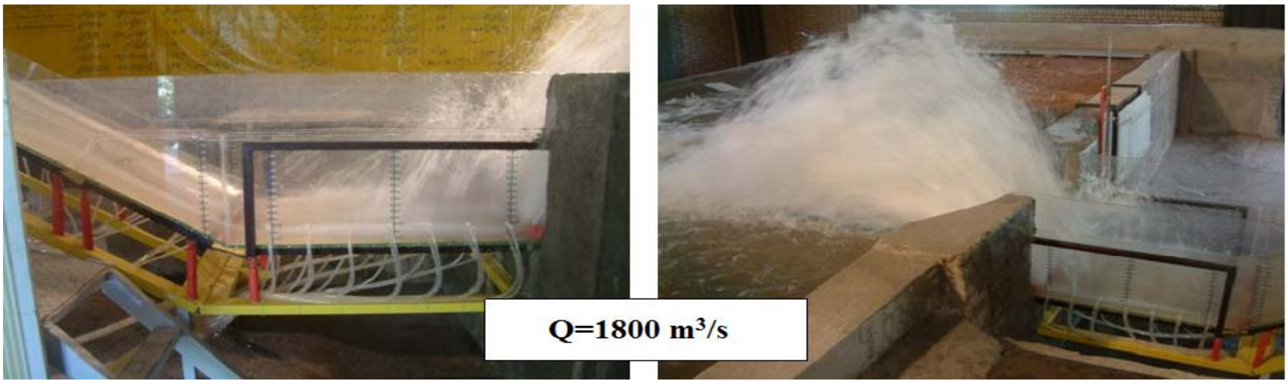


Figure 5. Formation of flow in the USBR II stilling basin with end adverse sloped for high discharge

So to remove this problem, dentate blocks were eliminated at the end stilling basin, and adverse slope surface at the end stilling basin was changed into a stepped surface (Figure 6). By implementing energy dissipater blocks at the end chute and 2, 3 and 4 steps at end of stilling basin, behavior and performance of flow were probed for discharging 830 m^3/s. Then the most optimal state of the stilling basin was selected. All of changes into structures of obstacles at the stilling basin are shown in Table 2.

Table 2. Inlet and outlet obstacles of the stilling basin

Number of the Model	Number of the end obstacles	Dimensions of inlet obstacles
1	*2 steps*	0.5H=0.75*0.5*0.5
2	*3 steps*	0.5H=0.75*0.5*0.5
3	*4 steps*	0.5H=0.75*0.5*0.5
4	*2 steps*	1H=1.5*1*1
5	*3 steps*	1H=1.5*1*1
6	*4 steps*	1H=1.5*1*1
7	*2 steps*	1.5H=3*1.5*1.5
8	*3 steps*	1.5H=3*1.5*1.5
9	*4 steps*	1.5H=3*1.5*1.5
10	*2 steps*	2H=4*2*2
11	*3 steps*	2H=4*2*2
12	*4 steps*	2H=4*2*2

3.1.3 Height of chute blocks

The changes made into the inlet obstacles at USBR II stilling basin are as depicted in Figure 7.

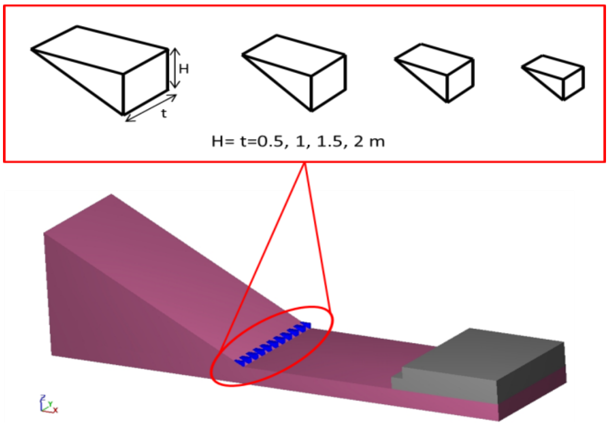


Figure 7. Applied changes in chute blocks

In Figure 8, the values of water height in length of USBR II stilling are illustrated for chute blocks with thickness and heights different for discharging 830m^3/s. According to Figure 8 by considering the changes of water height for different states of chute blocks, it can be stated that the highest water depth is related to obstacles with 1 and 1.5 equal to the standard height, and the least depth is related to the obstacles with height of 0.5 and 2 equal to standard height.

3.1.4 Number of steps at the end stilling basin

Figure 9, the water height is shown in stilling basin for 2, 3 and 4 steps at the end stilling basin for chute blocks with different height.

In Figure 9 according to the water height for different obstacles in the stilling basin, it can be concluded that when the height of chute blocks is 0.5 m, flow characteristics are almost similar, and there are insignificant different between water heights. Also, the start of hydraulic jump is almost in similar place, but the initial depth of hydraulic jump for the stilling basin with 4 steps is a little more, and the flow has the same characteristics.

For chute blocks with height of 1 m, by considering the same place of the start of hydraulic jump, the initial depth of hydraulic jump is higher for stilling basin with 2 steps, and conjugate depth in the stilling basin with 3 steps is almost 2.5 m higher than other states.

For the chute blocks with height of 1.5 m, the conjugate depth is same, but the initial depth for the stilling basin with 2 steps is about 3 to 5 m less than 2 other states. Furthermore, the difference between the initial and conjugate depths is about 10 m.

