

# Building The Leaning Tower of Pisa in Bryce

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# The Tower and the Swans

Ever wanted to own one of the real architectural treasures of the world, but didn't have the money or the room for it? Not to worry... you can build it in Bryce!

When people first think of the Leaning Tower of Pisa, the first thing that usually comes to mind is the fact that it's leaning. It's easy to overlook the fact that the tower is a beautiful example of Romanesque architecture.

There's a lot of steps involved in this project and it will probably take a couple of sessions to complete it. Before you start, I'd recommend that you print out this tutorial so you can check off the steps as you go.

## History of the Tower

What is now known as the Leaning Tower of Pisa, was built to be a bell tower (Campanile) for the Cathedral on the Piazza dei Miracoli in Pisa. Construction began in 1173 and stopped five years later when the tower began to lean to the north as the supporting ground began to settle. At this point the tower was only three stories tall. Construction was resumed around the year 1250 and attempts were made to correct the lean by curving the tower and using thinner columns on the downward side. By the time the top story (the bell chamber) was completed around 1350, the tower was leaning to the south.

Early in its history, it was popularly thought that the tower was leaning because one of the original builders had been a hunchback. If you've ever read the headlines in a supermarket tabloid, you'll see that people haven't changed that much.

The tower is also supposed to be the site of Galileo's experiment with gravity, in which he dropped two balls of different weights to prove that they would fall at the same rate because the acceleration due to gravity is a constant.

Many attempts have been made to straighten the tower. In 1934, Benito Mussolini tried adding weight to the base, but that just made things worse. In 1990, the tower was closed to the public because the lean was increasing. It was recently reopened after work on the foundation was able to restore the building to the lean it had 30 years before.

# Architectural Details

The tower is faced with white marble. It is 185 feet (55.8 meters) tall and 51 feet (15.4 meters) wide at the base.

There are eight stories, or levels (loggias).

The bottom story has 15 columns.

The middle stories have 30 columns.

The top story has space for 18 columns, but the space for every third column is taken by a bell window so there are 12 columns.

The weight of the tower is 14500 tons.

The angle of lean is 5 degrees.

## Modeling Strategy

To build our tower, we will use Boolean primitives in Bryce. Unless stated otherwise, the Veiny Stone texture will be used for all parts, positive and negative. We'll use the multi-rotate command a lot. In all cases, we'll do the replication about an origin placed at  $X$  and  $Z = 0$ .

