Airport Engineering: Designing an Airport

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Abstract

Designing an airport is a complex task and nowadays designing one is increasing its importance due to the huge growth of the passengers flying around the world each year. The main purpose of this document is to design an airport justifying all the decisions made to achieve it's complete design starting with some fixed parameters such as the aerodrome reference code, altitude, etc. The document will be organised in five sections stated in the introduction. The process followed to design the airport is to start with decisions such as the runway orientation and selection of the reference aircraft and continue defining all the airside, landside and its processes. After making all the decisions, the complete design of the airport has been completed mainly following ICAO recommendations, resulting in a passenger category 3C airport with an activity of six operations per hour. ***Keywords:*** *Airport, Design, ICAO, Airport Engineering.*

1 Introduction

The design of an airport includes many factors to consider. One must be aware that the optimisation of this proposed design is not as simple and straightforward as may seem. A variety of parameters will change the quality of the aerodrome, therefore much thought should go in to making each individual decision, as these will influence and limit future options and choices to be made.

To define an airport in a manner that is somewhat fixed, one could divide the sections to be worked on in the following manner:

- **Selection of the reference aircraft.** The parameter that will set many other variables that take into account aircraft performance, such as take off distance or turn radius, will fix and be a reference for characteristics like the runway declared distances (implicitly setting clearway and stopway sizes), taxiway turns, maximum apron parking stand dimensions and other.
- **Definition of the runway orientation.** Concerning the best direction in which to place the runway, it will be of utmost importance for not only the safety but the comfort of taking off and landing operations.
- **Definition of the airside.** Where important characteristics such as runway, taxiway and apron dimensions, distances and slopes must be considered for the correct usage, taking into account the reference aircraft as the maximum value. Moreover, the lighting and approach systems are specified in this section.
- **Dimensioning of the landside.** Where there are defined the dimensions of the terminal building and some of the other buildings in the airport such as the control tower, hangars or other service buildings.
- **Definition of the landside areas and processes.** Here the check-in and security processes are specified and also the minimum room necessary to make them possible according to the amount of passengers. The terminal building internal distribution is established and this section also specifies the access roads and public transport connections will be specified as well.

The project starts off with some predefined values given to each group, including the wind rose for the runways, the airport category, the location elevation and reference temperature. In the case of this group (group 10), the following values are used:

- **Wind Rose:** Figure 1
- **Airport Category** 3C
- **Location elevation:** 900 metres
- **Reference Temperature:** 23°C

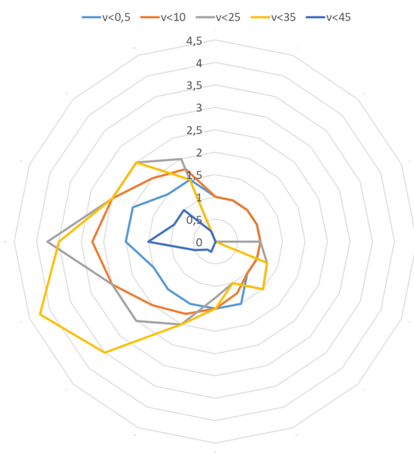


Figure 1: *Wind Rose*

By using the latter, the goal to achieve the final result is the definition of different values and characteristics.

2 Selection of the Reference Aircraft

In order to select a reference aircraft, one must take into account the characteristics of the airport. In the case of this specific group category 3C has been assigned. The latter fact describes the upper (1800 metres) and lower (1200 metres) bounds for the aeroplane reference field length, while the wingspan has to be between 24 and 36 metres. [1]. Therefore one of the possible reference aircraft is the Boeing 737-700. This aircraft has a reference field length of 1598 m and it's wing span is 34.3 m [2]. The latter fact positions the Boeing almost at the limit concerning category limitations, therefore it is good candidate to be able to include a variety of other aircraft below this specific range.

Another motivation to choose this candidate among others is the fact that it is a very common, well known aircraft; with many units in operation nowadays. Moreover, the aim of the airport is to mainly operate for passenger transport, so considering the fact that this is the 737-700's main use, it cements the aircraft as a good choice to be the reference.

3 Definition of the Runway Orientation

In order to select the correct runway orientation, one must satisfy the regulations given by ICAO. These state that the orientation must be such that the usability factor should be 95% or higher when landing or taking off in normal circumstances, and that the maximum acceptable crosswind is 37 km/h (20kt) except when poor runway breaking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency. In that case a cross-wind component not exceeding 23 km/h (13kt) should be assumed.[3], considering the reference field length for the reference aircraft that has been chosen (and discarding poor breaking action) the latter solidifies the maximum acceptable crosswind component to 37 km/h (20kt).

