Description of modifications proposed

In order to adapt Rule 2, all the functions have been tested into a variety of building layout types (Fig. R2.3), such as:

a. Buildings with a central corridor

b. Buildings with a double corridor

c. Buildings with gallery-style layouts (circulation areas along the façade)

d. Buildings with a central atrium (featuring central, double, or peripheral circulation areas).

e. Buildings crossing

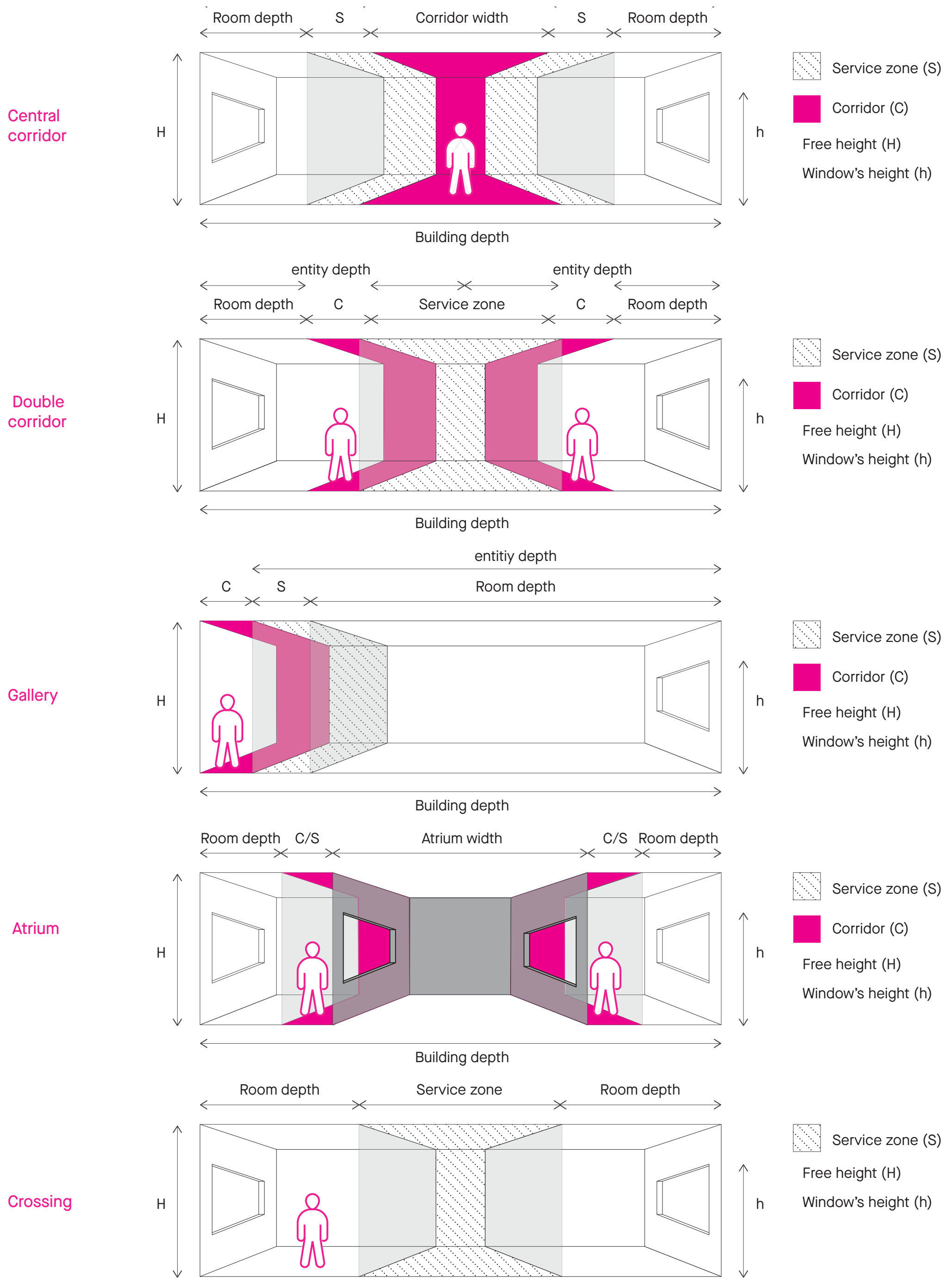


Fig. R2.3 Building layout types

Numerous aspects influence the feasibility of integrating these functions into a building with respect to natural light requirements such as the building's depth, storey height, room proportions, window dimensions, interior design, compliance with minimum area requirements, and more.

