APPENDIX 3- CENTRIFUGATION BASICS

The simplest example of a gear train has two gears. The "input gear" (also known as drive gear) transmits power to the "output gear" (also known as driven gear). The input gear will typically be connected to a power source, such as a motor or engine. In such an example, the power output of the output (driven) gear depends on the ratio of the dimensions of the two gears.

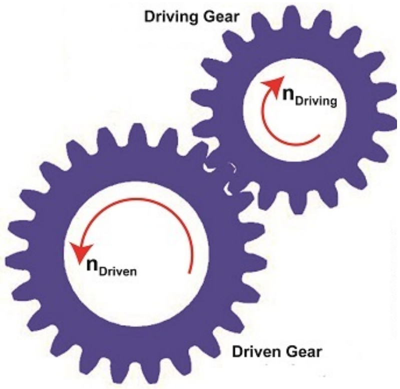

Figure 1. Simple gear train.
Source: http://www.engineeringexpert.net/Engineering-Expert-Witness-Blog/tag/driving-gear

The essential information required for designing a Gear box are as follows.

1. The lowest output rpm, n min
2. The highest output rpm, n max
3. The number of steps z into which the range between n max and n min is divided and
4. The number of stages in which the required number of speed steps are to be achieved.

Relative centrifuge force

To centrifuge the Windcrete towers precise centrifugation conditions will need to be computed, which must be specified in terms of relative centrifugal force (RCF) expressed in units of gravity (times gravity or x g). This is the force exerted on the contents of the mold, resulting from the revolutions of the rotor. Many centrifuge machines only have settings for rotational speed (revolutions per minute, RPM), not relative centrifugal force. Consequently, a formula for conversion is required to ensure that the appropriate RCF is applied on the concrete. The relationship between RPM and RCF is as follows:

$$RCF = (1.118 \times 10^{-5}) \text{ x } R \text{ x } RPM$$

Where RCF is the relative centrifugal force, in units of times gravity (x g)
R is the radius of the rotor in centimetres,
RPM is the speed of the centrifuge in revolutions per minute.

Note this formula is used for centrifugation machines from the fields of biochemistry, cellular and molecular biology. The validity of this formula for large-scale applications would need to be checked.

In the case of Windcrete, it would be necessary to compute the required centrifugal force based on the amount and type of concrete and the wall thickness. Then this centrifugal force could be translated in r.p.m and a train gear could be designed accordingly to provide the required rotational speed.

Alternatively, some specialized companies offer Nomograms to select the product that best suits the needs of the user (Figure 8). If the desired RCF is known, the speed of rotation for a given radius may be found by connecting the two known points and reading the Speed Scale at the intersection.

Note that these nomograms are readily available for commercial microcentrifuges used in clinical research laboratories and other small scale devices used in industrial applications.
No tabulated values for large scale centrifuging applications were found so the experience of centrifugal concrete pipes producers will be indispensable.

The torque (Nm) generated by the machine, the *required power* (W) used by the machine and the *bearing life of the machine* (million revolutions) will also be necessary parameters to design the centrifuging machine (Adedipe Oyewole, 2011). The amount of power and the bearing lifetime of the machine will help determine the feasibility of the proposal.

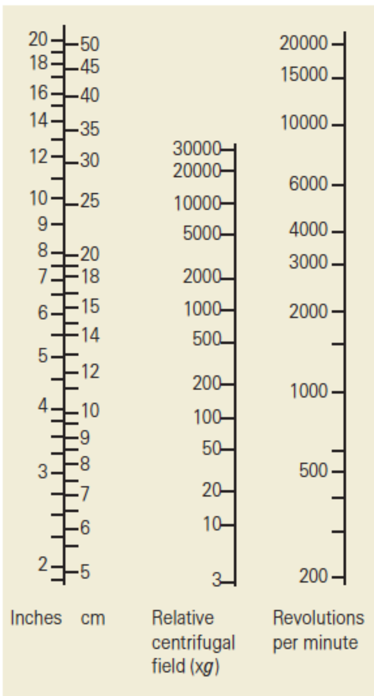

Figure 2 Nomogram used to convert r.p.m to relative centrifugal force (x g) and vice versa.
Source: (The Biomedical Scientist, 2013)

Centrifugation speed and time often are not critical factors. Usually, as long as speed and time are sufficient to ensure compacting of the concrete particles, it does not matter if the speed is faster or the time longer than necessary.

References

Adedipe Oyewole, A. M. S., 2011. Design and fabrication of a centrifugal casting machine. *International Journal of Engineering Science and Technology,* November, Vol. 3 (No.11), pp. 8205-8209.

The Biomedical Scientist, 2013. *Centrifugation: a guide to equipment use and maintenance,* s.l.: Biomedical Equipment Journal.