By observing Figure 1, one arrives to the conclusion that the only crosswind component breaching the limitations stated in the latter paragraph is only present during 1% of the time, a figure much lower than the maximum 5% allowed. This would mean any selected orientation is valid because the sum of the percentages with intensities surpassing the limit is not above the utilisation rate. However, one should try and obtain the best option, not solely the acceptable one. To accomplish said goal notice the winds are aligned at a highest percentage of time at orientation SW-NW (247° and 67°), therefore this will be the orientation of the runway, to force the wind to be aligned at the highest percentage of time with the centerline.

Table 1: *Wind Rose*

Heading		**Wind Intensity in km/h**					
N	0	1	1	0	0	0	2
NNE	22,5	1	1	0	0	0	2
NE	45	1	1	0	0	0	2
ENE	67,5	1	1	0	0	0	2
E	90	1	1	1	0	0	3
ESE	112,5	1	1	1,25	1,25	0	4,5
SE	135	1	1	1,5	1,5	0	5
SSE	157,5	1,5	1,25	1	1	0	4,75
S	180	1,5	1,5	1,25	1,5	0	5,75
SSW	202,5	1,5	1,75	2	2	0,25	7,5
SW	225	1,5	2	2,5	3,5	0,25	9,75
WSW	247,5	1,5	2,5	2,5	4,25	0,5	11,25
W	270	2	2,75	3,75	3,5	1,5	13,5
WNW	292,5	2	2,5	2,5	2,5	1	10,5
NW	315	1,5	2	2,5	2,5	1	9,5
NNW	337,5	1,5	1,75	2	1,5	0,25	7
		21,5	25	23,75	25	4,75	100

Table 1 shows the data plotted in the wind rose graphic shown in Figure 1. As has already been discussed and can cement the argument, the maximum permissible crosswind component is only affecting the last column, and the sum of this last column does not exceed the 5% maximum value of time admissible defined by the utilisation rate.

4 Definition of the Airside

As a first step, the configuration of the airside must be decided. The runway will be placed with the orientation stated in the previous section and will have two standard entrances at the headers and two rapid exit taxiways that will connect it to a parallel taxiway. These rapid exit taxiways are placed because this airport will have 6 operations per hour, so, in order to avoid a possible saturation of the runway, the rapid exits are placed to reduce the time of the aircraft on the runway. The parallel taxiway will have two access points to the apron. Both of the entrances will be at the extremes of the apron. These two access points will connect this taxiway to an apron taxilane parallel to the terminal building. This taxilane will be surrounded by four apron stands on the side of the terminal in a linear configuration and six remote stands on the opposite side (see Figure 5).

The decisions made to specify the number of parking stands are explained below. These stands will be named as follows:

- Remote: R1 to R6
- Linear: L1 to L4

The definition of the Airside comprises giving values to the certified distances (such as TORA, TODA, ASDA and LDA). Some correction factors will have to be applied to the reference field length (RFL) of the reference aircraft, given that the values supplied by the manufacturer are always referred to standard conditions (15° C, 0% slope, sea level altitude). These corrections factors ensure maximum safety and allow the computation of the non-standard RFL, providing the equations (functions of altitude, aerodrome reference temperature and runway slope) necessary to perform the switch.

4.1 Runway Length

The basic length selected for the runway should be increased at the rate of 7 per cent per 300 m elevation (Equation 1). The length of runway determined should be further increased at the rate of 1 per cent for every 1°C by which the aerodrome reference temperature exceeds the temperature in the standard atmosphere for the aerodrome elevation (Equation 2). If, however, the total correction for elevation and temperature exceeds 35 per cent, the required corrections should be obtained by means of a specific study. Where the basic length determined by take-off requirements is 900 m or over, that length should be further increased at the rate of 10 per cent for each 1 per cent of the runway slope (Equation 3) [4].

$$L_h = L \cdot \left(1 + \frac{0.07 \cdot h(m)}{100}\right) \tag{1}$$

$$\begin{gathered} L_T = L_h \cdot \left[0.01 \left(T_{ref} - T_{sh}\right)\right] \\ T_{sh} = T_{sh=0} - \frac{6.5 \cdot h(m)}{1000} = 15°C - \frac{6.5 \cdot h}{1000} \end{gathered} \tag{2}$$

$$L_p = L_T \cdot (1 + 0.1 \cdot p(\%)) \tag{3}$$

Having evaluated the corrected reference field length for taking-off, Equations 1, 2 and 3 are used, yielding 2202m. For landing operations, only the altitude correction (Equation 1) will be used [4], yielding 1934m. And finally, the runway length will be extended from the minimum TORA of 2202m to 2600m (see Figure 3, black colour) to ensure the safety of the aerodrome operations.

