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CERTAIN CHARACTERISTICS OF RUNWAY AND ASSOCIATED ASPECTS FOR RAIPUR & BILASPUR AIRPORTS IN CG

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Abstract

Raipur and Bilaspur airports in Chhattisgarh state have sustainable air-network under Regional Connectivity System-Ude Desh ka Aam Nagrik [RCS-UDAN], Government of India. Both airports belong to low traffic airport category with single runway and associated aspects as per regulatory and statutory bodies namely: AAI [Airport Authority of India] & DGCA [Directorate General Civil Aviation] respectively. The associated aspects of runway are: Taxiway, Apron, Helipad, Hanger, Air- strip etc. They serve the principle purpose for landing and taking off the aero- planes towards transporting the air travelers and cargo through airport. It is well supported and coordinated by navigation cum air traffic control system, flight booking, time-maintenance and security check up arrangements at airport through operating airlines and local community.

The basic norms of runway have been reviewed with respect to aviation history of Indian airports with major infra-structure. The runway and associated aspects have been discussed with comparative study of both airports in terms of SWOT analysis, runway characterization, and technical assessment of runway pavement. The safety parameters of runway have been scrutinized as per guidelines of Federal Aviation Administration [FAA] & International Civil Aviation Organization ICAO]. The status for maintenance of runway pavement for Indian airports has been empathized.

Introduction

Air transportation has been growing service industry in India for medium and long distance travel. It has resulted in implementation of low cost carrier system, available to affordable ticket among aero-plane movement with time saving. It is one of the major missions of RCS-UDAN with linking 486 airports in India presently [1].

AAI has classified Indian airports into three categories on the basis of the dimension of runway and facilities available at airport for passenger, cargo and aero-planes, along with Aerodrome Reference Code [ARC] by ICAO. There are three categories of Indian airports namely: Large traffic airport, Medium traffic airport and Low traffic airport. The Large traffic airports are only two namely New Delhi and Bombay. These

have global airlines of reputed nature with multi runway system. New Delhi has three runways with dimension [i] 11/29= 4430 m-length, 60m width, [ii] 10/28= 3810 m-length, 46 m width, [iii] 09/27= 2813m-length, 45m width; name of airport Indira Gandhi Int. Airport, ARC= 4E. Bombay has two runways with dimension [i] 09/27 =3445m-length, 60m width,[ii] 14/32=2825 m length,45m width [both runway cross cutting]; name of airport-Chhatrapati Shivaji Maharaj Int. Airport [CSMIA] at Sahar , ARC= 4D. The Medium traffic airports are ten with single runway with length in the range of 2000-2300 m length. These are Chennai, Surat, Kolkata, Gaggal, Imphal, Agartala, Vododara, Rajamundry, Khajuraho & Gaya. These have been under investigation through Airfield Pavement Management System [APMS]. They have ARC= 4C.The Low traffic airports have the majority with single runway, by other remaining airports having length in the range of 1200-1800 m.

The runway is rectangular area of plain land on airport, used for landing and taking off aero-plane. The taxiway is definite path for movement of aero-plane from one portion to another portion of airport / Support passengers moving from gate to runway. The Apron is land on airport intended to accommodate aero-plane for the purpose of loading/ unloading passengers, mail, cargo, fueling, parking and maintenance. The runway, taxiway and apron belong to air-side unit of airport, and illustrated as Fig.1 [6].



Fig. 1 Runway, Taxiway, Apron exhibiting at Heathrow Airport London [U K]

The Helipad is circular shaped plain land for operational activity of Helicopter. The Hanger is enclosed large space on airport for providing shelter to aero-plane for its maintenance, inspection, as equivalent to workshop cum garage for motor car. The Air strip is cleaned grass land for landing and taking off small aero-plane during training cum emergency purpose.

The airport infrastructure has two main units namely; Air-side and Land-side. The Air-side has Runway, Taxiway, Apron and Gate [a passage connecting to passengers from terminal to aero-plane]. The Land-side has terminal, Energy Generation, Waste, Water/Waste water treatment and Parking garage. The purpose for each such element of Air-side and Land-side with their stakeholder is summarized as Table 1[6].

