projected to 118,000 tons. In addition to using asbestos in brake linings, cars equipped with automatic transmissions get their drive from metal transmission discs which are covered with a super-tough asbestos paper. The average vehicle contains 8-12 of these. Output of over 8 million automatic transmissions annually require asbestos disc paper production in hundreds of tons.

Materials

The average composition of a typical automotive brake lining incorporates asbestos, phenolic resin, cashew-nut shell, graphite products (to lower the friction coefficient or reduce noise), aluminas or silicas (to improve wear), and metal or metal oxides (improved performance). A typical formulation would incorporate the following:

Asbestos	55
Resins	28
Oxides	9
Metals	3
Carbon	5

Alternatives to Asbestos

Possible asbestos alternatives for friction materials include the following:

glass fiber	Overall strength is lower but strong enough for friction materials. At temperatures during braking operations glass fiber melts, even below the operating surface.
steel wool	Overall strength is lower and the cost is higher. In addition, the material hardness of steel wool damages the brake drums.
mineral wool	Overall strength is very low and brittle to the extent of limiting mixing processes.
carbon fiber	Main properties are good, but somewhat inferior to asbestos. A major consideration is cost, which is more than asbestos.
sintered metals and cermets	Presently used to manufacture brake linings for aircraft. Wear properties are not good enough for automotive applications and the cost is higher.

Asbestos Emissions

The major effect of braking appears to be in separating bunches of fibers and reducing their average length. Brake lining debris contains a high percentage of fiber shorter than 2 um, with a substantial portion shorter than .5 um. Asbestos remaining in the brake lining is converted by thermal or other physical processes into magnesium silicates or other re-crystallised magnesium silicate structures different from asbestos.