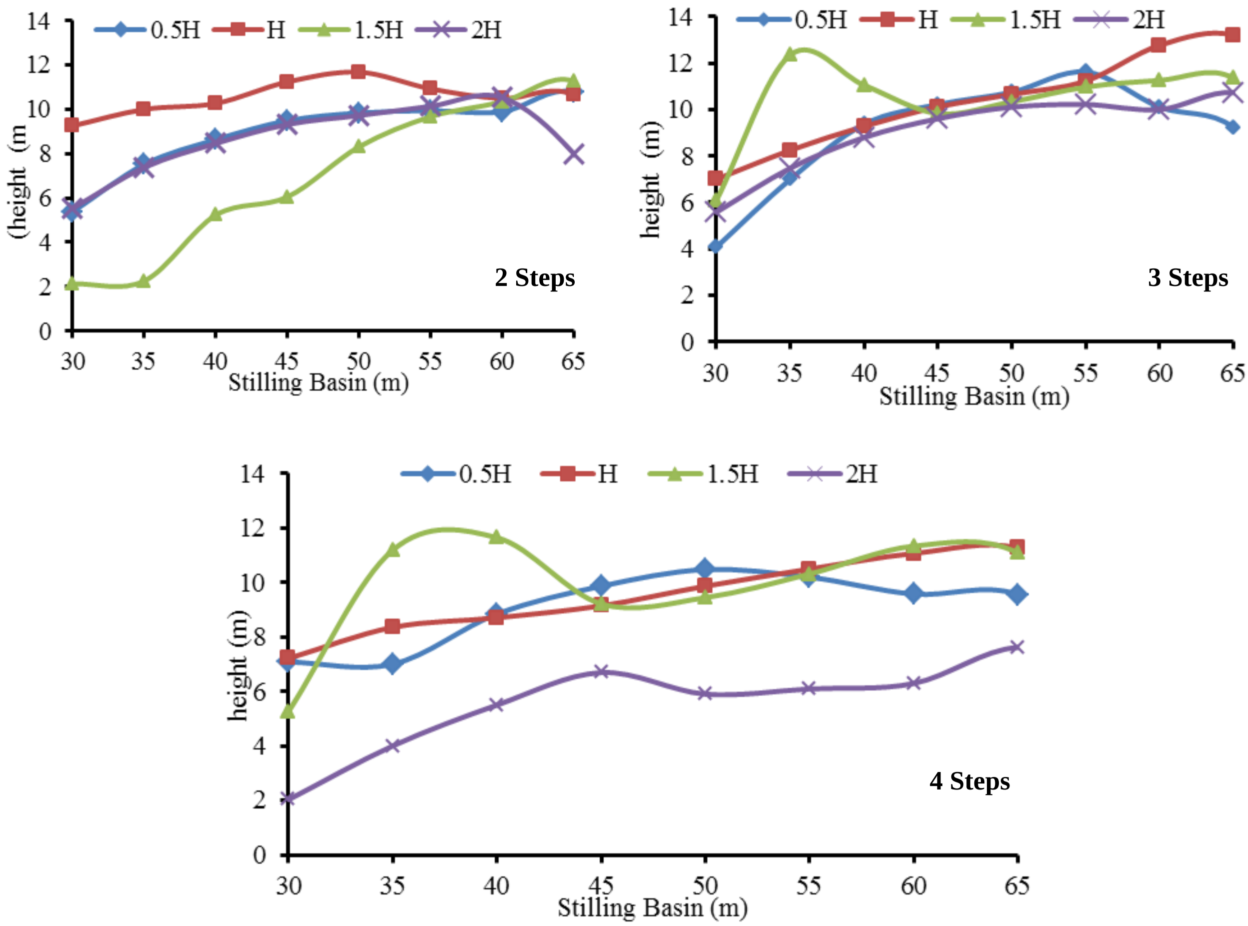


Figure 8. Water height for the different obstacles at the stilling basin

When the height of chute blocks is 2 m, the lowest water depth relates to the basin with 4 steps, and it is maximum value for the basin with 3 end steps. In general, it can be stated that in all conditions, the basin with 3 steps has higher relative depth in comparison with the other two states.