S N	Name of Element	Purpose	Primary Stakeholder
	AIR	SIDE	UNIT
1	Runway	Support Aero-plane for take-off/landing	Aviation regulation body
2	Taxiway	Support passengers moving from gate to runway/specific zone for movement of aero plane from one portion to another portion within airport.	Aviation regulation body
3	Apron	Place for passengers boarding/aero plane maintenance	Airline
4	Gate	Passage connecting terminal to aero plane for passengers	Airport
	LAND	SIDE	UNIT
5	Terminal	Process passengers from land-side to air-side	Airport/Local Community
6	Access Road	Transport passenger/employee to/from airport	Airport/Local Community
7	Energy Generation	Provides energy for airport operation	Airport/Local Community. Cochin Int. airport is the world's first airport to be fully powered by Solar Energy
8	Water/Waste water treatment	Provides safe and clean water for airport operation/treat effluent	Airport/Local Community
9	Waste	Manage waste from airport operation	Airport/Local Community
10	Parking/Garage	Provide space for passenger/employee parking	Airport

Table 1 Purpose and Stakeholder for airport operation and maintenance

Area of Study

The airport of Raipur is the oldest one in CG, with renovated in March 2011. The airport of Bilaspur is the youngest and started in March 2021. It was used by Royal Air Force in 1942 during World War II by British Army [14]. The geographic details of both airports have been summarized in Table 2. The geographic location for the area of study is illustrated as Fig.2.

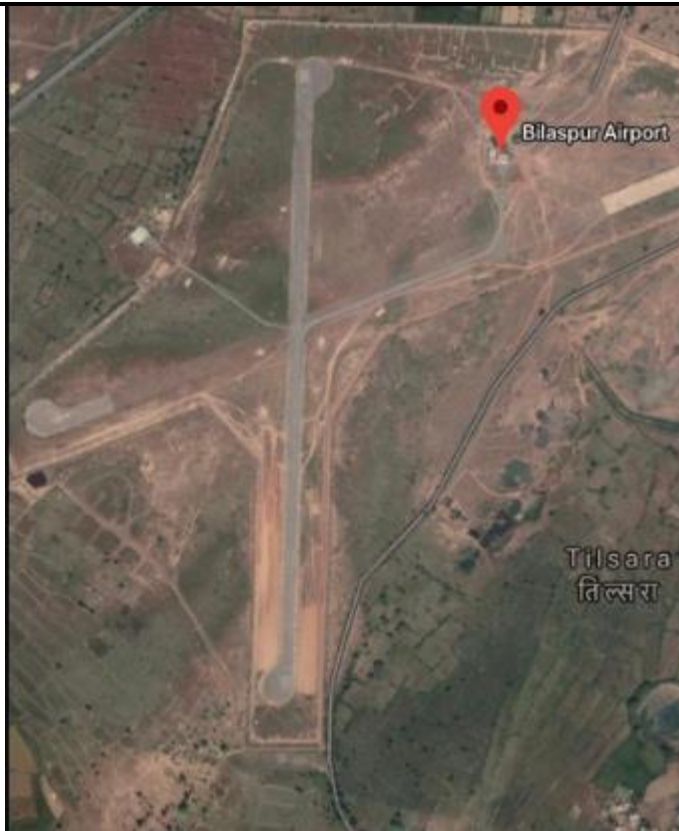
S N	Name of Locality	Name of Airport	Latitude N	Longitude E	Elevation [m]
1	Mana	Swami Vivekanand, Raipur	21° 10' 52"	81° 44' 18.5"	317
2	Chakar Bhata	Bilasa Devi Kewat, Bilaspur	21° 59' 18"	82° 06' 40"	274

Table 2 Geographic detail of Raipur & Bilaspur Airports



Raipur Airport View





Bilaspur Airport View

Fig.2 Area of Study

Evolved Methodology & Objectives

The evolved methodology has conventional approach and based upon Relevant Literature Review. Fourteen relevant literatures have been scrutinized in order to get solution for the following four objectives:-

- Basic information in about Raipur and Bilaspur airports
- SWOT analysis for Raipur and Bilaspur airports
- Runway characterization and safety measures
- Technical evaluation of Runway Pavement

Result & Discussion

The proper functioning of airport depends upon adequate planning, timely support through Government & Airlines, maintenance of air traffic control system, runway design with scope of improvement, sufficient number of passenger/ cargo and other commercial inputs. An attempt has been envisaged to achieve the solution for the desired objectives.