4.2 Runway Width

From Table 2 it can be extracted that the runway width should not be less than 30m when the Outer Main Gear Wheel Span is between 6 and 9 m. The reference aircraft selected has a OMGWS of 7m [2], so it is between these two values. Wrapping up all that data, the runway width selected will be 38 m, which is above the minimum stated by ICAO. This decision is taken considering the Boeing 737-700 has a span of about 34 m, therefore if a 30m runway is chosen, the aeroplane should not fit completely into the full width. To avoid the latter, the half-width increment is fixed at 4m, leading to a total width of 38 m (see Figure 3, black colour).

To further drive the decision taken, it has been taken into account that providing a wider runway will create the possibility for the operation of a bigger aircraft, enhancing probably the economic feasibility of the aerodrome.

Table 2: *Outer Main Gear Wheel Span. Source: ICAO Doc 9157, Chapter 5. Physical Characteristics, p.37*

Outer Main Gear Wheel Span (OMGWS)				
Code Number	Up to but not including 4.5m	4.5 m up to but not including 6m	6m up to but not including 9m	9m up to but not including 15m
1	18m	18m	23m	-
2	23m	23m	30m	-
3	18m	18m	23m	45m
4	-	-	45m	45m

4.3 Runway Shoulders

As the runway category assigned is a code letter C, it is not necessary to provide shoulders to the runway [5], however, shoulders of 25 m (extending 6 m beyond the runway edge) from the runway centerline will be provided in the design of the airport, as to minimise any hazard to an aeroplane running off the runway, and therefore augmenting the level of safety. These cannot be observed in Figure 3 due to the scale not permitting it, but can be visualised qualitatively in Figure 5.

4.4 Runway Strip

By following the recommendations in ICAO Doc 9157, Chapter 5.3 [6], a strip of 140m width from the centerline of the runway and 60 m beyond the threshold will be put in place. It will also include a graded strip that extends a distance 105 m from the centerline, except that the distance is gradually reduced to 75 m from the centerline at both ends pf the strip, for a length of 150 m from the runway end (see Figure 3, blue colour). Furthermore, longitudinal slopes will not exceed 1.75 % a and transverse ones will not surpass 2.5%, except that to facilitate the drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge, where it will be negative as measured in the direction away from the runway, with a value of 5%. [6].

4.5 Clearways

A clearway will be placed at the end of each runway header. The dimensions (following ICAO rules) will consist in a length of 150 m (as it should not exceed half the length of the TORA) and a width equal to 75 m from the runway centerline (see Figure 3, purple colour). The ground will not project above a plane having an upward slope of 1.25% starting from the end of the TORA [7], for the safety of aircraft performing these critical phases (TO and Landing).

4.6 Approach Guidance and Navigational Aids

The runways are both instrumental runways but, due to the high cost, only in header 25 there will be an instrumental landing system (ILS) installed. This header is chosen because when taking into account the winds, this header orientation is the one that has more frontal wind component (see Figure 1), helping to stop the plane safely. For this reason, this header will be mainly used for landings.

In addition, Precision Approach Path Indicator (PAPI) lights will be placed at the tower control side of the runway headers (at the opposite side of the terminal building side).

The ILS installed will be a CAT I. A weather study along some years at the airport location has been made showing that a very high percentage of the time the weather conditions were excellent, so, there is no reason to install a system with better performances. The days where the conditions are bad are hugely uncommon.

On the other header, a non-precision system will be used. There will be a VOR-NDB beacon at the end of the strip at the header 07 that will help the pilots to guide their aircraft horizontally.

4.7 Colours of the Horizontal Markings

The colours of the horizontal markings will be as the recommended by ICAO. Even so, in the list shown below the colours of the different markings will be stated:

- Runway (all markings): White
- Taxiway centerline: Yellow black edged line
- Taxiway edge line: Yellow
- Parking stand limits: Red
- Service roads: White (squared)

4.8 Lighting System

Regarding the lighting systems the recommendations of ICAO [8] will be followed. Nonetheless, the different lights will be explained below.

Talking about runway lights, the edge lights will be white and omnidirectional while the centerline lights will be unidirectional and as follows: white from the threshold until 900 m before the end of the runway, from 900 m to 300 m to the end they will be alternating white and red, and the last 300 m they will be red. Moreover, at the very end of the runway a crossbar of red unidirectional lights will be placed while at the very beginning a crossbar of green unidirectional lights will be set. This distribution will be used in both runway orientations.

Speaking now about the rapid exit taxiways, the Rapid Exit Taxiway Lights (RETIL) will be put into use. In the rest of the taxiways, the centerline and edge lines will be omnidirectional lights, green and blue coloured, respectively.