These multiple factors must align with standard requirements concurrently, and their interplay can affect one another. Given the intricacies of this multi-criteria evaluation, a dynamic Excel tool has been developed in order to facilitate the introduction and consideration of various design hypothesis, including room area, height, depth of services and circulation width, etc.

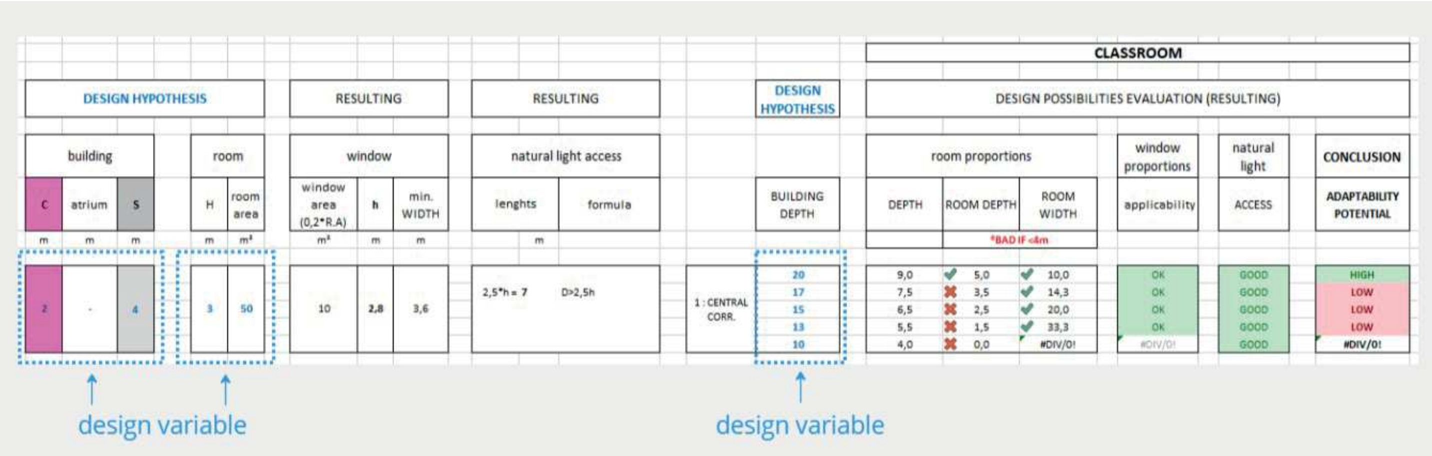
DESIGN VARIABLES

More precisely, with the aid of this tool, the following values can be introduced as a starting point of a design hypothesis (or design variables):

- Circulation depth
- Services depth
- Room free height
- Room area
- Building's depth

Those values are set in blue in the table.

Example:



DESIGN HYPOTHESIS					RESULTING			RESULTING			DESIGN HYPOTHESIS	CLASSROOM – DESIGN POSSIBILITIES EVALUATION (RESULTING)					
building			room		window			natural light access				room proportions			window proportions	natural light	CONCLUSION
C	atrium	S	H	room area	window area (0,2*R.A)	h	min. WIDTH	lenghts	formula		BUILDING DEPTH	DEPTH	ROOM DEPTH	ROOM WIDTH	applicability	ACCESS	ADAPTABILITY POTENTIAL
m	m	m	m	m²	m²	m	m	m					*BAD IF <4m				
2	-	4	3	50	10	2,8	3,6	2,5*h = 7	D>2,5h	1 : CENTRAL CORR.	20	9,0	✔ 5,0	✔ 10,0	OK	GOOD	HIGH
											17	7,5	✖ 3,5	✔ 14,3	OK	GOOD	LOW
											15	6,5	✖ 2,5	✔ 20,0	OK	GOOD	LOW
											13	5,5	✖ 1,5	✔ 33,3	OK	GOOD	LOW
											10	4,0	✖ 0,0	#DIV/0!	#DIV/0!	GOOD	#DIV/0!

