Airport with circular runway in India

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ABSTRACT

India being the developing country with large population inbound and with large tourism network. India is expected to welcome 217 million domestic with 76 million international passengers by 2020. There is a need for crowd handling airport facility with the high efficient airport in India. The circular runway had never been implemented in India till now. This will give us the foundation for the new type of airport in India. The taxiway will be available outside but along the runway. There is going to be short landing and fast take-off. This runway offers us to counter the wind in any direction. This enables us to use natural wind pattern to our advantage. Further, this will help in saving fuels, aircraft maintenance, and repairs. The capacity will be increased suddenly. This concept will be applied on the airport with a large crowd like Indira Gandhi International Airport. This concept cannot be applied to smaller airports where the need is less. There is going to be new ATM procedures which are to follow without any discrepancies. This will have low noise impact with possibly more aircraft accommodation. The circle of the runway, whose diameter is set to 3 kilometers, is large enough to provide sufficient room for infrastructure preferably inside the circle, even for a hub airport. This makes the airport compact, while allowing current-day aircraft to use the circle without significant structural modifications.

Keyword : *- Circular runway, traffic movement, noise, ATM tower.*

I. INTRODUCTION

India being the developing country with large population inbound and with large tourism network. There is a need for crowd handling airport facility with the high efficient airport in India. There are many abandoned airports in India which are to be rebuilt for smooth movement of traffic throughout the country. The traditional airport can be used at low-cost basis at places where the movement is very less but for hub airports like IGI in Delhi, it requires more runways, which comes at the cost of a lot of areas, facilities, location distance from the city, conveniences? To satisfy the all the requirements we are going to apply the concept of circular runway to the existing airport and check if this concept is to become feasible it is required to be applied properly. This concept will be applied on the airport with a large crowd like IGI and Chhatrapati Shivaji airports. Physical constraints on runway operations, like wake vortex separation minima and cross- and tailwind limits, make it hard to improve the performance of conventional airport configurations further. The Endless Runway is a radical and novel airport concept, which applies a circular runway. The concept of the Endless Runway can generate a breakthrough in sustainable airport capacity by avoiding the physical constraints of conventional runways through shifting the lift-off and touchdown points of individual aircraft. The main feature of the circular runway is that it will become possible to let an aircraft operate always at landing and take-off with headwind. The circle of the runway, whose diameter is set to 3 kilometers, is large enough to provide sufficient room for infrastructure preferably inside the circle, even for a hub airport.

1.2 Objective

The basic concept of operating the runway is to allow flexible lift-off and touchdown points that will enable every aircraft to lift-off or touchdown at any point on the circle depending on
1. Current wind conditions – the aircraft will take-off and land with headwind and minimum crosswind. Direction of flight – the aircraft will depart or arrive in the direction of their destination. Apply the circular runway concept to existing major hub airport in India and to compare it.

1.3 Problem Definition

Conventional runaways face the problem of lack of area for landing and take off, and major problem is wind direction, which results to accident. To overcome these limitations in conventional system, we are going to design round airport.

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II. LITERATURE SURVEY AND PROJECT OVERVIEW

2.1 Literature Survey

The motivation for taking one of the most demanding airports in Europe at its busiest day is that if the simulations demonstrate feasibility of the concept for this airport at this day, it will work for almost any other airport in Europe as well. The idea of a circular runway is not new: since the early days of aviation, People discuss and experiment new ways of take-off and landing, including the circular runway. All along the XX th century, engineers submitted articles, reports and patents related to circular runway concepts. In the middle of the 1960s, flight trials with takes-offs and landings were even undertaken by U.S. army pilots on a circular car track in Arizona. In 1919, a circular track appears for the first time in the press, in the “Popular Science Monthly” newspaper. In 1921, a first circular runway is patented by P.J. He proposes a flat and small circular track way, which was adapted to light aircraft of that time. In 1957, a refined design of the circular runway was proposed by Sir H. Tempest.