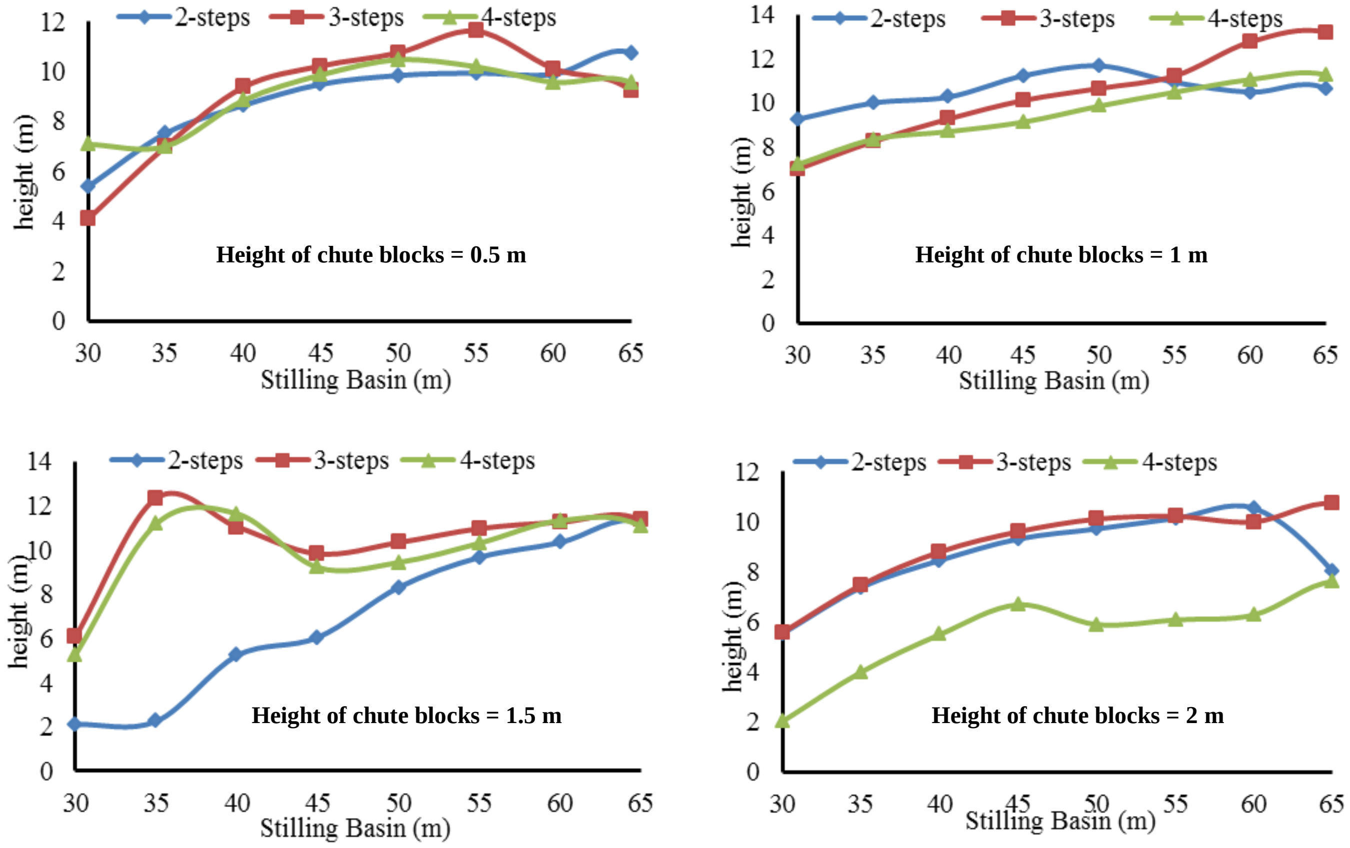


Figure 9. Water level changes in the stilling basin for different states

3.2 Investigation of Parameters in Optimal Stilling Basin

3.2.1 Pressure distribution

Comparing experimental and numerical values of pressure in Figure 10 shows that K-Ɛ turbulence model is more suitable estimator to static pressure rather than RNG turbulence model.

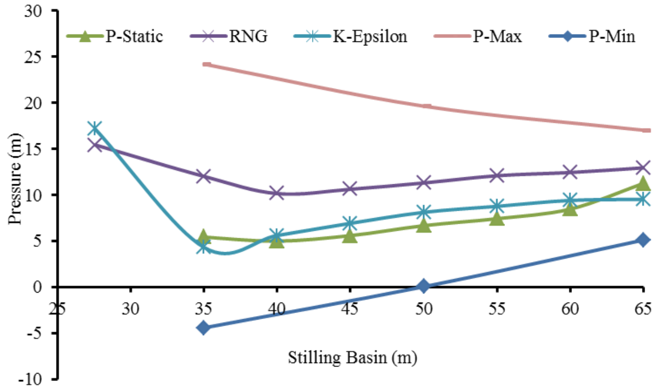


Figure 10. Pressure in the USBR II stilling basin with 3 steps

According to Figure 11, pressure is quite logically simulated by using K-Ɛ turbulence model surrounding obstacles and middle of stilling basin so that the pressure surrounding obstacles is more than the middle of stilling basin due to encountering flow to obstacles.

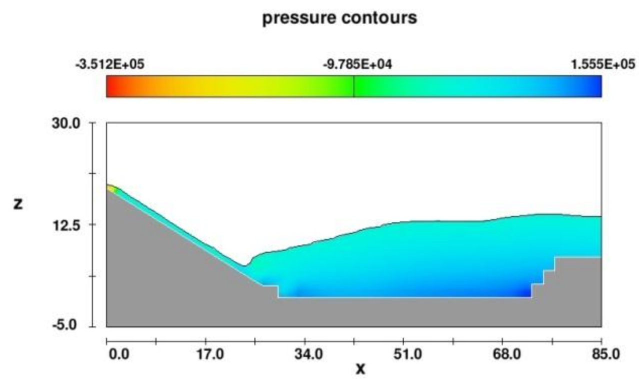


Figure 11.Pressure surrounding obstacles at stilling basin, K-Ɛ turbulence model

Simulation of pressures in different parts of basin depicts that the pressure less follows than the hydrostatic distribution in start of the basin due to the pressure fluctuations. When the pressure approaches to the static pressure, the fluctuations are diminished, and pressure is approximately hydrostatic.

3.2.2 Water Surface Profile in Optimal Stilling Basin

Comparison of values of water surface profile along the stilling basin using K-Ɛ and RNG turbulence models in Figure 12 shows that numerical model has good agreement with the experimental data.

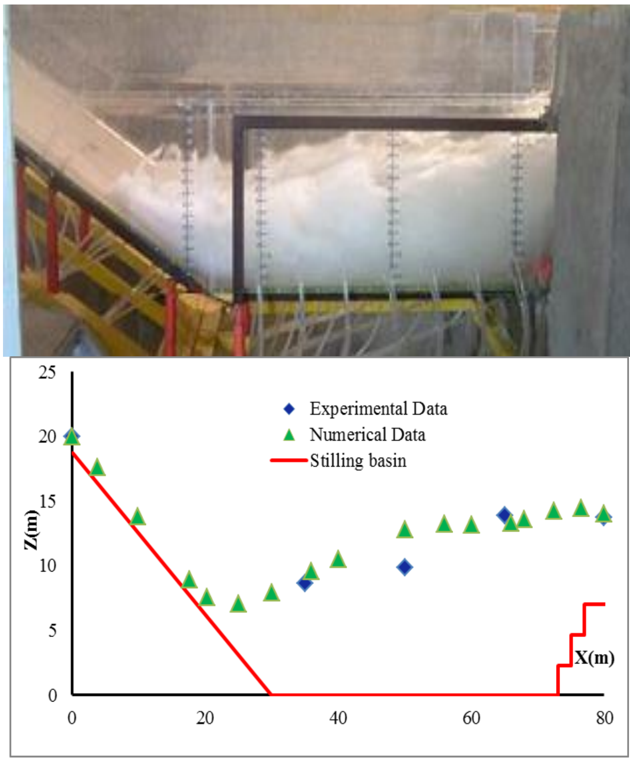


Figure 12. Water surface profile in the stilling basin

3.2.3 Turbulence Kinetic Energy and Turbulence Kinetic Energy Dissipation

Figure 13 demonstrates the simulation of turbulence kinetic energy in stilling basin by using κ-ε turbulence model. According to figure 13, the turbulence kinetic energy is high in the start of hydraulic jump in stilling basin, with approach to the end basin, value of this parameter reduces. Moreover, the turbulence kinetic energy increases after the chute blocks due to turbulence and formation of vortices caused by obstacles.

