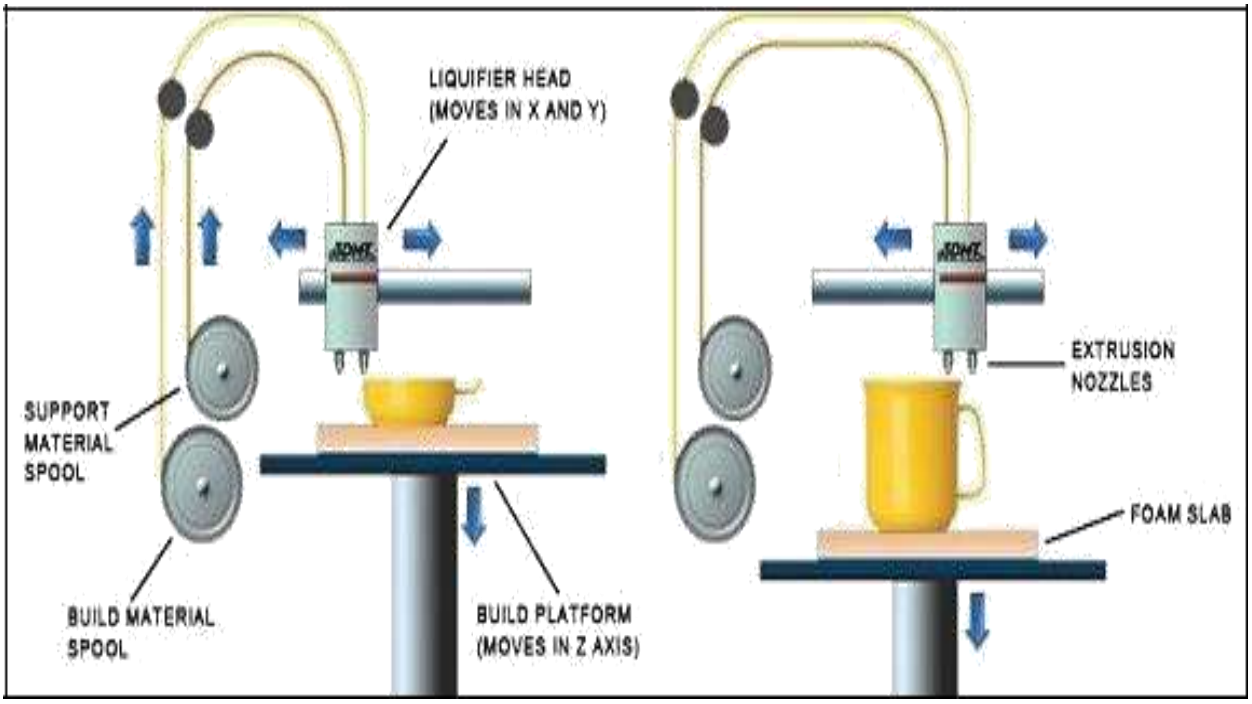

Fig 1.14: Fused Deposition Modelling for making tea cup shape product.

Table 1.4: FDM Material Properties

Material	Tensile Strength (Mpa)	Tensile Modulus (Mpa)	Flexural Strength (Mpa)	Flexural Modulus (Mpa)
ABDP	35.2	1535	66.9	2626
Medical Grade ABSP 500	38	2014	58.9	1810
Investment casting wax (ICWo6)	3.6	282	49.6	282
Elastometer	6.55	282	49.6	141

Advantages and Disadvantages

The main advantages of using FDM technology are as follows:

(1) *Fabrication of functional parts*. FDM process is able to fabricate prototypes with materials that are similar to that of the actual molded product. With ABS, it is able to fabricate fully functional parts that have 85% of the strength of the actual molded part. This is especially useful in developing products that require quick prototypes for functional testing.

(2) *Minimal wastage*. The FDM process build parts directly by extruding semi-liquid melt onto the model. Thus, only those material needed to build the part and its support are needed, and material wastages are kept to a minimum. There is also little need for cleaning up the model after it has been built.

(3) *Ease of support removal*. With the use of Break Away Support System (BASS) and Water Works Soluble Support System, support structures generated during the FDM building process can be easily broken off or simply washed away. This makes it very convenient for users to get to their prototypes very quickly and there is very little or no post-processing necessary.

(4) *Ease of material change*. Build materials, supplied in spool form (or cartridge form in the case of the Dimension or Prodigy Plus), are easy to handle and can be changed readily when the materials in the system are running low. This keeps the operation of the machine simple and the maintenance relatively easy.

The main disadvantages of using FDM technology are as follows:

(1) *Restricted accuracy*. Parts built with the FDM process usually have restricted accuracy due to the shape of the material used, i.e., the filament form. Typically, the filament used has a diameter of 1.27 mm and this tends to set a limit on how accurately the part can be built.

(2) *Slow process*. The building process is slow, as the whole cross-sectional area needs to be filled with building materials. Building speed is restricted by the extrusion rate or the flow rate of the build material from the extrusion head. As the build material used are plastics and their viscosities are relatively high, the build process cannot be easily speeded up.

(3) *Unpredictable shrinkage*. As the FDM process extrudes the build material from its extrusion head and cools them rapidly on deposition, stresses induced by such rapid cooling invariably are introduced into the model. As such, shrinkages and distortions caused to the model built are a common occurrence and are usually difficult to predict, though with experience, users may be able to compensate for these by adjusting the process parameters of the machine.

FDM Applications

FDM models can be used in the following general applications areas:

(1) *Models for conceptualization and presentation*. Models can be marked, sanded, painted and drilled and thus can be finished to be almost like the actual product.