Pilots reported that at first it was difficult to land with the correct roll angle and on the speed circle corresponding to the landing speed. One of the reasons why the circular runway remained at experimental level was probably the cost of such a runway and the need for new procedures and techniques. Construction costs would be higher than for capacity-equivalent conventional runways because of the requirement for precise banking of the runway and for larger runway width (98 meters instead of maximum 60 meters) and length (10,000 meters versus maximum 4,000 meters). Another reason was that the design studies of these concepts study did not involve devising new landing techniques and procedures, which are necessary for implementation in the air traffic environment. During the “Fentress Global Challenge: Airport of the Future” launched in the Spring 2011 and awarded early 2012, two students (one from Stanford university and the other one, Thor Yi Chun, from Malaysia's University of Science) proposed both a circular runway concept.

III. METHODOLOGY

3.1 The concept of operation and design of the Endless runway

Three different operational cases can be identified for aircraft landing on the circular runway: strong wind, low wind, and changing wind directions.

a. Strong Wind Condition.

In strong wind conditions, those exceeding 20 kts, the aircraft will fly in sequence towards the Endless Run way to allow for landing at the touchdown point where dependency from the wind is at a minimum (at exactly headwind).

b. Low Wind Condition.

In low wind conditions, aircraft can take-off and land in any direction. Aircraft are sequenced so that consecutive aircraft originate from different directions and do not interfere with each other and will not have needs for spacing according to wake turbulence categories.

c. Changing Wind Condition.

Three different operational cases can be identified for aircraft landing on and taking-off from the circular runway strong wind, low wind, and changing wind directions.
The part of the runway not allowed for lift-off and touchdown becomes shorter with increasing wind. Aircraft are sequenced so that consecutive aircraft originate from different directions and do not interfere with each other and will not have needs for spacing according to wake turbulence categories.

The runway width is set to 140 meters as a compromise between discomfort due to higher centrifugal forces for a narrower runway and the costs of a wider runway.
To limit the effects of the centrifugal forces, the circular runway lateral profile is banked with increasing angles to the outside. As the aircraft accelerates for take-off, it moves from the flat inner part of the runway toward the outer banked part until it reaches the lateral position on the runway where the bank angle fits its lift-off speed.

3.2 Airport Design

The taxiway system consists of an outer and an inner taxiway ring between the runway and the terminals area. The outer taxiway, operated in the same direction as the runway, is connected to runway access points through high-speed exit taxiways, where one aircraft can hold if needed. One to four terminals with connected generic gates called Multi-Aircraft Ramp Systems (MARS) can be built depending on the airport category (hub or seasonal), with additional remote stands in the latter case. The choice for midfield buildings is justified as to occupy less space, on the order of 30 or 40 meters, as compared to the 100 to 150 meter depth for standard airport terminals, leaving more space available inside the circle for further expansions. Access from the outside to the inside facilities is provided to employees and suppliers through tunnels passing under the runway, and to passengers through an APM (Automated People Mover) connecting the main terminal to the intermodal station located outside and to the parking lots that may be constructed under the runway.

3.3 Air Traffic Management procedures

From the Air Traffic Management (ATM) perspective, the circular runway will be split in segments: an aircraft will use a set of contiguous runway segments for takeoff and landing, and several aircraft will be authorized to use distinct runway strips simultaneously. Eighteen segments were chosen as a good compromise: low enough to minimize the taxiway construction and maintenance costs, movement area design and traffic complexity, and high enough to optimize throughput, runway occupancy time and route efficiency.
The Airport Reference Point (ARP) is chosen to be the canter of the circle.
The taxiway system consists of two parallel rings that are used to coordinate the traffic to and from the runway. While the outer ring is operated in the same direction as the runway, the inner taxiway ring is operated in the opposite direction. The connection to the apron is provided by a number of taxiways, whereas four main entries to the inner part of the apron are available. Conventional navigation aids as ILS are not suitable anymore as they cannot support curved approaches, but other ground based or space based navigation systems, like Microwave Landing Systems (MLS) and Differential Global Positioning Systems (D-GPS) can provide a high number of different approach paths. As a basic form of this technology are already available head-up displays (HUD) and can be used for additional on-board guidance to present approach information to the pilot. Procedures for TMA operations, ground operations and special procedures for missed approaches have been defined.

