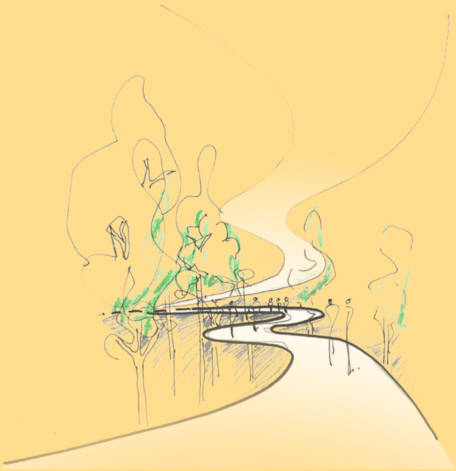

TAIKOO PLACE WALKWAYS

Hong Kong

HDA

HUGH DUTTON ASSOCIÉS

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TAIKOO PLACE WALKWAYS

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TAIKOO PLACE WALKWAYS GEOMETRIES

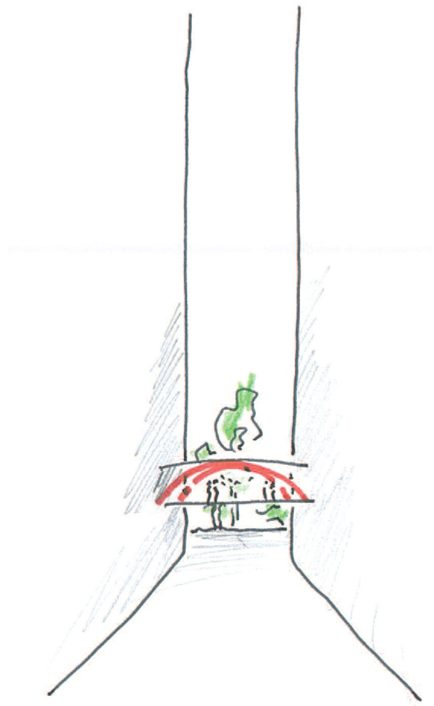
I. Concept and method

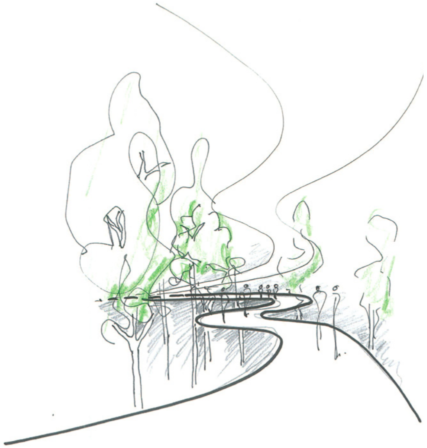
Swire Properties' redevelopment of Taikoo Place is about bringing a new life to the Quarry Bay community, interconnecting the business environment with public activities and social context. Hugh Dutton Associés designed the sculptural walkways that link the buildings around Taikoo Place.

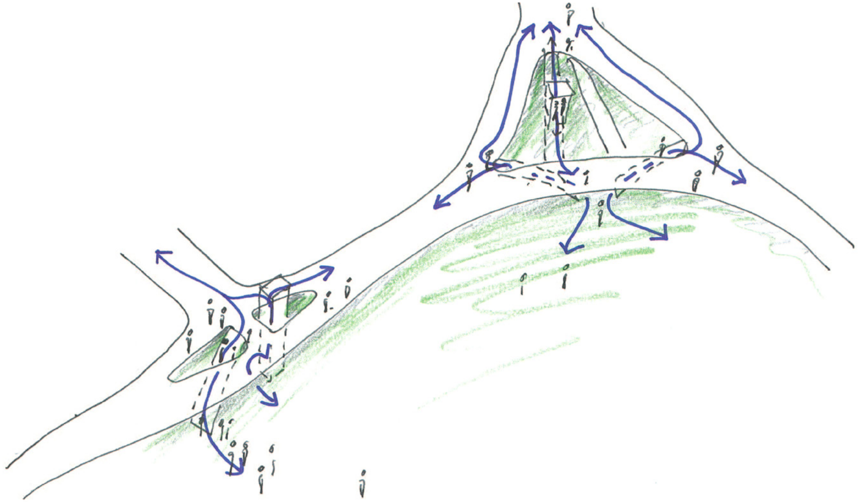
Iconic steel arches of the walkways dance between the towers expressing the linking of existing and new constructions. The walking decks are hung from the arches, floating above the garden. A mullion-free glass wall gives a generous transparency to the garden, supported on a handrail wide enough to lean on - Like being on a ship, floating in the garden.

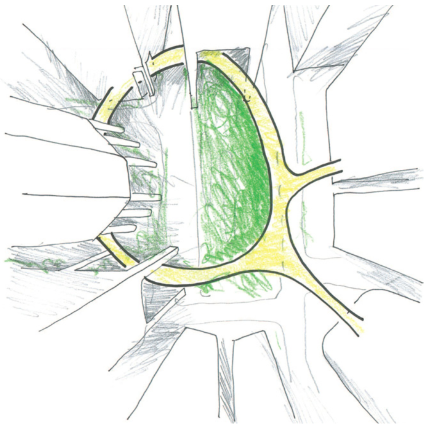
A luminous and transparent ribbon roof provides continuous natural wayfinding and a feeling of openness with glimpses of the sky and surrounding towers. Beneath the walkway, light is present too, as a shimmering anodized finish soffit reflects the plants and life in the garden, animating the pathways under the suspended decks.

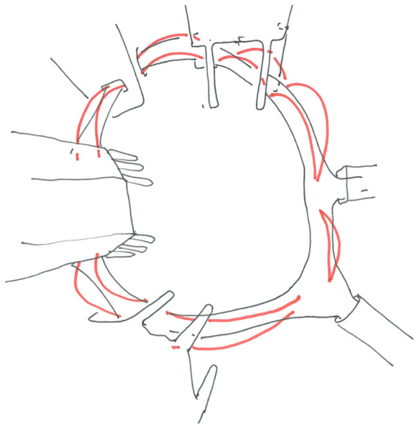
The curves are complemented with complex patterning using state of the art industrial processes to bring unique custom motifs and identity in cladding materials and finishes.











Above and opposite:
Concept sketches from Hugh Dutton

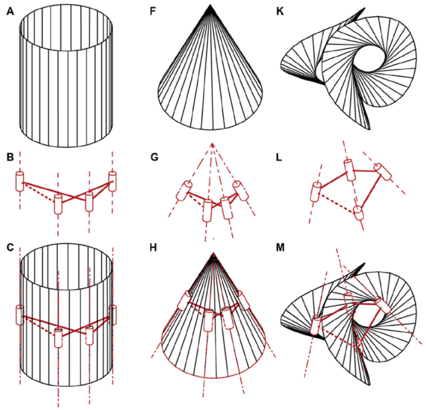
MAKING CURVES

I. Concept and method

The fluid and curved walkways are a sculptural counterpoint to the rectilinear towers that they connect. Building the curves requires creative design of complex geometries, involving use of inventive and innovative computer programming design tools.

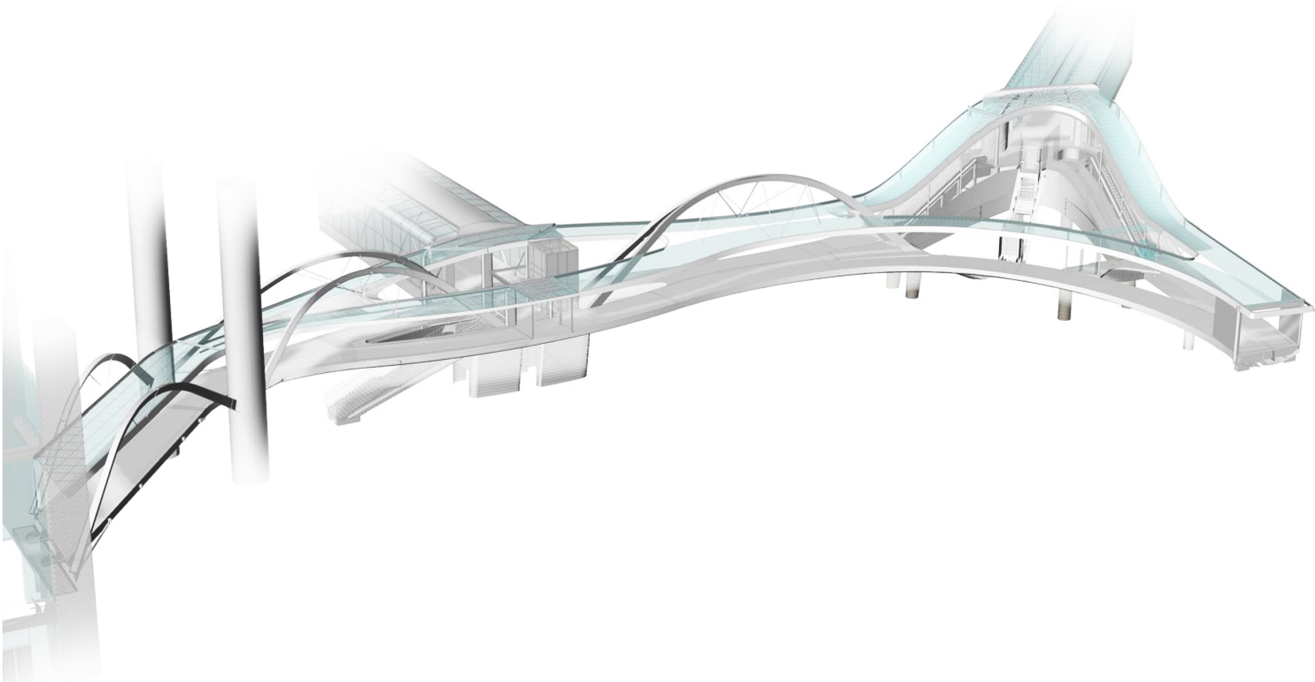
Deceptively simple in their appearance, the walkways are if fact very complex in their geometrical composition. It is necessary to find precise geometrical descriptions of the fluid curved lines to construct them in conventional materials which are generally planar and straight edged with elegance and detail quality.

The walkways are a composition of curved arches and meandering suspended decks in welded steel plate with curved stone floors, aluminium ceilings and glass facades. Each part requires a different construction technique to achieve the desired form that is compatible with constraints of the material in which it is made. Making complex curves involves defining 'developable' surfaces*, such as cylinders or cones for the steel plate, glass and aluminium cladding to be curved to.



Right: Developable surfaces.

**In mathematics, a developable surface is a smooth surface with zero Gaussian curvature. It is a surface that can be flattened onto a plane without distortion (i.e. "stretching" or "compressing").*



View of Segments 1, 2 and 3 from 1 Taikoo PLace to 2 Taikoo Place.

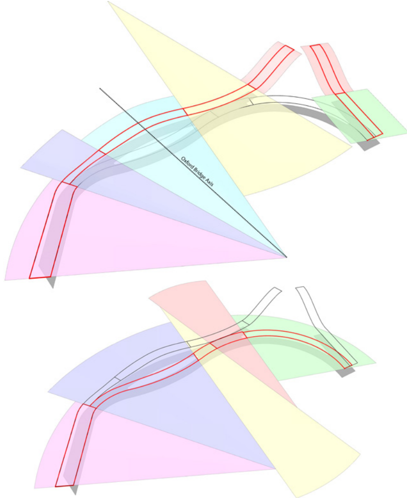
GENERAL LAYOUTS

I. Concept and method

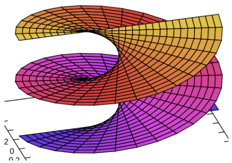
The bridges setting out in is defined in plan as a series of circular arcs that interface with each other at tangent points to achieve smooth transition between the curved segments.

