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Injustice in Competitive Swimming (Justification by Partitioned Pool)

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ABSTRACT: *This is an attempt to analyze the draw-backs of the present using swimming pool design in competitive races and to bring in to the notice of the entire swimming society. This is also intended to do justice to all participant swimmers in a competitive swimming race by providing equal and identical conditions (or) parameters in all lanes of the pool with the aid of a newly designed pool which is named as "PARTITIONED POOL" and to introduce one new coefficient named as "LANE COEFFICIENT" to the swimming science.*

Keywords: *Draw-backs, parameters, partitioned pool, lane coefficient.*

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I. INTRODUCTION

The present swimming pool design which is used for the competitive swimming races in collegiate, National, International championships and Olympic Games has some draw-backs. Even though it is being used in the above said aquatic meets. Due to this faulty design so many efficient swimmers had been disqualified at the qualifying rounds or heats and they were being made as patients of mental depression. Many young, emerging, efficient and talented swimmers who got end lanes by a lottery in the earlier days (collegiate swimming) of their careers had been to rehabilitation centres with great disappointment and frustration.

The great swimming torpedo of Australia Ian Thorpe was not even qualified for the London Olympics-2012 (swam in 7th lane). All time great swimmer of U.S.A Michael Phelps did not get even a bronze medal on the very first day of aquatics in London Olympics-2012 (swam in 8th lane) then, so many people thought and many papers wrote that his career came to an end. But, surprisingly on the next few days he bagged 4 gold and 2 silvers. (All medals from centre lanes only)

Actually competitive swimming race is a sport like that of a running race but, there are some notable differences.

a) In running races even the athletes are covered by the medium (air) they will have grip on earth and with that grip they use their muscle power and run.
   Where as in swimming races swimmers are placed in the medium itself where they do not have such grip to move forward. So, they first use their energy to float on the medium and then displace the medium to their sides and move forward. (Newton's third Law of motion)
b) Water is 11 times more resistant, 55 times more viscous and nearly 777 times denser than air.[4]
c) In running events we cannot find the boundaries of the medium because, air is everywhere on our planet.

In aquatics we are confined to a closed medium where, we find specific solid boundaries i.e., walls and bottom.

d) In running events other athletes are not disturbed by an athlete.

In swimming, side lane swimmers to a particular swimmer are very much disturbed by the waves produced by him

II. DRAW-BACKS OF THE EXISTING SWIMMING POOL DESIGN.

While conducting a competitive race in a closed medium all the participant swimmers must have equal and identical conditions or parameters. The parameters are

2.1 Boundary conditions

Since, the medium (water) obeys the Newton's law of fluid friction or Newton's law of viscosity it is called as a Newtonian fluid.

τ (tau) = $\mu \frac{du}{dy}$ ------- Newton's law of viscosity
Where, τ (tau) = shear stress μ = coefficient of viscosity or dynamic viscosity.
u = velocity of the swimmer. y = distance from the side wall.
$\frac{du}{dy}$ = velocity gradient.
F = τ (tau) × A
Where, F = force required by a swimmer to move forward with a velocity of u.
A = total wetted surface area of the swimmer.

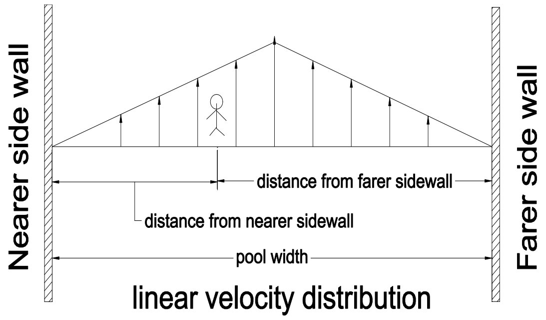


Figure- 1

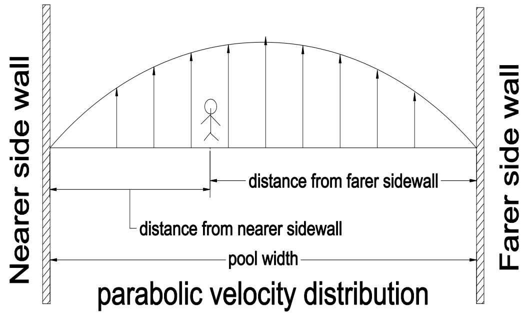


Figure -2

So, the swimmer's distance from the side wall increases, the force (F) required to move forward will be decreased.