✓ Basic information in about Raipur and Bilaspur airports :-

These are related to structure of airport and developmental facilities for its progress. Raipur airport has state Hanger and Helipad. Bilaspur airport has got DGCA approval for more large size apron [2]. Eight parameters for Raipur & Bilaspur airports have been summarized as Table 3.

S N	Parameters	Raipur Airport	Bilaspur Airport
1	Allotted land in Acre	400 + 12.8 land by Naya Raipur Development Authority [NRDA]	53 Acre more land, required as per approved AAI master plan
2	Nomenclature	Swami Viveka Nanad	Bilasa Devi Kewat
3	Geographic locality	Mana	Chakar Bhata
4	ARC	4C	3C
5	Type of Aero-plane /Airlines in operation	Indigo, Vistara Airlines	ATR 72600 of Alliance Air India Airlines
6	Flight Frequency	14 flights per day	4 flights per week
7	Night landing facility	Yes	No
8	Fire Fighting System	Yes	Yes

Table 3 Comparison of Raipur and Bilaspur Airport

✓ SWOT analysis for Raipur and Bilaspur airports

Strength, Weakness, Opportunity, Threats [SWOT] analysis is quantitative cum descriptive approach for ensure effective public relation and strategic planning. It provides prioritizing of work, required to grow business in commercial competition. It has been carried out for Raipur and Bilaspur airport and summarized as Table 4.

S N	Parameter	Raipur Airport	Bilaspur Airport
1	Strength	Political Capital of C G	Judicial capital of C G
2	Weakness	High land value, Real Estate of NRDA	Land was originally marked to Defense
3	Opportunity	Air Cargo handling- Common Use Domestic Cargo Terminal [CUDCT]	H Q of SECR, SECL, Seepat Super Thermal Power Plant
4	Threat	Exploitation of natural resources with urbanization	Fast Dynamic land Use/Land Cover change-converting Agricultural land in to Mixed Built up area

Table 4 SWOT analysis for Raipur and Bilaspur Airport

✓ Runway characterization and safety measures

The runway of any airport has nomenclature through its dimension and orientation. The dimension includes length and width in same unit, preferably meter. The orientation is based upon magnetic azimuth of runway heading and ending respectively. The orientation is documented in Decca degree, with heading/ending. It is represented by number 01 & 36. The difference in between heading and ending is always 18 [180°] or in straight line [7].

The runway of Raipur Airport is 06/24, which means it has alignment as 060° - 240° with length =2286 m and width =45 m. The length of runway has been further extended to 3251 m. Similarly, the runway of Bilaspur Airport is 17/35, which means it has alignment as 170° - 350° with length =1535 m and width =30 m. The length and width of Bilaspur airport's runway is required as 2190 & 45 m respectively for operation of further low cost aero plane like-Go Air, Air Asia, Indigo airlines and hence is needed of proper up-gradation for better utilization [2].

The other associated aspects of runway are Taxiway, Apron, Helipad and Hanger and their status for Raipur & Bilaspur airport has been summarized as Table 5.

S N	Associated aspects of Runway	Raipur airport	Bilaspur airport	Remarks
1	Taxiway	Four-A B C D	One with length of 630m	It is in between Taxiway & Apron at Bilaspur
2	Apron	Six Parking Bays: 4 =Power In-push back 2 = Power out-push back	Small Apron cum Helipad	One more Apron at Bilaspur of large size is approved by DGCA [2]
3	Helipad	H1, 20 m diameter with rigid pavement [concrete]	-	-
4	Hanger	Two	Both ends of runway have Turning Pad	-

Table 5 Comparison of associated aspects of Runway at Raipur & Bilaspur airport

The runway is classified in to three types, depending upon available instrumental facility at airport. These are [a] Non-instrumental runway- functioning through visual approach procedure. [b] Non-precision runway- based upon adequate guidance for straight movement through air tower system. [c] Precision runway- having précised instruments like ILS, IMC 54 and visual aids for operator. It is available at Raipur airport. The imported instrument of Rs 40 lakh has been functioning at Bilaspur Airport and illustrated as Fig. 3.