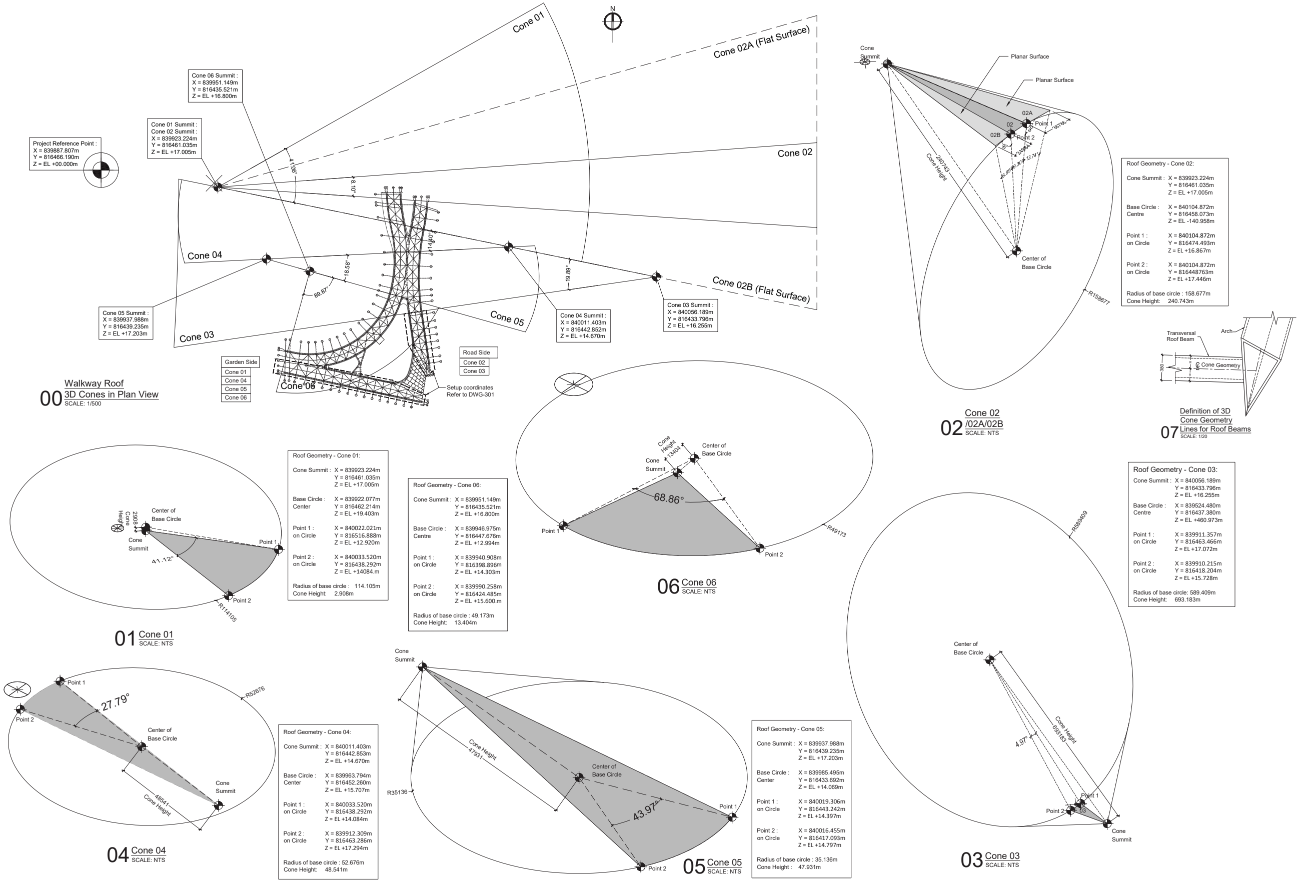
As the walkway pathways move through space, they are defined as helicoidal planes sloped to connect with the different buildings at different levels according to the site topography. They must comply with a statutory maximum slope of 1/25 for disabled people and must be levelled transversally for user comfort. The walking surface is helicoidal, like a spiral stair, where each tread is transversally level, but twisted in space with respect to each other. To achieve this spiral ramp geometry, the steel framing is set out with horizontal transversal members arranged just like the treads of a spiral stair, then composite corrugated steel decking is laid on top to follow the spiral surface and it can be slightly twisted to achieve the helicoidal surface. The concrete poured on top forms is then troweled to homogeneous thickness - to the spiral surface.

The glazed roof planes of the bridge are laid out as conical surfaces that generally correspond to the same circular arc fragment plan configuration. The cones are subdivided into a series of facets to allow the roof glazing to be realized as planar panels between radial joint lines.



Above: Roof conical surfaces.
Below: Principle of helicoidal surface of the pathway.





Right: Descritpion of concial surfaces for tender submission.

DESIGN TOOLS

I. Concept and method

3D SPATIAL DESIGN MODELLING

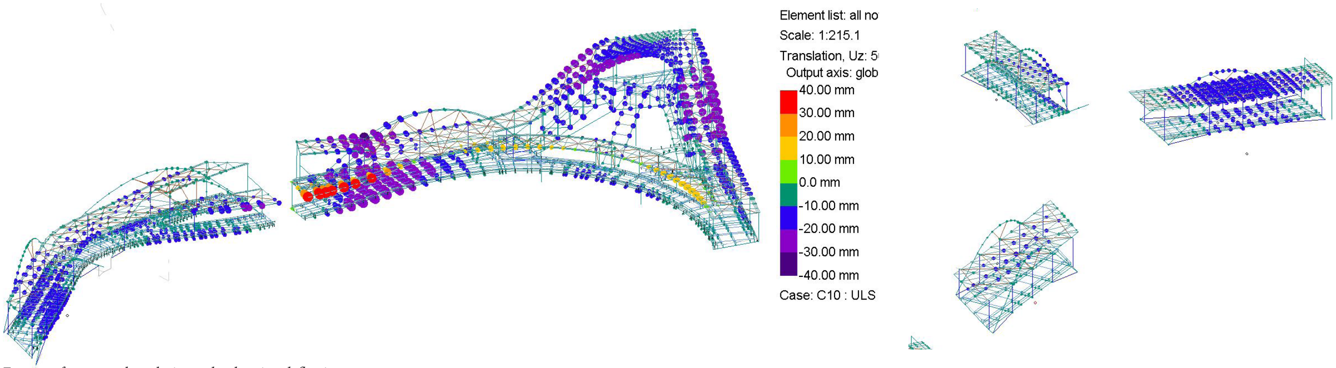
The bridges are entirely designed in 3D, using Rhino design modelling software, that is supplemented with many custom parametric 'plug ins' which permit to draw the components of the bridge by algorithmic code programming. We set out the rules for the geometry definition, and varied the parameters that modulate the shapes with the plug-in input. The plug-ins can simulate climatic effects such as daylight, solar radiation, rainfall as well as structural performance. So, the parametric design can be to a degree adaptable, but also optimal regarding sustainability, buildability and economy.

STRUCTURAL FINITE ELEMENT ANALYSIS

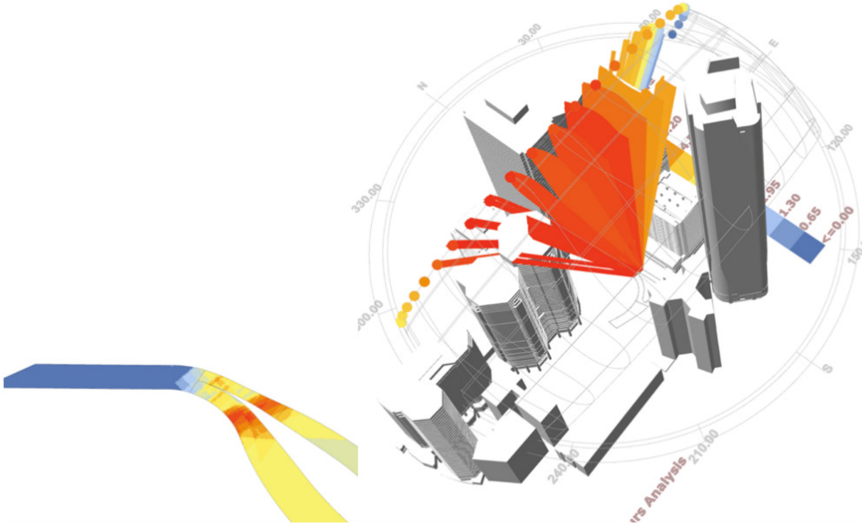
Once the geometry is defined in Rhino, it is transferred to structural software in a 'wire-frame' form, where each structural member is defined as a segment in space. These models are then analysed using GSA (General Structural Analysis by Oasys/Arup) for structural behavior,

BIM (Building Information Modelling)

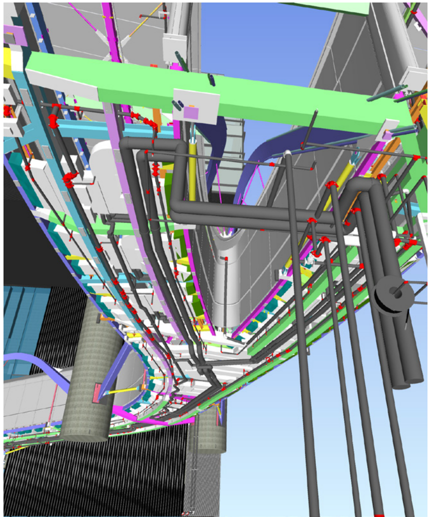
With the structural members defined, a full BIM model is built up. The model is an digital version of the whole bridge. Every member is created in a 3D environment in the computer, simulating the juxtaposition of all components, combining the structural profiles with air conditioning, sprinklers, electrical equipment and finally external cladding and internal finishes to verify if they are all coordinated spatially.



Extract of structural analysis results showing deflections.



Solar radiation at Taikoo place and plotting of exposure onto walkway roof surface impacting fritting and ceiling patterns.

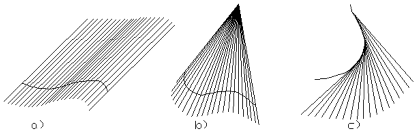


BIM model.