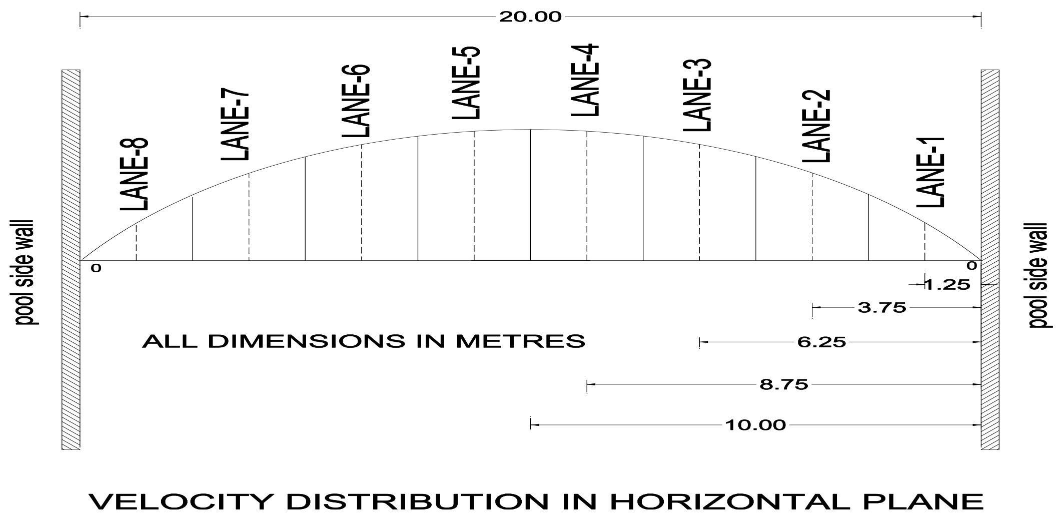
The above equation is used only in the case of linear velocity distribution shown in fig-1.

In case of swimming pools the velocity distribution is parabolic (see fig-2) because the swimming pool resembles an open channel in all respects. Only the difference is in open channels water is moving (flow) whereas, in pools object (swimmer) is moving.

While calculating drag force, velocity etc., of some objects the fundamental assumption taken by hydraulic engineers is "whether the object moves through the stationary fluid or the fluid passes around the stationary object is alike. [5] [6] Based on this assumption only now -a- days it is possible to test an aircraft model in wind tunnel and submarine and torpedo models in water tunnels (flumes) to predict satisfactorily the behaviour of their prototypes.[5]

2.2 calculations of velocities of the swimmers in all lanes of the 8- lane pool of 20m width (older Olympic pool design).

Now the velocity distribution in the 8– lane pool is like in fig-3 given below



VELOCITY DISTRIBUTION IN HORIZONTAL PLANE
Figure – 3

To calculate the velocity of a swimmer from a parabolic profile there are no fast formulae or equations. Hence, first we have to give some boundary conditions to the parabolic profile.

Let the equation of parabolic profile be

$u = Ay^2 + By + C$--------------equation –1 [1] [5]

Where,

A, B, C are constants to be calculated by giving the following boundary conditions to the right half portion of the velocity profile shown in fig – 4.

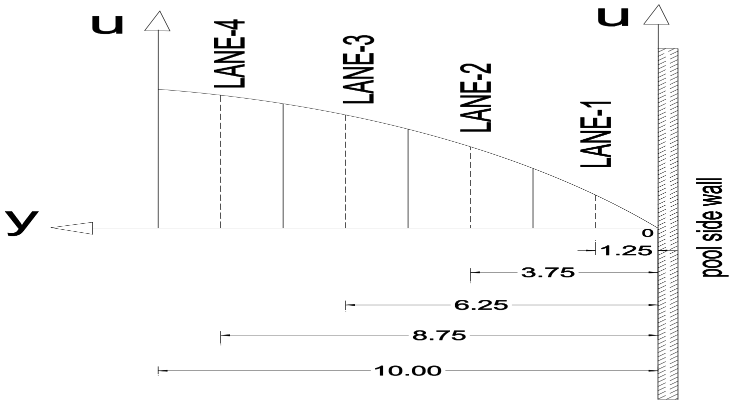


Figure -4

Let us assume the average velocity of a swimmer be 2m/sec [3]

a) $u = 0$ at $y = 0$

b) $u = 2$m/sec at $y = 10$m

c) $\frac{du}{dy} = 0$ at the vertex i.e., at $y = 10$m

Boundary condition (a) gives $C = 0$

Boundary condition (b) gives

$2 = A (10)^2 + B (10)$ -------equation-2

Boundary condition (c) gives

$\frac{du}{dy} = 2Ay + B$ (by differentiating equation -1)

$0 = 2A (10) + B \quad \therefore B = - 20A$ -------equation-3

by solving equations 2 and 3

$2 = A (10)^2 + (-20A) (10) \quad \therefore A = - 0.02$

Therefore, $B = 0.4$

Now the equation for velocity becomes $u = -0.02y^2 + 0.4y$

As the boundary conditions in lanes 5, 6, 7 and 8 are same to 4, 3, 2 and 1 respectively.

The velocities of swimmers in all lanes.

Velocities in 1st and 8th lanes

$u = -0.02 (1.25)^2 + 0.4 (1.25)$

$u = 0.4688$ m/sec

Velocities in 2nd and 7th lanes

$u = - 0.02 (3.75)^2 + 0.4 (3.75)$

$u = 1.2$ m/sec

Velocities in 3rd and 6th lanes

$u = -0.02 (6.25)^2 + 0.4 (6.25)$

$u = 1.7188$ m/sec

Velocities in 4th and 5th lanes

$u = - 0.02 (8.75)^2 + 0.4 (8.75)$

$u = 1.97$ m/sec

From the above velocities it is evident that the four middle lanes i.e., 3, 4, 5 and 6 are more advantageous than 1, 2, 7 and 8 lanes to win the competitive race.