DESIGN CONSTRAINTS:

Once those values established, a series of resultant values are generated in accordance with standard design principles. These resultant values are subsequently treated as design constraints.

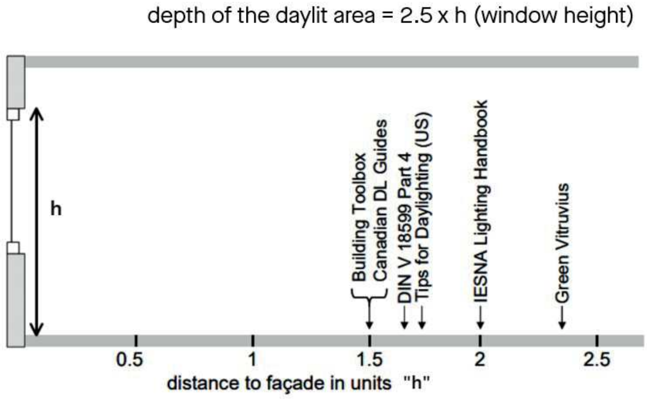
For instance, considerations include:

Window design proportions:

- The window (or glazing area) must be a minimum of 20% of the room area
- The window head height is typically situated 0.2 m below the ceiling height, following common practice (h = H – 0,2)
- Consequently, the minimum window width is automatically calculated as the window area divided by the ceiling height (window area / h).

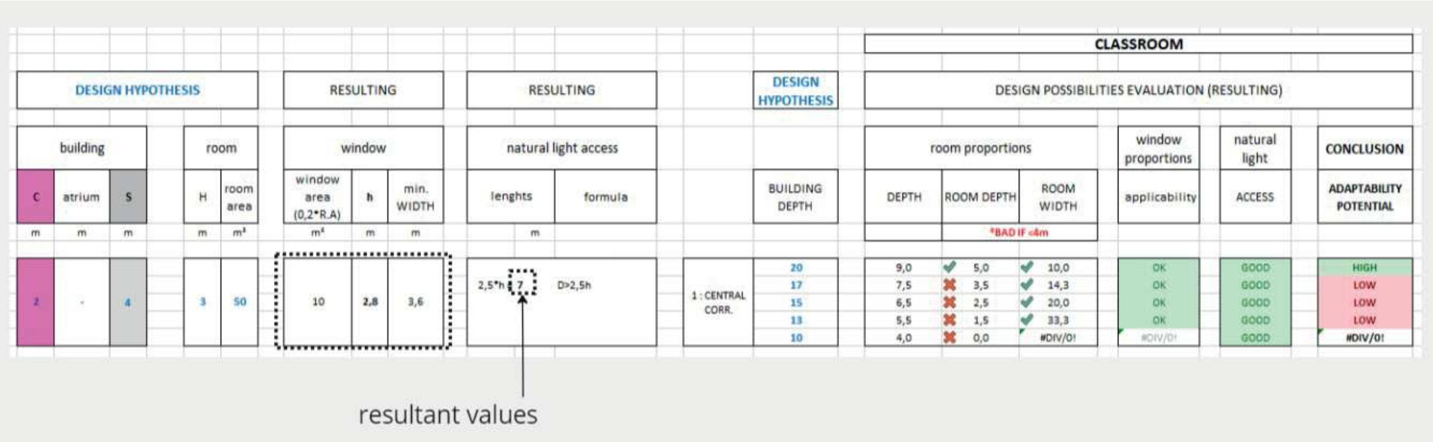
Natural light access (or depth of the daylit area):

Several rule-of-thumb formulas are available, and for this analysis, the less restrictive formula according to the literature is employed.