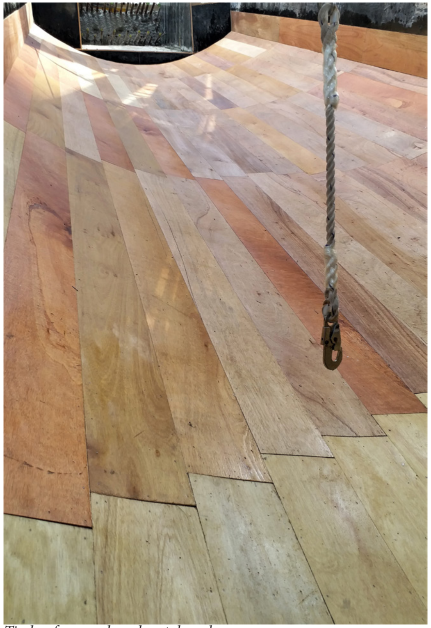
CONCRETE PIERS

II. ARCHITECTURAL COMPONENTS

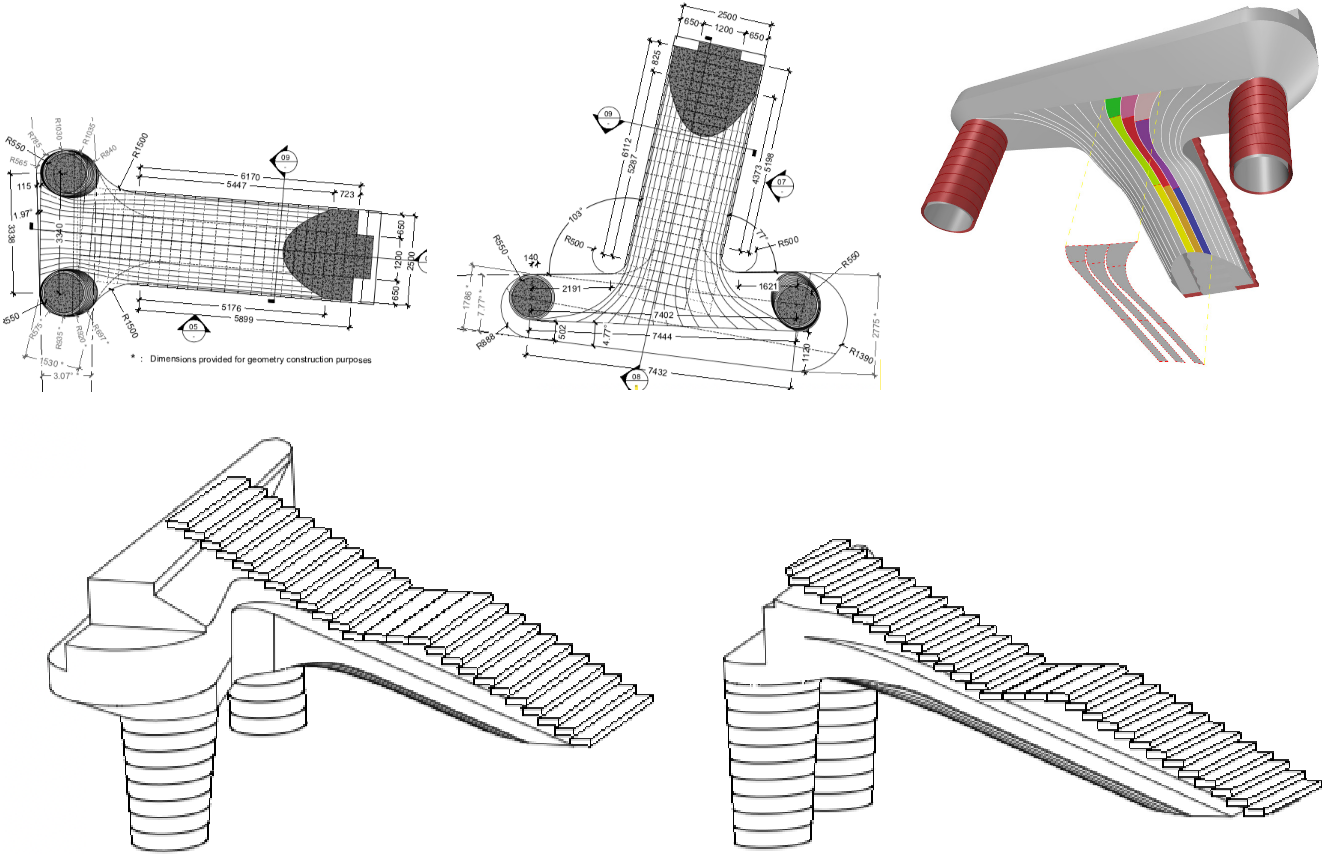
The concrete structural piles that support the bridges in the landscape are cast with formwork in curve-able plywood shuttering assembled and cut to form ruled surfaces.



Ruled surfaces.



Timber formwork and metal mesh.



Concrete piers and staicases.

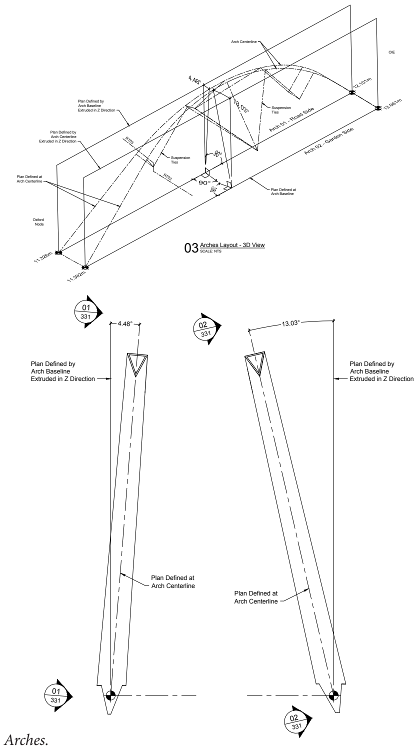
ARCHES

II. ARCHITECTURAL COMPONENTS

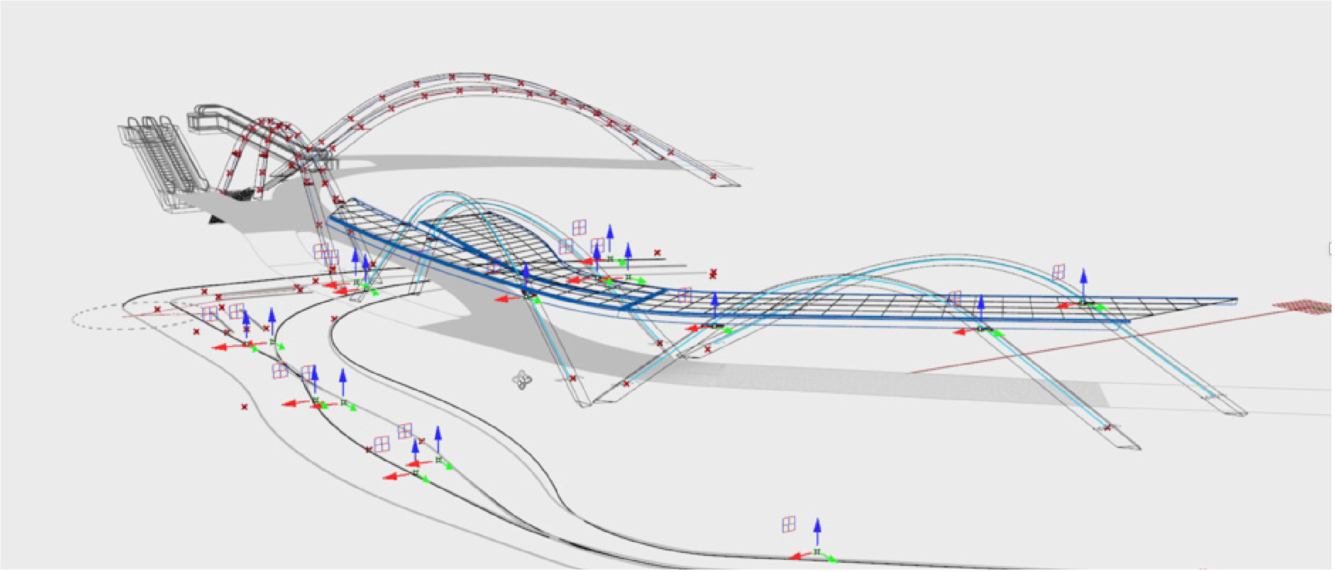
DESIGN

The Arches are the primary structural members, carrying the bridge decks back to the columns and support points. The arch shape is inspired by reversed funicular, close to parabolic profiles, which are curved above the roof levels and then straighten down to the supports, following the passage of forces in them. Each arch lies in an inclined plane to ensure that the force path is resolved without any distortion of the arch itself. Aligning the roof framing patterns with the arch support points and also with the deck framing patterns and support locations requires a tricky modulation of a multitude of interactive parameters.

The deck hanger points also need to align with the arch supports and the deck framing. These framing alignments simultaneously affect the repetitive roof glazing grid and the facade joint modulation, which in turn have to coincide with the anchor points at the bridge ends. Only a full interactive parametric model managing all the points and grids in space could ensure a synchronized resolution. The diagram shows the model used for the simultaneous geometries definition.



Arches.



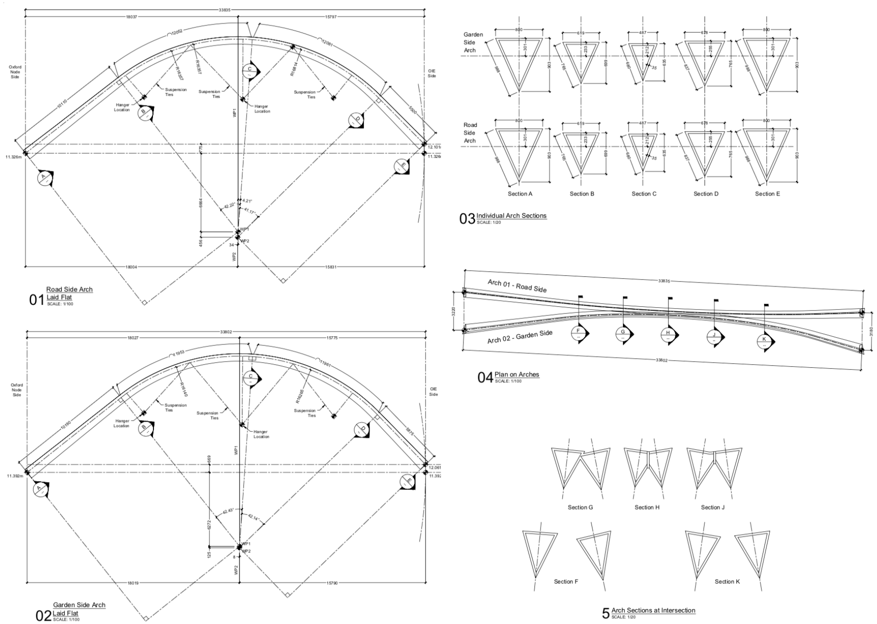
Framing definition.

ARCHES

II. ARCHITECTURAL COMPONENTS

• FABRICATION

The triangular section is fabricable from precut flat plate and cold formed to the desired geometries,(). These shapes are generated from the 3D shapes in the Rhino design model, and then 'unrolled' and laid flat. The diagrams show the unrolled surfaces 'Laid Flat'. The construction involves cutting the steel to these rolled out shape and laid onto jigs for welding.



Arch sections drawing.