2.3 wave disturbances

The waves produced by the centre lane swimmers move across the lanes and cause disturbance to side lane swimmers. To avoid this problem in 1960's Adolph Kiefer invented wave-crushing or wave-eating lane ropes. These lane ropes diminish the waves and make the pool less turbulent. [2] However, these lane ropes also have drawbacks. Actually lane ropes diminish the superficial waves only. They do not prevent the underwater currents because water moves in layers or laminas. See fig-5

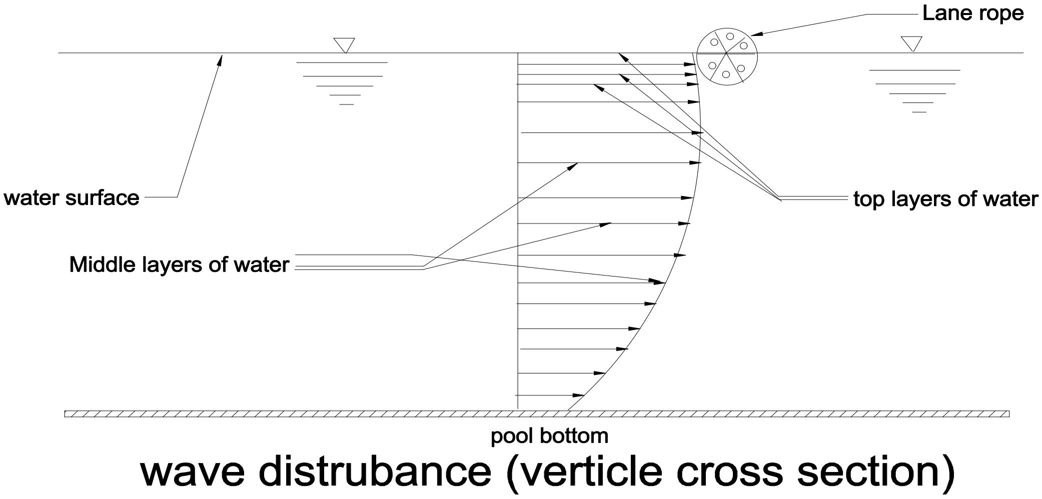
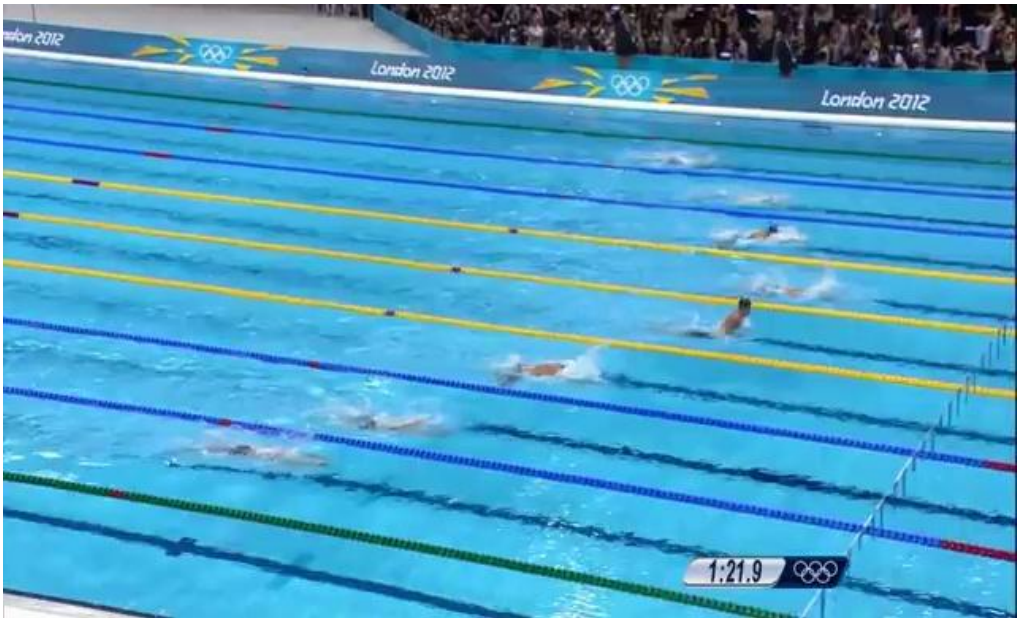


Figure – 5

The swimmers in the outside lanes i.e., 1, 2, 7 and 8 are being buffeted between the waves created by the centre lane swimmers and by the bounced back waves of their own from side walls. The waves produced by the centre lane swimmers move across the side lanes and cause turbulence in the pool waters and cause increased burden of extra drag force on the outer lane swimmers.

So, the wave disturbances are not eliminated completely by installing lane ropes.

Due to improper boundary conditions and partial elimination of wave disturbances, the final pictures of 200m, 400m, and 800m and 1500m races are looked like in an inverted “V” shape which is shown in the photograph (Fig- 6).