In relation to approach lights, at the header 25 where the ILS CAT I is installed, there will be the corresponding lighting system. As ICAO defines: "A precision approach category I lighting system shall consist of a row of lights on the extended centerline of the runway extending, wherever possible, over a distance of 900 m from the runway threshold with a row of lights forming a crossbar 30 m in length at a distance of 300 m from the runway threshold, the lights forming the centerline shall be placed at longitudinal intervals of 30 m with the innermost light located 30 m from the threshold" [9]. The choice for this airport will be Barrettes, the latter is visualised in Figure 2.

Moreover, at the header 07 the same lighting system as the previously defined for the header 25 will be put into use too. This decision is cemented by ICAO due to the recommendation they do about approach lighting for non-precision approaches (CITAR AQUÍ). The recommendation says that even so the approach is a non-precision one, an installation of a CAT I lighting system shall be considered.

4.9 Obstacle Limiting Surfaces

Once again, the regulations stated in ICAO Annex 14 (Obstacle Limitation Surfaces Section) [11] will be followed, considering the latter will not leave room for degrees of freedom or creativity, it will not be explicitly detailed. If the reader has interest in the values, observe the table cited.

Figure 2: *CAT 1 Precision Approach Lighting System [10]*

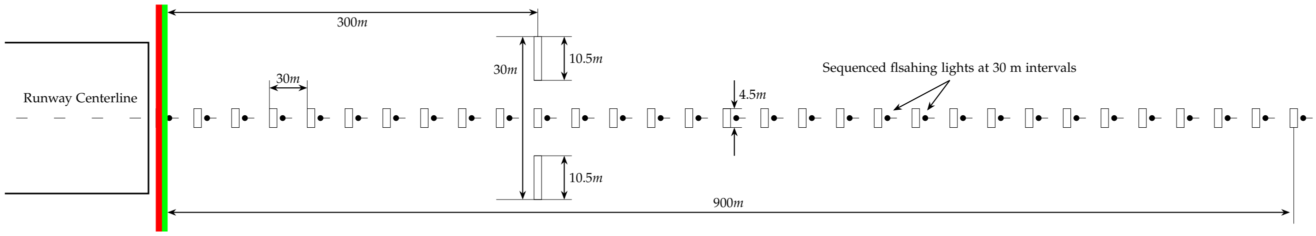
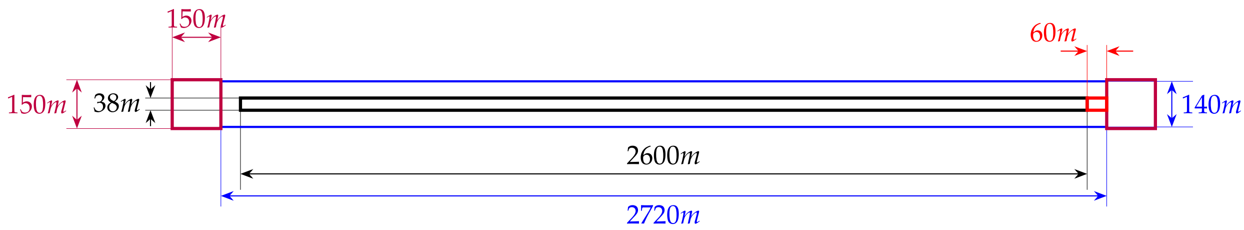


Figure 3: *Runway Diagram to Scale (without shoulders due to the size difference). Clearway, Runway, Stopway, Strip.*



4.10 Stopways

Concerning stopways, a paved one will be added at the runway with header 07, considering that the majority of time the wind is coming from this direction (as can be observed in Figure 1), being a tailwind for the aircraft in question and possibly reducing breaking capacity in an emergency situation. To add a safety margin to operations and therefore enhance the quality of the aerodrome, the stopway will be positioned as stated and will have a length of 60 m while adapting it's width to the runways (see Figure 3, red colour). Slopes will be the same as the ones found in the runway, to ensure no transition from runway to stopway will affect the breaking of the aircraft and the surface will be constructed as to provide a good coefficient of friction, compatible with that of the associated runway when the runway is wet [12].

Table 3: *Runway Declared Distances.*

Declared Distances Lengths		
Declared Distance	Runway Header 25 (m)	Runway Header 07 (m)
TORA	2600	2600
ASDA	2600	2660
TODA	2750	2750
LDA	2600	2600

The table shown above (Table 3) shows all the declared distances of the runway, wrapping up all the information discussed in the previous sections: Runway Length, Stopways, Clearways, etc.

In Figure 3 the dimensions of the runway (width and length), the strip, the TORA, the stopway and clearways are shown. The shoulders are not plotted due to the scale.