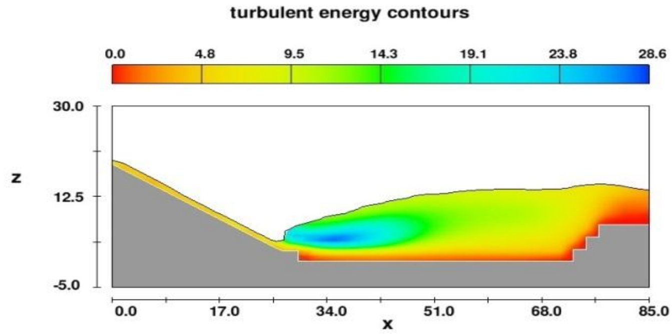
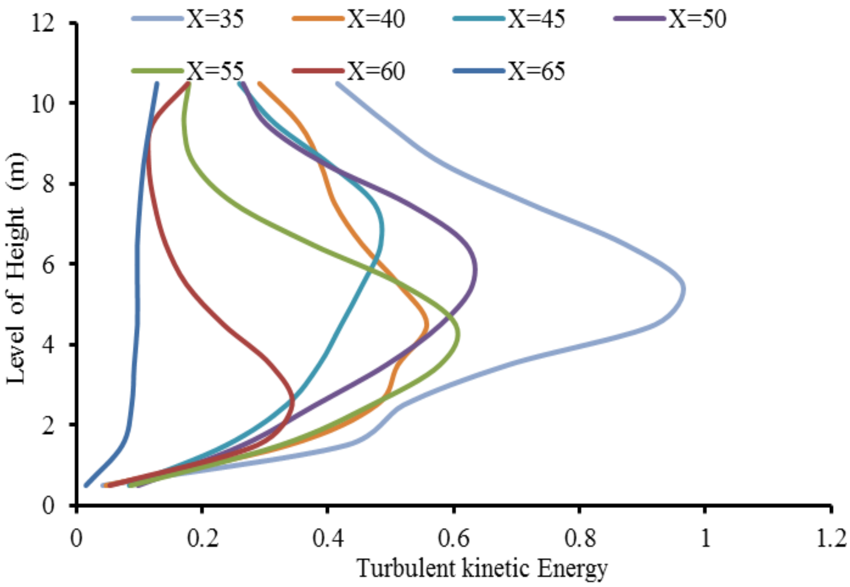


Figure 13. Turbulence kinetic energy in stilling basin, κ-ε turbulence model

In Figure 14, values of turbulence kinetic energy and turbulence kinetic energy dissipation have been calculated for different sections at stilling basin by using K- ε turbulence model. According to Figure 14, it can be noted that the maximum turbulence kinetic energy dissipation and turbulence kinetic energy almost occur at the initial sections, and flow has less turbulent at the end sections. In other words, with approach to the end stilling basin, the turbulence kinetic energy dissipation and turbulence kinetic energy profiles get more uniform. Also, in 20-30% of elevation, the maximum turbulence kinetic energy is generated so that considering this remark in the design of stilling basin increases the efficiency of them.



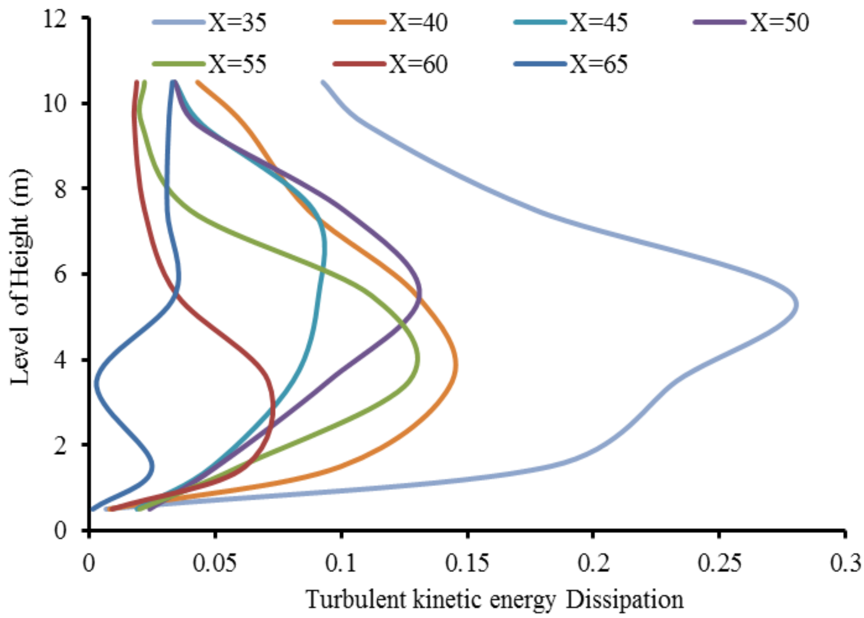


Figure 14. Turbulent kinetic energy and turbulent kinetic energy dissipation for different sections at stilling basin

4. CONCLUSION

In this study, the changes have been applied in the inlet and outlet obstacles of the USBR II stilling basin of Nazloochay dam model-Iran for discharge more than design discharge. The aim of this study is optimal design of inlet and outlet obstacles at USBR II stilling basin. Results demonstrated that stilling basin with chute blocks with height of 1 and 1.5 equal to the standard state and 3 adverse steps at end was selected as the most optimal stilling basin. The Numerical modeling of pressure and water surface profiles in the most optimal stilling basin was done by using VOF method and K-ε and RNG turbulence models. The results of numerical simulation showed that the numerical model has good agreement with the experimental model, as the numerical model can be used to analyze the flow in a stilling basin. Generally, it can be stated that numerical modeling is useful tool to calculate the non-measurable parameters in laboratory.

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State of Affairs in ICTs Usage within the Hospitality Industry (Guest House & Hotel) Operations: A Case of Brong Ahafo Region Ghana

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Abstract: The impact of the hospitality industry to the total growth of the Ghanaian economy cannot be exaggerated [1, 2]. Information and Communication Technologies (ICTs) play an important part in improving competitiveness, empowering development, and bringing advancement to all stages of society [3]. The Swift and significant development of ICTs and the spreading out of the internet have moved-in in all phases of human life [4]. Hospitality Industry as one of the presently fast growing industries in Ghana and the world Writings disputes that tourism cannot advance without a support of the ICTs application [1, 5, 6, 7]. In today's world, the Hospitality Industry in Brong Ahafo Region and Ghana at large must have suitable and appropriate adoption of ICTs novelties in order to achieve a first-hand form which is satisfactory in today's contemporary business world. This study probes the usage of ICTs and its application in the Hospitality Industry (Guest house & hotels) in the Brong Ahafo Ghana. By means of a descriptive and cross-section strategy, this study probed the nature of ICTs resources and the predominant impediments to the use of ICTs in Brong Ahafo Ghana. The outcome of the survey point out an average level of alertness of ICTs applications in the region's hospitality industry. On the other hand, low usage of ICT and employment in e-reservation and e-booking is still of a very low rate. The assumptive and strategy implications are discussed.