Process of fabrication

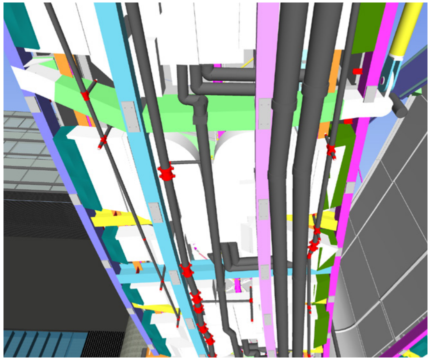
DECK AND SOFFIT CLADDING

SERVICES INTEGRATION

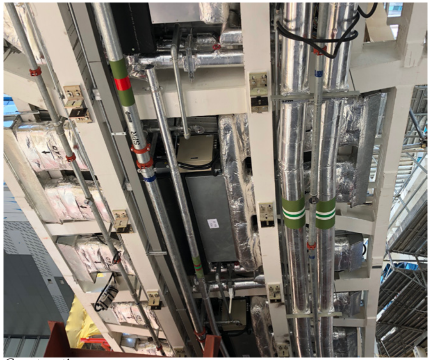
Achieving sensation of the walkways floating elegantly in space as they meander between columns and through the garden requires the deck to be as thin as possible. This means an optimal nestling of air conditioning equipment between the structural members. We used the analogy of the inside of a smartphone to explain the concept to the services engineers and contractors who conventionally have more generous volumes to work within.

The typical architectural section shows the services in detail but only in two dimensions. However, they must be designed and coordinated in 3 dimensions to fully optimize the space available and this is done with the BIM computer modelling. Fan Coil A/C units are fixed between the structural beams and the air distribution plenums are compacted into a minimal volume on the edges.

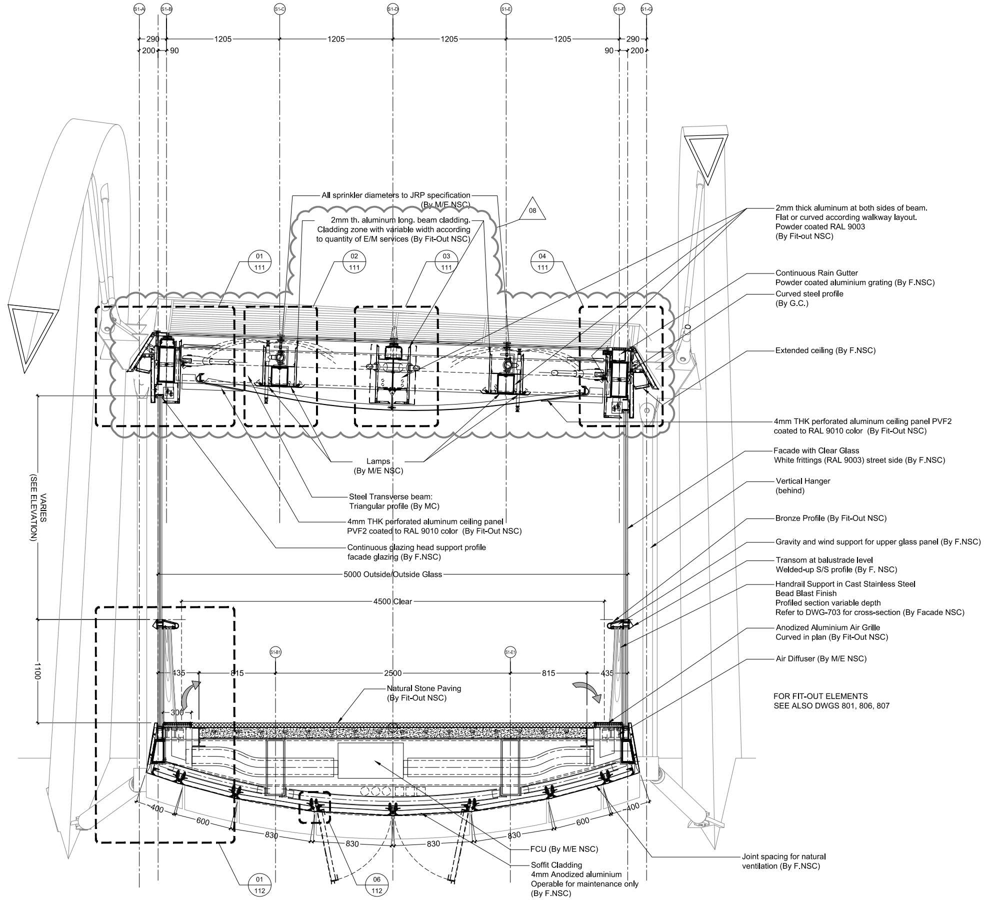
Each of these fan coil units as well as the free-cooling fans, the electrical supply, chilled water delivery pipes and the condensate drains that are necessary for the A/C functioning are created in the 3D space of the BIM model, to verify that all of the parts fit snugly.



BIM model.



Construction.



Typical architectural section

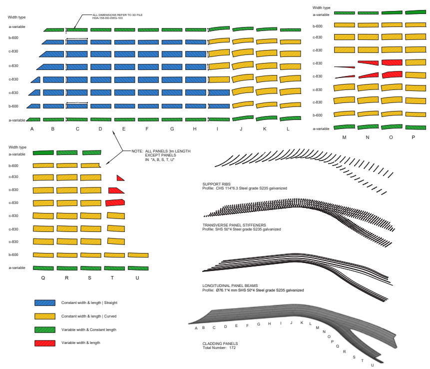
SOFFIT SURFACES

The surface of the deck is then clad with reflective cladding to conceal the air conditioning equipment and structure. All panels are operable for access and servicing of the air-conditioning equipment. Opening a curved panel means only two strategically placed hinges can be used and the volume in which the panel rotates needs to be clear of obstacles.

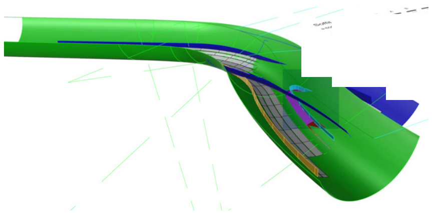
The cladding is lightweight aluminium sheets that are cut to developed shapes to follow the meandering curvature of the deck. The sectional curve for the cladding panels is a segmented curve, built up from several straight sections. The plan curve of the bridge means the panels need to be fragments of conical, or toroidal surfaces to achieve the desired fluid appearance.

The transversal segmented curve of the cladding allow to achieve the developed shape that can be cut from flat aluminium sheets. Small studs are factory welded to the inner face of the sheets to fix them to the hinged framing.

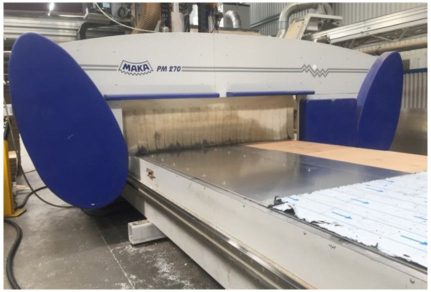
The diagram shows the toroidal surfaces in green that are then laid in segments onto a flat surface.



Drawing showing unrolled soffit panels.



Toroidal surfaces.



Left: Factory fabrication of soffit panels using cnc controlled machine tools.
Bottom left: Panels are thick enough to avoid visual distortion but thin enough to be curved by hand.
Top: Site work.

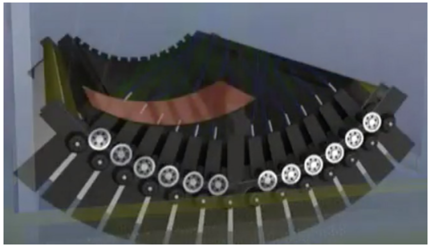
CURVED GLASS FACADES

All façade glass is factory curved to specific radii according to cylindrical shapes. It is heat bended in special curved conveyor arrays in tempering ovens. For safety reasons every panel of glass is a laminate of two sheets.. In case of breakage the glass will remain in place to prevent falling.

Current glass fabrication technology allows simultaneous curving and heat tempering to strengthen the glass and provide it with additional resistance to fire.

The curving machinery is CNC controlled as opposed to traditional curving methods which involved one-off moulds. The CNC machinery allows multiple radii of curvature without requiring new moulds for each curve. Nonetheless, it is still preferable to optimize curvature into 'families, for simple reasons such as replacement and repetitiveness of components.

Each plan curved segment of the walkway will require a different curvature to the facade panel as shown in the diagram opposite.



Above: Curving machinery.

Site Work.

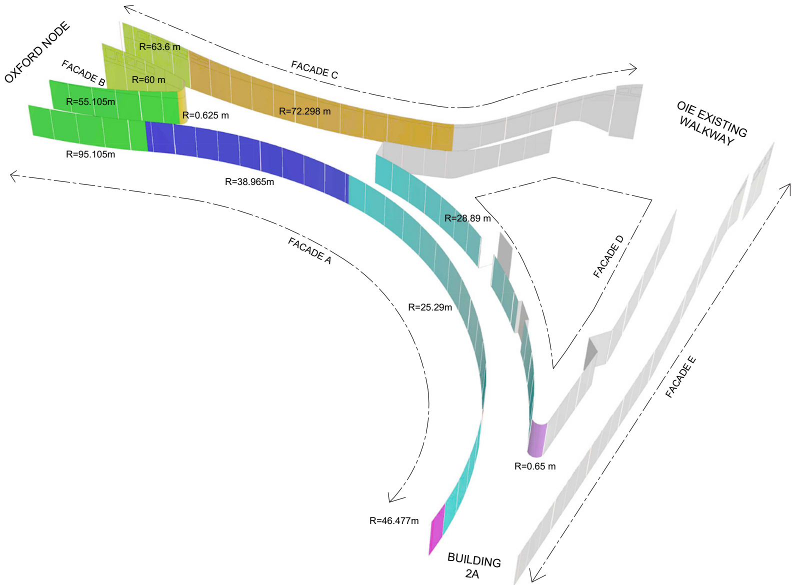


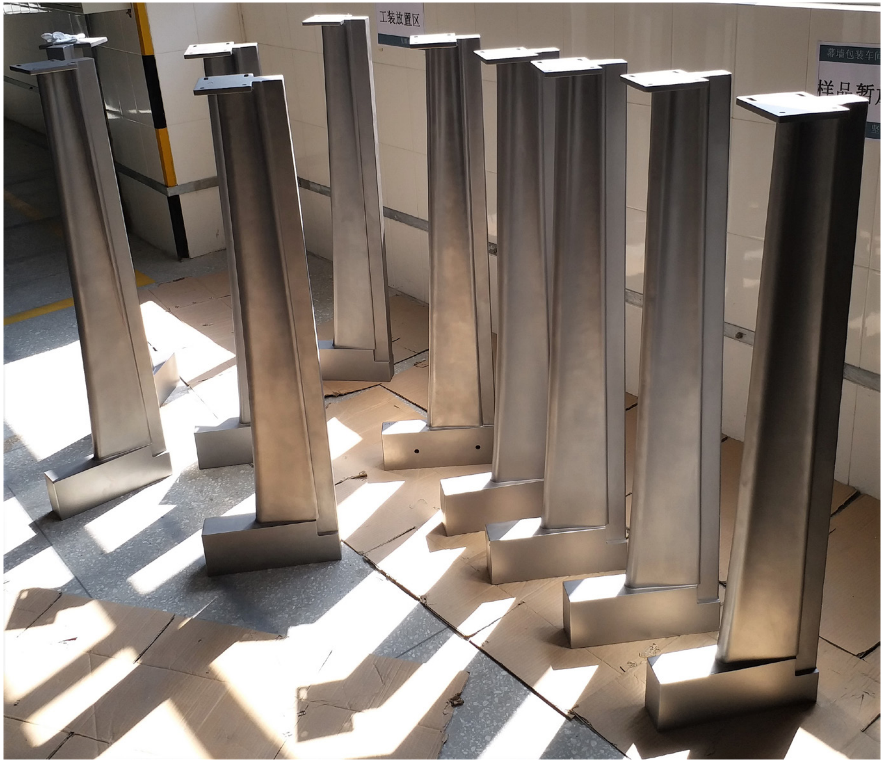
Diagram of facade curvature.