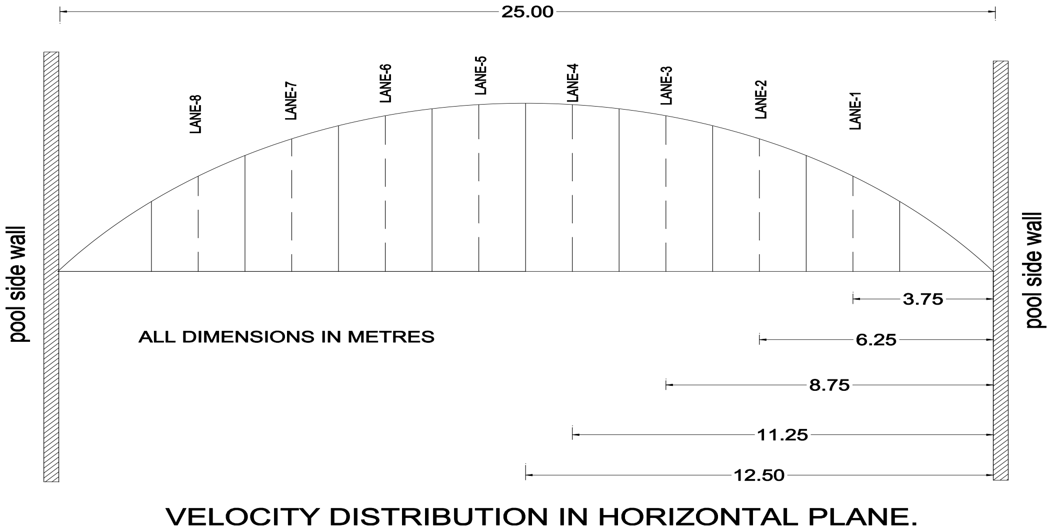


Figure– 6

2.4 Extra widening

Several attempts have been made to overcome the above mentioned drawbacks. One such attempt is to provide an extra lane at each end of the pool (extra widening by 5 meters) to rectify the velocity irregularities of the swimmers. Accordingly the swimming pool in the recent Olympics is constructed with 10 lanes of 2.5 meters lane width. Only 8 swimmers participate in all the races leaving the end lanes without swimmers. [2]

After extra widening by 5meters (extension of one lane of 2.5 meters lane width at both ends) the velocity distribution is shown in fig-7 given below.



VELOCITY DISTRIBUTION IN HORIZONTAL PLANE.
Fig – 7

The velocities in all the 8 lanes are calculated like in the case of 20 meter pool above.
By solving the equation $u = Ay^2 + By + C$ as in the previous case of 20 meter pool we get
A = -0.0128, B = 0.32and C = 0

Velocities in 1st and 8th lanes
u = 1.02 m/sec
Velocities in 2nd and 7th lanes
u = 1.5 m/sec
Velocities in 3rd and 6th lanes
u = 1.82 m/sec
Velocities in 4th and 5th lanes
u = 1.98 m/sec

After extra widening by 5 meters the 1st lane swimmer's velocity is increased from 0.4688 m/sec to 1.02 m/sec but, not equalized to the 4th lane swimmer's velocity of 1.98 m/sec.
As the swimming race conducting authority all over the world (FINA) is measuring the race time to an accuracy of 100thof a second, the variations in velocities should also be taken in to account.
To what extent we have to extra widen the pool to have the velocities of both 1st lane and 4thlane is the same? For this question lane coefficient table will give the answer.

2.5 Smoothening of side walls.

Another attempt was made to reduce the viscous forces near side walls in favour of the end lane swimmers by making the side walls very smooth. When the pool side walls are made very smooth to reduce the no-slip condition between the solid walls and the fluid then parabolic velocity distribution changes its form to logarithmic velocity distribution which is shown in fig- 8 and fig-9 below.

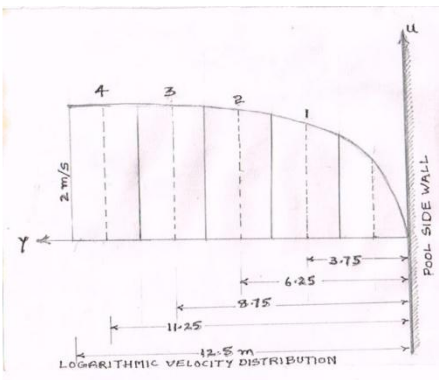


Figure -8

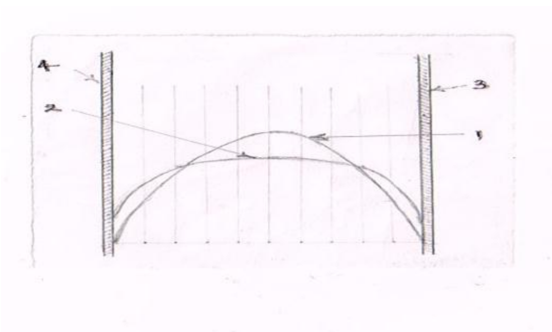


Figure -9

In figure-8: 1 = parabolic velocity distribution, 2 = logarithmic velocity distribution,
Now let us calculate the velocities in all lanes of 25m wide pool.
$u = A \log_{10} y$ is the equation to solve the logarithmic curve.
Where, u = velocity of swimmer, y = distance of the swimmer from nearer side wall
A = a constant.
Let us assume the average velocity of a swimmer be 2m/sec [3]