The entrances to the runway will be placed at their respective headers. They will be of conventional type (both taxiway and runway centerline will form an angle of 90°). There will be two rapid exit taxiways located symmetrically: one in every runway direction, whose turning radius will be 550 m and the angle will be more than 25° and less than 45° [13]. 30° will be taken as recommended by EASA.

4.11 Width of the Taxiway

Provided that the wheel track of the reference aircraft is 7 m, a width of 18 m for the taxiway is required [14] to satisfy ICAO regulations. To perform the computation, the following values are obtained from ICAO Annex 14 for a code C [15]:

- Strip width (SW): 140 m
- Maximum Lateral Deviation (X): 3 m
- Increment (Z): 5 m
- Service Road width: 10 m
- Parking Stand Distance: 44.5 m
- C (half wheeltrack) = 4.5 m
- Wingspan = 34.3 m

The latter data, coupled with the following information will allow the computation of Runway-Taxiway distance (using Equation 4), the Taxiway-Taxiway distance (using Equation 5) and the Taxiway-Object distance (using equation 6).

$$S_{r-t} = \frac{1}{2}(SW + WS) \tag{4}$$

$$S_{t-t} = WS + C + Z \tag{5}$$

$$S_{t-o} = \frac{1}{2}WS + X + Z \tag{6}$$

The results obtained are the following:

- Distance between runway and taxiway centerline: 175 m
- Distance between apron taxiway centerline and taxiway centerline: 44 m
- Distance between taxiway centerline and object: 26 m
- Distance between apron taxiway centerline and object: 26 m
- Distance between aircraft stand taxilane centerline and object: 24.5 m

The latter values coincide with ones given by ICAO [15].

4.12 Parking Stand Dimensions

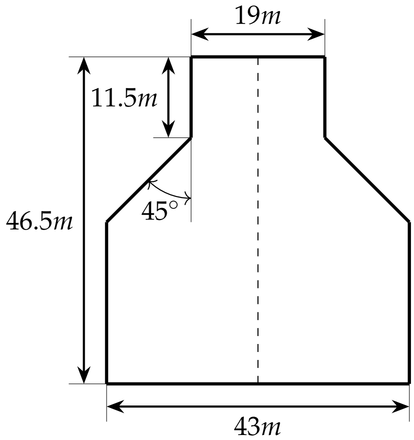
Using Equation 7, the parking width can be computed (with the values used in subsection Taxiway Width) for the case of the reference aircraft it will yield 47.5. This value is very similar and fitting for a type VI parking stand (see Figure 4), therefore it will be the one used taking into account the reference aircraft.

$$W_p = 2 \cdot \left(\frac{1}{2}WS + d + Z\right) \tag{7}$$

The distance between parking stands must also be defined, the number in question is denominated clearance, and it's value for the airport category in question (3C) is recommended by ICAO at 4.5 [16].

The latter can be observed in Figure 5 (except the number of parking stands, hangars and other buildings, which is defined in the next section; See Dimensioning the Landside section).

Figure 4: *Parking Stand Type VI. Source: Cuadernos de Ingeniería de Vicente Cudós [17]*



5 Dimensioning of the Landside

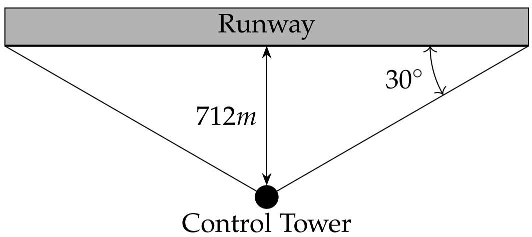
There will be a single terminal whose altitude will be 40 m (below the inner horizontal surface) and width will be 200 m. When taking into account a real world airport such Ibiza Airport whose category is 3C, one can realise that the width is much bigger than the 200 m selected to the terminal of this project airport. This is because the need of space is not highly important in this aerodrome (see Definition of The Landside Areas and Processes section) due to the relatively small amount of space needed for each process.

Hence, the terminal will be placed parallel to the apron and it will have a single level, discarding the second one when taking into account the relatively low amount of passengers that will have to pass through it. Therefore, given a 200 m width of the terminal, the maximum number of parking stands will be calculated using the parking stand width (see Figure 4) and the safety distance between these stands. This yields to 4. So, parallel to the terminal there will be 4 parking stands in a linear configuration. Obviously this amount of stands is not enough to fit the 6 operations per hour that this airport is designed to. To place more parking stands, there will be 6 more remote at the opposite side of the taxilane. To place them, a width of 300 m will be needed.