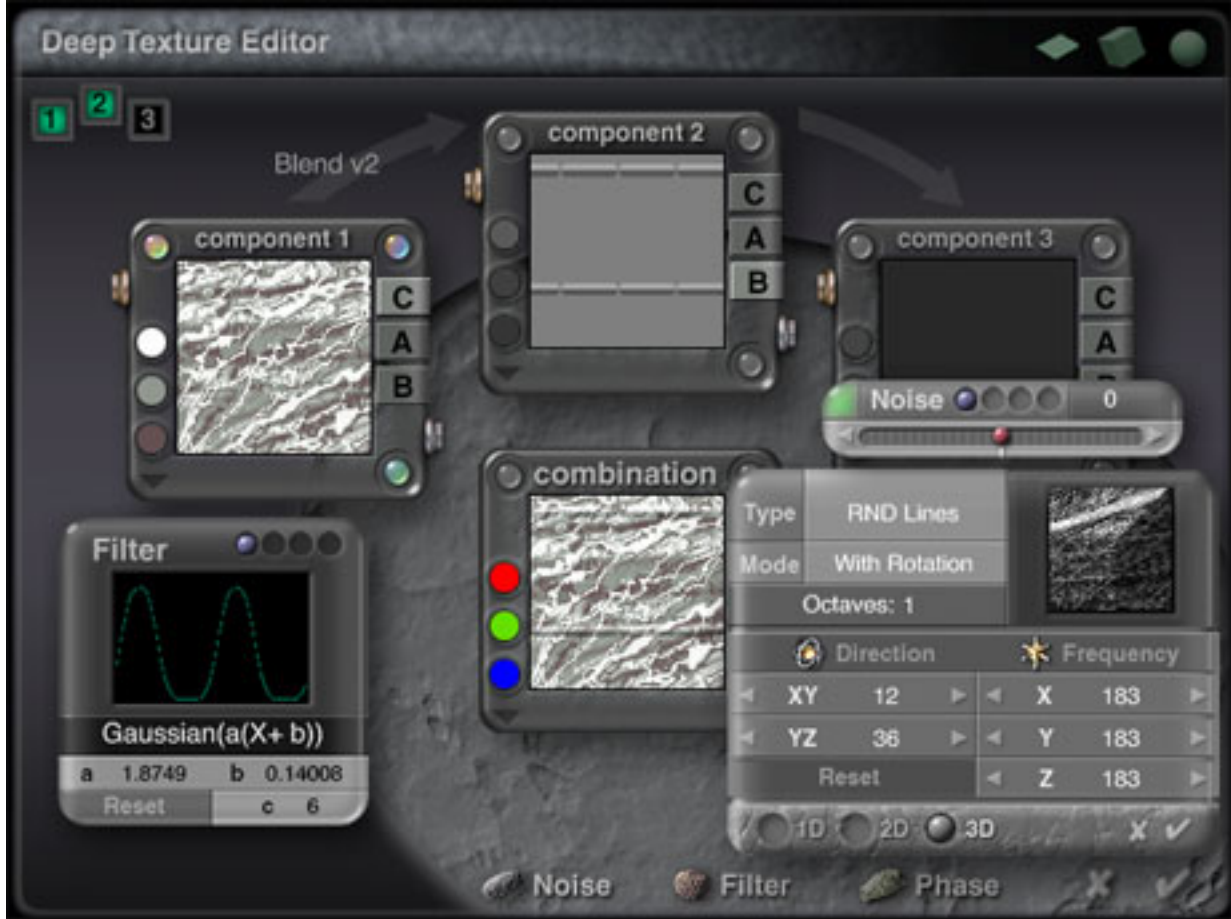
We'll simplify things a bit by modeling just three stories: the bottom level, a generic middle, and the top level bell chamber. We'll use a separate Bryce scene file for each of these stories. This will help keep things sorted out and minimize memory requirements during construction. We'll then merge these parts into a single file, ready for landscaping and rendering.

# Bricks in Bryce

We'll begin by creating a circular slab of bricks. Start up Bryce and create a cylinder with a size of 102 in the X and Z directions and 5 in the Y direction. Assign it to family 12. In the Materials palette, go to Rocks and Stones and select Veiny Stone. Open the Materials Lab and start adjusting the values as shown below.



In the Deep Texture Editor, adjust component 1 to match the values given below.



Set the noise and filter for component 2 as shown below.



Accept the values and try a test render from a side view of the brick slab cylinder. You should get something similar to the image below. Save your work as a scene file for later use. I called mine Slab.br5. This file will be merged into the scene file for each story later on.



# Making a Column

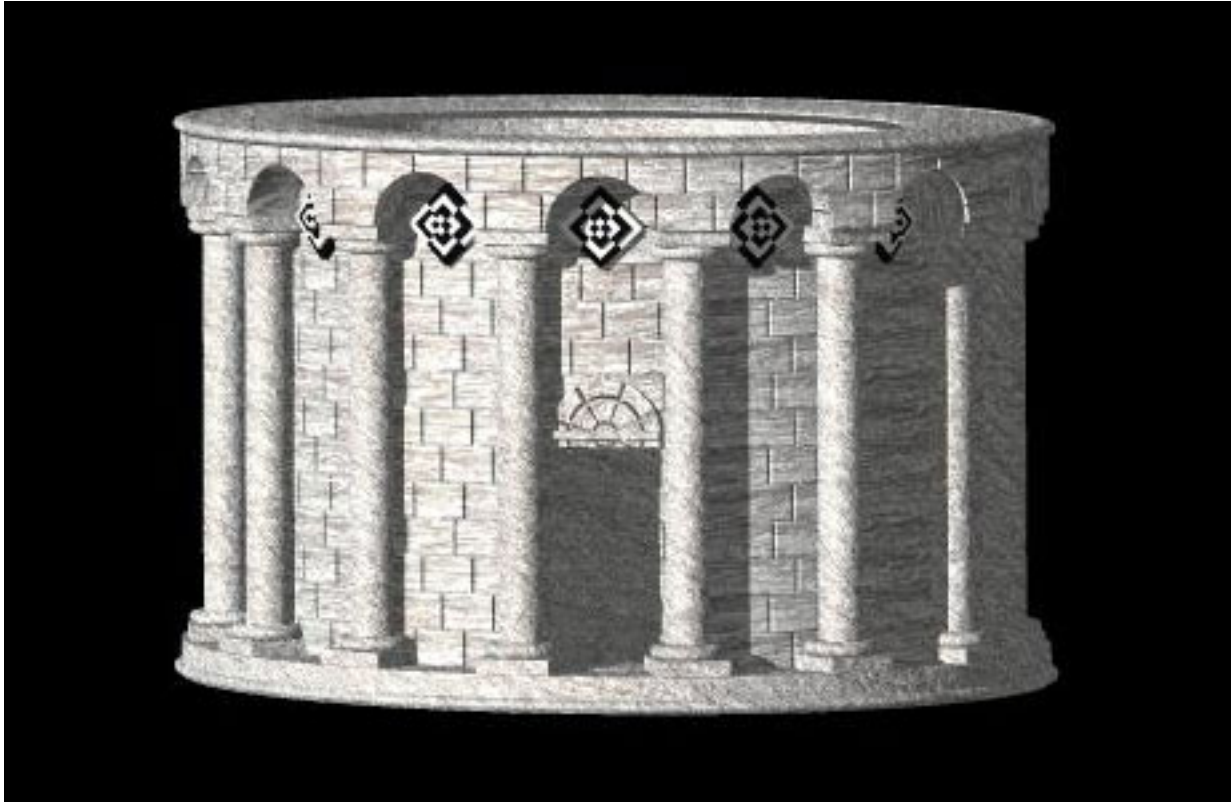
Press CTRL+N to start fresh in Bryce. Create a column out of 5 primitives using the values in the tables below. If a value isn't mentioned in the table, assume it to be zero.