At y = 12.5 m, u = 2 m/s Now, $A = u / \log_{10} y$
$A = 2 / \log_{10} 12.5$ ∴ A = 1.8233
Velocity in 1st and 8th lanes = $1.8233 \log_{10} 3.75$ = 1.0466 m / s
in 2nd and 7th lanes = $1.8233 \log_{10} 6.25$ = 1.4511 m / s
in 3rd and 6th lanes = $1.8233 \log_{10} 8.75$ = 1.7175 m / s
in 4th and 5th lanes = $1.8233 \log_{10} 11.25$ = 1.9165 m / s.
Now compare these values with the parabolic velocity distribution velocities of same 25 m wide pool

	Parabolic velocities	Logarithmic velocities
Lane 1 and 8	1.02 m / s	1.04 m / s
2 and 7	1.50 m / s	1.45 m / s
3 and 6	1.82 m / s	1.7175 m / s
4 and 5	1.98 m / s	1.9165 m / s

Even after making the side walls very smooth the middle lanes (3, 4,5and 6) are proved advantageous.

III. LANE COEFFICIENT (L.C)

Now I would like to introduce a coefficient which is invented by me is very new to the swimming science and it is named as *lane coefficient* (L.C).
Lane coefficient is the ratio of the distance from the farer side wall to the distance from the nearer side wall (Both distances measured from the centre of a lane).
L.C of a lane= farer side wall distance / nearer side wall distance
L.C of 8thand 1st lanes = (W+7Lw) / (W-7Lw)
L.C of 7thand2ndlanes = (W+5Lw) / (W-5Lw)
L.C of 6thand3rdlanes = (W+3Lw) / (W-3Lw)
L.C of 5th and4thlanes = (W+ Lw) / (W- Lw)
Where, W=width of the pool, Lw= lane width

20 Meter wide swimming pool boundary conditions (8-laned of 2.5m lane width)
1st and 8th lane coefficient = (20+17.5) / (20-17.5) =15.00
2nd and 7th lane coefficient = (20+12.5) / (20-12.5) = 4.3333
3rd and 6th lane coefficient = (20+7.5) / (20-7.5) = 2.2
4th and 5th lane coefficient = (20+2.5) / (20-2.5) = 1.2857

25 Meter wide swimming pool boundary conditions (10-laned of 2.5m lane width)
1st and 8th lane coefficient = (25+17.5) / (25-17.5) = 5.6666
2nd and 7th lane coefficient = (25+12.5) / (25-12.5) = 3.0
3rd and 6th lane coefficient = (25+7.5) / (25-7.5) = 1.8571
4th and 5th lane coefficient= (25+2. 5) / (25-2.5) = 1.2222
∴ Velocity of the swimmer is inversely proportional to the lane coefficient.
Still, there is a difference between first and fourth lanes after extra widening and smoothening of side walls. So, the concept of extra widening of the pool by 5 meters and smoothening of side walls did not eliminate the differences in boundary conditions of the participant swimmers. So, up to what extent the pool should be extra widened to equalize the Lane Coefficients between the 1st and 4th lane swimmers?

Lane coefficient values of all lanes (2.5m) with different pool widths: (only centre 8-lanes are to be used).

Pool width (in meters)	1 and 8 lanes	2 and 7 lanes	3 and 6 lanes	4 and 5 lanes
20	15.00	4.3333	2.2000	1.2857
25	5.6666	3.00	1.8571	1.2222
30	3.80	2.4285	1.6666	1.1818
35	3.000	2.111	1.5454	1.1538
40	2.5555	1.9090	1.4615	1.1333
45	2.2727	1.7692	1.4000	1.1176
50	2.0769	1.6666	1.3529	1.1052
55	1.9333	1.5882	1.3157	1.0952
60	1.8235	1.5263	1.2857	1.0869
65	1.7368	1.4761	1.2608	1.0800
70	1.6666	1.4347	1.2400	1.0740
75	1.6086	1.400	1.2222	1.0689
80	1.5600	1.3703	1.2068	1.0645
85	1.5185	1.3448	1.1935	1.0606
90	1.4827	1.3225	1.1818	1.0571
95	1.4516	1.3030	1.1714	1.0540

100	1.4242	1.2857	1.1621	1.0512
110	1.3783	1.2564	1.1463	1.0465
120	1.3414	1.2325	1.1333	1.0425
130	1.3111	1.2127	1.1224	1.0392
140	1.2857	1.1960	1.1132	1.0363
150	1.2641	1.1818	1.1052	1.0338
160	1.2456	1.1694	1.0983	1.0317
170	1.2295	1.1587	1.0923	1.0298
180	1.2153	1.1492	1.0869	1.0281
190	1.2028	1.1408	1.0821	1.0266
200	1.1917	1.1333	1.0779	1.0253
250	1.1505	1.1052	1.0618	1.0202
300	1.1238	1.0869	1.0512	1.0168
350	1.1052	1.0740	1.0437	1.0143
400	1.0915	1.0645	1.0382	1.0125
450	1.0809	1.0571	1.0338	1.0111
500	1.0725	1.0512	1.0304	1.0100

Table-1

If, there has to be no difference in the boundary conditions between first and fourth lanes, the pool must be widened up to 400 meters because, in the above table we can find L.C values of all lanes are equal up to one decimal point (i.e., 1.0) at 400meters only.