The easiest way to construct routes within the TMA is to use straight flightpaths for arrival and departure routes tangential to the segments they are connected to. Figure 16 shows the 18 segments (00-17) of the runway, the routes and the start/end points at the borders of the segments.

Taking into account that wake vortices appear only in the airborne part of the aircraft trajectory, to have the most efficient use of the Endless Runway in the high wind case, the new configuration should make certain that the aircraft departure and final approach trajectories from both parts are never closer than 760 meters, this to ensure that aircraft operations from both sides are independent.

To implement the concept let’s take in consideration two existing major airports in India which are as follows: Indira Gandhi International Airport (Delhi) Chhatrapati Shivaji International Airport (Mumbai). These Airport are selected due to their unique feature and being the hub of movement of passengers and recording the highest in-flight movement throughout India.

IV. RESULT AND CONCLUSION

I. Designing of the new runway:

A. IGI AIRPORT

Taking length existing of runway = 4430m
For movement of 3 aircraft at same time length of circular runway =3x4430m =13290m
Radius of runway (outer)R =2116.24m =2.5x60m =150m
Radius of runway (internal)r =1966.24m
Providing 4 taxiways along the strip and facilities inside the runway
Lights are provided at both outer and inner edge of the runway at 15m intervals with alternate red and white light for next 300m and 600m.
Total area covered =3.14xRxR sqm =3474.89 acres
Minimum Distance between two aircraft is =120m
The centralized terminal is provided underground with finger piers and 80 gates. High intensity runway lights are installed on the runway for different purposes like taxiway, centerline etc.

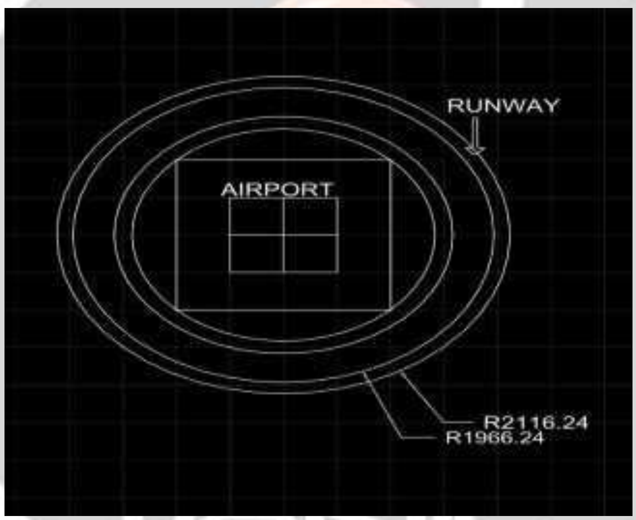

Chart-1: CAD Diagram of IGI Airport

B. CSI AIRPORT

Taking length existing of runway y= 4430m
For movement of 2 aircraft at same time length of circular runway =2x3660m =7320m
Radius of runway (outer)R =1165m (approx.)
Width of runway =2.5x60m =150m
Radius of runway (internal)r
=1015m
Minimum Distance between two aircraft is =120m
Providing 4 taxiways along the strip and facilities inside the runway
Lights are provided at both outer and inner edge of the runway at 15m intervals with alternate red and white light for next 300m and 600m.
Total area covered =3.14xRxR sqm =1053.086 acres
The centralized terminal is provided underground with finger piers and 60 gates.
Medium intensity runway lights are installed on the runway for different purposes like taxiway, centerline etc.