Object	Family	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cube	5	6	0	10	2	10	
Torus	6	8	90	10	10	2	256
Cylinder	7	38	0	6	60	6	
Torus	8	62	90	10	10	2	256
Cube	9	64	0	10	2	10	

Group the 5 primitives together and place them into Family 10. Apply the Veiny Stone material and save the scene as BotCol.br5.



# The Bottom Story



Now we're going to build a simple foundation for our tower. Press CTRL+N to start fresh in Bryce. Delete the ground plane so it doesn't get in the way later on. Create the foundation from 2 primitives using the values in the table below.

Object	Family	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Torus	2	1	90	122	122	2	16
Cylinder	3	2.5	0	120	5	120	



Next we are going to add the column we saved earlier and multi-rotate it into a ring of 15 columns. Click on File>Merge BotCol.br5 to add the column to the present scene. With the column (family 10) selected, open the Attributes window, and place the column at X = -54 and Z = 0. Apply a check to Show Origin Handle and place the Origin at X and Z = 0. Now, click on multi-rotate. We're going to have 15 columns and we already have 1, so set the quantity to 14 in the multi-rotate pop-up menu. Set the Y Rotate to 24 degrees (because  $360/15=24$ ). Leave the offsets at 0 and press enter. You should have an even ring of columns around the base.

Now we are going to add the brick slab we saved earlier and stack it up to make the outer shell of the tower. Click on File>Merge Slab.br5 to import the object and set the Y offset to 7.5 so it rests on top of the foundation slab. Multi-rotate the slab by setting the quantity to 11 with a Y offset of 5. This will give you a stack of 12 slabs. If you want, you can rotate the slab using a Y rotation of 6 degrees to stagger the bricks. Since we used parametric scaling on the brick texture, I found I got better results by selecting each slab, going into the Materials Lab, and setting the Y rotation for the material 2 degrees higher than that value for the preceding slab. In other words, the Y rotations for the 12 slab layers (starting from the bottom) will be 0,2,4,6,8,10,12,14,16,18,20,22.

Next, we'll make the tower hollow by adding a negative cylinder to be grouped later with the slabs. Create a cylinder with negative attributes and a Y position of 41. Set the X and Z size to 78.75 and the Y size to 75. Assign it to family 13.

To make the door, we'll use the primitives described in the table below. Apply the same texture to the flat end of the cylinder that was used for the brick slabs, but use spherical mapping for a decorative effect. You'll also want to increase the amplitude of component 2's filter in the Deep Texture Editor to enhance the chiseled effect.

