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1. Intro

There is a scene in the movie Armageddon that triggered some questions for me. It is the scene where the U.S. president (played by Morgan Freeman) announces that a mission to blown up a meteor heading toward Earth has failed (https://www.youtube.com/watch?v=ZNi3Qrcw1dE starting at 1.40). He continues to say that there is a place for one million Americans to survive for two years in caves.

Morgan Freeman

I couldn't help but think about this further. Why only one million? It's just 0.3 % of the US population. What about the rest? No plans for them at all? Should they peacefully sit on top of the hills to avoid drowning and then die of starvation?

If there is a threat out there and doomsday is in front of us, whether it be a big meteorite, alien ship, the Sun doubling its activity, nuclear war, a rapid increase in global warming, whatever you might think of, the movie suggests that only burying us underground would save us.

We will try to answer another question, which is how long it would take to bring us all underground to avoid the catastrophe, by using the **deep underground concept.**

This scene doesn't answer many questions, but it answer one.

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We will try to answer another question, which is how long it will take, to bring us all underground to avoid the catastrophe, by using the **Deep underground concept .**

2. How much place do we need underground.

In case of a serious disaster, we would have to be fully independent from the surface, so we would need to have space for the following underground:

- Food
- Living
- Industry and offices
- Public areas

Let's take a look at how much space we would need for each underground citizen.

Food:

Some sources say that the surface necessary to feed a person is about 0.1 ha or 1000 m^2. But in a controlled environment, where heat, humidity, water, and light can be controlled, the food production can be multiplied by a factor of five, using modern techniques. Underground space, constructed in a way to be able to maintain uniform conditions, should fulfil those requirements. Therefore, 200 m^2 of stable underground structure per person is a good approximation for the space needed to feed a single person.

Living:

Each person needs some privacy, say a room for a single person, or a flat for a family, for example a 25 m^2 private room per person and maybe about the same amount of space per person for other needs. Therefore, we estimate 50 m^2 per person for living.

Industry and offices:

I couldn't find relevant data specific to industry, but in the average city, the proportion between private, industry and business, and other public areas, is not far from being equal. So, it is reasonable to assign another 50 m^2 per person in this area.

Public areas:

We use a great deal of surface for public places, like squares or parks or schools, but we need to limit underground public spaces to 100 m^2 per individual.

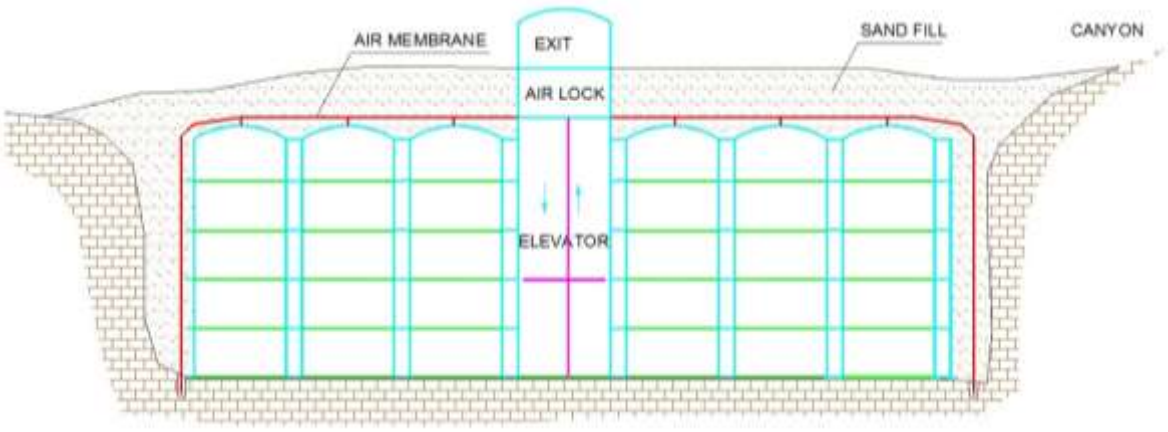
To summarize, a single person would need about 400 m^2 of underground space to live independently underground.

3. Types of underground structures

There are two types of underground construction. The first one, on this site often called a "molehill," is simply a construction, covered by a thin layer, say 1-2 m of soil. A version of a molehill, presented in picture 1, is constructed in a valley or canyon, and is quite safe against most threats, like bad weather, high velocity wind, polluted water and air. It offers some protection against radiation, too.