Now, let us calculate the velocities of all middle eight lanes (2.5m lane width) for the 400 meter wide swimming pool from the velocity distribution parabola with the same average velocity of 2 m/sec as in the case of 25 meter wide pool calculated above.

Velocities in centre 8 lanes of 400meter wide swimming pool.

Value of constant A = -0.00005, B = 0.02 and C = 0.

In lanes 1st and 8th u = 1.997m/sec

In lanes 2nd and 7th u = 1.999m/sec

In lanes 3rd and 6th u = 1.999m/sec

In lanes 4th and 5th u = 2m/sec

So, the newly invented Lane Coefficient concept is correct in estimating boundary conditions of different lanes in a pool.

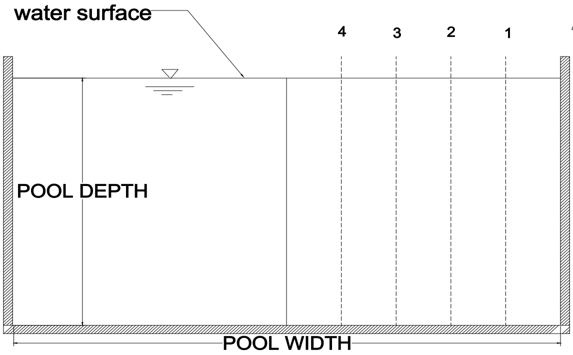
One more point is" under turbulent conditions swimming pools exhibit the open channel flow characteristics like parabolic or logarithmic velocity distributions." This point can be easily understood by anybody if they keenly observe any two swimming race videos (50m, 100m, 200m or 400m). In the 50m race all swimmers have nearly equal chances to win the race because; they will not face turbulent conditions in the first 50m. In case of 100m race after taking the first flip turn they will face lower degree turbulence then only the bounced back wave's action from side walls comes in to existence. So, the end lane swimmers (1, 2, 7 and 8 lanes) lose some extra energy when compared to middle lane swimmers and start trailing behind the centre lane swimmers. After taking the second flip turn (in case of races more than 100m) they enter in to higher degree turbulence, from that point they continuously lose their energies till the end of the race and stand well behind the middle lane swimmers. This is the actual story that what is happening in our existing competitive swimming pools and at the same time this is also the sad story of end lane swimmers.

Due to the above reason I did not put 50m, 100m races in the list of inverted "V" formation.

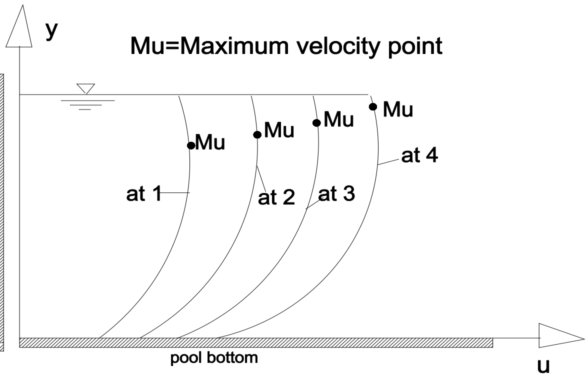
The three great swimmers Mark Spitz, Ian Thorpe and Michael Phelps won their medals from centre lanes only.

IV. MAXIMUM VELOCITY ZONE IN LANES.

If a line is drawn by joining all maximum velocity points (Mu) in a lane in the length (50m) wise direction of the pool gives the maximum velocity zone. The velocities of swimmers in swimming pools are retarded near the solid boundaries i.e., at the side walls and bottom. In addition to these the surface tension of the fluid–air interface (free surface of water) produces a resistance to the swimmer therefore the maximum velocity zone to occur at some distance below the free surface. In vertical direction the velocity is minimum at the pool bottom and attains a maximum value at a distance from the free surface which varies from 0.05 to 0.25 times the depth of the pool, the higher value is applicable to lane closer to the side wall. As we go away from the side wall towards centre the zone of maximum velocity shifts upwards and at the centre lanes (i.e., 4th and 5th lanes) the maximum velocity zone occurs almost at the free surface. [5]



swimming pool cross section
Fig – 10



velocity distribution in longitudinal section
Fig– 11

From the above conditions the end lane swimmers (1, 2, 7 and 8 lanes) will have the maximum velocity zones nearly 40cms to 75cms below the free surface (if the depth of the pool is 3 meters). But the centre lane swimmers (3, 4, 5 and 6 lanes) will have their maximum velocity zones just below the free surface where they actually swim. If the end lane swimmers wish to go fast in the maximum velocity zone they have to perform under water swimming which is not allowed by the FINA authorities. So, it is again advantageous to the centre lane swimmers.

V. OTHER PARAMETERS.

Any race (swimming or running) is intended to bring out the real talent and efficiency of an athlete which is not influenced by other's parameters. But, in swimming many other factors (not his own) influence a swimmer's performance and winning chances.