HANDRAILS

II. ARCHITECTURAL COMPONENTS

The handrails not only provide a sense of security for the public on the bridge which are at height above the garden, but also support the façade glass. They are simple curves that follow the deck helicoidal form. In extruded bronze, they are grooved to provide visual texture and emphasize the curve.

The curved extruded rails are supported on cast stainless steel posts. The form of the posts follows a taper from large at the base to slenderer at the top, with a smooth rounded texture. They are one-off pieces only found on the Taikoo Walkways and give a sense of crafted individuality. This variable geometry can only be made by casting and the finish quality requires a lost wax process. First, a mould is made in aluminium, from which wax replicas of the posts are made. The wax piece is then cased in a ceramic carapace into which the liquid stainless steel is poured. The final finish requires a bead blast finishing to remove the traces of the casting process, and notably the feeder connections seen in the casting photograph.

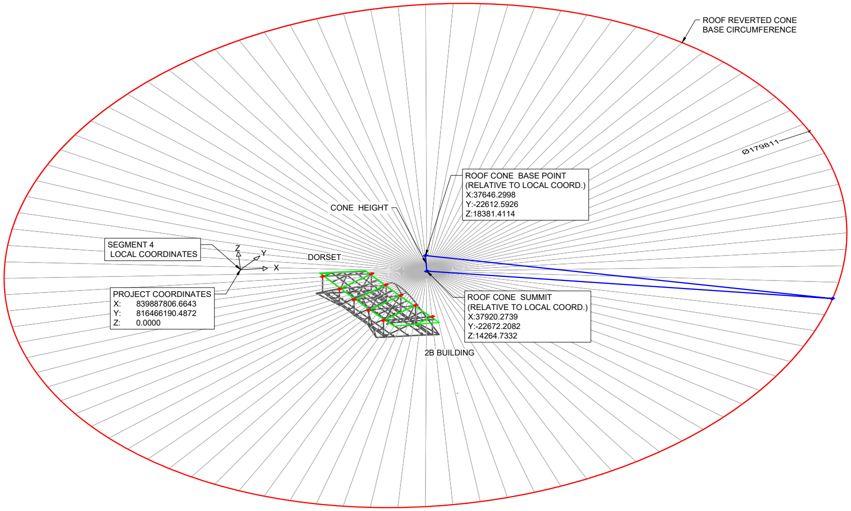


Above: Installation of handrail on site.
down: Fabrication of the cast stainless steel posts.

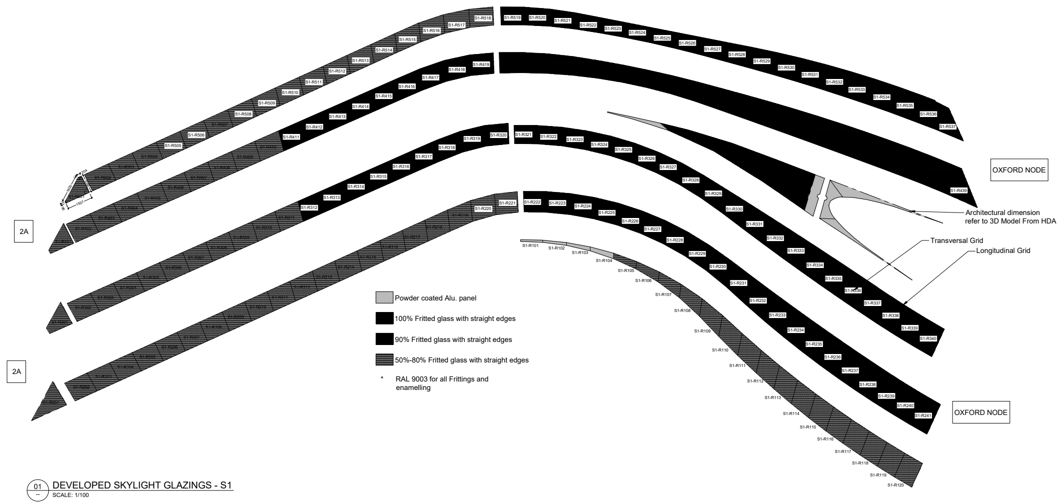
ROOF GLASS

II. ARCHITECTURAL COMPONENTS

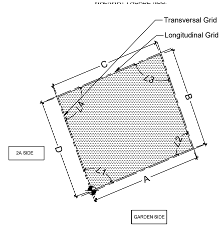
The roof glass panels are all flat but laid out according to facetted cones, such that the flat panels align along the axial cone generation lines but follow an overall curved conical surface. Walkways Segments 4 (from 2 Taikoo Place to Dorset) and 6 (from Lincoln to 1 Taikoo Place) are straight but do have conical roof surfaces that align with the facades of the parent buildings they connect to at each end, creating a gentle warping effect.



Opposite: Drawings of planar panels.
Right: Roof geometry definition.



01 DEVELOPED SKYLIGHT GLAZINGS - S1
SCALE: 1/100



04 GLASS DIMENSION NOMANCLATURE
SCALE: NS

	A (mm)	B (mm)	C (mm)	D (mm)	∠1 (°)	∠2 (°)	∠3 (°)	∠4 (°)
S1-R101	1285,29	129,79	1286,26	103,84	94,3	86,9	92,0	86,8
S1-R102	1404,22	166,78	1403,44	129,79	98,0	83,4	95,1	83,5
S1-R103	1416,97	230,67	1409,99	166,78	102,4	79,0	98,5	80,2
S1-R104	1435,74	320,92	1419,73	230,67	106,7	74,6	101,8	76,8
S1-R105	1461,9	440,59	1432,96	320,92	111,2	70,2	105,2	73,4
S1-R106	1497,79	596	1450,16	440,59	115,8	65,6	108,7	70,0
S1-R107	1544,86	792,74	1471,97	596	120,5	60,8	112,2	66,5
S1-R108	1610,77	1046,84	1499,3	792,74	125,6	55,8	115,8	62,9
S1-R109	1629,48	1256,27	1535,92	1046,84	127,7	53,7	119,5	59,2
S1-R110	1563,75	1318,92	1554,78	1256,27	125,2	56,1	121,3	57,3
S1-R111	1496,3	1362,88	1501,52	1318,92	122,1	59,2	118,7	59,9
S1-R112	1385,35	1399,15	1396,64	1362,88	119,2	62,1	116,0	62,7
S1-R113	1341,09	1430,17	1357,64	1399,15	116,4	64,9	113,3	65,4
S1-R114	1303,93	1459,31	1323,87	1430,17	113,8	67,6	110,7	68,0
S1-R115	1269,22	1479,3	1294,72	1459,31	110,8	70,6	108,1	70,6
S1-R116	1239,79	1490,96	1269,52	1479,3	107,8	73,5	105,5	73,1
S1-R117	1216,57	1500,89	1247,92	1490,96	105,1	76,2	103,0	75,7
S1-R118	1197,3	1510,36	1229,75	1500,89	102,5	78,8	100,4	78,2
S1-R119	1181,99	1519,05	1215,47	1510,36	99,9	81,4	97,9	80,8
S1-R120	1170,5	1525,3	1205,0	1519,1	97,2	84,1	95,4	83,3

	A (mm)	B (mm)	C (mm)	D (mm)	∠1 (°)	∠2 (°)	∠3 (°)	∠4 (°)
S1-R201	2557,6	1591,4	0,0	2618,2	37,3	83,8	0,0	63,9
S1-R202	1415,3	1209,8	1445,6	1212,7	96,2	85,2	94,8	83,8
S1-R203	1417,0	1207,7	1447,4	1209,8	94,8	86,7	93,3	85,2
S1-R204	1416,1	1206,3	1446,5	1207,7	93,3	88,1	91,9	86,7
S1-R205	1416,1	1205,7	1446,5	1206,3	91,9	89,6	90,5	88,1
S1-R206	1416,1	1205,8	1446,5	1205,7	90,5	91,0	89,0	89,6
S1-R207	1416,1	1206,8	1446,5	1205,8	89,0	92,4	87,6	91,0
S1-R208	1416,1	1208,4	1446,5	1206,8	87,6	93,9	86,1	92,4
S1-R209	1416,1	1210,8	1446,5	1208,4	86,1	95,3	84,7	93,9
S1-R210	1416,3	1214,0	1446,6	1210,8	84,7	96,7	83,3	95,3
S1-R211	1416,0	1218,0	1446,4	1214,0	83,3	98,1	81,9	96,7
S1-R212	1416,1	1222,6	1446,5	1218,0	81,9	99,6	80,5	98,1
S1-R213	1416,1	1228,0	1446,5	1222,6	80,5	101,0	79,1	99,6
S1-R214	1414,5	1234,1	1444,8	1228,0	79,1	102,3	77,7	101,0
S1-R215	1417,8	1241,0	1448,2	1234,1	77,7	103,7	76,3	102,3
S1-R216	1415,1	1248,5	1445,5	1241,0	76,3	105,1	75,0	103,7
S1-R217	1417,2	1256,7	1447,5	1248,5	75,0	106,4	73,6	105,1
S1-R218	1417,7	1260,7	1446,6	1256,7	73,6	107,7	72,5	106,2
S1-R219	1436,0	1232,6	1455,3	1260,7	73,0	108,4	73,0	105,7
S1-R220	1427,6	1211,5	1451,8	1232,6	79,3	102,0	79,0	99,7
S1-R221	1311,6	1205,9	1339,2	1211,5	87,5	93,8	86,5	92,2
S1-R222	1286,3	1218,0	1310,7	1206,7	93,2	88,0	91,4	87,4
S1-R223	1403,4	1235,0	1430,4	1218,0	96,5	84,9	94,3	84,3
S1-R224	1410,0	1257,2	1435,5	1235,0	99,8	81,5	97,4	81,3
S1-R225	1419,7	1284,8	1443,1	1257,2	103,2	78,2	100,5	78,2
S1-R226	1433,0	1318,5	1453,6	1284,8	106,6	74,8	103,6	75,1
S1-R227	1450,2	1359,1	1467,1	1318,5	110,0	71,3	106,8	71,9
S1-R228	1472,0	1407,6	1484,1	1359,1	113,5	67,8	110,0	68,7
S1-R229	1499,3	1465,2	1505,2	1407,6	117,1	64,2	113,3	65,4
S1-R230	1535,9	1562,2	1521,2	1465,2	120,8	60,5	115,7	63,0
S1-R231	1554,8	1702,0	1519,7	1562,2	122,7	58,7	116,1	62,6
S1-R232	1501,5	1809,8	1489,4	1702,0	120,1	61,3	114,3	64,3
S1-R233	1396,6	1885,4	1403,4	1809,8	117,3	64,0	112,4	66,2
S1-R234	1357,6	1937,2	1378,4	1885,4	114,6	66,7	110,6	68,1
S1-R235	1323,9	1968,4	1355,4	1937,2	112,0	69,3	108,8	69,9
S1-R236	1294,7	1981,1	1334,3	1968,4	109,4	71,9	107,0	71,7
S1-R237	1269,5	1977,3	1314,8	1981,1	106,9	74,5	105,1	73,5
S1-R238	1247,9	1959,3	1296,7	1977,3	104,3	77,0	103,3	75,4
S1-R239	1229,8	1941,4	1277,8	1959,3	101,8	79,6	100,8	77,8
S1-R240	1215,5	1927,7	1262,0	1941,4	99,3	82,1	98,2	80,4
S1-R241	1205,0	1918,1	1250,6	1927,7	96,7	84,6	95,6	83,0