Keywords: ICT; tourism; Guest-House; hotels; hospitality industry; Hotel Management; Hotel ratings; Brong Ahafo

1. INTRODUCTION

In a constantly mutable global society, the Information and Communication Technologies (ICTs) are now part of our everyday lives and have become a key element for economic development. Within the past decade, the deployment of ICT throughout societies started with the introduction of the net [2]. In some commerce, businesses are now learning that using ICT in everyday business activities is no more an option to consider, but a requirement for survival [2]. The introduction of ICT into business radically remodelled the worldwide tourism and leisure industry, providing new development views, particularly in terms of accelerating firms and organizational competitiveness. The net contributes considerably to the distribution on the widest potential scale of data concerning the offered merchandise and services, however additionally to facilitate their selling method in the hospitality industry [7]. A Google report in 2013 reveals that the internet forms 80% as a source for information for tourists planning for a holiday and the report declared that online source of information presented a higher measure of confidence for these tourists. The internet as a source of information for most tourists emerges from the fact that the internet massively aids the dissemination of information and the information process; thus to say that most tourists (43%) that visit online travel agency already knows precisely what services they wants and where they wish to travel to [7]. The holiday-makers knowledge has transformed more and more recently due to the fast expansion of social media, the communications and relationship between tourists and hotels have become more and more emphasized. Social Media channels such as Facebook, twitter and Instagram convey and provide more and accurate facts about tourists' consumption manners, which provides better link of the supply to market requirements. And also, the Social Media platform has provided an up-to-the-minute and latest tool for marketing, making the promotion of goods and services very effective and faster due to the speedy spread of info in the online environs. Currently it is estimated that the average rate of penetration of Social Media in the technologically advanced countries is roughly 44%, while in developing states its influence is 29% [8].

Several public declarations has been made in Ghana by governments, states-officials and policy makers on how the state intends to enhance its international attractiveness and economic opulence using the hospitality industries as a central facilitator. Tourism is one of the identified major socioeconomic activities and the quickest advancing sector of the economy of Ghana. Tourism contributes nearly 16% of the overall annual foreign exchange for Ghana [9]. The hospitality industries in the Brong Ahafo Region and Ghana as a whole are vital sources of employment to most of the youth, as well as creation of new solid business prospects to offer an increase to the stream of revenue to the government of Ghana in terms of tax and improving novelty. Same views were shared by [4, 10] explains that tourism contributes massively to innovation, employment and entrepreneurship.

According to [5] in the context of tourist hotels, that businesses realise a viable gain by either single out products and services or offering modest charges. But, Kumar (2001) cited by [4] proposes that gust house and hotels as service providers cannot advance competitiveness as a means of delivering higher value to their clients and customers without the right adoption of ICTs. The spread and diverse tourist needs have called for hotels that focus on tourism to leverage their offerings and services over ICT in order to gain advance facts of their clients and customers and deliver one-stop centres by exploiting online systems and applications.

For the hospitality industry in Ghana to succeed and compete globally, the need for well-organized and quick to respond hotel subsector which integrates modern trend of customer and business service cannot be overlooked. Hospitality Industry as one of the presently fast growing industries across in Ghana and the world cannot advance minus ICTs support. In today's world, the Hospitality Industry in Brong Ahafo Region and Ghana at large must have suitable and appropriate adoption of ICTs novelties in order to achieve a first-hand form which is satisfactory in today's contemporary business world.

ICT when employed in the right form assistance and make stronger the significance of the hospitality industry to the progressively more digital sector, raise the quality of the hospitality industry, speeding up the hospitality industry service participation and the upsurge customers and client's citizenship in form of trustworthiness. Even though the appealing role of ICTs in remodelling the relations between hospitality industries and their spread market, an investigation concerning to ICTs and the hospitality industry (hotels) sector seems to have overlooked developing economies [4]. Remarkable research on ICT in the hospitality industry include, Adopting Electronic Business in Ghana: Story of the Hospitality Industry in Ghana [1], The Information and Communication Technology – Impact on the Hospitality Industry in Romania [7], ICT as A New Competitive Advantage Factor- Case of Small Transitional Hotel Sector [6] and others.

In spite of these researches, their generalisability is still not away from doubt, because emergent economies haven't been well thought-out to the point that even the nature of ICTs used in the emerging economies of which Ghana is one hospitality industries as well as their saddling challenges are still not well investigated. This has created a gap in accepting the significance and role of ICTs and its related systems and applications in the hospitality industries (tourism hotel) sector an arguable matter. In an effort to close this empirical gap, this research was planned to establish the state of affairs of hotel associated ICTs in the Brong Ahafo Region of Ghana so as to make available an academic launch pad for future research. The expressive nature of the study is because its efforts to explore the predominance and level of application of ICTs.

The hospitality industry is a new mix of business principally in Ghana. Writings disputes that tourism cannot advance without a support of the ICTs application [1, 5, 6, 11, 7]. Internationally, at the end of the year 2011, it was projected that above 50% of vacation trips and more than 40% of business trips are reserved online [7]. Even though ICT is a key component in the competitiveness of hotels in the tourism sector [6], slight studies has been done in developing countries [4] such as Ghana. This study was for that reason set up to establish the form and types of ICT tools employed and defies encountered by the hospitality industries (Guest houses & hotels) in the deployment of ICT.