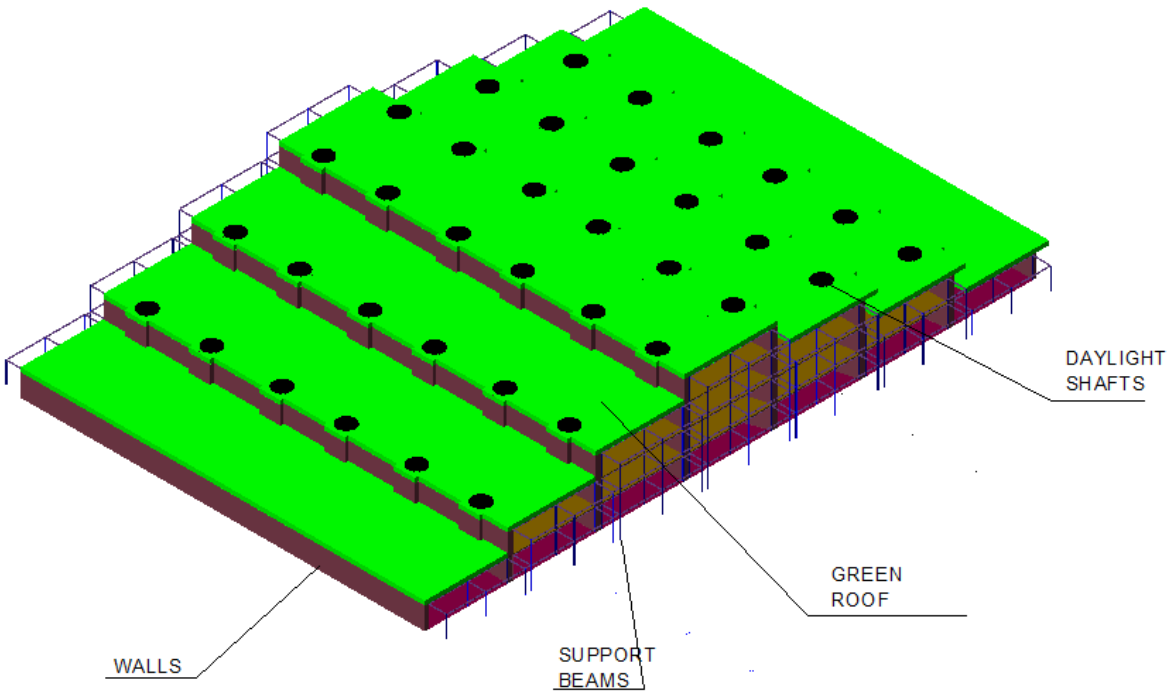
Meteorite

The other version of molehill, called a "hilly molehill" because it looks like a flat hill, offers less protection, but can be constructed almost entirely from natural materials. The one in picture 1 is meant to be made out of prefabricated straw bales, supported by wooden beams, covered by green roof, with clay plaster and hydro insulation.

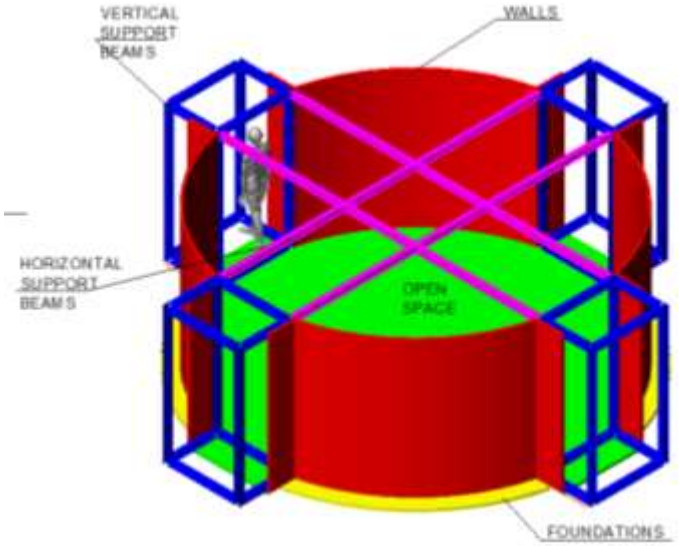


Picture 1-covered mollehill in the valley

Such relatively big constructions, built in the right places (for example, in protected areas between hills), should offer a high level of protection for many. They can be constructed easily, even without the heavy mechanization normally used in the construction industry, and mainly from natural materials that are available almost everywhere.



Picture2-"hilly molehill"



Picture 3:Covered molehill- single cell construction

The downside is that such constructions can offer only a certain level of protection, and because of statics, only relatively small rooms can be available, as shown in picture 3 (25-30 m^2 in covered molehill single cell construction, for example).

Molehills can't fulfill all needs, such as providing a stable environment for farming and large spaces for industry and gathering.

The other type of underground structures are the ones which use the intact soil or rock as walls.for the construction. A natural type of such construction is a cave.

The deep underground concept provides two types of construction. The first one is an "economical version" (picture 4), which involves the excavation of several circular tunnels of certain lengths by one another, later cutting the walls in between. The result is actually very similar to a hall with support pillars.

Picture 4: deep underground concept-type one underground construction

Such an underground structure has long-term stability in good geological conditions and can offer a large underground space, which is useful for everything that doesn't require height, including industry and farming.