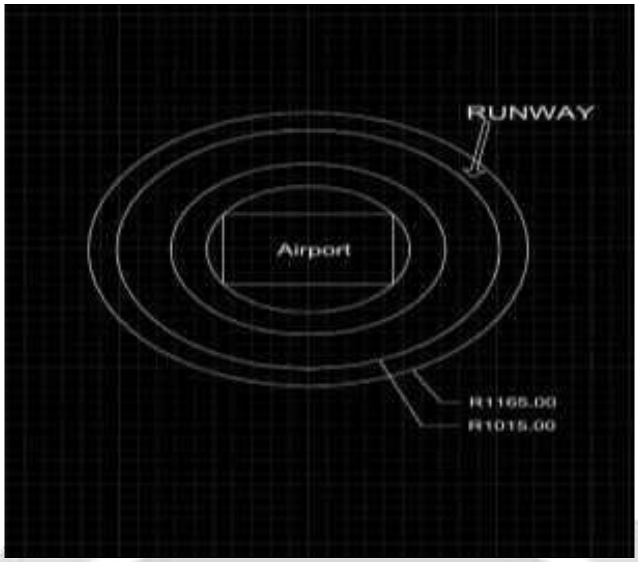

Chart-2: CAD Diagram of CSI Airport

II. FEASIBILITY IN INDIA
The project feasibility Depend on two major points
• The master plan of runway design
• Capital expenditure

Our project is to find the circular runway design feasibility in the place of the existing runway and can it be implemented in our country.

Parameters	Traditional Runway	Traditional Runway	Circular Runway	Circular Runway
	IGI AIRPORT	CSI AIRPORT	IGI AIRPORT	CSI AIRPORT
Runway Length Available	2813m 3810m 4430m	2990m 3660m	13290 m 2116.2 4m (outer radius)	7320m 1165m (outer radius)
Width	45m 46m 60m	45m 60m	150m 2-3 segment	150m 2-3 segment
Aircraft Movement At Same Time	1	1	3	2
Cost of Construction (Crore Rupees)	12718	12380	17169. 3	16713
AREA (In Acres)	5106	1500	3474.8 9	1053.0 8

4.1 Advantages

1. The capacity of an airport with an Endless Runway is at least similar to that of a conventional airport with four runways, while the length of the circular runway is comparable to three.
2. Flight times in the area around the airport will be reduced as aircraft can now almost fly straight in and out. We will be able to design routes that avoid the areas where most people live. Or we can design routes such that everyone around the airfield will experience a similar level of noise.
3. Another advantage of the concept is that the airport buildings can be constructed in the middle of the circle, reducing the size of the airport. We have estimated that a large airfield like the airfield of Paris will fit within the circle, which occupies an area of about one third of the size of the current airport.

4.2 Applications

1. Indian army for transportation of heavy material
2. Domestic flights
3. International flights
4. Air force
5. Navy support
6. Emergency landing and take-off in war condition

4.3 Conclusion

Through our project analysis, we now know that the circular runway is not feasible in India right now. This concept has not been implemented till now in India due to its non-executed trials and high requirements.

•The area covered at IGI is 5100 acres and at CSI is 1500 acres.
• Area required by Circular Runway at IGI is 3474.89 acres and at CSI is 1053.086 acres.
• Area profit at IGI is 1631.11 and at CSI is 446.914 acres.
• The Aircraft movement at Terminal 3 (IGI) is 1150 aircraft per day (approx...) and at CSI is 780 aircraft per day.
• The circular runway can provide 2300 at IGI and 1500 at CSI aircraft movement per day.
• Time delay at IGI (terminal 3) and CSI (terminal 2) is around 6 min. at min traffic on other hand time delay on the Circular runway is very rare.
• Require high capital investment.
• The circular runway cannot be extended if demand grows.

Design such a project and implement it, we gather great practical experience. We hope our project can bring dynamic change in our industrial level motor controlling system.
The project we have undertaken has helped us gain a better perspective on various aspects related to our course of study as well as practical knowledge of electronic equipment's and communication.

4.4 Future Scope

Since the Endless Runway concept offers a real discontinuity with today's airport layout, the project also defines an innovative aircraft that would be tailored to the circular runway and its specific procedures. The last step in defining a tailored aircraft consists of performing simulations within the same environment as has been done for the B747, to assess the ERAC from a performance point of view.
From a mission point of view, based on the expected 2050 mission characteristics, the ERAC is capable to transport 450 passengers at Mach 0.8 over a distance of 8000 Nm

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