Fig. 3 Imported Air Tower cum navigation system at Bilaspur airport

The runway has smooth air traffic movement during landing and take-off by aero-plane through typical marking and is illustrated as Fig.4 [7].

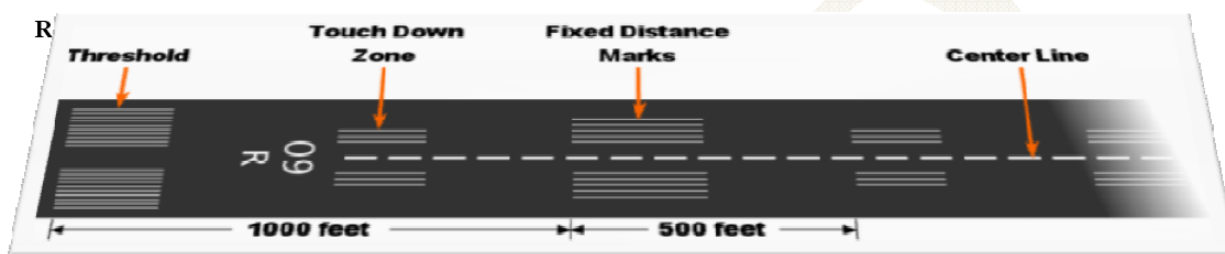


Fig.4 Typical marking on runway for smooth air traffic movement

The runway is associated with five types of lightening system and explained as follows [5]:

[1] Runway End Identifier Light: Unidirectional [facing approach direction] of synchronized flashing lights installed at runway threshold one on each side.

[2] Runway End Light: A pair of four lights on each side of runway [precised instrument]. These lights extend full width of runway. These light shows Green, when viewed by approaching aero-plane and Red, when seen from the runway.

[3] Runway Edge Light: White elevated light that run the length of runway on either side, or last third of the runway, whichever is less. It must be visible from 3 Km at least.

[4] Runway Centerline Lighting System: The lights embedded into surface of runway at 15 m interval along the centerline of precision instrument runway. The White light, except the last 900m, alternate White & Red lights for next 600m and Red light for last 300 m.

[5] Touch Down Zero Light: Rows of White light bars [with three in each row] at 30 m or 60 m interval on either side of centerline for 900 m.

Taxiway is differentiated by being bordered Blue light, depending upon the width of Taxiway [11].

The runway has basic safety norms in order to perform full proof landing and taking off aero-planes [4]. These are: Stop way, Cleared & graded area, Runway End Safety area and Clear way. The Stop way is rectangular shaped braking area on the ground at the end of taking off. The Cleared & graded area is the part of runway strip, cleared of all obstacles and graded, intend to reduce the risk of damage to an aero-plane running off the runway. The Runway end Safety area is symmetrical about the extended runway centerline and adjacent to the end of strip for reduce the risk of danger to an aero-plane during undershooting or over- running within 300 m distance. The Clear way is also rectangular shaped ground, over which aero-plane may make a portion of its climb to specific height.

✓ Technical evaluation of Runway Pavement

Runway Pavement comprises with multi layers of engineering materials like-Asphalt, Concrete & granular substances. It is prepared to carry aero-plane loading in static and dynamic condition under different environmental variations. It is the fundamental immovable asset of airport. It has significant impact on the cost, safety and commercial performance of airport's users [1].

Runway Pavement design depends upon air traffic loading/unloading, structural element, characterization of engineering material and environment [3]. The air traffic loading includes the tyre pressure in wheel of aero-plane and its contact to the pavement surface, wheel load, moving load, load repeating and axial configuration. The structural element includes the pavement response at various loads depending upon layered elastic material. The characterization of engineering material deals with modulus of elasticity, Poisson ratio, CBR value of material used in pavement construction. The environmental variant is related to wind condition, temperature, precipitation cum drainage [8].