2. Tourism and Hospitality Industry in Ghana

The hospitality industry in Ghana has received a significant consideration in the economic advancement strategy by various governments since the 1980s. Tourists' expenditure has seen a progressive increment and the average number of tourists have also seen increases every year, making various tourism subsectors activities expanded for both public and private. A separate ministry was established in 1993 by the Government of the republic of Ghana to emphasize their commitment to tourism development in the country called Ministry of Tourism (MoT), with help from foreign organizations like the World Tourism Organization (WTO) and United Nations Development Programme (UNDP) [1, 12]. A fifteen (15) Year development plan was proposed by MoT which was initiated in 1996 and to end in 2010. The hospitality industry in the country has contributed its quota progressively to the economy of the country, especially in recent years, between 2000 to 2005 tourist arrivals and spending shout up from 46% to 68% respectively. Incomes from tourism was estimated to reach an approximate value of $ 1.5 billion by the end of 2007 [1, 13]. The country's attention is said to be progressively shifting from principal produces to a market oriented economy with prominence in the hospitality industry and tourism in general. One can say the cultural, intellectual potential and economy of a country is directly linked the hospitality industry of the said country [1], hence this industry must be managed correctly and efficiently to meet intercontinental standards in order to appreciate the full profits and benefits that the industry offers.

2.1 Information & Communication Technology (ICT)

A universally acknowledged definition of ICT has not been established, because the theories, procedures and applications involved are frequently changing on an everyday basis [4]. Some researchers' defines Information and Communications Technology (ICT) as a system that comprises the usage of computer hardware, telecommunication and software devices for accumulation, transform, and control, protect, transmit and take delivery of data or information [1, 4, 11, 14]. ICTs are has become an important part of the business core. These days, employing ICTs is no more a distinctive, typical by itself. Only a resourceful and effective use of ICT enables establishments and individuals increase competitive benefits [15, 4].

Looking at the above definition of ICTs by [1, 4, 14], one can say that the term ICT involves electronic info-processing technologies such as the internet and computers, smartphones, fixed telecommunications line and other wireless communication device, broadband, networks and various smart and intelligent application equipment stretching from braille readers and barcode scanners. Some electronic, electrical and mechanical machines do have ICT embedded to enhance its functionality.

2.2 ICT and Hospitality Industry

Tourism defined by Holloway (2004) cited by [4] is the business which involves the provision for diverse types of visitors; rapid, overnight or elongated stay and daytime visitors comprising car-parking, accommodation, attractions and show biz, food and beverage. Tourism includes activities such as traveling to and remaining in places outside their usual environment or home not exceeding one uninterrupted year for business, leisure or other purposes. In the ancient days, people do call or write directly to the hotel or access a hotel via travelling agents to book a hotel room or make a reservation. On the other hand, with the introduction of ICT, the above approaches are considered slow and expensive. Writing and posting to the hotel involves a lot of time as with olden days 'snail mail' [11].

The coming of ICTs has modernised room reservation in hotels, now a person can make room reservation from online at anywhere at any-time so long as an electronic device with internet connectivity is available, thanks to the advancement of ICTs. The existing studies on ICTs and competitiveness deliberate numerous variables that define the diverse approaches of hotel firms to ICTs and its implementation. These factors include the size of the firm, classification, structure of ownership and type of governance employed, type of management model employed by the hotel, culture, contracts, tourism destination kinds and others [6]. It is reported that big hotel chains were more rapidly to move to ICT alliances as early as the 1980s, however self-dependent hoteliers have been more averse regarding ICT, partially due to technophobia [6].

Information Communication and Technology as a tool for tourism permits users and clients to partake in a fast moving world activity and various works are progressively transformed through access to varied and developing technologies. ICT has become a technology's version of economical increment to stratify the necessities and wants of community over-time [4]. In a tourism viewpoint, ICTs have been implemented in tourism from the time when the early adoption of Computer Reservation System (CRS) in commercial airline in the 1950s and in the revolution to Global Distribution Systems (GDSs) in the1980s [5]

2.3 ICT as a Competitive Advantage Strategy in Hotels & Guest Houses

A report by [5] indicates that a well-managed ICTs system aids in gaining a competitive benefit by either upholding price control in the market or by setting apart products and services. According to [3] ICTs brings efficiency increases, access to goods and productivity, services, info and markets. Hence the strategic implementation of ICTs and internet services is critical for all business, companies and organizations trying to survive in this highly competitive environment [10]. To researchers like [4] ICTs impacts, permits hotels to reach out to international audiences. Governments and Tourist Cottages and hotels across the globe keep up stylish websites and promote their exclusive features, booking and reservation handling and promoting specials to possible guests.

The introduction of ICTs into guest house and hotel operation has the ability to bring advancement and increment in productivity of hotels at reduced cost and also raised the information quality to managers for better decision making. It adds to tourist allure around the continent. In today's globalization, individuals wish and want to locate the suitable tourist environment and destinations, booking and purchasing air company tickets, check-in and receiving boarding passes at the comfort of the their home or offices. All these can be achieved perfectly with the help of ICT.

2.4 Research Study Area and its tourist sites

Figure 1, shows the map of Ghana indicating the Brong Ahafo (BA) Region. The Region has 19 administrative districts, with District Chief Executives (DCEs) as the political heads. The DCEs are assisted by District Coordinating Directors (DCDs) who are responsible for the day to day running of the districts. The DCEs work under the Regional Minister (the political head of the region), while the DCDs are under the Regional Coordinating Director. Sunyani is the administrative headquarters of the region, where the Regional Minister resides. The legislative wing of the District Assembly. One third of its membership is appointed by the Government in consultation with local leaders, while the remaining are elected on non-party lines. The District Assembly elects its own Presiding Member. The District Assemblies are divided into Town and Area Councils, depending on the population and land area of the district. A compact settlement or town with a population of 5,000 or more qualifies to have a Town Council status. An Area Council is made up of 2 or more towns which, when pulled together has a population of 5,000 or more. The region has 37 Town Councils and 106 Area Councils. Eight of the districts bears the name of the district capital, with the remaining five (Asunafo, Asutifi, Tano, Jaman and Sene) named after geographical landmarks or historical events. The Region measure 39,557 square kilometres and it's the 2nd largest region in the Ghana (16.6%) and parts boundaries with the Ashanti and Western Regions to the south, the Northern Region to the north, the Volta Region to the east, the Eastern Region to the southeast and La Cote D'Ivoire to the west. The central point of the landmass of Ghana is in the region, at Kintampo. The ecosystem of the region has brought about a lot of tourist attractions. The Pumpum River falls 70 metres down some beautiful rocky steps to form the Kintampo Falls, as it continues its journey towards the Black Volta. The Fuller Falls, 7 kilometres west of Kintampo, (the centre point of the country), also provides a scenic beauty as River Oyoko gently flows over a series of cascades towards the Black Volta. Another scenic site is the River Tano Pool which houses sacred fish that are jealously protected by the local community who live along the river near Techiman. There is also a pool on the Atweredaa River, which runs through the Techiman market. The Buabeng-Fiema Monkey sanctuary, located 22 kilometres north of Nkoranza [16].