	A (mm)	B (mm)	C (mm)	D (mm)	∠1 (°)	∠2 (°)	∠3 (°)	∠4 (°)
S1-R301	1445,6	1429,2	1723,3	383,3	96,6	85,3	57,5	120,7
S1-R302	1455,9	1078,3	1481,0	1065,9	92,7	88,7	90,8	87,9
S1-R303	1463,0	1095,7	1487,5	1078,3	95,8	85,6	93,7	85,0
S1-R304	1466,7	1118,0	1489,9	1095,7	98,9	82,4	96,6	82,1
S1-R305	1472,4	1145,7	1493,7	1118,0	102,1	79,3	99,5	79,2
S1-R306	1480,3	1179,1	1499,1	1145,7	105,3	76,1	102,4	76,2
S1-R307	1490,7	1218,9	1506,4	1179,1	108,5	72,9	105,4	73,3
S1-R308	1504,1	1265,7	1515,7	1218,9	111,7	69,6	108,3	70,3
S1-R309	1525,1	1321,4	1531,4	1265,7	115,0	66,3	111,4	67,3
S1-R310	1552,6	1424,4	1539,7	1321,4	117,2	64,2	111,9	66,8
S1-R311	1551,0	1557,3	1529,9	1424,4	117,2	64,2	110,8	67,8
S1-R312	1522,7	1662,2	1518,9	1557,3	115,3	66,1	109,7	68,9
S1-R313	1495,5	1740,5	1506,6	1662,2	113,3	68,1	108,6	70,0
S1-R314	1469,4	1794,2	1493,9	1740,5	111,4	70,1	107,4	71,2
S1-R315	1444,3	1825,0	1477,6	1794,2	109,4	72,0	106,3	72,3
S1-R316	1420,0	1834,6	1461,0	1825,0	107,5	74,0	105,2	73,4
S1-R317	1396,9	1824,4	1443,6	1834,6	105,5	75,9	104,0	74,6
S1-R318	1375,0	1804,6	1423,4	1824,4	103,2	78,2	102,2	76,4
S1-R319	1355,2	1789,5	1401,9	1804,6	100,4	81,0	99,3	79,3
S1-R320	1234,6	1778,9	1280,0	1789,5	97,6	83,8	96,4	82,1
S1-R321	1310,7	1078,0	1332,4	1066,7	92,62	88,56	90,97	87,9
S1-R322	1430,4	1094,8	1454,3	1078,0	95,66	85,68	93,58	85,08
S1-R323	1435,5	1116,4	1458,9	1094,8	98,74	82,6	96,42	82,25
S1-R324	1443,1	1143,1	1466,2	1116,4	101,83	79,51	99,27	79,39
S1-R325	1453,6	1175,4	1472,4	1143,1	104,95	76,39	102,14	76,52
S1-R326	1467,1	1213,8	1482,9	1175,4	108,11	73,23	105,03	73,63
S1-R327	1484,1	1259,2	1496,1	1213,8	111,32	70,02	107,96	70,7
S1-R328	1505,2	1312,7	1512,2	1259,2	114,59	66,75	110,94	67,72
S1-R329	1521,2	1403,6	1512,6	1312,7	117	64,36	112,04	66,61
S1-R330	1519,7	1535,2	1497,2	1403,6	117,45	63,9	110,99	67,66
S1-R331	1489,4	1642,7	1482,6	1535,2	115,66	65,7	109,91	68,73
S1-R332	1403,4	1721,7	1410,6	1642,7	113,76	67,56	108,88	69,81
S1-R333	1378,4	1778,6	1397,0	1721,7	111,93	69,4	107,83	70,85
S1-R334	1355,4	1815,1	1383,3	1778,6	110,1	71,23	106,77	71,9
S1-R335	1334,3	1832,6	1369,6	1815,1	108,28	73,05	105,72	72,96
S1-R336	1314,8	1832,3	1355,9	1832,6	106,46	74,87	104,65	74,02
S1-R337	1296,7	1816,1	1341,8	1832,3	104,6	76,73	103,5	75,16
S1-R338	1277,8	1799,1	1322,4	1816,1	102,17	79,17	101,19	77,48
S1-R339	1262,0	1786,3	1305,3	1799,1	99,56	81,78	98,5	80,17
S1-R340	1250,6	1777,27	1292,76	1786,26	96,96	84,37	95,82	82,84

	A (mm)	B (mm)	C (mm)	D (mm)	∠1 (°)	∠2 (°)	∠3 (°)	∠4 (°)
S1-R401	1477,7	1305,7	1786,8	220,0	94,8	86,7	56,0	122,6
S1-R402	1476,8	1206,3	1507,2	1207,7	93,3	88,1	91,9	86,7
S1-R403	1476,8	1205,7	1507,2	1206,3	91,9	89,6	90,5	88,1
S1-R404	1476,8	1205,8	1507,2	1205,7	90,5	91,0	89,0	89,6
S1-R405	1476,8	1206,8	1507,2	1205,8	89,0	92,4	87,6	91,0
S1-R406	1476,8	1208,4	1507,2	1206,8	87,6	93,9	86,1	92,4
S1-R407	1476,8	1210,8	1507,0	1208,4	86,1	95,3	84,7	93,9
S1-R408	1477,0	1214,0	1507,3	1210,8	84,7	96,7	83,3	95,3
S1-R409	1476,7	1218,0	1507,0	1214,0	83,3	98,1	81,9	96,7
S1-R410	1476,8	1222,6	1507,2	1218,0	81,9	99,6	80,5	98,1
S1-R411	1476,8	1228,0	1507,2	1222,6	80,5	101,0	79,1	99,6
S1-R412	1475,1	1234,1	1505,4	1228,0	79,1	102,3	77,7	101,0
S1-R413	1478,6	1241,0	1508,9	1234,1	77,7	103,7	76,3	102,3
S1-R414	1475,8	1248,5	1506,1	1241,0	76,3	105,1	75,0	103,7
S1-R415	1477,9	1256,7	1508,2	1248,5	75,0	106,4	73,6	105,1
S1-R416	1475,7	1262,2	1505,0	1256,7	74,0	107,4	72,8	105,9
S1-R417	1475,6	1235,0	1496,8	1262,2	75,7	105,6	75,7	103,0
S1-R418	1476,3	1212,1	1501,2	1235,0	81,4	100,0	81,1	97,6
S1-R419	1367,3	1205,8	1395,9	1212,1	88,1	93,3	87,0	91,6
S1-R420	1335,2	1188,4	1360,1	1205,1	91,3	89,9	90,8	88,1
S1-R421	1456,0	1152,3	1485,0	1188,4	92,6	88,8	92,6	86,1
S1-R422	1456,6	1097,7	1486,8	1152,3	93,8	87,5	94,5	84,1
S1-R423	1457,4	1040,1	1487,8	1097,7	95,1	86,3	95,9	82,8
S1-R424	1458,3	1014,5	1484,9	1040,1	96,1	85,0	95,9	82,8
S1-R425	1459,3	1022,2	1482,1	1014,5	97,6	83,8	95,8	82,8
S1-R426	1460,3	1063,1	1479,4	1022,2	98,8	82,6	95,8	82,9
S1-R427	1461,3	1137,2	1476,7	1063,1	100,0	81,3	95,7	83,0
S1-R428	1462,1	1238,4	1475,7	1137,2	100,7	80,6	95,3	83,4
S1-R429	1462,9	1344,0	1480,7	1238,4	99,7	81,7	94,1	84,6
S1-R430	1463,3	1442,2	1486,5	1344,0	98,4	82,9	93,1	85,5
S1-R431	1406,0	1522,1	1433,3	1442,2	97,2	84,1	92,6	86,1
S1-R432	1406,0	1587,9	1437,4	1522,1	96,0	85,3	92,0	86,7
S1-R433	1406,0	1639,5	1440,7	1587,9	94,8	86,5	91,4	87,3
S1-R434	1406,0	1677,0	1443,3	1639,5	93,7	87,7	90,8	87,9
S1-R435	1406,0	1700,5	1445,0	1677,0	92,5	88,9	90,2	88,5
S1-R436	1406,0	1711,6	1445,9	1700,5	91,3	90,0	89,5	89,1
S1-R437	1406,0	1709,7	1446,0	1711,6	90,5	90,8	89,3	89,4
S1-R438	1405,9	1709,6	1446,0	1709,7	90,6	90,8	89,3	89,4
S1-R439	2067,4	2475,4	307,3	1709,6	90,9	43,8	135,4	89,9

	A (mm)	B (mm)	C (mm)	D (mm)	∠1 (°)	∠2 (°)	∠3 (°)	∠4 (°)
S1-R501								
S1-R502	1507,2	1065,7	1534,0	1066,2	91,9	89,6	90,5	88,1
S1-R503	1507,2	1065,8	1534,0	1065,7	90,5	91,0	89,0	89,6
S1-R504	1507,2	1066,6	1534,0	1065,8	89,0	92,4	87,6	91,0
S1-R505	1507,2	1068,1	1534,0	1066,6	87,6	93,9	86,1	92,4
S1-R506	1507,2	1070,2	1534,0	1068,1	86,1	95,3	84,7	93,9
S1-R507	1507,3	1073,1	1534,1	1070,2	84,7	96,7	83,3	95,3
S1-R508	1507,0	1076,5	1533,8	1073,1	83,3	98,1	81,9	96,7
S1-R509	1507,2	1080,7	1534,0	1076,5	81,9	99,6	80,5	98,1
S1-R510	1507,2	1085,4	1534,0	1080,7	80,5	101,0	79,1	99,6
S1-R511	1505,4	1090,8	1532,2	1085,4	79,1	102,3	77,7	101,0
S1-R512	1508,9	1096,9	1535,8	1090,8	77,7	103,7	76,3	102,3
S1-R513	1506,1	1103,5	1532,9	1096,9	76,3	105,1	75,0	103,7
S1-R514	1508,2	1110,8	1535,1	1103,5	75,0	106,4	73,6	105,1
S1-R515	1505,0	1117,8	1531,6	1110,8	74,1	107,3	72,8	105,9
S1-R516	1496,8	1094,0	1516,2	1117,8	77,0	104,3	76,8	101,9
S1-R517	1501,2	1072,0	1523,4	1094,0	82,4	98,9	82,0	96,6
S1-R518	1395,9	1065,8	1421,6	1072,0	88,4	93,0	87,3	91,4
S1-R519	1360,1	1047,8	1382,4	1065,1	92,0	89,2	91,5	87,4
S1-R520	1485,0	1010,4	1511,5	1047,8	93,9	87,4	94,0	84,7
S1-R521	1486,8	953,4	1515,9	1010,4	95,9	85,5	96,6	82,1
S1-R522	1487,8	896,4	1516,8	953,4	97,2	84,1	97,9	80,7
S1-R523	1484,9	873,2	1508,3	896,4	97,2	84,1	96,7	82,0
S1-R524	1482,1	883,8	1501,4	873,2	97,2	84,2	95,3	83,3
S1-R525	1479,4	927,6	1496,3	883,8	97,1	84,3	94,0	84,7
S1-R526	1476,7	1004,3	1492,9	927,6	97,0	84,3	92,7	86,0
S1-R527	1475,7	1106,4	1493,4	1004,3	96,7	84,7	91,3	87,3
S1-R528	1480,7	1212,4	1503,2	1106,4	95,4	85,9	90,0	88,7
S1-R529	1486,5	1293,5	1513,3	1212,4	94,5	86,9	90,0	88,6
S1-R530	1433,3	1390,3	1462,1	1293,5	93,9	87,4	88,7	90,0
S1-R531	1437,42	1455,67	1468,92	1390,26	93,3	88,0	89,4	89,3
S1-R532	1440,74	1506,52	1474,32	1455,67	92,7	88,6	89,3	89,3
S1-R533	1443,26	1542,63	1478,4	1506,52	92,1	89,3	89,3	89,3
S1-R534	1444,96	1560,21	1481,15	1542,63	91,3	90,0	89,3	89,4
S1-R535	1445,9	1578,22	1482,53	1560,21	91,3	90,0	89,3	89,4
S1-R536	1445,94	1460,58	1485,43	1578,22	90,3	91,0	93,5	85,2
S1-R537	1753,19	2105,74	238,5	1460,58	90,7	43,2	141,1	84,9