Those resultant values figure in black in the table:

Example:



DESIGN HYPOTHESIS					RESULTING			RESULTING			DESIGN HYPOTHESIS	CLASSROOM – DESIGN POSSIBILITIES EVALUATION (RESULTING)					
building			room		window			natural light access				room proportions			window proportions	natural light	CONCLUSION
C	atrium	S	H	room area	window area (0,2*R.A)	h	min. WIDTH	lenghts	formula		BUILDING DEPTH	DEPTH	ROOM DEPTH	ROOM WIDTH	applicability	ACCESS	ADAPTABILITY POTENTIAL
m	m	m	m	m²	m²	m	m	m					*BAD IF <4m				
2	-	4	3	50	10	2,8	3,6	2,5*h 7	D>2,5h	1 : CENTRAL CORR.	20	9,0	✔ 5,0	✔ 10,0	OK	GOOD	HIGH
											17	7,5	✖ 3,5	✔ 14,3	OK	GOOD	LOW
											15	6,5	✖ 2,5	✔ 20,0	OK	GOOD	LOW
											13	5,5	✖ 1,5	✔ 33,3	OK	GOOD	LOW
											10	4,0	✖ 0,0	#DIV/0!	#DIV/0!	GOOD	#DIV/0!

Subsequently, additional results pertaining to room proportions are derived, with a focus on the building's typology.

More precisely for all typologies the tool considers:

- room(*) depth = entity depth(**) - services (S) (***)
- room(*) width = room area / room depth

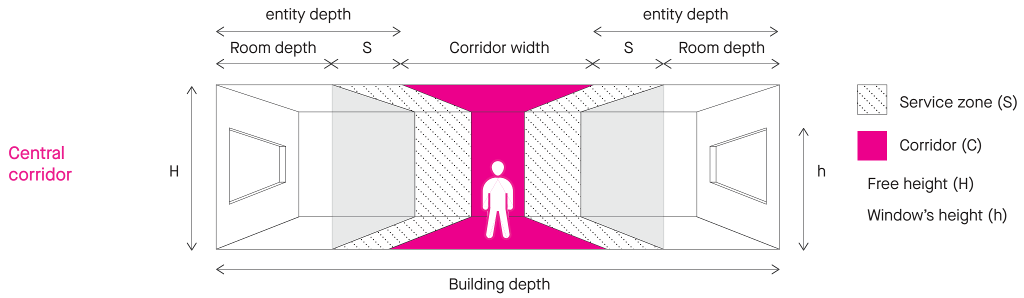
(*) whereas room = area with natural light requirements

(**) entity depth = area including services and excluding circulations

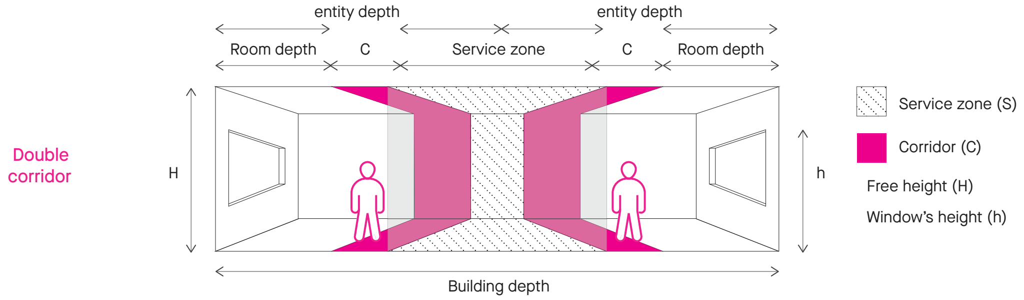
(***) with the exception of typology 2 and 5

And for each one of typologies that:

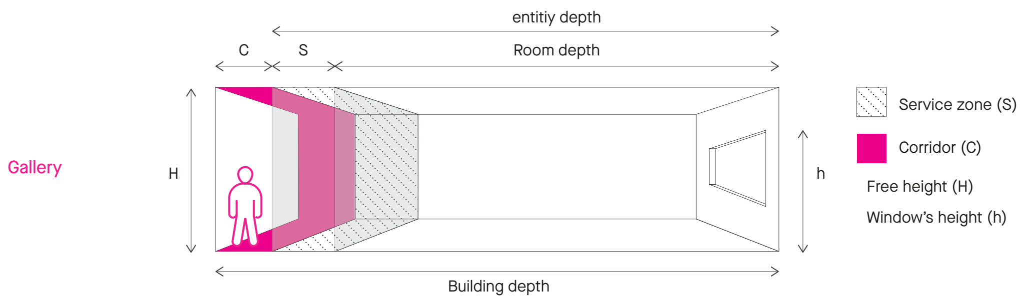
- Central corridor typology : entity depth = (building depth – circulations (C)) / 2



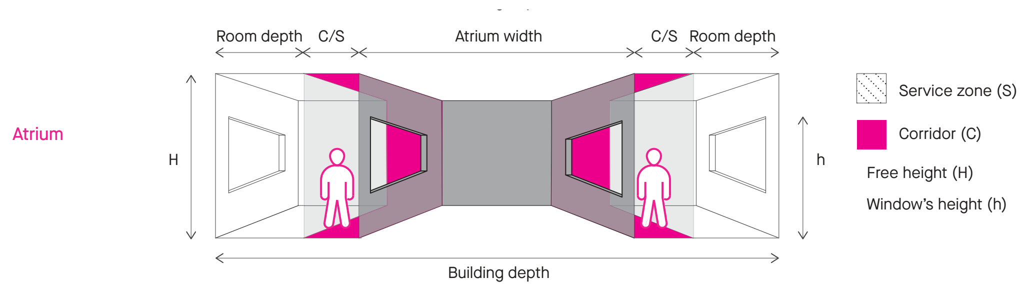
- Double corridor typology : entity depth = (building depth/2)– circulations (C) whilst room depth = Entity depth - (S/2)



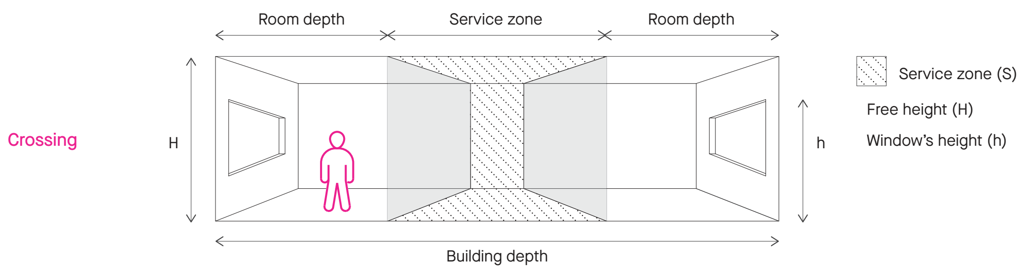
- Gallery typology : entity depth = building depth– circulations (C)



- Central atrium typology : room depth = (building depth-atrium)/2– circulations (C)



- Crossing typology : room depth = (building depth - S)/2



DESIGN CRITERIA:

Finally, considering those results, criteria are applied to assess the adaptability potential.

These criteria involve:

1. Room proportions.
2. The feasibility of window dimension requirements.
3. Access to natural light.

It is considered that all the criteria mentioned above must be met for the adaptability potential to be considered feasible in each case scenario.

The criteria are applied as follows:

1. Room proportions.

Concerning the room proportions a minimum value it is set for each distance of the room, in order to consider a function feasible. For instance, it is considered that classrooms cannot be narrower than 4 meters, whist only 2 meters are applied to offices.

In the following table those values are detailed:

	Minimum Room depth (M)	Minimum Room width (M)
Residential (lounge or bedroom)	3,5	3,5
Office spaces	2	2
Educational facilities(classrooms)	4	4
Healthcare settings (hospital rooms, consultation rooms)	3	3
Workshops	4	4
HORECA retail (Hotels, Restaurants, and Cafés)	3	3

If the requirement it is met, the box is checked green (see example for classroom below):

room proportions		
DEPTH	ROOM DEPTH	ROOM WIDTH
	*BAD IF <4m	
9,0	✓ 5,0	✓ 10,0
7,5	✗ 3,5	✓ 14,3
6,5	✗ 2,5	✓ 20,0
5,5	✗ 1,5	✓ 33,3
4,0	✗ 0,0	#DIV/0!