Object	Family	Attrib	X Position	Y Position	Z Rotation	X Size	Y Size	Z Size
Cube	19	Negative	45	20.25	0	15	30	15
Cylinder	20	Positive	46	35.25	90	15	11.67	14.8
Cube	21	Positive	45	34.75	0	14	1	14.8

Now we add the bricks for the arches to the top of this section. Add 2 more circular brick slabs by copying the top 2 in the stack you just replicated. Apply the values given in the table below. Set the Y rotations for the materials to 3 degrees for the lower slab and 6 degrees for the upper one. Also add the 2 toruses as shown in the table.

Object	Family	Attrib	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cylinder	14	Positive	67.5	0	120	5	120	
Cylinder	15	Positive	72.5	0	120	5	120	
Torus	16	Positive	76.1	90	122	122	2	32
Torus	16	Positive	76.1	90	122	122	2	200

To cut holes for the arches, create a negative cylinder with X, Y, and Z size of 15. Assign this object to family 18. Set the Z rotation to 90 degrees. Set the X position to 54 and the Y position to 65. Apply a check to Show Origin Handle and place the Origin at X and Z = 0. Multi-replicate the arch holes with quantity set to 14 and Y Rotate set to 24 degrees. This should produce a ring of 15 cylinders between the column tops.

To build the inlays that are set into the wall between the arches, we'll create a textured object that will be replicated around the building. Create the cubes using the values given in the table below. Apply the Classic Checkerboard texture using the Object Space mapping mode with a scale of 10% for texture size in X, Y, and Z.

Object	Family	Attrib	X Position	Y Position	X Rotation	X Size	Y Size	Z Size
Cube	22	Positive	48	65	45	8	8	8
Cube	22	Positive	48	65	-45	9	6	6
Cube	22	Positive	48	65	45	10	4	4
Cube	22	Positive	48	65	-45	11	2	2

Group the inlay cubes and place the Origin Handle at X and Z = 0. Multi-replicate the arch holes with quantity set to 14 and Y Rotate set to 24 degrees.

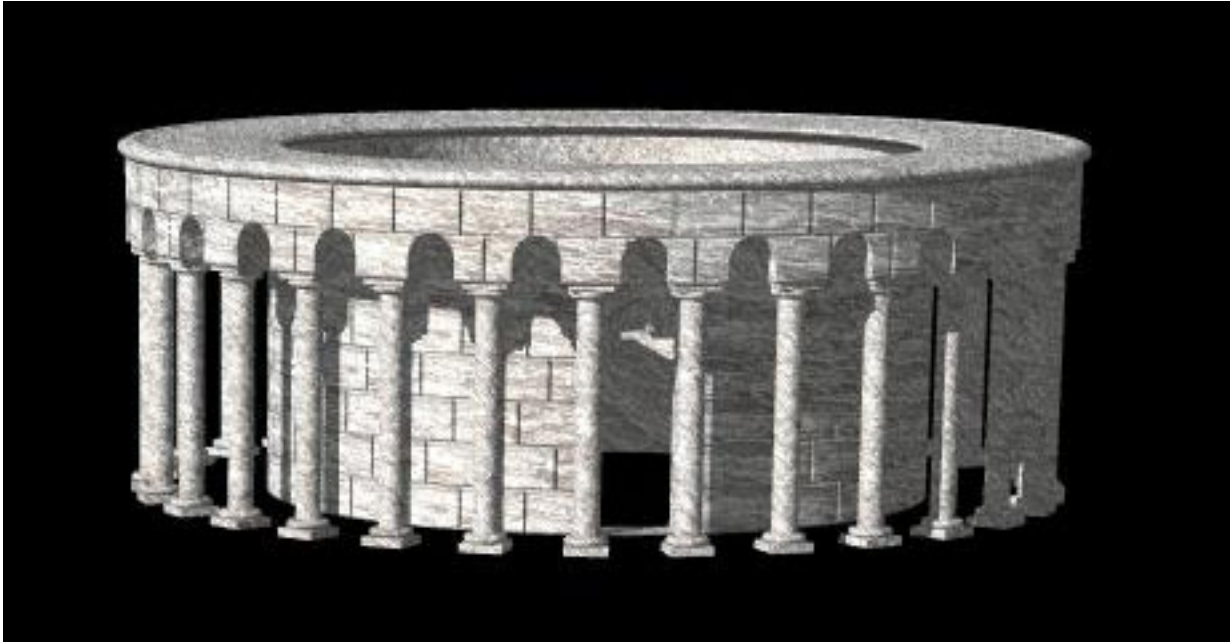
Finally (for this level) we'll put all of these pieces together. First save your work so you can easily backtrack if you need to change something later on. I saved mine as BotLevel.br5.