The airport runway pavement has design to accommodate planned air traffic with full-filling the following three basic criteria [12]:

[i] Adequate strength- It depends upon the characteristics of used engineering materials.

[ii] Good riding quality- It depends upon geometry, dimension and orientation of runway along with shape of paved surface.

[iii] Good surface characteristics- It depends upon the texture and drainage condition of paved surface, with avoiding deposition of fine sediments of clayey material and damp condition [having prone to slipping tendency].

Green House Gas [GHG] emission from runway pavement accounts for 2.5 % of global GHG during 2018 [6].

Airport Pavement is of two types namely: Flexible & Rigid. The semi flexible airport pavement is used along the end of runway's width as per prescribed dimension. The comparative study of airport pavement for airport at CG has been summarized as Table 6

S N	Parameter	Flexible Pavement	Rigid Pavement
1	Flexural Strength	Low to Nil	Worthy
2	Mode of load transfer	Grain to grain from top to bottom layer	No
3	Composition	Asphalt-concrete surface	Portland cement, concrete/pre-stressed concrete
4	Type & Number of layers	Five: wearing course, Binder, Sub Base, Soil formation bed, Natural ground surface[from top to bottom]	Four: Concrete slab, Sub base, Soil formation bed, Natural ground surface [from top to bottom]
5	Utilization	Main Runway	Taxiway, Apron, Helipad

Table 6 The Comparison of Flexible and Rigid airport pavement at airports of CG.

Pavement Classification Number [PCN] - It expresses the load carrying capacity of Runway, Taxiway and Apron. PCN has FIVE part code, separated by forward slashes, describing the status of particular pavement at specific airport [9] & [5]. These are as follows:-

First Part = It is whole number. It indicates geometry of aero-plane, air traffic pattern of aero-plane for safe air transportation.

Second Part = It has one capital letter either F or R. F indicates Flexible runway pavement. R indicates Rigid runway pavement.

Third Part = It has four letters A B C D, denoting the strength of runway pavement in decreasing order on the basis of California Bearing Ratio [CBR] value of used engineering material.

A= Very strong Sub base [C B R is in range of 13-15 %]

B= Strong Sub base [C B R is in range of 08-13 %]

C = Medium Sub base [C B R is in range of 04-08 %]

D= Poor Sub base [C B R is in range of 01-04 %]

Fourth Part = It has four letters W X Y Z, denoting tyre pressure in wheel of aero-plane in decreasing order on the basis of MP.

W = No tyre pressure limit [high-unlimited]

X = Maximum tyre pressure [1.75 MP a]

Y = Medium tyre pressure [1.25 MP a]

Z= Low tyre pressure [0.5 MP a]

Fifth Part = It has one capital letter either T or U having meaning-

T = Technically evaluated

U = Usage of physical test as required.

Thus the Runway of Raipur airport PCN is 54/F/B/W/T. It refers to 54 aero plane geometry for landing/take off purpose, Flexible runway pavement, strong sub base [CBR= 8-13 %], No tyre pressure limit and Technically evaluated.

Aero-plane classification Number [ACN] describes the bearing strength of runway pavement for enhancing safety measures of runway.

The overall responsibility of Airport Manager includes the periodic assessment for friction and texture characteristics of Runway, taxiway & Apron under its maintenance. The friction and texture of runway pavement surface depends upon load during take- off and landing of aero-plane and tyre pressure in wheel of aero-plane [13].

An aero-plane may find itself off the runway, because of it has either too high speed or has touched down the ground at too late. It may lead to lose wheel alignment of aero-plane. The specified length of runway has particular impact on performance of aero-plane during take-off to accelerate an accepted speed for producing lift to become airborne. The shorten in length of runway than required dimension encourages coefficient of runway friction. The friction of runway is governed by wheel load of aero-plane, fine layer of water film [even less than 3 mm] on the pavement surface, cross wind condition, reverse engine thrust and ability of pilot [10].