Figure 1 Map of Ghana (Showing Brong Ahafo)

3. METHODOLOGY

The research was conducted via a questionnaire survey amongst hotels and guest house in Brong Ahofo Region of Ghana, 125 hotels and guest houses of diverse grades and size are located in various districts of the Region. The questionnaire was given directly to heads of IT head, managing directors (MDs) and Receptionist of the various guest houses and hotels. The MDs were carefully chosen for this research because they hold a broader overview of how their various guest houses and hotels are responding to ICT in the hotel industries, most importantly. They are typically in charge for strategic improvement of the guest house and hotel, including the placement of ICT with business strategy. The units of analysis for this research were guest house and hotels, which were legally registered and licensed and by Ghana Tourism Authority (GTA).

Stratified sampling was used to group the guest house and hotels in the Region into Eight (8) geographical divisions, namely; Kintampo North Municipal, Asunafo North Municipal, Berekum Municipal, Wenchi Municipal, Sunyani Municipal, Dormaa Central Municipal, Nkoranza South Municipal and Techiman Municipal. Out of 125 registered guest houses and hotels situated in BA, 90 hotels were carefully chosen proportionately according to the number of guest house and hotels in each municipality as follows; Eight guest house and hotels in Kintampo North Municipal representing 8.89%, Four Guest house in Asunafo North Municipal representing 4.44%, six guest house and hotels in Berekum signifying 6.67%, Four Guest house in Wenchi Municipal representing 4.44%, Thirty-Three (33) Sunyani Municipal representing 55%, five Guest house in Dormaa Central Municipal representing 5.55%, six guest house and hotel in Nkoranza South Municipal and twenty-four hotels and guest house in Techiman Municipal. Diverse classes of guest house and hotels were carefully selected to evade the preconceived notion of smallness and/or client similarity. This diverse nature of guest house and hotels and custom permitted the research to acquire a balanced opinion of ICTs usage in the selected firms. The vital point of investigation were the nature and availability of ICT facilities the Region, ICT usage prioritization and difficulties encountered in make use of ICT facilities. These features were selected on purpose since they affect the diffusion of ICT in various sectors. Data was collected using questionnaires and analysed using Microsoft Excel and SPSS and outcomes are presented in statistical tables.

4. RESULTS AND DISCUSSIONS

The result and discussion of the study is presented in this section.

4.1 Hotel Grade and Size

Guest house and hotels grades were determined in relation to the number of stars the hotel has attained which intend determines the type of amenities and facilities in the guest house or hotel.

Table 1 Hotels Grade in the Region

Star Rating	Hotel Number
1 Star	19
2 Star	19
3 Star	7
4 Star	0
5 Star	0

4.2 Description of Respondent

In the selected guest houses and hotels four (4) questionnaires were given out; 1for manager, 1 for IT head and 2 for staff/receptionist in all 360 questionnaires were distributed. Out of 360 questionnaires distributed to the 90 guest houses and hotels, a total of 280 were received back. Out of the 280 received, 213 were successfully answered correctly while 67 were null and void. The breakdown of the 213 questionnaire successfully answered is as shown in figure 2.

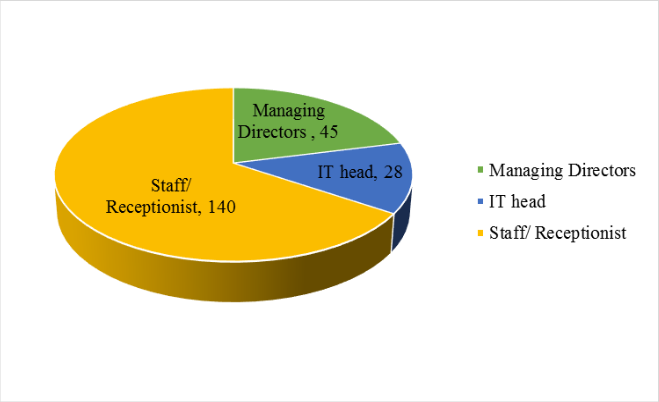

Figure 2 Field Data 2016

A low response 45 out of 90 from top management of was as a results that most of the managing directors were too busy to respond to us on our visit and some were not ready to attend to something that would not bring return to organization or them. Some of the guest houses and hotels had no IT/ICT department and IT/ICT personnel to respond to us, this resulted in the 28 out 90 turn out in the IT head response. A total of 190 respondents were expected from receptionist and other hotel staff but some hotels and guest houses only gave one responses instead of the two requested, hence resulting in 140 respondents in the staff/receptionist category.

4.3 Respondent Age and Gender

For gender analysis of the respondents, majority of the respondents 118 out of the 213 were males representing 55.4% whiles 95 were females representing 44.6%. As for age, the majority group were in the 25-35 group while the smallest amount age group were those aged fifty years and beyond. Looking at how new ICT applications are in Ghana’s guest house and hotel sector, the age category that had the highest in the sector’s enlistment appears to be marginally ahead of the sophisticated versions of ICT. For example respondents with age thirty-one and above represented 68%. This might mean that they are still at ease with old way or record keeping and technology and hence adjusting to new technologies makes them uncomfortable.

4.4 ICT Facilities Usage

One of the key objectives of this research was to investigate the nature of ICT facilities used by guest house and hotels in Brong Ahafo Region of Ghana. Figure 3, shows in usage of ICT facilities in the 45 management response. From figure 3, the most used ICT set-up is CCTV cameras, 35 out of 45 had these ICT equipment in place, followed by Intercom, which in 24 out of 45. From the chart in figure 3 it without question that the guest house and hotel in Brong Ahafo Region are not making use of ICT amenities.