Now, select the outer wall (family 12), the inner wall (family 13), the door parts (families 19, 20, 21) and the inlay cubes (family 22). Group the selected families together.

De-select all, then select the arch brick slabs (families 14,15) and the arch holes (family 18) and group them together.

Now, select all (CTRL + A) and assign everything to family 23. A test render should look like the image at the top of this section. Save your work as BotLevelGrp.br5.

## Generic Middle Level



The middle levels don't need a foundation slab since each one will sit on the top of the level beneath it. The brick slabs are not as wide and there are only 8 instead of 12. There are 30 columns instead of 15 and the columns are smaller. There are also 30 arches instead of 15, and the arches are narrower.

Press CTRL+N to start fresh in Bryce and delete the ground plane. Import the brick slab using the File>Merge command. Change the X and Z size from 102 to 80. Use the Multi-rotate command with quantity set to 7 and Y offset set to 5 to create a total of 8 stacked slabs. These are all positive and in family 12. In the Materials Lab, set the Y rotations for the 8 slab layers (starting from the bottom) to 0,1,2,3,4,5,6,7.

Create a column using values given in the table below.

Object	Family	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cube	5	.5	0	5	1	5	
Torus	6	1.5	90	5	5	1	256
Cylinder	7	20	0	3	40	3	
Torus	8	28.7	90	5	5	1	256
Cube	9	29.7	0	5	1	5	

Group the 5 parts of the column together and place it in family 10.

Set the column's X position to -54 and multi-replicate it with a quantity of 29 and a Y rotation of 12 degrees to produce a ring of 30 columns.

Make the middle level hollow by adding a negative cylinder to be grouped later with the slabs. Create a cylinder with negative attributes and a Y position of 20. Set the X and Z size to 70 and the Y size to 50. Assign it to family 13.

Add the door using the values in the table below.

Object	Family	Attrib	X Position	Y Position	Z Rotation	X Size	Y Size	Z Size
Cube	19	Negative	38	11.5	0	12	22.4	11.2
Cylinder	20	Positive	46	22.7	90	11.2	7.5	11.2
Cube	21	Positive	45	22.7	0	12	.75	11.2

Add the brick slabs for the arches and the roof disks using the table below.

Object	Family	Attrib	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cylinder	14	Positive	32.5	0	114.1	5	114.1	
Cylinder	15	Positive	37.5	0	114.1	5	114.1	
Torus	16	Positive	41	90	116	116	2	32
Torus	16	Positive	41	90	116	116	2	200

Add the holes arches using the table below.

Object	Family	Attrib	X Position	Y Position	X Size	Y Size	Z Size
Cylinder	18	Negative	54	32.18	8	6	5.5
Cube	18	Negative	54	29.18	8	6	5.5

Multi-rotate the arch holes with a quantity of 29 and a Y rotation of 12 degrees.

Save your work as MidLevel.br5. Group the parts of the middle level the same way as the bottom level was grouped. If all went well, a test render should look like the image at the top of this section. Assign all parts to family 24 and save your work as MidLevelGrp.br5.

## The Top Level





The top level is distinguished by the presence of railings, bells, and arches to hold the bells.

Press CTRL+N to start fresh in Bryce and delete the ground plane. Make the base of the top level by creating a torus with a radius of 512. Set the X and Y size to 110 and the Z size to 10. Rotate the torus 90 degrees on the X axis and set the Y position to 5.52. Set the family to 2.

Import the brick slab (family 12) and change the X and Z size from 102 to 60. Set the Y position to 12.92. Use the Multi-replicate command to create a total of 8 stacked slabs as you did with the middle level. In the Materials Lab, set the Y rotations for the 8 slab layers (starting from the bottom) to 0,1,2,3,4,5,6,7.

Create a column using values given in the table below.

Object	Family	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cube	5	10.5	0	5	1	5	
Torus	6	11.5	90	5	5	1	256
Cylinder	7	25	0	3	30	3	
Sphere	3	37.95	0	3	3	3	
Torus	8	38.45	90	5	5	1	256
Cube	9	39.45	0	5	1	5	

Group the 5 parts of the column together and place it in family 10.