Conclusion & Suggestion

The first commercial flight in India was operated on 18 February 1911 in between Bamrauli [Allahabad] and Agricultural Research Institute [Nani]. It was for 15 minute duration to carry Postal dak during Kumbh Mela.

The first Indian pilot, who took flight in India, was Late J R D Tata. He piloted himself for first flight on 15 October 1932 in between Digha road aerodrome Karachi to Juhu air strip Bombay via Ahmadabad, who later on established, Air India International Airline.

The Airfield Pavement Management System [APMS] has been initiated in India during October 2019 by AAI & Central Road Research Institute [CRRI] for carrying scientific study on maintenance & performance of runway pavement surface for medium traffic airports. The maintenance of runway at airport is key factor for landing and take- off of aero-plane. The safety norms, light signal system with respect to runway, taxiway, and apron are necessary for flight operation by airlines, besides considering prevailing meteorological conditions. The development of airport infrastructure has been critical catalyst for economic, logistic and social uplift of the geographic area. The suggested best practice for improving airport infrastructure is illustrated as Fig.5 [6].

The air travel is increasing day by day from Raipur/Bilaspur airports to other cities on account of affordable ticket, time saving and easy convenience. This has to be carefully monitoring with involving facilities at airport passengers by airport managers, with the following considerations:-

- Top priority for maintenance of runway, taxiway and apron as per national and international safety norms.
- Periodic monitoring of the runway pavement surface, after landing and take –off of aero-planes of different airlines during peak hours randomly.
- Regular documentation and analysis of meteorological data for preparation of wind rose diagram.
- More flight facilities during non peak hours may be initiated to reduce congestion problem.
- Obstacle free zone of 77.5 m should be provided on either side of centerline of runway for entire length towards unforeseen emergency.
- Runway end safety area should be provided after the prescribed length toward stop-way.

- Effective and affordable cum hygienic cafeteria, entertainment facilities, relevant information dissemination should be provided to air traffic passengers in waiting hall after security check up at airport.