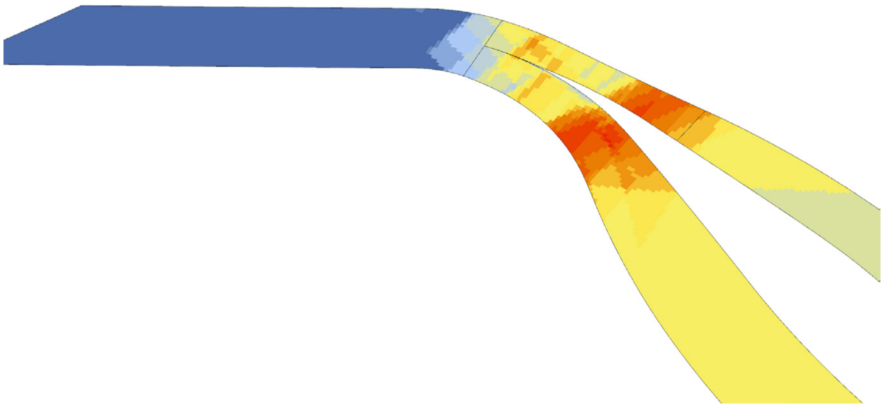
03 TABLES - GLASS GEOMETRY
SCALE: NS

Dimensions of glass panels are for reference only
Final size must be verified by contractor

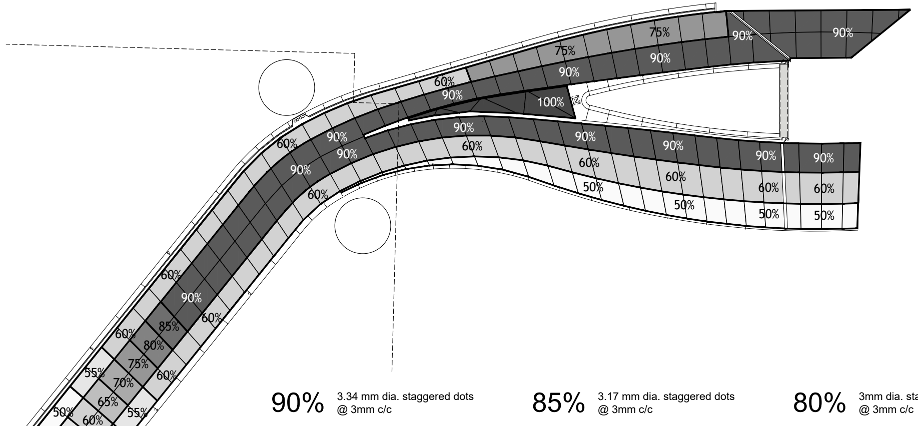
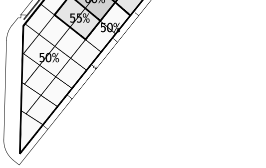
ROOF GLASS

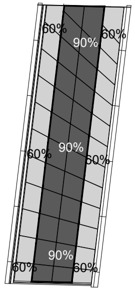
II. ARCHITECTURAL COMPONENTS

The roof glass is 'fritted' with a dot pattern to provide some visual masking from above of the roof services and structure and to provide a degree of protection from solar radiation. The density of the dot pattern varies according to the solar exposure and to the desire for clear views.



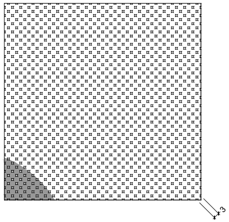
Opposite: Drawings of frit pattern.
Top right: Solar study.

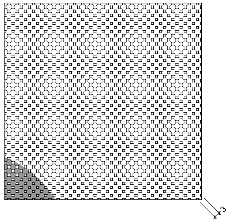


02 SEGMENT 6 FRIT PATTERN MAPPING FOR THE ROOF
NOT TO SCALE

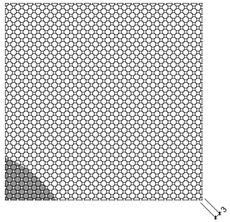
90% 3.34 mm dia. staggered dots @ 3mm c/c



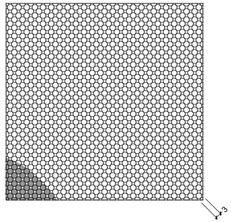
85% 3.17 mm dia. staggered dots @ 3mm c/c



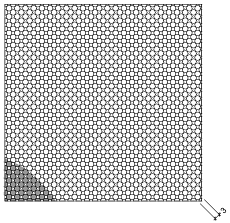
80% 3mm dia. staggered dots @ 3mm c/c



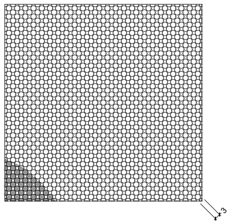
75% 2.932mm dia. staggered dots @ 3mm c/c



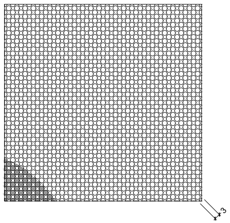
70% 2.8322mm dia. staggered dots @ 3mm c/c



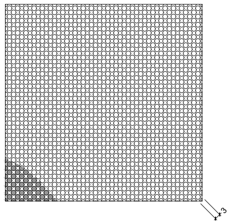
65% 2.730mm dia. staggered dots @ 3mm c/c



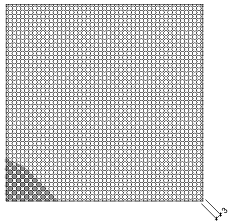
60% 2.6221mm dia. staggered dots @ 3mm c/c



55% 2.512mm dia. staggered dots @ 3mm c/c



50% 2.3937 mm dia. staggered dots @ 3mm c/c



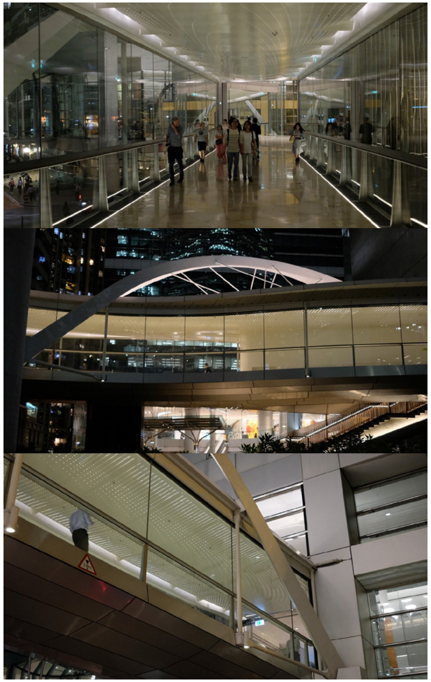
CEILINGS

II. ARCHITECTURAL COMPONENTS

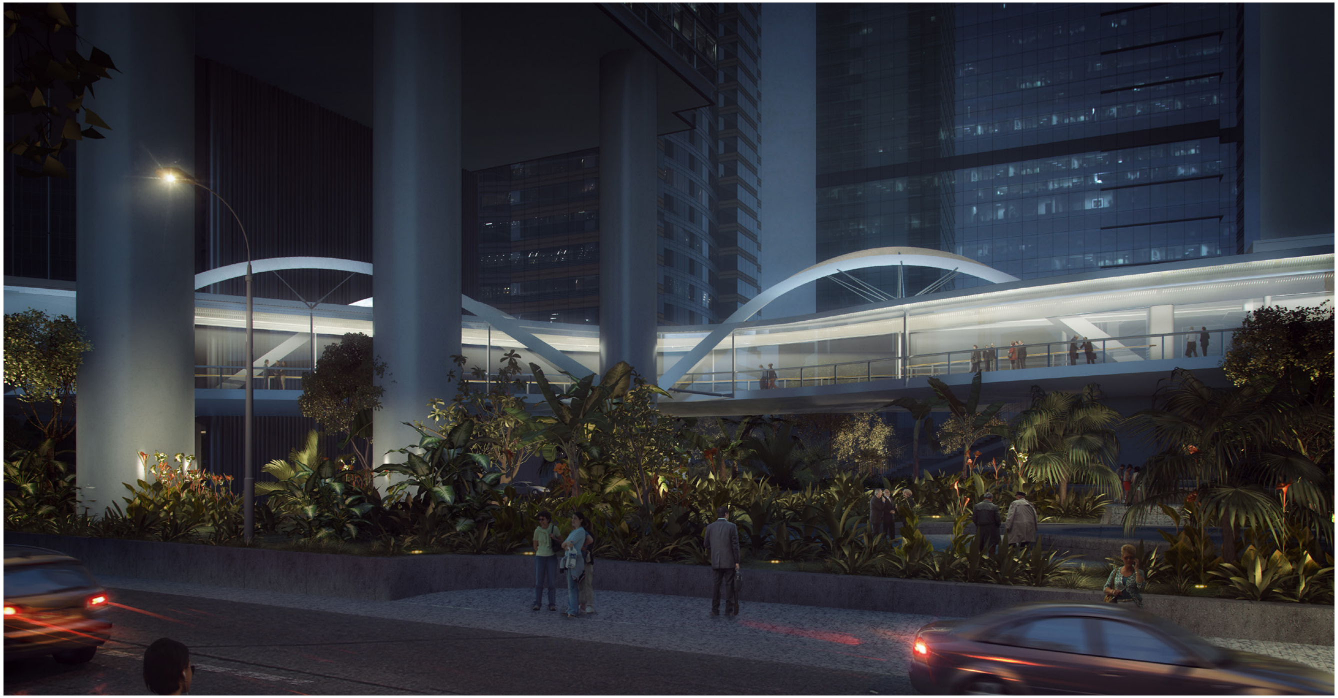
At night, the walkways are ribbons of luminous ceilings. The ceilings are the source of artificial light, either direct or indirect. A suspended surface of perforated aluminium is illuminated in a unique pattern of perforations from lights above it in the roof. Strip lights in the floor illuminate the ceiling to indirectly project light back onto the floor.