Set the column's X position to -32.5 and multi-replicate it with a quantity of 17 and a Y rotation of 20 degrees to produce a ring of 18 columns. Six of these columns will be removed later after the bells and railings have been added.

Make the middle level hollow by adding a negative cylinder to be grouped later with the slabs. Create a cylinder with negative attributes and a Y position of 25. Set the X and Z size to 50 and the Y size to 51. Assign it to family 13.

Add the brick slabs for the arches and the toruses for the roof disks using the table below.

Object	Family	Attrib	Y Position	X Rotation	X Size	Y Size	Z Size	Radius
Cylinder	14	Positive	42.5	0	70	5	70	
Cylinder	15	Positive	47.5	0	70	5	70	
Cylinder	11	Negative	45	0	64	10	64	
Torus	16	Positive	50	90	72	72	1	32
Torus	16	Positive	50	90	70	70	2	150
Torus	16	Positive	50	90	52	52	1	32

Make the arch holes by creating a negative cylinder with an X and Z size of 6 and a Y size of 10. Set the family to 18. Rotate it -90 degrees on the X axis and position it at X = 0, Y = 40, and Z = -34. Multi-replicate it with a quantity of 17 and a Y rotation of 20 degrees to produce a ring of 18 cylinders.

Make the arches for the small bells using the values in the table below and group the cylinder and cube into family 5. Multi-rotate this group with a quantity of 5 and an angle of 60 degrees. Select family 5, group it again, and rotate it on the Y axis 10 degrees.

Object	Att	X Pos	Y Pos	Y Rot	Z Rot	X Size	Y Size	Z Size
Cylinder	Negative	15.5	37.5	0	90	5	31	5
Cube	Negative	15.5	33.75	90	0	5	7.5	31

Make the arches for the large bells using the values in the table below and group the cylinder and cube into family 6. Multi-rotate this group with a quantity of 5 and an angle of 60 degrees. Select family 6, group it again, and rotate it on the Y axis 40 degrees. When you're done, group 5,6,11,12,13,14,15,18 together.

Object	Att	X Pos	Y Pos	Y Rot	Z Rot	X Size	Y Size	Z Size
Cylinder	Negative	17.5	30.5	0	90	10	35	10
Cube	Negative	17.5	23.0	90	0	10	15	35

You'll notice that the six negative stones used to cut the arches for the large bells each have a column standing directly in front of it. In these six columns, delete the cylinder, the bottom torus, and the bottom cube.

Now group 5,6,11,12,13,14,15,18 together. If everything works, a test render should show the top level with everything but the bells and the railings.

Below is the table showing the components of one of the small bells. Create these components in family 19 and group them together. Multi-replicate this group with a quantity of 5 and an angle of 60 degrees. Select family 19, group it again, and rotate it on the Y axis 10 degrees.

Obj	Att	X Pos	Y Pos	Z Pos	X Rot	X Size	Y Size	Z Size	Rad	Texture
Torus	N	27.5	35.56	0	90	7.52	7.52	5.19	350	Bronze
Sphr	P	27.5	32.69	0	0	4	6	4		Bronze
Sphr	N	27.5	31.84	0	0	4	6	4		Bronze
Cube	P	27.5	36.19	0	0	0.5	0.5	5		Iron
Cyl	P	27.5	34.18	0	0	0.25	3.5	0.25		Iron
Sphr	P	27.5	32.25	0	0	0.75	0.75	0.75		Iron
Sphr	P	27.5	35.89	-0.35	0	0.75	2	0.75		Iron
Sphr	P	27.5	36.09	0	0	0.75	2	0.75		Iron
Sphr	P	27.5	35.89	0.35	0	0.75	2	0.75		Iron
Torus	N	27.5	32.69	0	90	4.05	4.05	0.25	16	Bronze

Below is the table showing the components of one of the large bells. Create these components in family 20 and group them together. Multi-replicate this group with a quantity of 5 and an angle of 60 degrees. Select family 20, group it again, and rotate it on the Y axis 40 degrees.