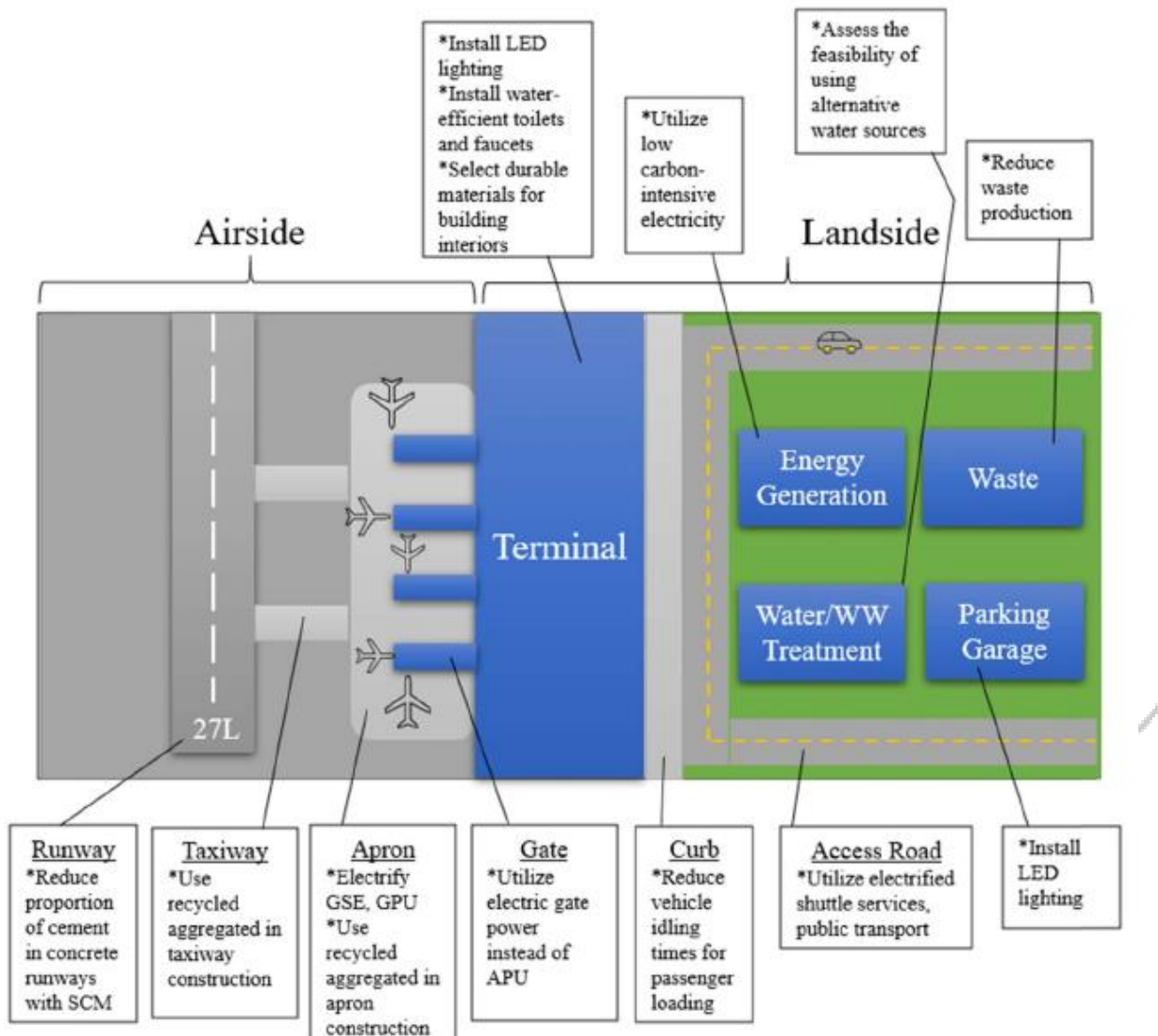


Fig.5 Improving infrastructural facilities at Airport

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Selected References

1. Airport Authority of India [2018]: Extension of runway at Swami Vivekanand airport Raipur, Information Brochure for Raipur airport, 14 January 2018, 2p.
2. Bhasakar News Paper [2021]: Air Tower Control at Bilaspur airport through mobile tower, Hindi Danik Newspaper, Bilaspur edition, Dated 13 February 2021.
3. Bhasakar News Paper [2021]: D G C A approval for one more large size apron at Bilaspur airport, Danik Newspaper, Bilaspur edition Dated 02 April 2021.
4. Class Notes on Air transportation [2015]: Governing factors for design of runway pavement, Department of Civil Engineering I I T Powai Bombay.
5. Federal Aviation Administration [2020]: Guidelines & Procedures for maintenance of airport pavement, Washington, September 2020.
6. Fiona Greer, Jaseka Rakas, Arpad Horvath [2020]: Airports and environmental sustainability; a comprehensive review, Pub. Environmental Research Letter, 15 [2020] 103007, 25 p.
7. International Civil Aviation Organization [2019]: ACN, PCN, Load carrying capacity of pavement on runway.
8. Over- seas Territories Aviation Circular [2020]: Runway pavement characteristics and maintenance OCTAC-1399, 23 Issue 2.00, 16 January 2020, 14 p.
9. Pradeep Kumar [2019]: Airfield Pavement Management System-CRRI & AAI Joint Project, Central Road Research Institute, New Delhi [CSIR] Annual Report-2019.
10. RCS-UDAN [2020]: Category of airports in India, D G C A, September 2020.
11. Sanjeev Gill, Rajiv Kumar, Shivam Singhal, Rahul Kumar, Rishi Raj Mani, Shubham Shrivastav, Purushatam [2015]: To study & design of airport runway pavement, Int. Jour. of latest Research in Engineering & Computing, Vol.3, Issue 4, Sept-Oct 2015, pp 7-10.
12. Salvatore A B, Francesca H, Francesca R, Resa V, Glanluis D A [2020]: A broad based decision making procedure for runway friction decay analysis in maintenance operation, Jour. Sustainability, 2020, 12, 3516, 21 p.
13. U A E Aviation- Physical characteristics of airport, aircraft, Abu Dhabi, 51 p.
14. Wikipedia [2021]: Construction and maintenance of runway, taxiway & apron at airport, 15 March 2021.