The pattern is the result of a parametric exercise where the density varies as a function of the presence of roof sprinklers, solar exposure and views through the edges of the roof to the sky. The variable transparency and opacity masks unsightly fire protection services in the roof whilst providing a feeling of lightness and views at the edges and the ends of the bridge. The pattern is unique to Taikoo Place and thereby provides a sense of identity.

Elliptical holes milled in aluminium sheets follow influence lines expressing movement and direction. The patterns are intense in places that reflect also an analogous pattern and scale in the floor paving, so they relate to each other in a subtle way.



Opposite: Rendering of walkways showing luminous ceilings.
Right: Photos of completed works.



CEILINGS

II. ARCHITECTURAL COMPONENTS

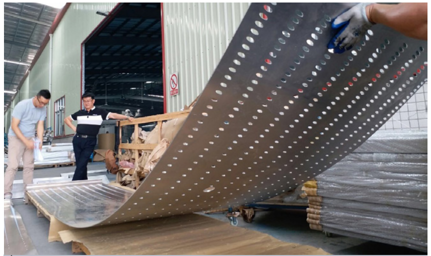
The patterns are generated in Rhino with algorithms overlaying influence parameters for opacity and movement dynamic on the base setting out geometrical parameters of the walkway structure and façade envelope. A tight common denominator rhythm of radial setting out lines whose geometry is set within the structure transversal roof members aligned strictly with the primary conical generating axes (1).

A second set of progressive curves whose intensity varies is overlaid to intersect the tight radial setting out lines (2).

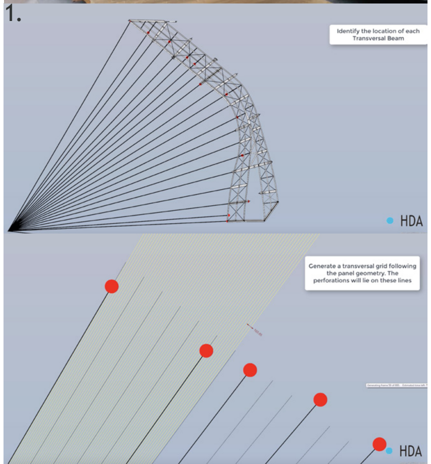
An interference pattern is generated where the radial lines and the progressive curves that influences the orientation and dimension of the individual elliptical holes (3).

The resulting pattern is scaled using attractor curves to regulate the transparency. The ceiling intensity pattern also echoes that of the floor paving patterns (4).

Finally, the pattern is projected onto the developable toroidal surfaces of the suspended ceiling whose shape emulates a draped fabric surface hung between the roof edge beams (5).



1.



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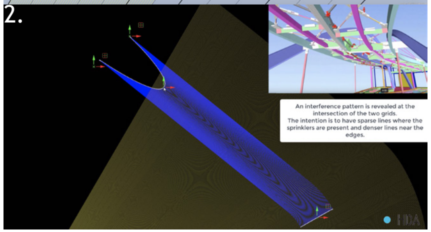
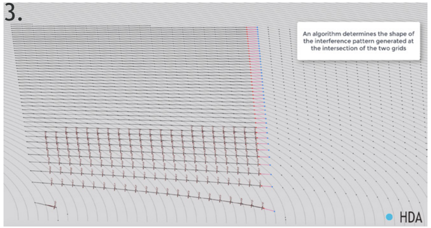
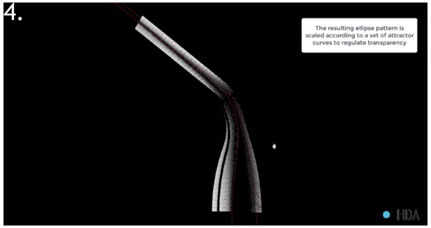
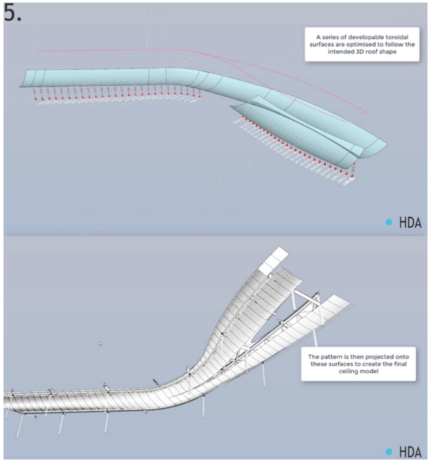
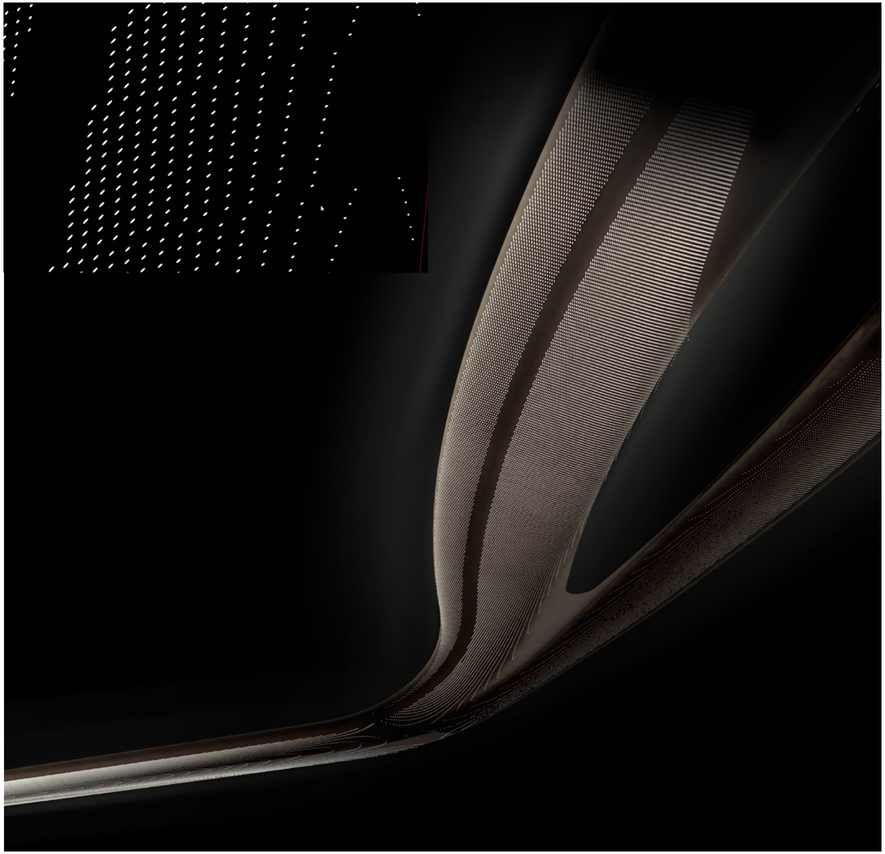










Above: Detail of elliptical hole pattern and final perforation patterns.
Left: Milled panels of ceiling cladding during factory inspections.
Other images: Perforation pattern generation. Refer to text.

FLOOR PAVING

Similar to the ceiling pattern generation, a parametric algorithmic code was written to generate a non-periodic paving, only using a small set of basic elements. Inspiration was drawn from the well-known Penrose tiling, an algorithm developed by the physician Roger Penrose. This algorithm is used to pave any surface using only very basic geometric shapes such that each piece of the pavement is made from the base shape.

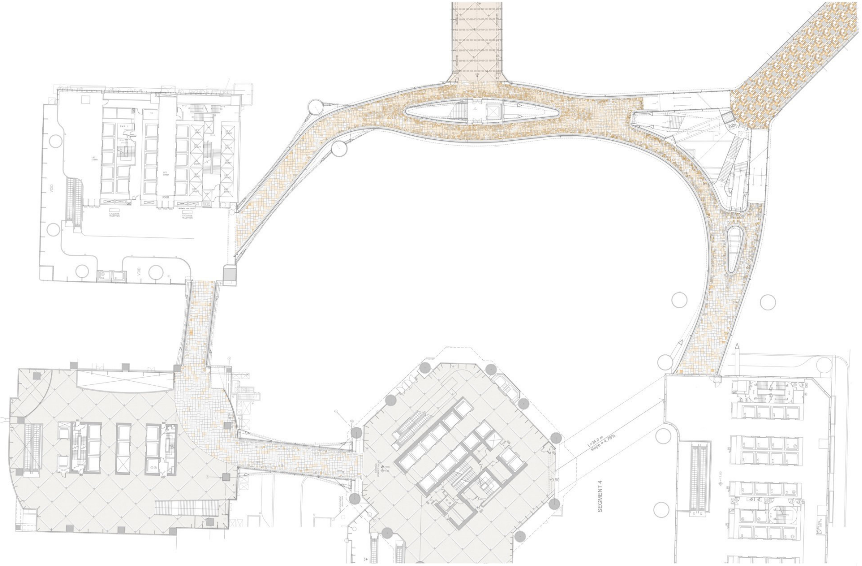
For the floor paving of this project, a simplified Penrose algorithm has been used to divide randomly an original golden rectangle into smaller pieces in order to generate a non-periodic pattern of smaller squares and rectangles.

The pattern is dense at the perimeters to manage the scale of the angular cuts necessary to achieve the edge curves. This intensification of the patterns at the edges, denser the tighter the radius, transforms the impact of curves of a rectilinear pattern into a feature that expresses the curve as a compatible design composition. The image below shows how a simple scaling can express a natural curve.

The basic orientation of the floor stone laying pattern has an orthogonal North/South orientation of squares and rectangles to align with Gustafson Porter + Bowman's landscape geometry, so the floor paving and garden paving as well as pond directions can be subliminally connected. The grounds relate to each other at different levels.

Choi Comer, a Hong Kong based design studio, with experience from Fergus Comer's work on the stonework at Pacific Place ensured the final patterns and stone selection and quality control, with notable factory pre-laying of all pieces. Choi Comer introduced delicate inlays of bronze strips highlight key interfaces and assisted in wayfinding signage.

Below: Penrose principle.
Opposite left: Drawing of flooring pattern apply to all segments.
opposite right: Prelay and installation on site.




LINCOLN HOUSE

II. CONCLUSION

Together all of the Taikoo Geometries contribute to a holistic composition that creates a unique sculpture in a garden. From the common denominator orthogonal Taikoo Garden patterns to the radial conical setting out of the ceiling patterns, all the geometries are related for a coherent expression.

Noble materials are fabricated and crafted to curved geometries where their distinct and different forms and shapes become natural and fluid curves together.

The walkways are a sculptural centerpiece of the Taikoo Place, as a timeless composition of geometric coherence for people.

TAIKOO PLACE WALKWAYS

Client :	Swire Properties
Designer :	Hugh Dutton Associés
Landscape Designer :	Gustafson Porter + Bowman
Lighting Designer :	Speirs and Major
Local Architect :	Wong and Ouyang
Local Interior Architect :	Choi Comer
Structural Engineer :	ARUP
M/E Engineer :	J. Roger Preston
Facade Engineer :	HS&A
BIM Manager :	WSP
Quantity Surveyor :	Rider Levett Bucknall
Main Contractor for Phase 1 :	Gammon
Facade Sub-contractor for Phase 1 :	Permasteelisa
Interiors Sub-Contractor for Phase 1 :	Pat Davie

HDA

HUGH DUTTON ASSOCIÉS