If both width and depth dimensions are satisfied, the tool deems the design hypothesis feasible concerning room proportions (in the floor plan only).

2. The feasibility of window dimension requirements.

At this stage, it is checked whether the previously calculated minimum window width can fit within the room's overall width. In the majority of cases, the window aligns with the room's proportions when they are deemed feasible.

If the window fits, the box is marked as "good" and displayed in green. In cases where it doesn't fit, it is labelled as "bad" and shown in red.

Example (see table below):

In cases where the room width falls below the minimum window width (4.2 M), the window proportions are designated as "NOK" and displayed in red. Conversely, when the room width allows the window to fit, the results are considered positive.

window			natural light access				room proportions			window proportions
window area (0,2*R.A)	h	min. WIDTH	lenghts	formula		BUILDING DEPTH	DEPTH	ROOM DEPTH	ROOM WIDTH	applicability
m²	m	m	m					*BAD IF <4m		
16	3,8	4,2	2,5*h = 9,5	D>2,5h	2 : DOUBLE CORR.	20	8,0	✓ 18,0	✓ 6,0	OK
						17	6,5	✓ 15,0	✓ 4,5	OK
						15	5,5	✓ 13,0	✗ 3,5	NOK
						13	4,5	✓ 11,0	✗ 2,5	NOK
						10	3,0	✓ 8,0	✗ 1,0	NOK

3. Access to natural light.

The 3rd assessment criteria concern the depth of the daylit area.

As mentioned above, the depth of the daylit area is evaluated with the aid of the following formula:

depth of the daylit area = 2.5 x h (window height)

The tool checks whether the room's depth is equal to or less than the calculated depth of the daylit area. If the room's depth is within this limit, it is deemed adequately illuminated with natural light. If the room's depth exceeds this threshold, it is categorized as too deep and consequently not adequately naturally lit.

Example (see table below):

room		window			natural light access				room proportions			window proportions	natural light
H	room area	window area (0,2*R.A)	h	min. WIDTH	lenghts	formula		BUILDING DEPTH	DEPTH	ROOM DEPTH	ROOM WIDTH	applicability	ACCESS
m	m²	m²	m	m	m					*BAD IF <4m			
3	50	10	2,8	3,6	2,5*h = 7	D>2,5h	5 : CROSSING	20	20,0	✔ 8,0	✔ 6,3	OK	BAD
								17	17,0	✔ 6,5	✔ 7,7	OK	GOOD
								15	15,0	✔ 5,5	✔ 9,1	OK	GOOD
								13	13,0	✔ 4,5	✔ 11,1	OK	GOOD
								10	10,0	✖ 3,0	✔ 16,7	OK	GOOD

depth of the daylit area

> room depth

bad result

FINAL EVALUATION:

Lastly, the tool performs a calculation to ensure that all the aforementioned criteria are simultaneously satisfied. It only deems the design scenario feasible if all three criteria are met concurrently.

In simpler terms, the absence of compliance with any one of the criteria results in elimination, signifying that the design is not feasible. The fulfilment of the three criteria and their feasibility is indicated in the last column of the table.

room proportions			window proportions	natural light	CONCLUSION
DEPTH	ROOM DEPTH	ROOM WIDTH	applicability	ACCESS	Design feasibility
	*BAD IF <4m				
20,0	✔ 8,0	✔ 6,3	OK	BAD	LOW
17,0	✔ 6,5	✔ 7,7	OK	GOOD	HIGH
15,0	✔ 5,5	✔ 9,1	OK	GOOD	HIGH
13,0	✔ 4,5	✔ 11,1	OK	GOOD	HIGH
10,0	✖ 3,0	✔ 16,7	OK	GOOD	LOW

Conclusions

The dynamic excel provides useful data to analyse different functions and building layouts, as well as to check daylight and proportions in early stage design. However, the tool is a simplification of the many possible designs and should be tested on multiple case studies in order to have reliable function-by-function results.