Drag force plays an important role in deciding the winner of a swimming race.

Calculation of relative drag forces of all lane swimmers in a swimming pool with a set of 8 members in turbulent waters is a very difficult task because, it depends upon the degree of turbulence of the medium. Again the degree of turbulence depends upon so many factors or parameters. Some of them are listed below.

1. Lane positions of all 8 swimmers.
2. Body parameters of all swimmers.
3. Type of stroke.
4. Stroke performance or swimming action of all swimmers.

Let us deal each factor in brief only as the given space is limited.

1. Lane positions: --- As we are going to do justice to all lane swimmers just avoid lane allocation or assignment. Then according to permutation and combination theory we get 40,320 permutations and that many degrees of turbulence.

i.e., 8! = 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 = 40,320 Where, ! is known as factorial function.

2. Body parameters :--- This parameter contains many sub-parameters like

A) Body shapes of all swimmers ---Some may have stream lined body shapes and some may have obstructive or bluff bodies. Again permutations and that many degrees of turbulence in the pool.
B) Head size and shape for perfect sculling action. Again P&DT. (P&DT= permutations and that many degrees of turbulence.)
C) Hands – long or short to perform better swimming action. Again P&DT.
D) Palm size and shape used in water displacement and wave generation. Again P&DT.
E) Shoulders --- broad or narrow which may have great impact in propulsion. Again P&DT.
F) Legs and feet sizes and shapes show great variations in wake dissipation. Again P&DT.
G) Total body mass which influence wave generation while diving at the starts. Again P&DT.
H) Total wetted surface area of the body which is a main cause for form drag. Again P&D T.
I) Hair on heads which may increase form drag. Again P&DT.
J) Hair on body parts. Again P&DT.
K) Head caps. Again P&DT.
L) Body suits. Again P&DT.

3. Type of stroke: a) free style b) back stroke c) breast stroke and d) butterfly in each stroke the water displacement by the swimmer is different so, many more permutations in each stroke.
4. Stroke performance: Any one swimmer's wrong performance of the stroke in the set of 8 swimmers may lead to another degree of turbulence. Again P&DT.

The above said all factors indirectly affect the velocity of a swimmer and reduce the winning chances. Example- If a swimmer with more wetted surface area (tall & broad shouldered) swimming in a lane will cause an increased drag not only to his adjacent lane swimmers but also a little to other lane swimmers. At the same time he will change the degree of turbulence of the entire pool in to another degree.

VI. SALIENT FEATURES OF THE NEWLY DESIGNED SWIMMING POOL

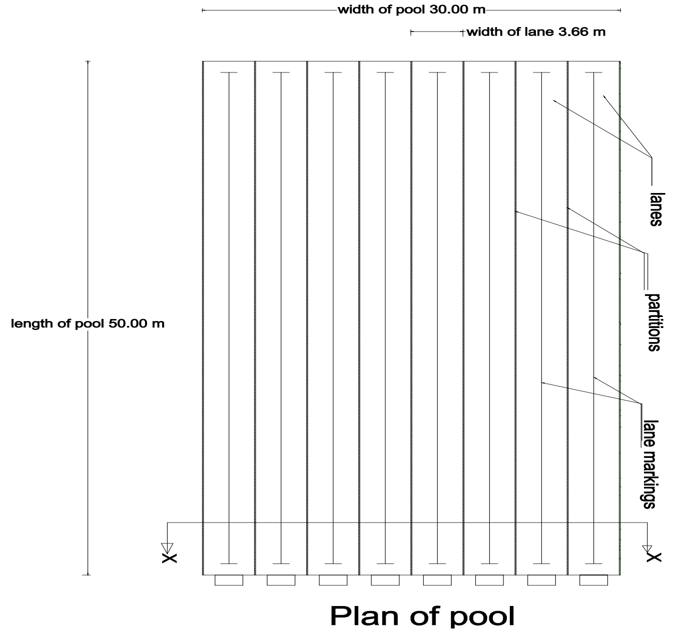


Figure -12

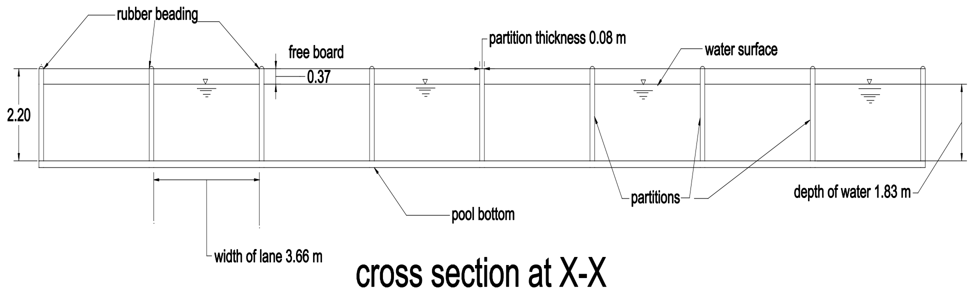


Figure -13

New design is named as "*partitioned pool*".