Obj	Att	X Pos	Y Pos	Z Pos	X Rot	X Size	Y Size	Z Size	Rad	Texture
Torus	N	27.5	27.63	0	90	15.04	15.04	10.38	350	Bronze
Sphr	P	27.5	21.88	0	0	8	12	8	0	Bronze
Sphr	N	27.5	20.19	0	0	8	12	8	0	Bronze
Cube	P	27.5	28.88	0	0	1	1	10	0	Iron
Cyl	P	27.5	24.87	0	0	0.5	7.0	0.5	0	Iron

Sphr	P	27.5	21.0	0	0	1.5	1.5	1.5	0	Iron
Sphr	P	27.5	28.28	-0.7	0	1.5	4.0	1.5	0	Iron
Sphr	P	27.5	28.68	0	0	1.5	4.0	1.5	0	Iron
Sphr	P	27.5	28.28	0.7	0	1.5	4.0	1.5	0	Iron
Torus	N	27.5	21.88	0	90	8.1	8.1	0.5	16	Bronze

Now we'll build the lower railing for the top level and put it into family 21. Use the values in the table below and apply an iron texture. Group the pieces together and multi-replicate with a quantity of 29 and a Y rotation of 12 degrees.

Object	X Pos	Y Pos	Z Pos	X Rot	Y Rot	X Size	Y Size	Z Size
Sphere	52.96	14.25	0	0	0	1.6	1.05	1.6
Cylinder	52.4	12.85	-5.54	90	5.72	0.53	11.14	0.53
Cylinder	52.4	10.06	-5.54	90	5.72	0.53	11.14	0.53
Cylinder	52.96	10.76	0	0	0	0.53	6.98	0.53

Now we'll build the upper railing for the top level and put it into family 22. Use the values in the table below and apply an iron texture. Group the pieces together and multi-replicate with a quantity of 17 and a Y rotation of 12 degrees.

Object	X Pos	Y Pos	Z Pos	X Rot	Y Rot	X Size	Y Size	Z Size
Sphere	32.93	57.48	0	0	0	1.65	1.05	1.65
Cylinder	31.96	56.08	-5.68	90	9.61	0.55	11.6	0.55
Cylinder	31.96	56.08	-5.68	90	9.61	0.55	11.6	0.55
Cylinder	32.93	53.99	0	0	0	0.55	6.98	0.55

A test render should look like the image at the top of this section. Assign all parts to family 25 and save your work as TopLevelGrp.br5.

## Putting It All Together

Press CTRL+N to start fresh in Bryce and delete the ground plane. Using the table below, merge the previously built files to build the tower, level by level. When you're through, group all 8 levels into family 2 and save your work as TowerPisa.br5.

Level	File to Merge	Family	Y Position	Y Rotation
1	BotLvlGrp.br5	2	39.0	0
2	MidLvlGrp.br5	3	96.6	45
3	MidLvlGrp.br5	6	138.5	0
4	MidLvlGrp.br5	7	180.2	45
5	MidLvlGrp.br5	8	227.5	0
6	MidLvlGrp.br5	9	265.2	45
7	MidLvlGrp.br5	10	307.3	0
8	TopLvlGrp.br5	11	352.5	0

Now that your tower is built, open a new scene by pressing CTRL + N and create the landscape you want to put the tower into. Remember to leave family 2 free. When the landscaping work is done, incorporate the tower into the scene by merging TowerPisa.br5. For the finishing touch, apply a 5 degree rotation to the tower along the X axis to make the tower lean.

## The Rest of the Picture

The picture at the top of this tutorial "The Tower and the Swans" was pretty straight forward once the tower was built. The sky was produced using the Bit Of Snow sky preset and tweaking the colors a bit. The trees were made using the Bryce 5 Tree Lab. The swans were made from a posable model by Bloodsong at 3dMenagerie.

## Wrapping Things Up

That's it for this time around. If you check out some of the sites listed below, you'll see that our model has room for a lot of extra details, particularly in the area of ornamental carvings and the building's interior staircase. How much more you put into the model depends on how much close-up work you'll be doing with it.

Until next time, Arrivederci!

## Related Links

[http://torre.duomo.pisa.it/index\\_eng.html](http://torre.duomo.pisa.it/index_eng.html)

[http://torre.duomo.pisa.it/towersgallery/eng/index\\_tour.html](http://torre.duomo.pisa.it/towersgallery/eng/index_tour.html)

<http://www.pbs.org/wgbh/nova/pisa/panorama.html>

<http://www.endex.com/gf/buildings/ltpisa/ltpisa.html>



<http://www.endex.com/gf/buildings/Itpisa/Itpinfo/schel.gif>

<http://www.3dmenagerie.com/>

[RETURN TO TUTORIALS]

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