5.1 Control tower

The control tower will be placed at the intersection of two lines coming from the runway thresholds forming a 30° angle with the runway centerline. This means a distance from the tower to the runway of about 712 m straight to the centerline, allowing a clear vision of the runway, taxiways and apron. The tower will have a height of 40 m, below the inner horizontal surface height and it will be connected to the exterior of the aerodrome by a service road. The latter can be visualised in Figure 6.

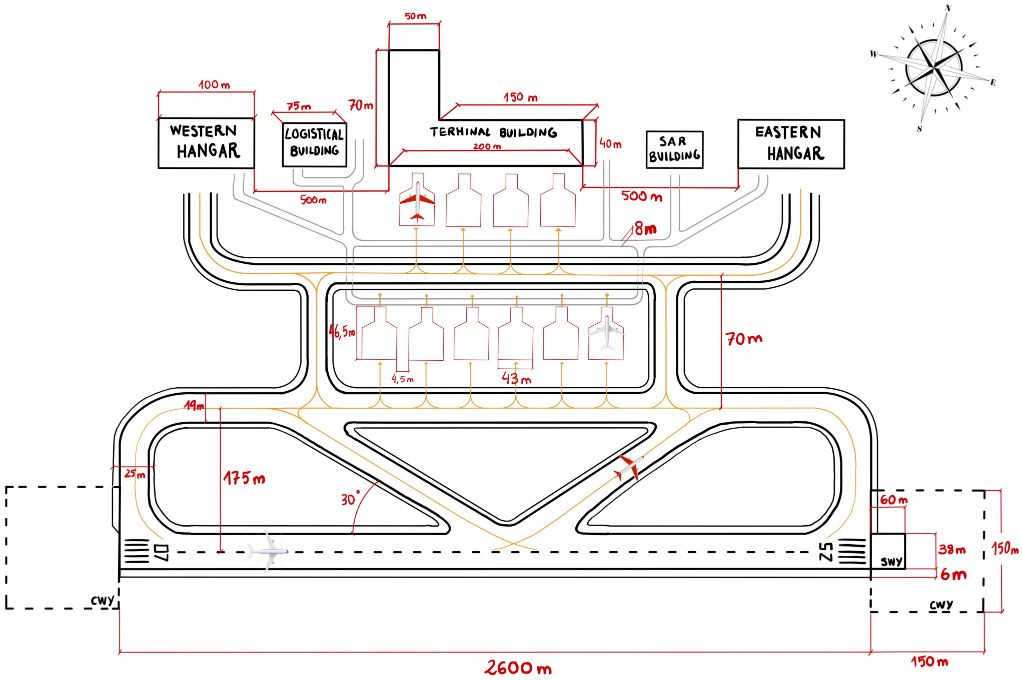
Figure 6: *Control Tower Position*



5.2 Hangars and other service buildings

There will be two hangars symmetrically placed at both sides of the terminal building, at a distance of 500 m from the terminal itself. They will have a

Figure 5: *Airside Diagram (Not to scale)*



width of 100 m and a height of 40 m. A taxilane will be extended from the taxilane apron previously stated to permit the traffic of aircraft in and out the hangars.

Between the eastern hangar and the terminal there will be a building that will be used to contain the Search and Rescue equipment and personnel. This location is chosen because it is pretty centred and close to all the locations of the airport.

Therefore, between the western hangar and the terminal there will be a logistical building were the aerodrome vehicles and equipment necessary will be stored. This building will have a width of 75 m and a height of 30 m.

6 Definition of the Landside Areas And Processes

In order to define the terminal building distribution some calculations must be made to know the minimum areas that will have to be accomplished. So, in the following subsections the area needed to the Check-In area and Security Checkpoints will be calculated and with that information the detailed distribution of the terminal building will be set.

6.1 Capacity

For the capacity, an estimation and some assumptions will be required as to proceed. To start off, the airport will have a maximum of 6 operations per hour, therefore the maximum amount of passengers per hour (using the maximum passengers on board the reference aircraft) will be 894, and the latter figure is named Peak Hour Passengers (PHP).