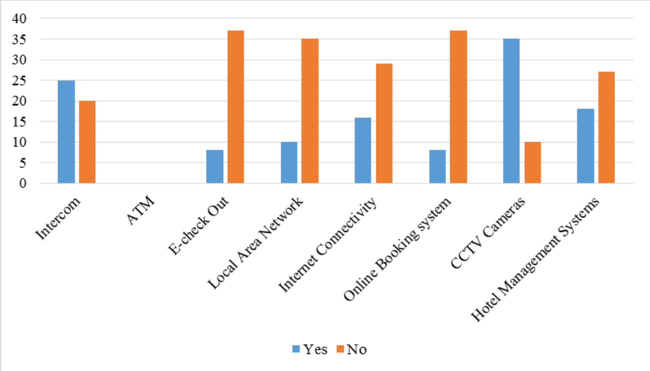

Figure 3 ICT facilities usage in the in select guest houses and hotels

It was recognised that CCTV Cameras and telephone applications were more accessible with each having. Banking services (ATM), Internet Connectivity and Online Booking were less available. The least used was E-check Out which was very rare in most guest houses and hotels. This shows that the ICT applications in the Region guest houses and hotels are not up-to-date to international standards of offering an all-inclusive guest house and hotel service platform that is self-contained and can facilitate a full service offering. This may flag the competiveness of these guest houses and hotels particularly with the higher class of tourists and other visitors that might wish to perform transaction that requires ICT such as online purchases and checking of mails in the rooms without moving out to search for ICT facilities around.

ICT Challenges	Mean	Std. Deviation
Outdated ICT Tools	2.21	0.617
System Failure	2.25	0.696
Un Skilled Labour	3.45	1.041
Low Internet Speed	4.01	0.918
Un Reliable Power	3.85	1.271
Unreliable Service Providers	3.49	1.149
Very Costly	3.68	1.271
Unreliable Out Sourcing Personnel	2.37	0.823

5 = Very prevalent, 4 = Prevalent 3 = Less prevalent, 2 = Sometimes prevalent, 1 = not sure

Table 1 shows the challenges faced by guest houses and hotels in the Region in the implementation and usage of ICT applications and systems.

From table the outcome of low internet speed is seen to be a predominant worry and appears that almost everyone is affected because of a low standard deviation. Other problems face the usage and implementation are high cost of ICT tools, System Failure and Unstable electricity. Looking back at the level of education, it becomes evident that some of these hotels have heavily invested in the tools but their main challenge is lack of the organizational desire to diffuse the technology especially at operational level. Comparing outdated ICT tools to the low level of internet speed might indicate that either the guest house and hotel managers but low-priced used tools for purposes of feeling that they are part of the responsibility to use them. But due to the outdated state of the ICT tools, they might become inefficiency and sometime unproductive by failing to become well-matched with contemporary servers used by the targeted markets. Related cases of ICTs challenges were reported to prevail in some African countries [4] particularly lack of capacity of locals to operate imported ICTs to suit their local conditions and situations.

The study realised that addressing the challenge of staff know-hows in the application of the ICTs tools in these guest house and hotels will alleviate other ICTs challenges of the form system failure and unreliable outsourced ICTs staff. Other researchers also established in their studies that lack of ICT education contributes to the bad factors in ICT adaptation. They observed that slow internet connectivity and band coverage were also obstacles [4,17].

5. CONCLUSIONS AND RECOMMENDATIONS

This study presents insights about the state of ICTs in the Brong Ahafo Region of Ghana. Notwithstanding its descriptive nature, the study tries to ascertain some of the vital features that the hospitality industry (hotel) sector in Brong Ahafo Region utilises ICT tools. This of course throws more light on the business opportunities for individuals engaged in the supply chain and also identifying the idle and unexploited technologies such as destination management systems.

The conclusions are as follows:

- ✓ ICTs role in promoting competitive advantage, the study focused on establishing the degree to which gust house and hotels engages ICT usage to aiding their operations. It was recognised that 35% of the guest houses and hotels owners looks at ICT as very important while 50% just regard it as important. Meanwhile, 15% did not see any need for ICTs applications in their setups or operations. Even though the prioritization of ICT seemed to be somehow good, the implementation, application and commitment to the use of ICT and its applications was low. As a result, the nature of ICT tools is of importance to contemplate while analysing its prioritization. For instance, most of the people tend to think that ICTs is just about having some computers with internet connectivity. However, ICTs goes further than that to comprise business operations structures with technology applications.
- ✓ The results revealed a significant low utilization of ICT in the area of Internet Connectivity, Online Booking, Banking services (ATM), and E-check Out and about 20% had websites. But again the question of how often do they use and update the websites raises a big concern.

- ✓ The study established there exit a low rate of distribution of ICTs applications related to the guest house and hotel marketing sector. This might be due to lack of sufficient alertness and training about these ICTs tools. When one examines the staffs' nature particularly persons in the IT departments, their over-all level of education is low. This might hinder or reduce intellectual networks of such staffs.

The recommendations are as follows:

- ✓ The study recommend that guest house and hotel sector investors to do incorporate ICT in their determinations to advance service quality so as to make stronger the loyalty of their customers whilst building an remarkable image and accessibility in reaching out to their potential clienteles.
- ✓ With the coming of smart and intelligent smart phones and the availability mobile applications including the hospitality mobile apps for real time communication, there is an important need for the software developers in Ghana to look further than the usage of desktop computers as the only applicable ICTs tools.
- ✓ Also to at least minimize or avoid the difficulties associated with unreliable electricity, there is need by the guest house and hotel operates to embrace current mobile ICTs technologies.
- ✓ ICT applications high cost and unreliable power were among the main established challenges in running ICTs tools and systems. This seems to be an outside threat to the advancement of ICTs. In respect to this we appeal to authorities such as the government in conjunction with NEDCo (Northern Electricity Department (NED) of the VRA) to improve the voltage and dependability of power supply.

6. FEATURE WORKS

The objective of this research was to establish the nature of ICT usage and distribution. Due to some degree of resources in terms of finances and time, the survey was made only for Brong Ahafo Regeion of Ghana. Hence there is a need conduct a study across other regions so as to get a better and complete view of the state of affairs. This will advance the establishment of a wide-ranging viewpoint to easily guide policy and the specialists on exactly how to advance the usage and diffusion of ICT in the guest house and hotel sector for better competitiveness. Further research should consider assessing the degree to which the integration of ICT can bring improvement in diverse areas of business such market-accessibility, operational efficacy, market desirability and loyalty of customer.

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