1. INTRODUCTION

Real life measurements show that the distribution in an ultrasonic field is Gaussian. This makes Gaussian beams attractive as useful elements in field representation. As a result of recent analytical developments, any source field can be expressed exactly as a self-consistent superposition of Gaussian beams. This extends the use of Gaussian beams systematically to realistic transducer outputs. Because Gaussian beams have favourable propagation characteristics and represent physically observable entities, they have played a prominent role in many modelling schemes. However, scattering from localised fault zones or abrupt terminations are not beam—preserving. As a result the output for many transducers (such as a flat piston) gives rise to side lobes and other marked deviations from a well collimated Gaussian beam. For modelling the non-Gaussian effects without losing the characteristics of Gaussian beam propagation, the decomposition of the field into basic functions is required.

In this paper, four theoretical approaches will be considered. All of them describe the spreading effects for a Gaussian distribution in an elastic isotropic liquid. Each of these models has its own characteristics for some specific cases. The aim of presenting these different approaches is the implementation of a toolbox of models, which can be useful to estimate the parameters of the CHW-model and the GBS-model by an inversion procedure. Comparison is made with experimental results.

2. GENERAL CHARACTERISTICS OF A PROPAGATING BOUNDED BEAM

We assume a transducer to be placed at \( z = 0 \) which emits a plane Gaussian acoustic wave, which propagates in the \( z \)-direction (see Fig. 1). The displacement field at \( z = 0 \) is given by (the factor \( e^{-i\omega t} \) which depends on the angular frequency \( \omega \), has been omitted):

\[
u(x, y, 0) = \frac{2}{\pi} \frac{1}{W_0} \left( \frac{x^2 + y^2}{W_0^2} \right),
\]

where \( W_0 \) is the initial halfwidth.

After propagation over a distance \( z \), the field can be written as:

\[
u(x, y, z) = \frac{2}{\pi} \frac{1}{W(z)} e^{-i(kz - \Psi(z))} e^{-\frac{1}{2} \left( \frac{x^2 + y^2}{R(z)^2} \right)} e^{-\frac{1}{2} \left( \frac{x^2 + y^2}{W(z)^2} \right)},
\]

where

\[R(z) = z + \frac{\pi W_0^2}{\lambda} \frac{1}{z};\]

\[W(z) = W_0 \sqrt{1 + \left( \frac{\pi W_0^2}{\lambda} \right)^2};\]

and

\[\Psi(z) = \arctan \left( \frac{\lambda}{\pi W_0^2} \right).\]