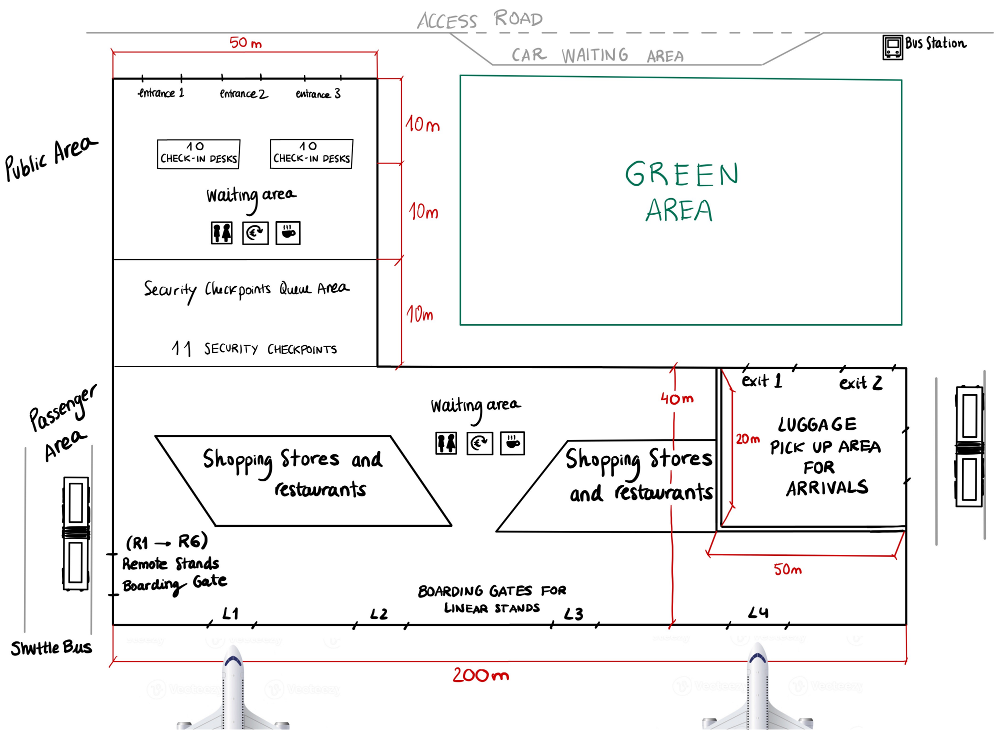
This however (PHP), is not the value used for the design of an airport, considering there is a margin that is left to avoid over-designing. The constraint applied to the Peak Hour Passengers will be taking only 80% of the full amount, therefore the Design Peak Hour Passengers (DPHP) is set at 716.

The expected number of movements that can be performed in 1 hour on a runway system without violating ATM rules (assuming continuous aircraft demand) is the Maximum Throughput Capacity (or Saturation Capacity). Provided the airport being designed is not particularly busy and is not in the vicinity of any major airport that could increase the traffic of the area, the Maximum Throughput Capacity will be the same as the value of 6 operations per hour.

Practical capacity will also be the same, considering the design is adequate and the airside has the necessary elements (well equipped runway with rapid exit taxiways) to ensure no bottlenecks are produced in this zone. This means aircraft arrive approximately once every 10 minutes, above the 4 minutes needed to compute the practical capacity (and an extra margin anything was to occur). Therefore the declared capacity (As stated before) is 6 flight per hour.

To obtain a numerical approximate value of the

Figure 7: *Landside Diagram*



capacity in Pax, using information from tables in Documento de Regulación Aeroportuaria (DORA) [18] it is observed that a similar case is given for airports like Logroño, Burgos, Albacete and Huesca-Pirineos; for which the airport capacity in Pax is 300000 in all cases. It is assumed therefore that this will be a valid number for the airport being designed.

6.2 Check-in Capacity

To compute the check-in capacity, it has been assumed that all passengers use standard methods, no auto check-in is considered.

The analytical method to approximate values concerning capacity are given by the following equations given by IATA in the Airport Development Reference Manual (ADRM), and are the following:

$$CD_y = \frac{DPHP_{dep} \cdot PK \cdot PT}{60} \frac{1}{(30 + MQT)} \tag{8}$$

$$CD = C_f \cdot CD_y \tag{9}$$

$$Q_{MAX} = Q_f \cdot DPHP_{dep} \cdot PK \tag{10}$$

$$A = Q_{MAX} \cdot SP + CD \cdot A' \tag{11}$$

Where (strictly for standard, not auto check-in):

- CD_y: Approximate number of counters.
- $DPHP_{dep}$: Peak Hour Pax on Departures.
- PK: Peak Factor in a 30min period [% $DPHP$].
- PT: Average time to process a passenger [sec].
- MQT: Maximum waiting time [min].
- C_f: Correction factor due to demand variability.
- Q_{MAX}: Maximum number of passengers in the waiting queues.
- A : Total surface.
- A': Design constant taking into account aisle and counter dimensions, and check-in area spacing.

Using the information provided in ADRM [19], the optimum MQT for economy class is 10-20min. For the purpose of this project it will be taken as 15min. $DPHP_{dep}$ will be taken equal to the $DPHP$ calculated beforehand, 716. PK, PT, SP and A' will be set at the value given in the sample calculation (with acceptable values) in the ADRM [20] (50 %, 150s, 1.4 m^2 per person and 12m^2 respectively).