For places that require height, the deep underground concept provides a second type of construction, which must have a circular or elliptic shape, as a giant tunnel or cave, and must be built in good geological conditions to be stable.

Picture 5-hall with pillars

The problem with the second type of underground construction is that it requires a lot more excavation and therefore a lot more time and resources.

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4. What to construct?

Picture 6: deep underground concept-type two underground construction

We determined the types of underground construction we need, but how much of each type do we need?

Molehills can offer private rooms, common space, and offices. It's not unreasonable to say that they can provide 25% of underground space for individual needs, which is 100 m^2 out of 400 m^2. Underground construction type one, an underground hall, could cover most of the needs for farming and industry, say 250 m^2 out of 400 m^2. For the rest, 50 m^2, we should use underground construction type two.

5. How long does it take to construct the molehills for all humanity?

If there is a looming disaster, there needs to be enough construction for all people.

Construction material	World production	Use of material for m^2 of molehill	Molehill construction
	(million tones)	(t/m^2)	millions m^2/year
Straw	100	0,04	2.500
Wood	1000	0,08	12.500
Steel	2000	0,08	25.000
Concrete	4000	0,4	10.000
All together			**50.000**

Table 1: Possible yearly production of space in molehills.

Table one shows the yearly production of concrete materials and approximate use of materials per square m of a molehill. The results show that if all of the available world resources of construction material are used to construct molehills, theoretically, enough molehill space for 500 million people could be provided every year.

This means, of course, that theoretically, if we assume that someday there will be 10 billion people on Earth, enough space in molehills can be assured for all the people in the world in 20 years.

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6. How long does it take to construct the underground structures for all humanity?

Underground structures can be built by using heavy mechanization, or at some point in the future (hopefully soon), as the deep underground concept proposes, by using newly developed mechanization with the price, technical complexity, and time required for the production of an average car. There are close to 100 million cars produced every year, so if we assume that all car production is replaced by equipment production, we will have about 100 million pieces of equipment available each year.

According to the deep underground concept, each piece of equipment can be expected to construct about 100 m^2 of type one and about 10 m^2 of type two of the underground construction every year.

Table 2 shows us how much space can be constructed each year with the available equipment for each type of underground construction.

Year	Available equipment	production of space type one u. construction	production of space type two u. construction
	million of pieces	millions of m2	millions of m2
1	0	0	0
2	100	3500	650
3	200	7000	1300
4	300	10500	1950
5	400	14000	2600
6	500	17500	3250
7	600	21000	3900
8	700	24500	4550
9	800	28000	5200
10	900	31500	5850
11	1000	35000	6500
12	1100	38500	7150
13	1200	42000	7800
14	1300	45500	8450
15	1400	49000	9100
16	1500	52500	9750
17	1600	56000	10400
18	1700	59500	11050
19	1800	63000	11700
20	1900	66500	12350
21	2000	70000	13000
22	2100	73500	13650
23	2200	77000	14300
24	2300	80500	14950
25	2400	84000	15600
26	2500	87500	16250
27	2600	91000	16900

28	2700	94500	17550
29	2800	98000	18200
30	2900	101500	18850
31	3000	105000	19500
32	3100	108500	20150
33	3200	112000	20800
34	3300	115500	21450
35	3400	119000	22100
36	3500	122500	22750
37	3600	126000	23400
38	3700	129500	24050
39	3800	133000	24700
40	3900	136500	25350
All together		**2730000**	**507000**

Table 2: Possible yearly production of space in underground construction

We need 250 m^2 for each person of type one underground construction and 50 m^2 for type two underground construction. For both, by sharing production capacities, this can be achieved in 40 years for every person, assuming that there will 10 billion people in the world someday.

7. Heat, energy, water

It's all available underground. We are already going subsurface to heat our homes. Energy can be produced underground too, by geothermal power plants, as is already done in many places. Water is available underground more and less everywhere.

Therefore, all of our needs can be fulfilled underground.

8. How to start such a project

It is better not to concentrate molehills in one area. It would be better to construct, say, 1 million different molehills that are each the size of a small town, with 10,000 habitants each. This way, work can start at the same time at all sites.

For the underground part, good geological conditions are required, so there should be less of those, but they would be bigger.

Therefore, the right way to do it would be to build several molehills in a neighborhood of a big underground facility. For example, a number of molehills would be constructed in valleys in between hills or mountains, and a huge underground facility inside those hills or mountains.

Where to construct und underground facility

9. Conclusion

To summarize, the results are rather interesting. If we decide today to put all our resources into play, we can ensure that in 40 years, there will be enough underground space for every person in this world to hide and have everything they might need if a disaster hits.

There are a lot of ifs in this paper, of course, but it shows that the task of bringing all humanity underground in a time of need is not a mission impossible nor a 1000-year project. So, Morgan Freeman, you should learn something from this.

Deep underground project
March 2021

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