1. All lanes are separated by transparent partitions.
2. No wave disturbance (by the side lane swimmers) in any lane.
3. Costly wave eating lane ropes are discarded.
4. Each lane acts like an individual swimming pool.
5. Each and every lane has a lane coefficient value of 1.00
6. Easy to modify the older pools to partitioned pools.
7. After completion of the races it is easy to remake the original big pool by removing the partitions.
8. For all the athletes the boundary conditions are equal, identical and unique.
9. No splashes from side lanes.
10. Bottom with the same material of partitions (with minimum joints).
11. Small holes of 2 to 3cms diameter size may be provided in the bottom panels throughout the length (50m) of partitions to maintain same depth and temperature of water in all lanes.
12. Top edges of the partitions are with colored rubber or plastic beadings.
13. Justice to all swimmers

6.1 suggested example

Length of the pool ------ 50m Width of the pool -------30m

Each lane is 3.66m (12 feet) wide because it is twice the average wingspan length of a swimmer to facilitate free swimming action.

Depth of the pool is 1.83m (6 feet) because each lane has to act like a hydraulically most efficient section. The present using (50m×25m×3m) pool has no hydraulically most efficient section. That is why it is allowing extra deepening and giving extra velocity to the swimmers. It allows an extra deepening up to 12.5m deep to give the maximum velocity. Beyond 12.5m deepening the swimmer's velocity will be reduced. This is the secret behind extra deepening.

The hydraulically most efficient section is the one which has the minimum wetted perimeter for a particular cross sectional area. [6] To get this section depth must be half of the width of the lane and the materials used for the side walls and bottom must have the same roughness coefficient. If tiled bottom is inevitable then the number of joints between tiles must be the same both in pattern and in number in all lanes and then the depth must be adjusted according to the coefficient of roughness of tile texture and joints. In this type of section drag force will be minimized and velocity will be maximized.

Partition height is 2.2m to leave a free board of 0.37m to prevent the splashes from the adjacent lanes. The partitions must be transparent (irrespective of the material) or at least the top 1.1m portion should be transparent to watch the relative positions of other swimmers by a particular swimmer while the race goes on. Partition thickness is 8cm.The transparent partitions top edges are covered with higher wave length colour (eye catching colours like red, yellow or orange) rubber beadings for the visibility of diving swimmers.

VII. DISCUSSION

Nearly 120 years back swimming was included in Olympic Games. Since then we have been conducting the competitions in an unscientific way by ignoring the end lane swimmers who have been suffering by choppier swim by cross lane and bounced back waves from side walls. Since 1960s we have been using lane ropes to defend the waves from side lanes. If lane ropes do its duty well then the question of waves across the lanes does not arise. So they are being used to minimize the apparent turbulence only but not the underwater currents. Every swimmer and coach is very much aware of shaving bodies and heads (because even a single small hair may cause added drag) and about swim suits not with a single stitch (untailored) but they won't mind about the pool bottom which is made with small tiles with many more joints which can cause much more drag on swimmers. [4] Many well experienced coaches know the fact that the centre four lanes (i.e., 3, 4, 5 and 6 lanes) are more advantageous because they have been giving answers to FAQ in some web sites about the fact.

"SW 3.3 in other competitions, the draw system may be used for assigning lane positions." This rule is from FINA swimming rules 2009-2013. Swimming race should not be a lottery. Lanes must not play the judge role in deciding the winners.

If the best timed swimmers are assigned or allocated with end lanes (i.e., 1^{st} and 8^{th} lanes) could they win gold medals?

First the FINA people must prove that all lanes of presently using pool have equal conditions and equal chances of winning the race

VIII. CONCLUSION

If all the eight participant swimmers should have equal and identical parameters to win a swimming race the swimming pool must be constructed with 400 meters width and the 8 swimmers must swim in centre 8 lanes of 2.5 meters lane width leaving all side lanes without swimmers. Is it practicable? Therefore, there exists a long felt need to provide well designed swimming pools for competitive swimming which can overcome the above discussed drawbacks and provide equal opportunities to the swimmers in all lanes of winning the race. Finally, we expect such type of good and better designs from eminent scientists and well experienced coaches who are related with the swimming science.

NOTE: This paper is not intended to criticize or to blame any individual or any institution or any association or any federation. This is a small trail to do justice to the end lane swimmers. Mistakes are to be regretted.

REFERENCES

[1]. Bansal R.K (2011) *A text book of fluid mechanics and hydraulic machines*. laxmi publications New Delhi. Pp 13-14.

[2]. http://swimming.about.com/od/swimmingpoolsandspas/qt/fastpool_secret.htm

[3]. http://www.livestrong.com/article/456880-the-speed-of-human-swimming/

[4]. http://www.topendsports.com/sport/swimming/science-biomechanics.htm

[5]. Jain A.K. (2009) *Fluid mechanics including hydraulic machines*. Khanna publishers New Delhi-110002. Pp 462, 623

[6]. Modi P.N. and Seth S.M. (1987) *hydraulics and fluid mechanics including hydraulic machines*. Standard book house Delhi-6. Pp 719.

Vijaya Rama Raju Mudunuri. "Injustice in Competitive Swimming (Justification by Partitioned Pool)." American Journal of Engineering Research (AJER) 6.7 (2017): 231-240.