Once these values have been inputted into Equation 8, the result of the approximate number of check-in desks is: $CD_y = 20$.

To continue and obtain the total number, the correction factor must be applied as described in Equation 9. The value of C_f is given also in the ADRM [21], with a value of 1.01, therefore, after the calculation $CD = 20$.

Once the latter has been computed, one can calculate Q_{MAX} using Equation 10, with a different coefficient Q_f given also in the ADRM [21], with a value of 0.364, therefore $Q_{MAX} \approx 130$ passengers.

And finally, the last step is to compute the check-in surface area, via Equation 11, which yields $A = 422m^2$, that as can be observed is used for the diagram of Figure 7.

6.3 Security Control Area (time)

To compute the parameters that define the security control area, the exact same process will be followed as has been done in the latter section. To not clutter this project, the equations will be stated and the values taken will be given, these are the following:

$$SEC_i = \frac{DPHP_{dep} \cdot PK \cdot PT}{60} \frac{1}{(30 + MQT)} \tag{12}$$

$$SEC = C_f \cdot SEC_i \tag{13}$$

$$Q_{MAX} = Q_f \cdot DPHP_{dep} \cdot PK \tag{14}$$

$$A = Q_{MAX} \cdot SP + SEC \cdot A' \tag{15}$$

And the values given in the ADRM are as follows [22]:

- $DPHP_{dep}$: 716 passengers.
- PK: 65 %.
- PT: 60 [sec].
- MQT: 7 [min].
- C_f: 0.364 for Q_{MAX}, 1.01 for SEC.
- A': $20m^2$.
- SP: $1.4m^2$ per passengers.

And the values calculated are:

- $SEC_i = 11$.
- $SEC = 11$.
- $Q_{MAX} = 169$ passengers.
- $A = 437m^2$.

The latter information is used to reach the diagram in Figure 7.

6.4 Distribution of the terminal building

The distributions of the terminal building is as shown in Figure 7. The terminal will have three main entrances beside the access road where the passengers will enter the check-in zone with 20 desks available (as calculated above). This zone has an area of $500m^2$. This area is slightly above the minimum required by the calculations done in the previous sections (which is $422m^2$). This is because it is a public area and everyone can come in, so, to avoid overcrowding the check in some more squared meters are provided. In this zone, the passengers will receive their boarding pass and, if desired, they will check-in their luggage. After the check-in zone there is a waiting area provided with restrooms, money exchange machines and one or more coffee shops.

Just after the previous waiting area the security checkpoint area is found. Here, there will be 11 security checkpoints. The area provided to this zone is $500m^2$. This is, again, slightly above the minimum calculated in the previous sections (which is $437m^2$). The reason to give some extra area is to avoid possible overcrowded situations.

When passing the security area, the commercial zone and the boarding gates are found. Within this area, a passenger could find some shopping stores and restaurants. These non-aeronautical business will help to increase the benefits of the airport itself and ensure its economic reliability. Besides, along this passenger area there will be some plants, trees. An ornamental fountain will be placed in the middle of the two commercial areas.

In the southern part of the passenger area, there will be the access points to the boarding gates. On the western side there will be the boarding door for the shuttle bus that will bring the passengers (after passing a checkpoint) to their plane parked in a remote stand. The shuttle bus will travel along the service roads to the stands. On the fully southern part there will be the boarding gates for the linear stands where the passengers (after passing a checkpoint) will access the plane by foot. As stated above, the remote stands are named from R1 to R6 while the linear stands are named from L1 to L4. Along all this area there will be plenty of seats to wait until the boarding call.

To manage the arrivals, the passengers will go by foot (for those coming from the linear stands) or by shuttle bus (for those coming from the remote ones) to the luggage pick up area supervised by the airport personnel. There, they will be able to pick-up their suitcases and will go out through the two exits.

6.5 Handling

The handling of the departing luggage will be underground by a set of conveyor belts that will bring the suitcases from the check-in area to the personnel responsible of loading it in the plane. The same process will take place for the arrivals: the conveyor belts will bring (underground) the luggage from the plane to the luggage pick-up area. For the remote stands, a luggage truck will be used to the transport of the suitcases from the stands to the terminal.

6.6 City side

The airport main accesses will be by an access road parallel to the terminal where there will be also a bus station that will have direct connection to a metro and train station located near the aerodrome. That service road will also connect the airport to a parking lot for those passengers coming with their personal vehicle. Just ahead of the terminal building there is also a car waiting area for taxi drivers or people who come to pick-up their relatives.

Furthermore, there is a green area just beside the terminal building (as shown in Figure 7). This zone will be filled up with trees and vegetation that will be checked periodically to ensure that they do not surpass any obstacle limiting surface of the airport.

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